

Curriculum Booklet
Integrated Teacher Education Program (ITEP)
4-year Integrated BSc-BEd Program (Secondary Stage)
With Major in Mathematics/Physics/Chemistry

<https://www.iitj.ac.in/itep>



Indian Institute of Technology Jodhpur

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I. OVERVIEW OF THE CURRICULUM STRUCTURE

1. Introduction

India boasts a large youthful population, contributing to a demographic dividend. However, for this demographic advantage to translate into economic growth, there must be a corresponding investment in quality education. Teachers play a pivotal role in developing the human capital needed to maximize the potential of the young workforce. They shape the skills, knowledge, and attitudes of students, preparing them for the challenges of the modern workforce, especially in the area of science & technology. Such education is intrinsically linked to productivity and innovation. Teachers of a high professional calibre contribute to enhancing the learning experience, fostering critical thinking, problem-solving skills, and creativity among students, which are essential for economic advancement in the twenty-first century.

Therefore, the NEP 2020 mandates that HEIs like IITs also should offer programmes in teacher education. The policy document notes that, *“The 4-year integrated B.Ed. offered by such multidisciplinary HEIs will, by 2030, become the minimal degree qualification for school teachers. The 4-year integrated B.Ed. will be a dual-major holistic bachelor's degree, in Education as well as a specialized subject such as a language, history, music, mathematics, computer science, chemistry, economics, art, physical education, etc. Beyond the teaching of cutting-edge pedagogy, the teacher education will include grounding in sociology, history, science, psychology, early childhood care and education, foundational literacy and numeracy, knowledge of India and its values/ethos/art/traditions, and more”* [Para 15.5, NEP 2020].

The significance of the proposed four-year Integrated Teacher Education Programme (ITEP) gains greater weight with the reconfiguration of the curricular and pedagogical structure of school education involving a 5 + 3 + 3 + 4 design as recommended by NEP 2020. As a policy measure, ITEP seeks to develop accomplished teachers who have the knowledge, capacities, and values and dispositions required for developing and improving the practice of teaching at a particular Stage of school education, i.e. Foundational Stage (Preschool to grade 2) or Preparatory Stage (grade 3-5) or Middle Stage (grade 6-8) or Secondary Stage (grade 9-12).

2. ITEP at IIT Jodhpur

1. The **Integrated Teacher Education Programme (ITEP)**, as envisioned by the National Education Policy, 2020, offers a unique opportunity for the IIT ecosystem as a whole to directly contribute to shaping the next generation of leaders.
2. The **Secondary Stage (classes IX to XII)**, which represents a critical point of transition between school and higher education, deserves special attention in the Indian context. The significant challenges at this stage include the issue of retaining students in the school system, streaming them according to their innate potential and interests, and preparing them to acquire the necessary technological and discipline specific exposure for future academic and career choices.
3. The pedagogical ideals at the heart of the **Guru-Shishya parampara** are an important resource which can revitalize teacher education in India. This is acknowledged by the NEP 2020 as well as the guidelines of the National Council of Teacher Education (NCTE). However, there is more scope for focusing on the aspects of this pedagogical relationship between the *guru* and the *shishya*, which enables the student to cultivate lifelong learning practices that lead to self knowledge. Importantly, greater attention can be devoted at the institutional level to how one can translate this ideal into

concrete and actionable curricular goals as well as pedagogical practices suitable for a just, equitable and inclusive Bharat.

4. While the ITEP is a progressive and holistic preparation for teacher education, the NCTE guidelines also envision **institutional freedom and innovation** in designing and implementing the BSc Components as well as the pedagogy of the BEd portions of the curriculum envisioned by NCTE offers an important opportunity to interpret and develop a truly innovative dual degree teacher education programme that serve as a **model for other Institutes of technology as well as Higher Education Institutions**.
5. The Jodhpur model of Teacher Education envisions **the all-round development of the Graduate Teacher for the Secondary Stage** who will have (i) strong technological, pedagogical and content knowledge (ii) motivation for self-improvement and self-organization (iii) commitment to constitutional values and fundamental duties (iv) strong ethics and values (v) passion and drive for innovation in teaching (vi) effective communication skills (vii) dedication to lifelong learning, and (viii) empathy for students and commitment to their well-being.
6. In addition to the NCTE guidelines, **the Curriculum for the BSc-BEd programme** must be **research-based**, drawing on the state of the art research in education as well as education technology, lessons from innovative and contemporary best practices in teacher education and pedagogical practices inspired by the rich philosophical and cultural traditions of our country. The Curriculum should foster nation-building, justice and inclusivity.
7. The **Pedagogy of the BSc-BEd** must build a strong foundation for learning, with a focus on (i) strong disciplinary knowledge, (ii) technology integration, (iii) learning opportunities for making connections between the local, national and global levels, (iv) exemplary commitment to equality, equity, inclusivity and social justice in every interaction with students, and (v) upholding the best of our nation's values and cultural traditions, for this present period.

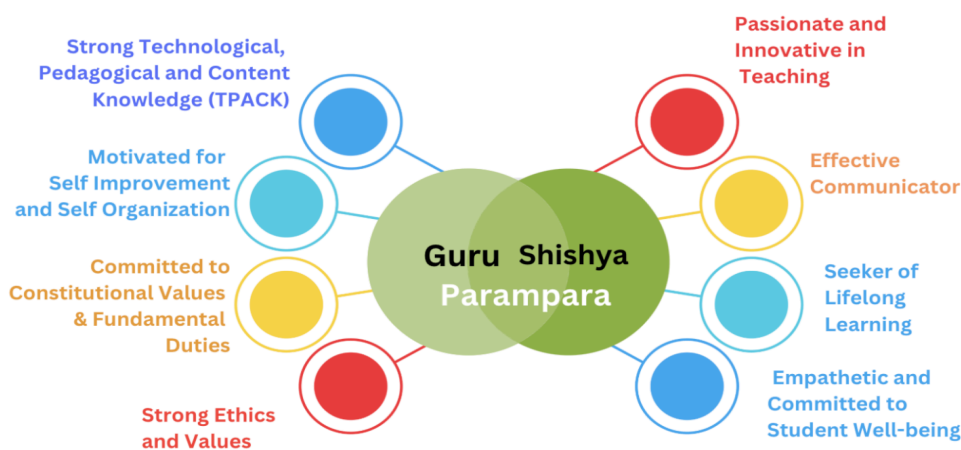


Fig 1: Proposed Jodhpur Model of Teacher Education: Vision of the all-round development of a Graduate Teacher for the Secondary Stage

8. **The USP of the Jodhpur model** in terms of curriculum enhancement and pedagogical innovation will have the following aspects:
 - a. **The design and content of the Science Courses**, designed keeping in mind the multiple exit options in this program as well as the need to prepare interested students to pursue further studies in their chosen Science Major.
 - b. **A focus on Education Technology** spread over the last four semesters of the program, so that students will be able to apply the theoretical insights they have gained.
 - c. **A model for local engagement** which will demonstrate how the knowledge, practices and traditions of local communities can be used by the students in their future development of lesson plans and content which engage children, etc.
 - d. **Diversity of school exposure experiences** will be provided to the students in addition to the school practicum component, beginning from their first year.
9. The BSc-BEd programme (with a Major in Physics/Chemistry/Mathematics) has been offered at IIT Jodhpur from the Academic Year 2024-2025. The selection of students into the programme is presently based on their scores in the National Common Entrance Test (NCET), in addition to them meeting the eligibility criteria defined by the Institute's admission guidelines.
10. Six Academic Units jointly contribute to the teaching of the Integrated Teacher Education Programme: The Center for Education Technology (Overall Anchoring and Coordination), the Department of Mathematics, the Department of Physics, the Department of Chemistry, the School of Liberal Arts, the School of Management and Entrepreneurship and the School of Design.

3. Program Objectives

To ensure that future educators are equipped with the skills, especially in the area of science, technology, and pedagogy, which are required to adapt to evolving educational needs, the objectives of the ITEP program are:

1. Developing necessary competencies in graduates for teaching at the secondary stage of school education (classes 9 to 12) (as envisioned by NEP and [NCTE Curriculum Framework, p.18](#))
2. Capacity building in the area of Science & Technology Education in India
3. Developing pedagogical skills among teachers in India
4. Enabling technology integration in the classroom for future learners of India
5. Building connection with the society and inculcate the required communication skills

4. Expected Graduate Attributes

After completing this programme, the graduate will have:

1. a deep understanding of educational theories and principles, suitable for teaching at the secondary stage of school education (classes 9 to 12) (as envisioned in NEP and [NCTE Curriculum Framework, p.18](#))
2. the ability to demonstrate attributes specific to teaching in Grades (9-10) and Grades (11-12)
3. a comprehensive knowledge of the subject to be taught
4. skillset to integrate technology into teaching to enhance learning experiences
5. an understanding of various forms of assessments to measure student progress
6. a commitment to continuous professional development

- a commitment to build positive connections with the surrounding society through their teaching practice and model this to their future students by example.

5. Program Outcomes

After completing this program, the students will be able to:

- demonstrate a deep understanding of educational theories and principles as required for the Secondary Stage Specialization.
- demonstrate comprehensive knowledge of the subject to be taught, in order to teach at the Secondary Stage.
- integrate technology into teaching to enhance learning experiences.
- apply various forms of assessments to measure student progress.
- engage in continuous professional development to cater to the needs of the learners.
- build valuable connections with society through their teaching practice and inculcate a sense of social responsibility in learners.

6. Credit Structure

To bring parity with other programs in the Institute, the equivalent credit structure of the proposed ITEP program is as shown in Table 01.

Table 01: Credit Structure of the Programme

Source Of Course Criterion	Course Component	Total Credits	Course Category*	Credits Per category	Year 1		Year 2		Year 3		Year 4	
					S1	S2	S3	S4	S5	S6	S7	S8
NCTE Curriculum Framework	An induction programme at the start of each semester	Non Graded										
	Foundations in Education	31	PC	28	03	-	04	04	-	04	06	07
			OE	03	-	-	-	-	-	-	03	
	Science Major	72	SC	48	12	12	12	12	-	-	-	-
			SE	24	-	-	-	-	12	12	-	-
	Ability Enhancement & Value-Added courses	28	PC	28	07	07	02	-	03	-	04	05
Stage-specific content -cum- pedagogy	16	PC	16	-	-	04	04	04	04	-	-	

	School Experience	22	PC	22	-	-	-	-	03	02	12	05
	Community Service	02	NG	02	-	-	-	-	-	-	-	02
IITJ Recommended	Design & Computational Thinking	03	PC	03	-	03	-	-	-	-	-	-
	Design Credit Project	02	NG	02	-	-	-	02	-	-	-	-
Total Credits		176		176	22	22	22	22	22	22	22	22

*Course Category: PC (Programme Core), PE (Programme Elective), SC (Specialization Core), SE (Specialization Elective), OE (Open Elective), NG (Non-Graded)

7. Nomenclature of Degrees at Different Exit Points in the Programme

As per NEP 2020 and NCTE guidelines on multiple points of exit within the ITEP, Table 02 contains the nomenclature of the degrees which will be given at different exit points, as approved in the 43rd Meeting of the Senate of IIT Jodhpur.

Table 02: Exit Degrees

Year & Semester		Proposed Division of Credits	Science Credits	Education Credit	Exit Option
Year 1	Semester 1	22	12	10	
	Semester 2	22	12	10	
Total Credits		44	24	20	Certificate in the Natural Sciences
Year 2	Semester 3	22	12	10	
	Semester 4	22	12	10	
Total Credits		88	48	40	Diploma in Science Education at the Secondary Stage
Year 3	Semester 5	22	12	10	
	Semester 6	22	12	10	
Total Credits		132	72	60	BSc (Mathematics/ Physics/ Chemistry) & Diploma in Science Education at the Secondary Stage

Year 4	Semester 7	22	0	22	
	Semester 8	22	0	22	
TOTAL CREDITS		176	72	104	BSc-BEd (Secondary Stage) with Major in Mathematics/Physics/Chemistry

8. The Programme Structure for Each Major

In the following tables, the programme structure of each major is described in detail.

8.1. Major in Mathematics

A student enrolled in the ITEP program with Mathematics Major will undertake following semester wise courses. The first-year courses will be common across all majors. The Department of Mathematics will offer two courses of 4 credits each in Semesters I and II. In Semesters III and IV, a student must do all the compulsory courses (12 credits each in Semester III and IV). In Semesters V and VI, all mathematics major students must take three courses of 4 credits each to earn 12 credits in each semester.

Table 8.1.1. Courses and Credit Distribution for BSc-BEd (Secondary Stage) with a Major in Mathematics

(CAT - Category; LTP - Lecture-Tutorial-Practical; C - Credits, PC - Programme Core; PE - Programme Elective; SC - Specialization Core; SE - Specialization Elective; OE - Open Elective)

SEMESTER 1 (MATHS MAJOR)				SEMESTER 2 (MATHS MAJOR)			
Cat	Course	LTP	C	Cat	Course	LTP	C
SC	General Physics-1	3-1-0	4	SC	General Physics-II	3-0-2	4
SC	Mathematics-1	3-1-0	4	SC	Mathematics-2	3-1-0	4
SC	General Chemistry-1	3-0-2	4	SC	General Chemistry-II	3-0-2	4
PC	Evolution of Indian Education	3-0-0	3	PC	Design and Computational Thinking	1-0-4	3
PC	Language-1 Hindi	3-0-0	3	PC	Language-2 English	3-0-0	3
PC	Understanding India: Indian Ethos and Knowledge Systems-1	2-0-0	2	PC	Understanding India: Indian Ethos and Knowledge Systems-2	2-0-0	2
PE	(1) Art Education: Elements of Theatre	1-0-2	2	PC	Teacher and Society	2-0-0	2

	Making (2) Art Education: Methods & Materials of Visual Arts						
TOTAL			22	TOTAL			22

SEMESTER 3 (MATHS MAJOR)				SEMESTER 4 (MATHS MAJOR)			
Cat	Course	LTP	C	Cat	Course	LTP	C
SC	Real Analysis	3-1-0	4	SC	Groups and Rings	3-1-0	4
SC	Linear Algebra	3-1-0	4	SC	Multivariable Calculus	3-1-0	4
SC	Probability Theory	3-1-0	4	SC	Differential Equations	3-1-0	4
PC	Basics of Pedagogy at the Secondary Stage	3-0-2	4	PC	Content-cum-pedagogy of Mathematics at the Secondary Stage-1	1-0-2	2
PC	Child Development and Education Psychology	3-0-2	4	PC	Content-cum-pedagogy of the Physical Sciences at the Secondary Stage-1	1-0-2	2
PC	Mathematical and Quantitative Reasoning	2-0-0	2	PC	Philosophical and Sociological Perspectives on Education-1	3-0-2	4
				NG	Design Credit	-	2
TOTAL			22	TOTAL			22

SEMESTER 5 (MATHS MAJOR)				SEMESTER 6 (MATHS MAJOR)			
Cat	Course	LTP	C	Cat	Course	LTP	C
SE	Specialization Elective-1*	-	4	SE	Specialization Elective-4*	-	4
SE	Specialization Elective-2*	-	4	SE	Specialization Elective-5*	-	4
SE	Specialization Elective-3*	-	4	SE	Specialization Elective-6*	-	4

PC	Content-cum-Pedagogy of Mathematics at the Secondary Stage-2	1-0-2	2	PC	Content-cum-Pedagogy of Mathematics at the Secondary Stage-3	1-0-2	2
PC	Content-cum-Pedagogy of the Physical Sciences at the Secondary Stage-2	1-0-2	2	PC	Content-cum-Pedagogy of the Physical Sciences at the Secondary Stage-3	1-0-2	2
PC	ICT in Education	2-0-2	3	PC	School Observation	1-0-2	2
PC	Pre-Internship Practice	1-0-4	3	PC	Assessment and Evaluation	2-0-0	2
				PC	Inclusive Education	2-0-0	2
TOTAL			22	TOTAL			22

* *List of Specialization Electives for Semester 5 & 6 (Table 8.1.2)*

SEMESTER 7 (MATHS MAJOR)				SEMESTER 8 (MATHS MAJOR)			
Cat	Course	LTP	C	Cat	Course	LTP	C
PC	Perspectives on School Leadership and Management	3-0-0	3	PC	Philosophical and Sociological Perspectives on Education-II	3-0-2	4
PC	Curriculum Planning and Development for the Secondary Stage	3-0-0	3	PC	Education Policy Analysis	3-0-0	3
PC	Sports and Fitness Education	1-0-2	2	PC	Yoga and Understanding the Self	1-0-2	2
PC	Internship in Teaching	-	10	PC	Citizenship Education, Sustainability and Environment Education	3-0-0	3
PC	School-based Research Project	-	2	PC	Post-Internship Review and Analysis	0-0-4	2
PE	Elective related to Art Education*	1-0-2	2	PC	Creating Teaching Learning Material (TLM)	2-0-2	3
				NG	Community	-	2

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					Engagement and Service		
				OE	Open Elective (Related to Education)	-	3
	TOTAL		22		TOTAL		22

* [List of Elective Courses for Art Education \(Table 8.1.3\)](#)

Table 8.1.2. List of Specialization Elective Courses for Semester 5 and Semester 6 for Maths Major Students

SNo	Course Name	Credit Structure (L-T-P)	Credit
1	Complex Analysis	3-1-0	4
2	Statistics	3-1-0	4
3	Introduction to Programming	2-0-4	4
4	Operations Research	3-0-2	4
5	Numerical Computations	3-0-2	4
6	Field Theory	3-1-0	4
7	Graph Theory	3-1-0	4
8	Elementary Number Theory	3-1-0	4
9	Integral Transforms and Applications	3-1-0	4
10	Introduction to Combinatorics	3-1-0	4

Table 8.1.3. List of Programme Electives for Art Education

SNo	Course Name	Credit Structure (L-T-P)	Credits
1	Music and Technology: Bridging Art & Innovation	1-0-2	2
2	Theatre in Education and Care	1-0-2	2
3	Mixed Media Art	1-0-2	2
4	Handmade Papermaking	1-0-2	2
5	Learning to Weave	1-0-2	2
6	Basics of Pottery	1-0-2	2

7	Material manifestations:Mural and casting	1-0-2	2
8	Film making	1-0-2	2
9	Interactive Art	1-0-2	2

8.2. Major in Physics

A student enrolled in the ITEP program with Physics Major will undertake the semester wise courses as detailed in Table 8.2.1. The first year courses will be common across all majors. The Department of Physics will offer two courses of 4 credits each in Semesters I and II. In Semesters III and IV, a student must do all the compulsory courses (12 credits each in Semesters III and IV. In Semesters V and VI, students must complete 12 credits of program electives, from among the specialization electives offered by the Department of Physics in each semester.

Table 8.2.1. Courses and Credit Distribution for BSc-BEd (Secondary Stage) with a Major in Physics

(CAT - Category; LTP - Lecture-Tutorial-Practical; C - Credits, PC - Programme Core; PE - Programme Elective; SC - Specialization Core; SE - Specialization Elective; OE - Open Elective)

SEMESTER 1 (PHYSICS MAJOR)				SEMESTER 2 (PHYSICS MAJOR)			
Cat	Course	LTP	C	Cat	Course	LTP	C
SC	General Physics-I	3-1-0	4	SC	General Physics-II	3-0-2	4
SC	Mathematics-I	3-1-0	4	SC	Mathematics-II	3-1-0	4
SC	General Chemistry-I	3-0-2	4	SC	General Chemistry-II	3-0-2	4
PC	Evolution of Indian Education	3-0-0	3	PC	Design and Computational Thinking	1-0-4	3
PC	Language-1 Hindi	3-0-0	3	PC	Language-2 English	3-0-0	3
PC	Understanding India: Indian Ethos and Knowledge Systems-1	2-0-0	2	PC	Understanding India: Indian Ethos and Knowledge Systems-2	2-0-0	2
PE	(1) Art Education: Elements of Theatre Making (2) Art Education: Methods & Materials of Visual Arts	1-0-2	2	PC	Teacher and Society	2-0-0	2
TOTAL			22	TOTAL			22

SEMESTER 3 (PHYSICS MAJOR)				SEMESTER 4 (PHYSICS MAJOR)			
Cat	Course	LTP	C	Cat	Course	LTP	C
SC	Fundamentals of Thermodynamics	3-0-0	3	SC	Electromagnetic Theory	3-1-0	4
SC	Fundamentals of Optics	3-0-0	3	SC	Foundations of Quantum and Modern Physics	3-1-0	4
SC	Mathematical Methods in Physics	3-0-0	3	SC	Differential Equations	3-1-0	4
SC	Physics Lab-I	0-0-6	3				

PC	Basics of Pedagogy at the Secondary Stage	3-0-2	4	PC	Content-cum-pedagogy of Mathematics at the Secondary Stage-1	1-0-2	2
PC	Child Development and Education Psychology	3-0-2	4	PC	Content-cum-pedagogy of the Physical Sciences at the Secondary Stage-1	1-0-2	2
PC	Mathematical and Quantitative Reasoning	2-0-0	2	PC	Philosophical and Sociological Perspectives on Education-1	3-0-2	4
				NG	Design Credit	-	2
TOTAL			22	TOTAL			22

SEMESTER 5 (PHYSICS MAJOR)				SEMESTER 6 (PHYSICS MAJOR)			
Cat	Course	LTP	C	Cat	Course	LTP	C
SE	Specialization Elective-1*	-	3	SE	Specialization Elective-5*	-	3
SE	Specialization Elective-2*	-	3	SE	Specialization Elective-6*	-	3
SE	Specialization Elective-3*	-	3	SE	Specialization Elective-7*	-	3
SE	Specialization Elective-4*	-	3	SE	Specialization Elective-8*	-	3
PC	Content-cum-Pedagogy of Mathematics at the Secondary Stage-2	1-0-2	2	PC	Content-cum-Pedagogy of Mathematics at the Secondary Stage-3	1-0-2	2
PC	Content-cum-Pedagogy of the Physical Sciences at the Secondary Stage-2	1-0-2	2	PC	Content-cum-Pedagogy of the Physical Sciences at the Secondary Stage-3	1-0-2	2
PC	ICT in Education	2-0-2	3	PC	School Observation	1-0-2	2

PC	Pre-Internship Practice	1-0-4	3	PC	Assessment and Evaluation	2-0-0	2
				PC	Inclusive Education	2-0-0	2
TOTAL			22	TOTAL			22

*From the list of specialization electives listed in Table 8.2.2

SEMESTER 7 (PHYSICS MAJOR)				SEMESTER 8 (PHYSICS MAJOR)			
Cat	Course	LTP	C	Cat	Course	LTP	C
PC	Perspectives on School Leadership and Management	3-0-0	3	PC	Philosophical and Sociological Perspectives on Education-II	3-0-2	4
PC	Curriculum Planning and Development for the Secondary Stage	3-0-0	3	PC	Education Policy Analysis	3-0-0	3
PC	Sports and Fitness Education	1-0-2	2	PC	Yoga and Understanding the Self	1-0-2	2
PC	Internship in Teaching	-	10	PC	Citizenship Education, Sustainability and Environment Education	3-0-0	3
PC	School-based Research Project	-	2	PC	Post-Internship Review and Analysis	0-0-4	2
PE	Elective related to Art Education**	1-0-2	2	PC	Creating Teaching Learning Material (TLM)	2-0-2	3
				NG	Community Engagement and Service		2
				OE	Open Elective (Related to Education)		3
TOTAL			22	TOTAL			22

** [List of Elective Courses for Art Education \(Table 8.1.3\)](#)

Table 8.2.2. List of Specialization Elective Courses for Semester 5 and Semester 6 for Physics Major Students

SNo	Course Name	Credit Structure (L-T-P)	Credit
1	Electronics I	3-0-0	3
2	Solid State Physics	3-0-0	3
3	Modern Optics	3-0-0	3
4	Introduction to Plasma Physics	3-0-0	3
5	Foundations of Nuclear and Particle Physics	3-0-0	3
6	Introduction to Materials Characterization	3-0-0	3
7	Numerical Computations	3-1-0	4
8	Electronics II	3-0-0	3
9	Physics Lab II	0-0-6	3
10	Physics Project	0-0-3	3

8.3. Major in Chemistry

A student enrolled in the ITEP program with a Chemistry Major will undertake following semester wise courses as described in Table 8.3.1. The first year courses will be common across all majors. The Department of Chemistry will offer two courses of 4 credits each in Semester I and II. In Semester III and IV, a student must do all the compulsory courses (12 credits each in Semester III and IV). In Semester V and VI, a student must do 12 credits of programme electives each, from among the elective courses offered by the Department of Chemistry.

Table 8.3.1. Courses and Credit Distribution for BSc-BEd (Secondary Stage) with a Major in Chemistry

(CAT - Category; LTP - Lecture-Tutorial-Practical; C - Credits, PC - Programme Core; PE - Programme Elective; SC - Specialization Core; SE - Specialization Elective; OE - Open Elective)

SEMESTER 1 (CHEMISTRY MAJOR)				SEMESTER 2 (CHEMISTRY MAJOR)			
Cat	Course	LTP	C	Cat	Course	LTP	C
SC	General Physics-I	3-1-0	4	SC	General Physics-II	3-0-2	4
SC	Mathematics-II	3-1-0	4	SC	Mathematics-II	3-1-0	4
SC	General Chemistry-I	3-0-2	4	SC	General Chemistry-II	3-0-2	4
PC	Evolution of Indian Education	3-0-0	3	PC	Design and Computational	1-0-4	3

					Thinking		
PC	Language-1 Hindi	3-0-0	3	PC	Language-2 English	3-0-0	3
PC	Understanding India: Indian Ethos and Knowledge Systems-1	2-0-0	2	PC	Understanding India: Indian Ethos and Knowledge Systems-2	2-0-0	2
PE	(1) Art Education: Elements of Theatre Making (2) Art Education: Methods & Materials of Visual Arts	1-0-2	2	PC	Teacher and Society	2-0-0	2
	TOTAL		22		TOTAL		22

SEMESTER 3 (CHEMISTRY MAJOR)				SEMESTER 4 (CHEMISTRY MAJOR)			
Cat	Course	LTP	C	Cat	Course	LTP	C
SC	Basic Principles of Chemistry	3-0-2	4	SC	Chemistry of Inorganic Compounds	3-0-2	4
SC	Molecular Structure and Spectroscopy	3-0-2	4	SC	Equilibrium Thermodynamics	3-0-2	4
SC	Linear Algebra	3-1-0	4	SC	Separation and Elucidation of Organic Compounds	3-0-2	4
PC	Basics of Pedagogy at the Secondary Stage	3-0-2	4	PC	Content-cum-pedagogy of Mathematics at the Secondary Stage-1	1-0-2	2
PC	Child Development and Education Psychology	3-0-2	4	PC	Content-cum-Pedagogy of the Physical Sciences at the Secondary Stage-1	1-0-2	2
PC	Mathematical and Quantitative Reasoning	2-0-0	2	PC	Philosophical and Sociological Perspectives on Education-1	3-0-2	4
				NG	Design Credit	-	2
	TOTAL		22		TOTAL		22

SEMESTER 5 (CHEMISTRY MAJOR)				SEMESTER 6 (CHEMISTRY MAJOR)			
Cat	Course	LTP	C	Cat	Course	LTP	C
SE	Specialization Elective-1*	-	3	SE	Specialization Elective-5*	-	3
SE	Specialization Elective-2*	-	3	SE	Specialization Elective-6*	-	3
SE	Specialization Elective-3*	-	3	SE	Specialization Elective-7*	-	3
SE	Specialized Project-1	0-0-6	3	SE	Specialized Project-2	0-0-6	3
PC	Content-cum-Pedagogy of Mathematics at the Secondary Stage-2	1-0-2	2	PC	Content-cum-Pedagogy of Mathematics at the Secondary Stage-3	1-0-2	2
PC	Content-cum-Pedagogy of the Physical Sciences at the Secondary Stage-2	1-0-2	2	PC	Content-cum-Pedagogy of the Physical Sciences at the Secondary Stage-3	1-0-2	2
PC	ICT in Education	2-0-2	3	PC	School Observation	1-0-2	2
PC	Pre-Internship Practice	1-0-4	3	PC	Assessment and Evaluation	2-0-0	2
				PC	Inclusive Education	2-0-0	2
TOTAL			22	TOTAL			22

*From the list of specialization electives listed in Table 8.3.2

SEMESTER 7 (CHEMISTRY MAJOR)				SEMESTER 8 (CHEMISTRY MAJOR)			
Cat	Course	LTP	C	Cat	Course	LTP	C
PC	Perspectives on School Leadership and Management	3-0-0	3	PC	Philosophical and Sociological Perspectives on Education-II	3-0-2	4

PC	Curriculum Planning and Development for the Secondary Stage	3-0-0	3	PC	Education Policy Analysis	3-0-0	3
PC	Sports and Fitness Education	1-0-2	2	PC	Yoga and Understanding the Self	1-0-2	2
PC	Internship in Teaching	-	10	PC	Citizenship Education, Sustainability and Environment Education	3-0-0	3
PC	School-based Research Project	-	2	PC	Post-Internship Review and Analysis	0-0-4	2
PE	Elective related to Art Education**	1-0-2	2	PC	Creating Teaching Learning Material (TLM)	2-0-2	3
				NG	Community Engagement and Service		2
				OE	Open Elective (Related to Education)		3
TOTAL			22	TOTAL			22

** [List of Elective Courses for Art Education \(Table 8.1.3\)](#)

Table 8.3.2. List of Specialization Elective Courses for Semester 5 and Semester 6 for Chemistry Major Students

SNo	Course Name	Credit Structure (L-T-P)	Credit
1	CYL3XX0 Organic Reactions and Mechanisms	3-0-0	3
2	CYL3XX0 Main Group and BioInorganic Chemistry	3-0-0	3
3	CYL3XX0 Physical Organic Chemistry	3-0-0	3
4	CYL3XX0 Quantum Chemistry and Applications	3-0-0	3
5	CYL3XX0 Coordination and Organometallic Chemistry	3-0-0	3
6	CYL3XX0 Numerical Methods and Group Theory	3-0-0	3
7	CYL3XXX Organic Synthesis	3-0-0	3
8	CYL3XXX Industrial Catalysis	3-0-0	3
9	CYL3XXX Heterocyclic Compounds and Applications	3-0-0	3
10	CYL3XX0 Principles of Spectroscopy	3-0-0	3

11	CYL3XXX Statistical Thermodynamics	3-0-0	3
12	CYL3XX0 Solid State and Material Chemistry	3-0-0	3
13	Specialized Project-1 (Sem 5)	0-0-3	3
14	Specialized Project-2 (Sem 6)	0-0-3	3

II. MAJOR-WISE COURSE CONTENT

1. Courses In Mathematics

Title	Mathematics-I	Course No.	MAL1XXX
Department	Mathematics	L-T-P [C]	3-1-0 [4]
Offered for	BSc-BEd	Type	Core
Prerequisites	None		

Objectives

1. To train the student in the area of geometry and calculus.
2. To give sufficient knowledge of the subject which can be used by students for further applications in their respective domains of interest.

Learning Outcomes

1. Understanding of basic operations of sets, relations, and functions.
2. Understanding of conics and conicoid.
3. Understanding of ϵ - δ definitions of limit, continuity and differentiability of a function.

Contents

Review of Set Theory [3 Lectures]: Sets and Set operations, Finite and infinite sets, Power set, Cartesian Product of sets, Partition of a set, Algebra of sets, Cardinality of a set, Principle of Inclusion-Exclusion, Countable and uncountable sets.

Relations [3 Lectures]: Relations, total number of relations, Equivalence relation, Equivalence classes and partitions, Partial order relation, Poset, Linear order relation.

Functions [3 Lectures]: Functions, Injective, Surjective, and Invertible functions, composition of functions, relation between composition of functions and various set theoretic operations.

Two Dimensional Geometry [6 Lectures]: Review of Conic Sections in 2D, General equation of conic, Tangent, Normal, Chord of contact, Diameter, Special properties of Parabola, Ellipse and Hyperbola.

Three Dimensional Geometry [9 Lectures]: Review of lines and planes in 3D, Change of axes, Shift of origin, Rotation of axes, Sphere, Section of a sphere by a plane, Sphere through a given circle. Intersection of a line and sphere, tangent line, tangent plane, Angle of intersection of two spheres and condition of orthogonality, Equations of ellipsoid, hyperboloid, paraboloid in the standard form, Tangent plane, and Normal.

Polar Coordinates [3 Lectures]: Polar equations of straight line, circle and conics. Polar equation of Chord of contact, Tangent, and Normal.

Limits and Continuity [6 Lectures]: Rate of changes and Limits, Epsilon-Delta definition of the limit of a function, Basic properties of limits, Continuous functions and classification of discontinuities.

Differentiation and Integration [6 Lectures]: Differentiability, Differentiation Rules, Chain Rule, Applications of Derivatives, Integration of a function, Indefinite Integrals, Riemann Sums and Definite Integrals.

Textbooks

1. Singh, S. and Zameeruddin, Q., Modern Algebra, Ninth Edition, Vikas Publishing House.
2. Thomas, G. B., Finney, R. L., Calculus and Analytic Geometry, Ninth Edition, Addison Wesley, 1998.

Reference Books

1. Daniel W. Cunningham, Set Theory: A First Course, Cambridge University Press, 2016

2. Chatterjee, D. , Analytical Geometry: Two and Three Dimensions, Alpha Science International Limited, 2009
3. Spivak, M., Calculus, Third Edition, Cambridge University Press, 1994.

Online Course Material

1. Kubar, A., Set Theory and Mathematical Logic, NPTEL Course Material, Department of Mathematics, IIT Kanpur.
2. Singh, A., Basic Calculus-I, NPTEL Course Material, Department of Mathematics, IIT Madras.
<https://archive.nptel.ac.in/courses/111/106/111106146/>

Title	Mathematics-II	Course No.	MAL1XXX
Department	Mathematics	L-T-P [C]	3-1-0 [4]
Offered for	BSc-BEd	Type	Core
Prerequisite	None		

Objectives

1. To train the student in the area of matrix theory, theory of equations, infinite series, complex numbers.
2. To give sufficient knowledge of the subject which can be used by student for further applications in their respective domains of interest.

Learning Outcomes

1. Consistency and solution of systems of linear equations.
2. Determinants, eigen-values, eigenvectors of a matrix.
3. Number of roots of an equation, Descartes' rule of signs.
4. Convergence and divergence of a series.

Contents

Matrix Algebra and Determinants [12 Lectures]: Systems of linear equations, matrices, elementary row operations, Gauss elimination method, row-reduced matrices, row-reduced echelon matrices, row-rank, consistency and solution of systems of linear equations using matrix. Determinants, eigen-values, eigenvectors, and the characteristic equation of a matrix, statement of Cayley-Hamilton theorem and its use in finding the inverse of a matrix.

Theory of Equations [12 Lectures]: Quadratic Equations and its solutions, Polynomials in one variable and the division algorithm, graphical representation, Binomial Theorem, relations between the roots and the coefficients, real roots, imaginary roots, number of roots of equation, Descartes' rule of signs, approximate solutions of polynomials.

Sequences and Series [15 Lectures]: Limits of sequences of numbers, Bounded and monotonic sequences, Cauchy's convergence criterion, Infinite series of non-negative terms, tests for convergence, alternating series, absolute and conditional convergence, Power series, Taylor and Maclaurin Series, convergence of Taylor Series, error estimates, applications of power series.

Textbooks

1. Bhattacharya, P. B., Jain, S. K. , and Nagpaul, S. R., First Course in Linear Algebra, New Age International Private Limited Publishers, 2015.
2. Thomas, G. B., Finney, R. L., Calculus and Analytic Geometry, Ninth Edition, Addison Wesley, 1998.
3. Hall and Knight, Higher algebra, Arihant Publications, Sixth edition, 2016.

Reference Books

1. S. R. Ghorpade and B. V. Limaye, A course in multivariable calculus and analysis, Springer, 2009
2. DeFranza, Jim and Gagliardi Daniel, Introduction to linear algebra and its applications, Waveland Press, Inc.; 1st edition, 2015.

Online Course Material

1. Jaikrishna J., Real Analysis I, NPTEL Course Material, Department of Mathematics, IIT Palakkad, <https://nptel.ac.in/courses/111106142>
2. Haridas P., Linear Algebra, NPTEL Course Material, Kerala School of Mathematics, <https://nptel.ac.in/courses/111106135>.

Course Title	Real Analysis	Course No.	MAL2XXX
Department	Mathematics	L-T-P (C)	3-1-0 (4)
Offered for	BSc-BEd	Type	Core
Prerequisite	None		

Objectives

1. To train the students in the area of Real Analysis.
2. To give sufficient knowledge of real analysis and its applications which can be used to do advanced courses in pure and applied mathematics.

Learning Outcomes

The students will be able to

1. analyse limits, convergence of sequences and series, and continuity and differentiability of functions.
2. apply Bolzano-Weierstrass to prove boundedness, and Mean Value Theorems to analyse function behaviour.
3. compute Riemann integrals and use them to find areas, average values, and solve problems in physics and engineering contexts.

Contents

The algebraic and order properties of \mathbb{R} , Absolute value and Real line, Completeness property of \mathbb{R} , Applications of supremum property; intervals. (3L)

Sequences and their limits, Convergent sequences, Cauchy's criterion, Monotone sequences, Necessary and Sufficient condition for Convergence of Monotone Sequence, Limit Point of Sequence, Subsequences, Bolzano-Weierstrass theorem, Cauchy Sequences, Cauchy's general principle of convergence. (8L)

Introduction to series, convergence of series. Cauchy's general principle of convergence for series, tests for convergence of series, Absolute convergence and conditional convergence. (5L)

Real valued Functions, Bounded functions, Limits of functions, Limits at infinity, Continuous functions, Combinations of continuous functions, Continuous Functions on intervals, uniform continuity. (6L)

The derivability of a function: on an interval, at a point, Derivability and continuity of a function, Graphical meaning of the Derivative, Mean value Theorems; Rolle's Theorem, Lagrange's Theorem, Cauchy's Mean value Theorem. (7L)

Riemann Integral, Riemann integral functions, Darboux theorem. Necessary and sufficient condition for R-integrability, Properties of integrable functions, Fundamental theorem of integral calculus, integral as the limit of a sum, Mean value Theorems. (10L)

Textbooks:

1. Robert G. Bartle and Donald R. Sherbert, Introduction to Real Analysis, John Wiley.
2. Sudhir R. Ghorpade and Balmohan V. Limaye, A Course in Calculus and Real Analysis, Springer-Verlag New York Inc.; 2006.

Reference Books

1. K.R. Davidson, and A.P. Donsig, Real analysis and applications: Theory in practice, Springer Publications, 2010.
2. Tom M. Apostol, Mathematical Analysis, Second edition, Narosa, 2002.

Online Course Material

Rana, I.K., Basic Real Analysis, NPTEL Course material, Department of Mathematics, IIT Bombay, <https://archive.nptel.ac.in/courses/111/101/111101134/>

Course Title	Linear Algebra	Course No.	MAL2XXX
Department	Mathematics	L-T-P (C)	3-1-0 (4)
Offered for	BSc BEd	Type	Core
Prerequisite	None		

Objectives:

1. Understand the structure of vector spaces and subspaces.
2. Understand linear transformations and their representations.
3. Analyze eigenvalues and eigenvectors and apply them to various problems.

Learning Outcomes

The students will be able to:

1. Solve systems of linear equations using methods such as Gaussian elimination and matrix inversion
2. Compute eigenvalues and eigenvectors to analyze the properties of matrices and their transformations
3. Apply vector space concepts, including linear independence, span, and basis, to model and solve real-world problems such as image compression, data dimensionality reduction (e.g., PCA), and machine learning feature transformations

Contents

Part 1: Introduction to Linear Algebra [15 lectures]

Review of Matrix Theory, Vector Spaces, Subspaces, Linear Independence, Basis and Dimension, Direct Sum, Quotient Space.

Part 2: Eigenvalues and Eigenvectors [15 Lectures]

Linear Transformations, Rank Nullity theorem, Eigenvalues and Eigenvectors, Diagonalization, Characteristic Equation, Eigenvectors and Eigenspaces, Applications of Eigenvalues and Eigenvectors, Symmetric Matrices and Spectral Theorems (without Proof), Eigen Value Decomposition.

Part 3: Advanced Topics in Linear Algebra [9 Lectures]

Inner Product Spaces, Normed linear space, Orthogonal Vectors, Cauchy Schwarz inequality, Gram-Schmidt Process, Orthogonal Projections.

Textbooks

1. "An Introduction to Linear Algebra" by I. K. Rana, Ane Books Pvt. Ltd., 2010.
2. "Linear Algebra and Its Applications" by Gilbert Strang, Cengage Learning, 2018

Reference Books

1. Kumaresan, S., (2000) Linear Algebra – A Geometric Approach, PHI Learning.
2. Artin, M., Algebra, Prentice Hall of India, 1994.
3. Sharma, R. K., Shah, S. K. and Shankar, A. G., Algebra I: A Basic Course in Algebra, Pearson Education, 2011.
4. "Linear Algebra Done Right" by Sheldon Axler, Springer, 1997.
5. "Introduction to Linear Algebra" by Serge Lang, Springer New York, 2012.

Online Course Material

1. Rana, I.K., Basic Linear Algebra, NPTEL Course material, Department of Mathematics, IIT Bombay, <https://nptel.ac.in/courses/111101115/>

Course Title	Probability Theory	Course No.	MAL2XXX
Department	Mathematics	L-T-P (C)	3-1-0 (4)
Offered for	BSc BEd	Type	Core
Prerequisite	None		

Objectives

The Instructor will:

1. Demonstrate the basic principles of probability theory and random variables.
2. Demonstrate the use of various families of probability distributions to model various types of data.

Learning Outcomes

The students will be able to

1. Solve questions using basics of probability theory and random variables
2. Apply useful distributions to real life applications
3. Apply probability theory in different decision theoretic problems

Contents

Probability Spaces [6 lectures]: Axioms of probability, conditional probability, Independence, Bayes' rule

Random Variables and Probability Distributions [8 lectures] Discrete and Continuous Random variables, Probability distribution of a random variable, Functions of random variables, moments and moment generating function, moment inequalities, Distribution of Functions of Random Variable

Some common distributions [8 lectures] Some common discrete (Binomial, Poisson, Geometric, Negative Binomial) and their properties. Some common continuous distributions (Uniform, Exponential, Gamma, Normal) and their properties

Bivariate Distributions [8 lectures] Joint probability distributions, marginal and conditional distributions and their moments, Functions of two or more random variables, distributions of functions or more than one random variable, bivariate normal distribution

Random Sampling and sampling distribution [9 lectures] Law of Convergence, Laws of large numbers, Central limit theorem, sample mean and sample variance and their distributions

Textbooks

1. Ross, S. M., (2010), A First Course in Probability, Pearson Prentice Hall
2. Ross, S.M., (2012), Introduction to probability and statistics for engineers and scientists.

Reference Books

1. Rohatgi, V. K. & Saleh, A.K.M.E., (2011), An Introduction to Probability and Statistics, Wiley

2. Casella, G. and Berger, R. (2002). Statistical Inference, Cengage Learning
3. Ross M.S., (2008), Stochastic Processes, John Wiley and Sons.
4. Hoel, P.G., Port, S.C. & Stone, C.J. (1986) Introduction to Stochastic Processes, Houghton Mifflin Company

Online Resources: Introduction to Probability and Statistics, Prof. G. Srinivasan , IIT Madras, <https://nptel.ac.in/courses/111/106/111106112>

Course Title	Groups and Rings	Course No.	MAL2XXX
Department	Mathematics	L-T-P (C)	3-1-0 (4)
Offered for	BSc BEd	Type	Core
Prerequisite	None		

Objectives

The instructor will

1. Train the student in the domain of Abstract Algebra.
2. Give sufficient knowledge of abstract algebra, required to do advanced courses in pure and applied mathematics.

Learning Outcomes:

The student will be able to

1. precisely define terms like group, ring, field, subgroup, normal subgroup, ideal, and quotient group.
2. identify and provide examples of various algebraic structures, such as cyclic groups, Abelian Groups, Dihedral Groups, Symmetric and Alternating Groups, General Linear Groups, and rings.
3. apply the theory to solve a variety of problems, including finding the order of elements in groups, determining the structure of finite abelian groups, to determine if a given group is simple.
4. apply the concept of group actions in counting techniques.
5. develop abstract reasoning and thinking such as recognizing patterns, symmetries and making generalizations.

Contents:

Group Theory: Definition of groups, Examples and basic properties of groups, Cyclic groups, Abelian Groups, Dihedral Groups, Symmetric and Alternating Groups, General Linear Groups, Subgroups. [**9 lectures**]

Normal Subgroups, Quotient groups, Homomorphisms, Kernel and Image, Isomorphism theorems. Automorphism groups. Simple groups and Simplicity of Alternating groups. Direct Products, Statement of structure theorem of finite abelian groups. [**9 lectures**]

Group actions, Examples of group action, Conjugacy Classes, Centralizer, Normalizer, Class Equation, Cayley's Theorem, Lagrange's Theorem, Cauchy's Theorem, The Sylow Theorems (without proof) and their applications. [**12 lectures**]

Ring Theory: Definition of Rings, Examples and basic properties of rings, Subrings and Characteristics of a ring, Ideals, Sum and direct sum of ideals, Definition of Fields, Examples of finite and infinite fields. Applications in Cryptography and Coding Theory [**9 lectures**]

Textbooks:

1. J. A. Gallian, Contemporary Abstract algebra, Fourth Edition, Narosa Publishing House.
2. P. B. Bhattacharya, S.K. Jain, S. R. Nagpaul, Basic Abstract Algebra, Second Edition, Cambridge University Press, 1994

Reference Books:

1. M. Artin, Algebra, Pearson Education, 2011.
2. I. N. Herstein, Topics in Algebra, New York: Wiley, 1975.
3. D. S. Dummit and R. M. Foote: Abstract Algebra, 2nd Edition, John Wiley, 2002.

Online Course Material

1. Hanumanthu, K., Introduction to abstract group theory, NPTEL Course Material, Department of Mathematics, Indian Institute of Technology Madras, <https://nptel.ac.in/courses/111106113/>
2. Mousumi Mandal and Ramakrishna Nanduri, Rings and Modules, NPTEL Course Material, Department of Mathematics, Indian Institute of Technology Kharagpur, <https://nptel.ac.in/courses/111105161>

Course Title	Multivariable Calculus	Course No.	MAL2XXX
Department	Mathematics	L-T-P (C)	3-1-0 (4)
Offered for	BSc BEd	Type	Core
Prerequisite	Single variable calculus		

Learning Objectives

1. Develop understanding of multivariable functions, limits, derivatives, and integrals.
2. Apply differential and integral tools to analyze and solve problems in higher dimensions.
3. Connect vector calculus theorems with geometric and physical interpretations.

Learning outcomes

The students will be able to

1. Determine convergence, continuity, and differentiability in \mathbb{R}^n .
2. Compute derivatives, optimize functions, and classify critical points.
3. Evaluate multiple, line, and surface integrals using transformations.
4. Apply vector calculus theorems to interpret work, flux, and circulation.

Contents

Review: Single-variable calculus, vectors and the geometry of space, sequences and their convergence in \mathbb{R}^2 and \mathbb{R}^n , functions of several variables, limit and continuity in higher dimensions, and their properties, vector-valued functions [7 lectures]

Multivariable differential calculus: Differentiability, partial derivatives, chain rule, directional derivatives, and gradient vectors, higher order partial derivatives, total derivative, Jacobian matrix, a sufficient condition for differentiability, a sufficient condition for equality of mixed partial derivatives, multivariable Taylor's formula, local and global extrema of real-valued functions of several variables, saddle points, method of Lagrange multipliers [16 lectures]

Multivariable integral calculus: Multiple Riemann integrals, double integrals on rectangles, Fubini theorem and multiple integrals by iterated integration on rectangle, change of variables, triple integrals, applications of multiple integrals to calculate area, volume and surface area, vector calculus: vector fields, divergence and curl, line integrals, Statements and proofs for special cases: Green theorem, Stokes theorem, Gauss theorem and applications of vector integration [16 lectures]

Textbooks

1. M D. Weir, J. Hass and F. R. Giordano, Thomas' calculus, 11th Ed., Pearson, 2008
2. S. R. Ghorpade and B. V. Limaye, A course in multivariable calculus and analysis, Springer, 2019
3. Apostol, T. M., Mathematical analysis, 2nd Ed, Narosa Publications, 1996

Reference Books

1. S. Lang, Undergraduate analysis, Springer, 1997
2. J. E. Marsden, A. Tromba and A. Weinstein, Basic Multivariable Calculus, Springer, 1993

Online Course Material

Sanjeev Kumar and S. K. Gupta, Multivariable Calculus, IIT Roorkee

<https://nptel.ac.in/courses/111107108>

Title	Differential Equations	Course No.	MAL2XXX
Department	Mathematics	L-T-P [C]	3-1-0 [4]
Offered for	B.Sc.-B.Ed.	Type	Core
Prerequisite	None		

Objectives

This course aims to

1. Develop analytical techniques to solve ordinary differential equations
2. Understand the properties of solution of ordinary differential equations
3. Classify and obtain solutions of first and second order partial differential equations

Learning Outcomes

Upon successful completion of the course, the student will be able to:

1. Solve first-order nonlinear differential equations and linear differential equations of higher order using various techniques.
2. Recognise an appropriate solution method for a given problem.
3. Obtain a series solution of differential equations.
4. This course will ensure that courses like basic analysis and linear algebra play a significant role in solving differential equations.

Contents

Ordinary Differential Equations: (2 lectures) Motivation for studying ODEs.

(13 lectures) First order: initial and boundary conditions, Solution of first-order ordinary differential equations by separation of variables, homogeneous equations, linear equations, Exact differential equations, integrating factors, Equations of the first order and higher degree, Clairaut's equation, Equations reducible to the linear form. Bernoulli's equation. Clairaut's form and equations reducible to it. Wronskian and its properties.

(15 lectures) Linear differential equations with constant coefficients, Complementary functions and particular integral, Cauchy's homogeneous linear equations, Legendre's linear equation, Method of variation of parameters, undetermined coefficients, The Cauchy-Euler equation and Total differential equations. Euler's method. Taylor series method. Picard's method of successive approximations. Applications of second order linear differential equations. Bessel and Legendre equations.

Partial Differential Equations: (9 lectures) Motivation for studying PDEs, Order and degree of partial differential equations, Concept of linear and non-linear partial differential equations, Formation of first order partial differential equations, Linear partial differential equations of first order, Lagrange's method, Charpit's method. Classifications of second-order partial differential equations.

Textbook

1. Deo, Lakshmikantam and Raghvendra, Ordinary Differential Equations.
2. Ross, S. L., Introduction to ordinary differential equations, 4th Ed., John Wiley Publications, 1989.
3. Rao, K.S., Introduction to partial differential equations, 3rd edition, PHI, 2010.

References

1. G.F. Simmons, Ordinary Differential Equations- (Tata McGraw Hill).

2. M.Braun, Differential Equation and Application, (Narosa)
3. E.A. Coddington, Ordinary Differential Equations.
4. W.E. Boyce, R. DiPrima, Elementary differential equations, 8th Ed., John Wiley, 2005
5. A. K. Nandakumaran, P. S. Datti, Notes, Problems and Solutions in Differential Equations, (Cambridge), Cambridge University Press (June 2025).

Title	Complex Analysis	Course No.	MAL3XXX
Department	Mathematics	L-T-P [C]	3-1-0 [4]
Offered for	B.Sc.-B.Ed.	Type	Elective
Prerequisite	None		

Objectives: This course aims to help the students with

1. Understand the algebra, geometry, and functions of complex numbers.
2. Develop the theory of analytic functions and complex integration.
3. Learn series expansions (Taylor, Laurent) and classification of singularities.
4. Explore conformal mappings and applications in mathematics and engineering.

Learning Outcomes: Students should be able to:

1. Understand analytic functions and their properties.
2. Evaluate contour integrals using Cauchy's theorem. Apply power series and Laurent series expansions.
3. Solve real integrals using complex analytic methods.

Contents:

Complex numbers: definitions and algebraic properties, complex conjugates, argument of complex numbers, exponential form, powers and roots of complex numbers, from algebra to geometry and back, the Riemann sphere and stereographic projection. (4 lectures)

Differentiation: Limits and continuity, differentiability and holomorphicity, the Cauchy–Riemann equations, harmonic functions, antiderivatives. (6 lectures)

Elementary functions: Polynomials and rational functions, several functions (e.g., the exponential, complex trigonometric, logarithmic, complex hyperbolic, Möbius transformations, etc.).(4 lectures)

Integration: definition and basic properties, contour integrals, Cauchy–Goursat theorem, Cauchy's theorem, Cauchy's integral formula, antiderivatives again, taking Cauchy's formulas to the limit, Cauchy-Goursat theorem, simply connected domains, Liouville's theorem, fundamental theorem of algebra.(12 lectures)

Harmonic functions: Definition and basic properties, mean-value and maximum/minimum principle.(1 lecture)

Series: Convergence of sequence and series, power series, absolute and uniform convergence of power series, sequences and series of functions, regions of convergence, Taylor series, analytic functions, the identity principle, bounds for analytic functions, classification of zeros and poles.(9 lectures)

Applications of complex analysis in diverse fields. (3 lectures)

Textbooks:

1. J. Brown and R. Churchill, Complex Variables and Applications, McGraw-Hill, 2009.
2. J. Bak and D. Newman, Complex Analysis, 3rd Edition, Springer, 2010.
3. J.M. Howie, Complex Analysis, 1st edition, 2012

References:

1. T.W. Gamelin, Complex Analysis, 1st edition, Springer 2001.
2. J. H. Mathews and R.W. Howell, Complex Analysis for Mathematics and Engineering, 3rd edition, Narosa, 1998.
3. T. Needham, Visual Complex Analysis, Oxford, 1997.
4. Ponnusamy S., Foundations of Complex Analysis, Narosa Publishing House, 1995.

Online Resources: Prof. P. A. S. Sree Krishna, Complex Analysis, IIT Guwahati,
<https://nptel.ac.in/courses/111103070>

Course Title	Statistics	Course No.	MAL3XXX
Department	Mathematics	L-T-P (C)	3-1-0 (4)
Offered for	B.Sc. B.Ed.	Type	Core
Prerequisite	Understanding of Probability Theory		
<p>Objectives</p> <p>The Instructor will:</p> <ol style="list-style-type: none"> 1. Demonstrate the basic principles of data analysis 2. Discuss from descriptive statistics to inferential statistics 3. Explore the applications of probability theory for data analysis <p>Learning Outcomes</p> <p>The students will be able to</p> <ol style="list-style-type: none"> 1. Present the data in form of charts and numbers 2. Apply useful distributions to the given data set 3. Use statistical tools for decision theoretic problems <p>Content:</p> <p>Descriptive Statistics [4 lectures]: Classification & Tabulation of Data, Graphical Representation of Data, Measures of Central Tendency (Mean, Median, Mode) and Measures of Dispersion (Range, Variance, SD, CV), Correlation Coefficient.</p> <p>Sampling Distributions [4 lectures] Chi-square, t, F distributions, Central Limit Theorem.</p> <p>Statistical Inference [10 lectures] Point Estimation, Properties of Point Estimators (Unbiasedness, Consistency, Efficiency, Sufficiency), Method of Moments and Maximum Likelihood Estimator, Confidence Interval Estimation.</p> <p>Hypothesis Testing [10 lectures] Null & Alternative Hypotheses, Type I and Type II Errors, Power of a Test, p-values, One Sample Tests for Mean, Variance and Proportion, Two Sample Tests, Test for Independence, Chi-Square Goodness of Fit Test.</p> <p>Regression and Correlation [8 lectures] Karl Pearson's Correlation, Rank Correlation, Simple Linear Regression & Multiple Regression.</p> <p>Demonstration Using R [4 lectures]</p> <p>Textbooks</p> <ol style="list-style-type: none"> 1. Ross, S.M., (2012) Introduction to probability and statistics for engineers and scientists. 2. Hogg, McKean and Craig (2019) Introduction to Mathematical Statistics <p>Reference Books</p> <ol style="list-style-type: none"> 1. Casella, G. and Berger, R. (2002). Statistical Inference, Cengage Learning 2. Rohatgi, V. K. (2012) Introduction to Probability and Statistics, Wiley <p>Online Resources</p> <p>Introduction to Probability and Statistics, Prof. G. Srinivasan , IIT Madras, https://nptel.ac.in/courses/111/106/111106112</p>			

Course Title	Introduction to Programming	Course No.	MAL3XXX
Department	Mathematics	L-T-P (C)	2-0-4 (4)
Offered for	B.Sc.-B.Ed.	Type	Core
Prerequisite	None		
<p>Objectives</p> <ol style="list-style-type: none"> 1. To introduce the basics of computer programming in C++. 2. To develop well-structured programs in C++. <p>Learning Outcomes</p> <ol style="list-style-type: none"> 1. Develop the writing skills of well structured programs in C++. 2. Ability to implement fundamental data structures in C++. <p>Contents</p> <p>Introduction to Computer [2 Lectures]: The Von-Neumann architecture, machine language, assembly language, high-level programming languages, compiler, interpreter, loader, linker, and flowchart.</p> <p>Basic features of programming [12 Lectures]: Introduction to C++, Basic data types, Enumerated data types, Derived data types, constants, variables, operators, standard header files, expressions, control structures, functions, classification of functions, parameter passing conventions, recursion in functions.</p> <p>Advanced features of programming [12 Lectures]: Pointers, arrays, operations on arrays/data (Insert, delete, search, traverse, modify and sorting), structures.</p> <p>Textbooks:</p> <ol style="list-style-type: none"> 1. Balaguruswamy, E., <i>Object Oriented Programming with C++</i>, McGraw-Hill, Eighth Edition, 2020. 2. Lafore, R., <i>Object-Oriented Programming in C++</i>, Fourth Edition, Pearson, 2002. 3. Stroustrup, B., <i>Programming: Principles and Practice Using C++</i>, Addison-Wesley, 2024. <p>Reference Books:</p> <ol style="list-style-type: none"> 1. Schildt, H., C: <i>The Complete Reference</i>, Fourth Edition, McGraw Hill, 2000. 2. Hubbard, J.R., <i>Schaum's Outline of Programming with C++</i>, McGraw-Hill, 2002. 3. Lippman, S., Lajoie, J., Moo, B., <i>C++ Primer</i>, Pearson Education, 2012. <p>Online Course Material</p> <ol style="list-style-type: none"> 1. Kumar, S.A., Principles of Programming Languages, NPTEL Course Material, Department of Computer Science and Engineering, IIT Delhi, https://nptel.ac.in/courses/106102067/. 2. Gupta, D., Introduction to Problem Solving and Programming, NPTEL Course Material, Department of Computer Science and Engineering, IIT Kanpur, https://nptel.ac.in/courses/106104074/. 			

Title	Operations Research	Number	MAL3XXX
Department	Mathematics	L-T-P(C)	3-0-2(4)
Offered for	B.Sc.-B.Ed.	Type	Elective
Prerequisites	Linear algebra		
<p>Objectives</p> <ol style="list-style-type: none"> Learn linear programming models and its use in operations research. Understanding Transportation problems. <p>Learning Outcomes</p> <ol style="list-style-type: none"> Understand basic concepts and application of operations research in various fields. Modeling real life situations as linear programming and solving. Analyze the relationship between a linear program and its dual. Understanding Transportation problems. <p>Contents</p> <p>Basics of Operational Research: Origin and Development of Operational Research, Different Phases of an Operational Research Study, Scope and Limitations. [3 lectures]</p> <p>Linear Programming: Two variable LP models, Graphical solution concepts, Convex sets, Extreme points, Hyperplanes and Half spaces, Convex cones, Polyhedral sets and cones, Concept of Basic Feasible solution [9 lectures]</p> <p>Simplex method: Iterative scheme in standard form of LPP, Simplex iterations, Big-M method, Two-phase method. Special cases of Degeneracy, Bland's rule, Unboundedness and Infeasibility, solve system of equation using simplex method, [8 lectures]</p> <p>Duality: Dual of LPP, Weak and strong Duality theory, Dual Simplex Method, Sensitivity analysis. [6 Lectures]</p> <p>Integer Programming: Branch and Bound method, Cutting plane method. [3 Lectures]</p> <p>Application of LPP: Introduction to transportation problem, Initial BFS using Northwest corner Rule, Vogel's M method, Checking Optimality using simplex explanation, Special case as Assignment problem, Hungarian Method, Shortest Path Problem, Max flow problem, Minimum spanning tree, Introduction to game theory [10 Lectures]</p> <p>Labs: Implementation of above concepts in spreadsheet solver</p> <p>Textbooks</p> <ol style="list-style-type: none"> Hamdy A. Taha: <i>Operations Research-An Introduction</i>, Prentice-Hall, 9th Edition, 2010. F.S. Hillier. G.J. Lieberman: <i>Introduction to Operations Research-Concepts and Cases</i>, 9th Edition, Tata Mc-Graw Hill, 2010. <p>Reference Books</p> <ol style="list-style-type: none"> Luenberger, D. G., <i>Linear and Nonlinear Programming</i>, Yinyu Ye, Third Edition, Springer, 2008. Dantzig, G. B., & Thapa, M. N., <i>Linear programming: Theory and extensions</i> (Vol. 2). New York: Springer. 2003. <p>Online Course Material</p> <p>Srinivas, G, Introduction to Operations Research, NPTEL Course Material, Department of Management Studies, IIT Madras, https://nptel.ac.in/courses/110106062</p>			

Title	Numerical Computations	Number	MAL3XXX
Department	Mathematics	L-T-P (C)	3-0-2 (4)
Offered for	B.Sc.-B.Ed. (MA)	Type	Core
Prerequisite	None		

Objectives

1. Learn numerical techniques for a variety of mathematical problems.
2. Analyze the validity and error in the numerical results.

Learning Outcomes

1. Develop an understanding of some numeral systems and basics of numerical error and the applicability of a particular method.
2. Solve numerically algebraic equations and linear systems of equations.
3. Carry out numerical differentiation, integration, and interpolation.

Contents

Numeral System: Number representation, External and internal representations, Decimal, binary, octal, and hexadecimal number systems and their conversion, Binary Arithmetic. [5 lectures]

Errors analysis: Numerical Algorithms and errors, Floating point systems, Types of error, Propagation of Error, Stability of algorithms. [6 lectures]

Nonlinear equations: Intermediate Value Theorem, Bisection method, Secant method, Method of false position, Newton-Raphson method. [6 lectures]

Solution of a system of linear equations: Gauss elimination, Gauss-Jordan method, LU decomposition, Crout's Method, Do-little method, Cholesky decomposition, Gauss-Seidel method, Gauss-Jacobi method. [10 Lectures]

Interpolation: Errors in polynomial interpolation, finite differences, Newton's formulae for interpolation, Lagrange interpolation formula. [6 Lectures]

Numerical Integration and Differentiation: Newton-Cotes integration formulae, Difference Formulae for numerical differentiation, Method of Undetermined Coefficients. [6 Lectures]

Lab: Implementation of above numerical algorithms.

Textbooks:

1. Vandergraft, J.S., Introduction to Numerical Computations, Academic Press, 2014.
2. Sastry, S.S., Introductory Methods of Numerical Analysis, Prentice Hall of India Pvt. Ltd., 2007.

Reference Books:

1. Süli, E. and Mayers, D.F., An Introduction to Numerical Analysis, Cambridge Uni. Press, 2006.
2. Burden, R. L., Numerical Analysis, 9th Edition, Cengage Learning India, 2012.

Online Course Material

1. Usha, R., Numerical Analysis, NPTEL Course Material, Department of Mathematics, IIT Madras, <https://nptel.ac.in/courses/111106101/>

Course Title	Field Theory	Number	MAL3XXX
Department	Mathematics	L-T-P (C)	3-1-0 (4)
Offered for	BSc BEd	Type	Elective
Prerequisite	Understanding of groups and rings		

Objectives

1. To introduce fundamental concepts of rings, integral domains, and fields.
2. To study field extensions and their properties, including algebraic and transcendental elements, minimal polynomials, and splitting fields.
3. To understand special classes of field extensions, such as separable, normal, cyclotomic, and finite fields, and their structural properties.

Learning Outcomes:

The student will be able to:

1. Understand and apply the theory of rings and integral domains.
2. Analyze and construct field extensions, determine degrees of extensions, minimal polynomials.
3. Identify and study algebraic structures of field extensions, including separable and normal extensions and cyclotomic fields.
4. Understand the structure and classification of finite fields.

Contents

Review of Rings: Definition and Examples, Characteristics of a ring, Ideals, Prime Ideals, Maximal Ideals, Ring homomorphisms. [3 lectures]

Quotient Rings and Field of Fractions: Quotient rings, Isomorphism Theorems, Zero divisors, Integral Domains, Construction of the field of fractions. [6 lectures]

Divisibility in Integral Domains: Polynomial rings, Division Algorithm, prime elements, irreducible elements, irreducibility in $F[x]$, Gauss Lemma, Eisenstein's Criterion, Euclidean Domains, Principal Ideal Domains, Unique Factorization Domains [12 lectures]

Fields and Field Extensions: Definition and Examples of Field, Properties of a field, Characteristic of a field, Basic Theory of Field Extensions, Algebraic and Transcendental Elements, Minimal Polynomial, Degree of extension, Tower Law, Algebraic Extensions and algebraically closed fields, Classical Straightedge and compass constructions. [12 lectures]

More on Field Extensions: Splitting Fields, Separable Extensions, Finite Fields. [6 lectures]

Textbooks:

1. J. A. Gallian, Contemporary Abstract Algebra, 4th Edition, Narosa Publishing House.
2. P. B. Bhattacharya, S. K. Jain, and S. R. Nagpaul, Basic Abstract Algebra, 2nd Edition, Cambridge University Press.

Reference Books:

1. D. S. Dummit and R. M. Foote, Abstract Algebra, Third Edition, Wiley.
2. I. N. Herstein, Topics in Algebra, Second Edition, Wiley.
3. Ian Stewart, Galois Theory, Fifth Edition, Chapman and Hall

Online Course Material

NPTEL, Introduction to Rings and Fields, Prof. Krishna Hanumanthu, Chennai Mathematical Institute. https://onlinecourses.nptel.ac.in/noc21_ma06/preview

Title	Graph Theory	Number	MAL3XXX
Department	Mathematics	L-T-P (C)	3-1-0 (4)
Offered for	B.Sc.-B.Ed.	Type	Elective
Prerequisite	None		

Objectives

1. To introduce students to the basic concepts and structures in graph theory through intuitive and visual reasoning.
2. To develop the ability to model and analyze simple real-world problems using graphs.

Learning Outcomes:

The student will be able to:

1. represent and interpret real-world situations using graphs and related terminology
2. analyze graphs using concepts such as degree, paths, cycles, and connectivity
3. apply graph coloring and matching concepts to simple optimization problems
4. understand structural properties of planar graphs and apply Euler's formula

Contents

Graphs as Models of Reality [6 lectures]: Visualizing connections (social media, family trees); nodes, edges, and multigraphs; the Handshaking Lemma; connectivity and "Six Degrees of Separation."

Routes, Puzzles, and Tours [6 lectures]: Seven Bridges of Königsberg; paths and cycles; Eulerian circuits for delivery routes; Hamilton's "Icosian Game" and the Traveling Salesperson puzzle.

Trees and Hierarchies [6 lectures]: Properties of trees and leaves; Spanning Trees for minimal network design; finding the "Center" of a tree; applications in school organizational charts.

Matching and Resource Allocation [6 lectures]: Bipartite graphs; maximum vs. perfect matchings; practical pairing problems (assigning teachers to classes or students to projects).

Coloring and Conflict Resolution [6 lectures]: Map coloring and the Four Color Theorem (only statement); Vertex coloring intuition; scheduling applications for exam timetables and school rosters.

Planarity and Visual Layouts [6 lectures]: Drawing without edge crossings; the Three Utilities puzzle; Euler's formula ($V - E + F = 2$); intuition for non-planar graphs and floor planning.

Graphs in ML [3 lectures]: Introduction to the Erdős-Rényi model; intuition for "phase transitions" (how networks suddenly connect); how data clusters form in Machine Learning (no proofs); visualizing network growth using GeoGebra or other online tools.

Textbooks:

1. D. B. West, *Introduction to Graph Theory*, 2nd edition, Pearson Education Inc., 2001
2. R. J. Wilson, *Introduction to Graph Theory*, 4th edition, Prentice Hall, 1996

Reference Books:

1. R. Diestel, *Graph Theory*, 6th edition, Springer, 2025.
2. K. Rosen, *Discrete Mathematics and its Applications*, 8th edition, McGraw Hill, 2019.

Online Course Material

Prof. S. A. Choudam, Graph Theory, IIT Madras, NPTEL course, available at <https://nptel.ac.in/courses/111106050>

Title	Elementary Number Theory	Course No.	MAL3XXX
Department	Mathematics	L-T-P (C)	3-1-0 (4)
Offered for	B.Sc.-B.Ed.	Type	Elective
Prerequisite	None		

Objectives.

1. Develop foundational understanding of integers and divisibility.
2. Enhance logical reasoning and proof-writing skills.
3. Introduce applications of number theory in modern mathematics.

Learning Outcomes:

After successful completion of the course Elementary Number Theory, students will be able to:

1. Apply concepts of divisibility, primes, residue systems, and classical results such as Fermat's, Euler's, and Wilson's theorems.
2. Analyze and solve linear congruences and systems of congruences, and problems in modular arithmetic.
3. Analyze and compute important arithmetic functions.
4. Formulate and solve linear, quadratic, and Diophantine equations.

Contents

Divisibility and Factorization [8 Lectures] Well ordering principle, Principle of mathematical induction, Divisibility of integers, Euclidean algorithm, prime numbers and their basic properties, Complete and reduced residue systems.

Congruences and Modular Arithmetic [15 Lectures] Linear congruences and their solutions, the Chinese Remainder Theorem and its applications, Diophantine Equations, quadratic congruences, Classical results including Fermat's theorem, Euler's theorem and Wilson's theorem, Primitive roots and Indices, and The quadratic reciprocity law.

Arithmetic Functions [12 Lectures] Definitions and basic examples. Multiplicative Functions. The Möbius function and the Möbius inversion formula, Euler's Phi Function, The number of divisors, sum of divisors functions and their applications.

Representation of Integers as Sums of Squares [4 Lectures]: Sums of Two Squares, and Sums of More Than Two Squares.

Textbooks:

1. David M. Burton, Elementary Number Theory. McGraw Hill Education, 2012.
2. G. H. Hardy and E. M. Wright. An Introduction to the Theory of Numbers. Oxford University Press, 1960.

Reference Books:

1. J. Silverman, A Friendly Introduction to Number Theory, Fourth Edition, Pearson India Education Services Pvt. Ltd. in 2019.
2. H. Davenport, The Higher Arithmetic, Cambridge University Press, Eighth Edition 2008.

Online Course Material:

1. Saikia, A., Number Theory, NPTEL Course Material, Department of Mathematics, IIT Guwahati, <https://nptel.ac.in/courses/111103020/>.

Course Title	Integral Transforms and applications	Course No.	MAL3XXX
Department	Mathematics	L-T-P (C)	3-1-0 (4)
Offered for	B.Sc.-B.Ed	Type	Elective
Prerequisite	Complex Analysis		

Objectives:

1. Introduce integral transforms and their role in simplifying mathematical problems.
2. Develop computational skills in Fourier, Laplace, and related transforms.
3. Illustrate applications of integral transforms in solving differential equations.

Learning Outcomes:

After successful completion of the course, students will be able to:

1. Compute and apply Fourier and Laplace transforms to solve mathematical problems.
2. Analyze and solve differential equations using Laplace transform techniques.

Contents:

Introduction to Integral Transforms [6 Lectures]: Definition of an integral transform (including Laplace Transform), Kernel, linearity, scaling, shifting properties, Basic idea of inversion, examples of standard transforms.

Fourier Series and Fourier Transforms [21 Lectures]: Motivation and introduction, Fourier series for periodic functions, Dirichlet conditions and convergence, even and odd functions, half-range expansions, examples and computations, Fourier transform, inverse Fourier transform (idea and formula), properties (linearity, scaling, shifting, modulation, convolution theorem), and applications.

Mellin and Hankel Transforms [12 Lectures]: Definition of Mellin Transform, examples; Gamma function and Beta function, Bessel Functions, properties and applications.

Textbook:

1. B. Patra, An Introduction to Integral Transforms (1st ed.). CRC Press, 2018.
2. G. B. Folland, Fourier Analysis and its Applications, Wadsworth & Brooks/Cole Advanced Books & Software, 1992.

Reference Books:

1. L. Debnath and D. Bhatta. Integral Transforms and Their Applications (3rd ed.). Chapman and Hall/CRC, 2014.
2. A. C. King, J. Billingham and S. R. Otto, Differential equations: Linear, nonlinear, ordinary and partial, Cambridge Publications, 2003

Online Course Material:

1. Sarthok Sircar, Integral Transforms and their Applications, NPTEL Course Material, Department of Mathematics, IIT Delhi, <https://nptel.ac.in/courses/111102129>.

Title	Introduction to Combinatorics	Number	MAL3XXX
Department	Mathematics	L-T-P (C)	3-1-0 (4)
Offered for	BSc BEd	Type	Elective
Prerequisite	None		

Objectives

The instructor will:

1. Introduce students to the basic ideas and methods used in combinatorial counting.
2. Develop the ability to solve counting problems in a systematic and logical manner.
3. Enable students to understand important counting sequences and strengthen their mathematical reasoning skills.

Learning Outcomes:

The student will be able to:

1. apply the basic principles of counting to solve combinatorial problems
2. compute permutations and combinations and derive identities involving binomial coefficients
3. apply the pigeonhole principle and the inclusion-exclusion principle to solve counting problems
4. formulate and solve simple recurrence relations arising from counting problems

Contents

Introduction to Combinatorics: Examples illustrating combinatorial reasoning and counting arguments from simple problems; addition and multiplication principles; permutations of sets; combinations of sets; permutations and combinations of multisets; counting subsets; elementary applications to finite probability. [4 lectures]

Pigeonhole Principle: The pigeonhole principle in its simple and generalized forms; applications to existence problems, including problems on divisibility, equal sums in subsets, and repetitions in sequences. [4 lectures]

Generating Permutations and Combinations: Algorithms for generating permutations and combinations; inversions in permutations; generation of r-subsets; equivalence relations and their role in combinatorial classification. [3 lectures]

Binomial Coefficients: Pascal's triangle; binomial theorem; combinatorial identities involving binomial coefficients; combinatorial proofs of identities; multinomial coefficients and multinomial theorem. [6 lectures]

Inclusion-Exclusion Principle: Principle of inclusion-exclusion; combinations with repetition; derangements; permutations with forbidden positions; applications to counting with restrictions. [7 lectures]

Recurrence Relations: Recurrence relations arising from counting problems; linear homogeneous recurrence relations with constant coefficients; characteristic equation method; Fibonacci numbers and related sequences. [5 lectures]

Generating Functions: Formal power series; the calculus of ordinary generating functions and exponential generating functions; power series; applications to labelled counting [6 lectures]

Special Counting Sequences: Catalan numbers and their combinatorial interpretations, including Dyck paths, balanced parenthesis sequences, and triangulations of polygons; brief introduction to Stirling numbers of the second kind. [4 lectures]

Textbooks:

1. R. A. Brualdi, Introductory Combinatorics, 5th Edition, Pearson, 2009
2. H. Wilf, generatingfunctionology, 2nd edition, Academic Press, 1994

Reference Books:

1. M. Bóna, A Walk Through Combinatorics, 3rd edition, World Scientific, 2011.
2. P. J. Cameron, Combinatorics: Topics, Techniques, Algorithms, Cambridge University Press, 1994.
3. K. Rosen, Discrete Mathematics and its Applications, 8th ed., McGraw Hill, 2021.
4. R. Stanley, Enumerative Combinatorics, Volume 1, 2nd ed., Cambridge University Press, 2011.

Online Course Material

1. MIT OpenCourseWare, Combinatorial Analysis,
<https://ocw.mit.edu/courses/18-314-combinatorial-analysis-fall-2014/>
2. NPTEL, Discrete Mathematics, IIT Ropar, IIT Gandhinagar,
https://onlinecourses.nptel.ac.in/noc20_cs82/preview

MAJOR-WISE COURSE CONTENT

2. Courses In Physics

Title	General Physics-I	Number	PHL1XXX
Department	Physics	L-T-P [C]	3-1-0 [4]
Offered for	BSc - BEd (ITEP)	Type	Core
Prerequisite	None		

Course Objectives

The Instructor will:

1. Introduce fundamental concepts of mechanics, including motion, forces, energy, rotation, and gravitation.
2. Develop problem-solving skills using basic physical principles and prepare students to communicate and teach these concepts at the school level effectively

Learning Outcomes

The students will be able to:

1. Solve numerical problems related to motion, forces, energy, rotation, and gravitation.
2. Analyze physical situations and explain everyday phenomena using basic mechanics principles

Course Contents

Vectors, Kinematics, and Newtonian Mechanics

Review of Newtonian mechanics, Relative motion, Friction, Applications of Newton's laws, Inertial and non-inertial frames, Galilean transformation, Basic idea of pseudo-forces, Rotating frame and Coriolis force. (5 Lectures)

Work, Energy, Momentum, and Rotational Motion

Work, energy, and conservation laws, Linear momentum and impulse, Centre of mass and its motion, Collisions, Torque, Angular momentum and its conservation, Moment of inertia, Rolling motion without slipping, Gyroscope, Torque free rotation and wobbling of earth. (13 Lectures)

Central force and Gravitation

Motion under Central force, Newtonian Gravitational potential and energy for a point mass, Orbits and eccentricity, 2 body problem and reduced mass, Kepler's laws, Escape velocity, Satellites and geosynchronous orbits. (11 Lectures)

Properties of Matter and Fluid Mechanics

Elasticity, Hook's law, Elastic behaviour of solids, Tensile and Compressive stress, Poisson's ratio, Young's modulus, Laminar and Viscous flow, Viscosity, Newton's laws of viscosity, Bernoulli's theorem and applications, Euler's equation, critical velocity and Reynolds' number, Determination of coefficient of viscosity. (10 Lectures)

Textbooks:

Mechanics, Berkeley Physics, vol.1, C. Kittel, W. Knight, et.al. 2007, Tata McGraw-Hill
 Fundamentals of Physics, Resnick, Halliday, and Walker 8/e. 2008, Wiley
 Mechanics, D.S. Mathur, S. Chand and Company Limited, 2000

Reference Books:

Feynman Lectures, Vol. I, R.P. Feynman, R.B. Leighton, M. Sands, 2008, Pearson Education
 An introduction to mechanics, D. Kleppner, R.J. Kolenkow, 1973, McGraw-Hill
 Classical Dynamics of Particles and Systems, J B Marion, 2003, Academic Press

Self-Learning MaterialNPTEL lectures by Prof. Debamalya Banerjee, IIT Kharagpur <https://nptel.ac.in/courses/115105098>

Title	General Physics II	Number	PH1XXX
Department	Physics	L-T-P [C]	3-0-2 [4]
Offered for	BSc-BEd	Type	Core
Prerequisite	None		

Course Objectives

The Instructor will:

- Discuss the fundamental principles of waves and vibrations.
- Provide concepts and problem-solving approaches for particle dynamics.

Learning Outcomes

The students are expected to have the ability to:

- Analyze and predict the behavior of periodic motion and energy transfer in physical systems.
- Design and solve numerical problems involving oscillations and wave motion.

Course Contents

Harmonic Oscillator: Simple harmonic motion, superposition of simple harmonic oscillations, Damped oscillation, Forced oscillations with harmonic forces, Impedance, Displacement and resonance, Quality factor of the oscillator, Coupled Oscillations, Normal modes of vibrations, Nonlinear oscillations, Duffing Oscillator, Limit cycles and stability, Introduction to chaos (12 Lectures)

Transverse Waves: Transverse wave, Wave equation and solution, Characteristic impedance of string, Standing waves, Wave and Group velocity, Bandwidth theorem, Application in periodic structure, Doppler Effect (8 Lectures)

Longitudinal waves: Sound waves in Gases, Longitudinal waves in Solids, Reflection and Transmission at interface, Dispersion relation (ω - k relation), Wave packets and pulse propagation, Physical meaning of group velocity, Energy transport in waves (8 Lectures)

Waves In Optics: Fermat Principle, Reflection and refraction of plane waves, Rays and Wavefronts, Huygens secondary wavefronts, Superposition of wavefronts, Interference, Young's-double slit experiment, Diffraction, Diffraction by single slit, Diffraction grating, Fraunhofer vs Fresnel diffraction, Dispersion of light, Polarization. (11 Lectures)

Laboratory Experiments:

1. Measurement using Vernier callipers, Screw Gauge, Spherometer, and Error Analysis
2. Moment of Inertia of a Flywheel
3. Moment of Inertia of rectangular bar
4. Determination of the value of g using a bar pendulum
5. Determination of g by compound pendulum

6. Gyroscope
7. Verify Stokes' law and find the coefficient of viscosity
8. Air track and friction
9. Standing wave in a string and measurement of its velocity
10. Velocity of transverse wave using Sonometer
11. Velocity of sound wave by Kundt's tube
12. Modulus of rigidity by Statical method.

Textbooks:

1. Waves, F. S. Crawford, (Berkeley Physics Course, Tata McGraw-Hill Ltd, 2008)
2. The Physics of Vibrations and Waves by H. J. Pain, John Wiley & Sons Ltd., 6th edition, 2005
3. IITJ Manual for the labs.

Reference Books:

1. Mechanics, Waves and Thermodynamics : An example based approach. Sudhir Ranjan Jain
Cambridge University Press (2016)
2. The Physics of Waves. Howard Georgi, Prentice Hall (1993)
3. Optics, Eugene Hecht and A. R. Ganesan, Pearson, 5th edition, 2019.
4. Optics, A. Ghatak, McGraw Hill, 2020.

Self-Learning Material

1. Oscillations and Wave, NPTEL course (by Prof. S.P. Kastagir and Prof. S. Bharadwaj).
<https://nptel.ac.in/courses/115105083>.
2. Introduction to Oscillations and Waves, MIT OpenCourseWare, Fall 2006,
<https://ocw.mit.edu/courses/mathematics/18-303-linear-partial-differential-equations-fall-2006/index.html>, (by Dr. Matthew Hancock, Veryst Engineering, LLC)

Title	Fundamentals of Thermodynamics	Number	PHL2XXX
Department	Physics	L-T-P [C]	3-0-0 [3]
Offered for	BSc-BEd	Type	Core
Prerequisite	None		

Course Objective

The instructor will:

1. Provide a basic understanding of the fundamentals of thermodynamics.
2. Explain the laws of thermodynamics, thermodynamic equations, and their applications.

Learning Outcomes

The students will be able to:

1. Explain the macroscopic properties of gases by relating them to the microscopic behavior of their constituent molecules, utilizing the kinetic theory of gases and the Maxwell-Boltzmann speed distribution.
2. Calculate the temperature change during the Joule-Thomson expansion of a real gas, given its equation of state and initial conditions.

Course Content

1. **Kinetic theory of gases:** Maxwell-Boltzmann speed distribution law, Mean free path, collision probability, Fundamentals of transport phenomena, Brownian motion and its significance, Viscosity, diffusion, effusion, thermal conductivity in gas (6 Lectures)
2. **Thermodynamics Laws:** Temperature, Definition of thermal equilibrium, Temperature scales, Specific heat of solids, Dulong-petit law, Zeroth law, Conservation of mass for closed and open systems, First law of Thermodynamics for Cyclic and Non-cyclic processes, Concept of total energy E, Various modes of energy, Internal energy and Enthalpy (8 Lectures)
3. **Entropy:** Reversible and irreversible processes, Carnot's cycle and Carnot's theorem, Second and third law of thermodynamics, Clausius inequality, definition of Entropy, entropy change in reversible and irreversible processes. Entropy and disorder, Principle of increase of entropy, Entropy and unavailable energy, Entropy of ideal gases, Entropy as a thermodynamic variable, S-T diagram (9 Lectures)

4. **Equation of States:** Thermodynamic potentials, Equation of state for Real gasses, deviation from ideal gas equation, The Van-der Waals equation of state, Clausius–Clapeyron relation, Gibbs- Helmholtz and energy equations, Enthalpy, Helmholtz and Gibbs free energies, Maxwell’s thermodynamic equations and their applications. (10 Lectures)
5. **Phase Transitions:** 1st and 2nd order phase transitions, Phase diagram and Triple point, Ehrenfest equations, Gibbs phase rule and simple applications, Joule-Thomson effect, Thermodynamic analysis, Inversion temperature (6 Lectures)

Text Books:

1. Heat and Thermodynamics, Zemansky M W and Dittman R H, McGraw Hill, 2017
2. Heat and Thermodynamics: Brij Lal and N. Subramanyam, S Chand & Company Pvt Ltd - Se, 2007
3. Thermal Physics: B.K. Agarwal, Kedar Nath Ram Nath, 2017

Reference Books:

1. Schroeder D, An Introduction to Thermal Physics, Oxford University Press, 2021
2. Heat and Thermodynamics: Dayal, Verma and Pandey, Ram Chand and Sons, 1972

Self-Learning Materials:

1. <https://www.damtp.cam.ac.uk/user/tong/kinetic.html>
2. https://www.math.uwaterloo.ca/~mscott/Little_Notes.pdf
3. <https://ocw.mit.edu/courses/8-333-statistical-mechanics-i-statistical-mechanics-of-particles-fall-2013/>

Title	Fundamentals of Optics	Number	PHL2XXX
Department	Physics	L-T-P [C]	3-0-0 [3]
Offered for	BSc - BEd (ITEP)	Type	Core
Prerequisite			

Course Objectives

The instructor will:

1. Provide a basic understanding of fundamental optics.
2. Explain the classical approaches for understanding the characteristics of light waves

Learning Outcomes

The students will be able to:

1. Explain the fundamentals of geometrical and wave optics.
2. Identify and characterise the phenomenon of Fourier optics in various optical instruments.

Course Content

Geometrical optics: Introduction to light - Corpuscular model, Wave model, Fermat's principle - laws of reflection and refraction, Ray paths in an inhomogeneous medium - Mirage, Reflection and Refraction by spherical surfaces, focal lengths of a lens, thin lens, magnification, matrix method, Optical aberrations (10 Lectures)

Wave optics: Review of waves, group and phase velocity, wave propagation, wave equation, definition and properties of wave front, Huygens Principle and its applications.

Interference: Division of wavefront and amplitude, Lloyd's Mirror and Fresnel's Biprism. Interference in Thin Films: parallel and wedge shaped films, Newton's Rings, Temporal and Spatial Coherence, Young's double slit experiment, Michelson Interferometer. (14 Lectures)

Diffraction: Fraunhofer diffraction, Single slit diffraction pattern, Circular aperture, Resolution, Two slits, Multiple slits, Diffraction grating. Resolving power of grating. Rayleigh criterion for resolution, Fresnel Diffraction, Half period zones, rectilinear propagation of light, diffraction by a long narrow slit, transition to Fraunhofer region. (10 Lectures)

Electromagnetic character of light: Introduction to polarised light, Malus law, Brewster angle, phenomenon of double refraction, interference of polarized light: quarter and half wave plates, Analysis of polarised light (5 Lectures)

Textbooks

1. Ghatak A, Optics, 7th Edition Mcgraw Hill Publisher, 2021
2. Hecht E., Optics, 4th Edition, Pearson Publisher, 2007.

Reference Books

1. Born & Wolf, Principles of Optics (7th edition), Cambridge University Press 1999.
2. K K Sharma, Optics: Principles and Applications, Academic Press 2006.

Self-Learning Material

1. Applied Optics, NPTEL by Prof Akhilesh Kumar Mishra, IIT Roorkee, <https://nptel.ac.in/courses/115107131>
2. Optics, MIT OCW, <https://ocw.mit.edu/courses/2-71-optics-spring-2009/pages/lecture-slides/>

Title	Mathematical Methods in Physics	Course Code	PHL2XXX
Department	Physics	L-T-P [C]	3-0-0 [3]
Offered for	BSc - BEd (ITEP)	Type	Core
Prerequisite			

Course Objectives

The Instructor will:

1. Provide the basic mathematical skills required to approach problems in various areas of physics.
2. Introduce special functions and their applications in different physics domains

Learning Outcomes

The students are expected to have the ability to:

1. Explain the properties of various special functions and partial differential equations.
2. Apply the mathematical tools in various physical problems.

Course Contents

Complex Number: Introduction to complex numbers, algebra of complex numbers, geometrical representation of complex numbers, Euler's formula, square roots and roots of complex numbers, De Moivre's theorem and its applications, circular, hyperbolic, and logarithmic functions of complex variables, limits and continuity, differentiability and analytic functions, Cauchy-Riemann equations in Cartesian and Polar forms, harmonic functions, orthogonal curves, and elementary applications of analytic functions. (14 Lectures)

Vector Calculus: Concept of scalar and vector fields, vector differentiation; directional and normal Derivatives, gradient, divergence, curl, vector identities. vector integration; Jacobian determinant, concepts of infinitesimal elements; Line, surface, and volume integrals, flux of vector fields, integral theorems, orthogonal curvilinear coordinate systems, cylindrical and spherical coordinates. (13 Lectures)

Fourier series: Definition of periodic functions, orthogonality of sine and cosine functions, Dirichlet Conditions (statement only), expansion of periodic functions into sine and cosine series, Fourier coefficients, complex form of Fourier series, functions with arbitrary period, even and odd functions, various applications, summing of infinite series, Term-by-term differentiation and integration of Fourier series, Parseval identity. (12 Lectures)

Textbooks

1. G. B. Arfken, H. J. Weber, and F. E. Harris, Mathematical Methods for Physicists, Elsevier, 7th Ed., 2012.
2. S. D. Joglekar, Mathematical Physics: The Basics, Universities Press, 1st Ed., 2005.

Reference Books

1. Mathematical Methods in the Physical Sciences, M. L. Boas, 2005, Wiley.
2. S. D. Joglekar, Mathematical Physics: Advanced Topics, Universities Press, 1st Ed., 2006.
3. Vector Analysis and an introduction to TENSOR ANALYSIS, S. Lipschutz, D. Spellman, M. R. Spiegel, Schaum's Outline Series, Tata McGraw-Hill Education Private Limited, edition 2009
4. Fourier Analysis by M.R. Spiegel, 2004, Tata McGraw-Hill

Self-Learning Material

1. Mathematical Physics-1, NPTEL by Prof Saurabh Basu, IIT Guwahati, <https://nptel.ac.in/courses/115103036>
2. Mathematical Methods in Physics, NPTEL, by Prof Auditya Sharma, IISER Bhopal, https://onlinecourses.nptel.ac.in/e-learning/preview/noc21_ma27

Title	Physics Lab 1	Course Code	PHP2XXX
Department	Physics	L-T-P [C]	0-0-6 [3]
Offered for	B.Sc.-B.Ed. (ITEP)	Type	Core
Prerequisite			
<p>Course Objectives The instructor will</p> <ol style="list-style-type: none"> 1. Provide the experimental understanding of optical phenomena. 2. Provide the experimental understanding about heat and thermodynamics. 3. Provide the experimental understanding of electricity and magnetism. <p>Learning Outcomes At the end of the course, Students will</p> <ol style="list-style-type: none"> 1. Demonstrate the practical aspects of optical concepts and their real world applications. 2. Understand heat and thermal transport in different media. 3. Gain experimental insights from electricity and magnetism <p>Course Contents</p> <ul style="list-style-type: none"> • Dispersion of light by prism • Determination of wavelength of different colours using diffraction grating. • Single and double slit diffraction • Newton's ring • Malu's law • Interference by Biprism • Interference of light by ultrasonic waves • Laurent half shade polarimeter • Nodal slide • Lee's disc • Measuring the thermal and electrical conductivities of metals • Stefan Constant • Specific heat of solid • Sterling Engine • Current balance • Biot Savart's law • Electromagnetic damping of compound Pendulum <p>Textbooks B.Sc. Practical Physics, C L Arora, S Chand publication Manual provided by IITJ</p> <p>Reference Books Advanced Practical Physics, B L Worsnop and H T Flint, Khosla Publishing</p>			

Title	Electromagnetic Theory	Course Code	PHL2XXX
Department	Physics	L-T-P [C]	3-1-0 [4]
Offered for	BSc - BEd (ITEP)	Type	Core
Prerequisite			

Course Objectives

The instructor will:

1. Introduce the fundamental principles and mathematical framework of classical electrostatics, magnetostatics and electromagnetism.
2. Develop problem-solving skills in applying the theory and concepts to describe and predict operation of various circuits.

Learning Outcomes

The students are expected to have the ability to:

1. Understand and explain Maxwell's equations in differential and integral form and apply them to solve problems involving charge and current distributions.
2. Apply the knowledge to build various circuits and calculate energy stored and transmitted during operation of those circuits.

Course Contents

Electrostatics: Gauss's law and its applications (in differential form), Electric field in conductors, Electrostatic Energy, Electrostatic potential, Laplace's and Poisson's equation, Uniqueness theorem, method of Images, Electric field in Dielectrics, Bound Charges, Gauss's Law for dielectrics, Boundary conditions, Energy in Dielectric Systems. (13 Lectures)

Magnetostatics: Biot-Savart's law, Ampere circuital law, Lorentz force, Divergence and Curl of Magnetic Field, Vector potential, Magnetic Field inside matter, types of magnetism, Bound Currents, Ampere's law in Materials, Boundary Conditions. (12 Lectures)

Electromagnetic Induction: Faraday's law, Lenz's law, Self and mutual inductance, Energy stored in magnetic field, LR, RC and LCR circuit, Introduction to Maxwell's equation, Displacement Current and Electromagnetic wave, Materials, metal, semiconductor and insulator and their behaviour in EM fields (10 Lectures)

AC Circuit: Resonance Circuit, Quality factor, RLC Circuit, AC Networks and Power transmission. (4 Lectures)

Textbooks

1. Prucell, E.M. and Morin, D.J., Electricity and Magnetism, Cambridge University Press, 2013
2. Griffiths, J. David, Introduction to Electrodynamics, Prentice Hall

Reference Books

1. Lorrain, P. and Corson, D., Electromagnetic Fields and Waves, CBS Publishers, 2003.
2. Jackson, J. D., Classical Electrodynamics, Wiley India Pvt. Ltd., 2007
3. Panofsky W.K.H. and Philips M., Classical Electricity and Magnetism, Dover Publishers, 1990.

Self-Learning Material

1. Dighe, A., Electrodynamics, Tata Institute of Fundamental Research, Mumbai, <https://nptel.ac.in/syllabus/115101004/>.

2. Gut, A., Lecture notes on Electromagnetism II, MIT open course ware
<https://ocw.mit.edu/courses/physics/8-07-electromagnetism-ii-fall-2012/lecture-notes/>

Title	Foundations of Quantum and Modern Physics	Course No.	PHL2XXX
Department	Physics	L-T-P [C]	3-1-0 [4]
Offered for	BSc - BEd (ITEP)	Type	Core
Prerequisite	None		

Course Objectives

This course aims to:

- Explain the limitations of classical physics and introduce the fundamental principles of quantum, atomic, and nuclear physics.
- Develop understanding of theoretical models describing atomic and nuclear structure and quantum systems.
- Illustrate key phenomena and applications across quantum, atomic, and nuclear physics.

Learning Outcomes

Students will be able to

- Understand the fundamental concepts of quantum mechanics and apply them to microscopic systems.
- Explain atomic structure, related phenomena, and their practical applications.
- Describe nuclear properties and processes and analyze their physical significance and applications

Course Contents

Quantum Mechanics:

Failure of classical physics; black body radiation, photoelectric effect, and Compton scattering, De Broglie hypothesis; Fundamental postulates; Superposition principle, Uncertainty principle, Operators for observables, Schrödinger equation, Particle in a box, Potential wells, Tunneling, Harmonic oscillator, Pauli Exclusion Principle (18 Lectures)

Atomic Physics:

Bohr model and its limitations, Hydrogen atom, Atomic spectra, Franck–Hertz experiment, Spontaneous and stimulated emissions, Atomic transitions and Einstein coefficients, Introduction to lasers (9 Lectures)

Nuclear Physics:

Rutherford scattering experiment; Nuclear properties and experimental determination; Binding energy and nuclear stability; Radioactive decay and half-life; Nuclear models; Nuclear fission and fusion (12 Lectures)

Textbooks

1. Beiser, A. (2003). Concepts of Modern Physics. McGraw-Hill.
2. Introductory Nuclear Physics, Kenneth S. Krane, John Wiley & Sons Inc, 3rd Ed.
3. D. J. Griffiths and D. F. Schroeter, Introduction to Quantum Mechanics, Cambridge, 3rd Ed., 2018.

Reference Books

1. R. Shankar, Principle of Quantum Mechanics, Springer, 2nd ed. 2014
2. R. P. Feynman, R. B. Leighton, and M. Sands, The Feynman Lectures On Physics - Vol. 3 - Quantum Mechanics: The New Millennium Edition, Pearson Education, 1st Ed., 2012.

Self-Learning Material

1. NPTEL Course Material, Balakrishnan, V., Department of Physics, IIT Madras <https://nptel.ac.in/courses/122106034/>.
2. Prof. H. C. Verma, IIT Kanpur, <https://hcoverma.in/QuantumMechanics>

Title	Electronics I	Course No.	PHL3XXX
Department	Physics	L-T-P [C]	3-0-0 [3]
Offered for	ITEP	Type	Elective
Prerequisite	None		

Course Objective

The instructor will:

1. Develop understanding of semiconductor devices and their applications.
2. Understand amplifier and oscillator fundamentals.
3. Learn operational amplifier basics and applications.

Learning Outcomes

Upon successful completion of this course, students will be able to:

1. Explain diode and transistor characteristics clearly.
2. Analyze basic amplifier and OPAMP circuits.
3. Understand oscillator principles.

CONTENTS

1. **Circuit Analysis and Network Theorems:** Basic circuit elements: R, L, C and sources. Kirchhoff's laws: KCL and KVL. Network theorems: Superposition, Thevenin, Norton. (4 Lectures)
2. **PN Junction Diodes and Electronics:** Formation of p-n junction, Forward and reverse bias, I-V characteristics of diode, Zener diode and breakdown mechanism, Applications of Zener diode (voltage regulation), Half wave and full wave rectifier circuits. (8 Lectures)
3. **Bipolar Junction Transistor:** Structure and working of BJT, Current components and operation, Characteristics in CB, CE, and CC configurations, Transistor as amplifier and switch (10 Lectures)
4. **Amplifiers and Oscillators:** Single-stage transistor amplifier, Gain and signal amplification (qualitative), Two-stage R-C coupled amplifiers, Frequency response (basic idea), Concept of feedback, Barkhausen condition, Sinusoidal oscillators (basic types and working) (12 Lectures)
5. **Operational Amplifiers:** Introduction to OPAMP, Inverting amplifier, Non-inverting amplifier, Applications of OPAMP (5 Lectures)

Textbook

Electronic Principles, Malvino, bates, Hoppe, Mc Graw Hill, 2021

Reference Book

Electronic Devices, Floyd, Pearson, 10e

Title	Solid State Physics	Course No.	PHL3XXX
Department	Physics	L-T-P [C]	3-0-0 [3]
Offered for	BSc - BEd (ITEP)	Type	Elective
Prerequisite	None		

Course Objective

The Instructor will:

1. Provide an introduction to crystals and their representation in physics
2. Provide the concepts of thermal, electronic, magnetic and dielectric properties due to the periodic nature of crystals

Learning Outcomes

The students are expected to have the ability to:

1. Understand the physical properties of crystalline materials using simple models and approximations
2. Develop the understanding how many body interactions at quantum scale manifests into measurable and observable physical effects

Course Content

1. **Crystal Structure:** Solids and Liquids, Symmetry, Periodic Lattice, Unit Cell, Miller indices, Reciprocal Lattice, Brillouin Zone, X-ray diffraction and extinction rules, **Crystal Binding:** Crystals of inert gasses, Van der Waals London interaction, Cohesive energy, Ionic, Covalent and Metallic bonding, Hydrogen bonds (13 Lectures)
2. **Phonons in Solid:** Phonon dispersion for mono and diatomic systems, Phonon heat capacity, Density of states, Einstein and Debye model of specific heat capacity, Thermal expansion and Thermal conductivity. **Electron in Periodic potential:** Free Electron model, Density of states, Heat capacity, Electrical conductivity, Motion in magnetic field, Thermal conductivity and Lorentz number, Energy Bands, Bloch function, Kronig-Penney model, metals, semiconductors and insulators (16 Lectures)
3. **Magnetism and Superconductivity:** Types of Magnetism, Quantum theory of dia and paramagnetism, Weiss model of Ferro and Antiferromagnetism, Domains and hysteresis, Meissner effect, Theoretical Models of Superconductivity, BCS theory, Josephson effect, Flux quantization. (10 Lectures)

Textbooks

1. Kittel, C., Introduction to Solid State Physics, Wiley, 8th Edition, 2008.
2. Omar, M. A., Elementary Solid State Physics, Pearson, 2009.

Reference Books

1. Ashcroft, N., W. and Mermin, N., D., Solid State Physics, Cengage Learning, 1976
2. Simon, S., The Oxford Solid State Basics, Oxford University Press, 2013
3. Dekker, A. J., Solid State Physics, Springer, 1981

Self-Learning Material

1. Rangarajan, G., Condensed Matter Physics, NPTEL Course Material, Department of Physics, Indian Institute of Technology Madras, <https://nptel.ac.in/courses/115106061/>.
2. Wen, X-G., Physics of Solids I, MIT open course, <https://ocw.mit.edu/courses/physics/8-231-physics-of-solids-i-fall-2006/>

Title	Introduction to Plasma Physics	Course No.	PHL3XXX
Department	Physics	L-T-P [C]	3-0-0 [3]
Offered for	BSc - BEd (ITEP)	Type	Elective
Prerequisite	Electromagnetic theory		

Course Objective

This course aims to:

- introduce fundamental properties and parameters of plasmas (e.g., Mean free path, Debye length, Debye shielding, plasma temperature, plasma oscillations, degree of ionisation, etc.)
- provide an understanding about basic plasma models (single-particle, fluid description)
- present an overview of the importance of plasma science and develop problem-solving skills using simplified plasma models.

Learning Outcomes

Students will be able to:

- Understand plasma and explain key concepts like quasi-neutrality and Debye shielding, etc.
- Calculate important plasma parameters and describe motion of charged particles in electric and magnetic fields
- Identify and understand real-world plasma applications

Course Content

Introduction to Plasma: Definition and characteristics of plasma, laboratory plasmas, Plasma vs ordinary gases, Degree of ionization, Saha equation, Temperature Concept, Debye Shielding Concept, Plasma frequency, Criteria for plasma behavior, Concept of quasi-neutrality and plasma sheath. (10 Lectures)

Oddities of plasma: Breakdown conditions, Ionization kinetics, Electron heating mechanisms and energy coupling, Electron energy distribution function, DC plasma, DC-pulsed plasma, RF Plasma, Capacitive plasma, Inductive plasma, Atmospheric pressure cold plasma (8 Lectures)

Single Particle Motion: Motion in electric field, Motion in magnetic field, combined electric and magnetic fields, Drift motions ($E \times B$ drift, gradient drift -conceptual level) (5 Lectures)

Plasma as a Fluid: Fluid description of plasma, continuity equation, momentum equation, concept of pressure and temperature in plasma, plasma oscillations (electron oscillations), basic wave propagation, qualitative introduction to dispersion (8 Lectures)

Applications of Plasma Physics: Space plasmas (ionosphere, solar wind, and auroras), industrial applications (plasma cutting, semiconductor processing), plasma in everyday life (food, health and agriculture, etc.), controlled thermonuclear fusion (tokamak concept) (8 Lectures)

Textbooks

1. F.F. Chen, Introduction to Plasma Physics and Controlled Fusion, Volume 1: Plasma Physics, NY, Plenum Press, 1984
2. J.A. Bittencourt, Fundamentals of Plasma Physics, 3rd Ed., Textbook, Springer (2004)

3. P.I John, Plasma Sciences and the Creation of Wealth, Tata McGraw-Hill Education Company Pvt. Ltd., New Delhi, 2005

Reference Books

1. D. R. Nicholson, Introduction to Plasma Theory, John Wiley & Sons, New York, 1983, XII, 292 pp.
2. R.J Goldston and Paul H. Rutherford, Introduction to Plasma Physics, Institute of Physics Publishing, Bristol 1995.
3. Michael Lieberman and Allan J. Lichtenberg, Principles of Plasma Discharges and Materials Processing, John Wiley, 2005

Self-Learning Material

<https://nptel.ac.in/courses/115102020/>

Title	Modern Optics	Course Code	Course No. PHL3XXX
Department	Physics	L-T-P [C]	3-0-0 [3]
Offered for	B.Sc.-B.Ed. (ITEP)	Type	Elective
Prerequisite	Fundamental of optics		

Course Objective

The instructor will:

- Provide an understanding about advanced optical phenomena which are applicable in modern optical instruments.
- Provide a detailed understanding about the Fourier optics as well as laser physics

Learning Outcomes

Upon successful completion of this course, students will be able to:

- Understand the behavior of light propagating in a medium.
- Solve the complex optics problems and develop new optical devices using Fourier optics as well as implanting interference.

Course Contents

Propagation of Light- Maxwell's wave equation, EM wave propagation in isotropic and anisotropic media, Simple harmonic motion, damped simple harmonic motion, Forced vibration, Origin of refractive index, Rayleigh Scattering, Optical Scattering, Mie Scattering, Dispersion and Absorption of light, EM spectrum. (8 Lectures)

Fourier Optics: Fresnel diffraction integral, The Fraunhofer Approximation, Fraunhofer diffraction by a long narrow slit, Fraunhofer diffraction by rectangular aperture and circular apertures, Spatial frequency filtering, 4f correlator, The Fourier transforming property of thin lens, Basic understanding Holography and its applications. (11 Lectures)

Interferometry: Multiple beam interference by multiple reflections from plane parallel film, The Fabry-Perot Etalon, The Fabry-Perot Interferometer, resolving power, The Interference filters, Mach-Zehnder Interferometer, Applications. (8 Lectures)

Laser Physics: Absorption, Spontaneous and Stimulated Emission, Einstein coefficients, Temporal coherence, Spatial coherence, Lasing Mechanism, Laser oscillator, Laser characteristics, Principles of operation of lasers, Modes and modes selection, Laser line width, Line broadening mechanisms, Laser rate equations for 2,3 and 4 levels systems, Types of lasers and their applications. (12 Lectures)

Textbooks:

1. Optics; Ajoy Ghatak, McGraw Hill Education, 7e, 2022.
2. Optics; Eugene Hecht and A. R. Ganesan, Person, 4e, 2008
3. Fundamental of Photonics; B. E. A. Saleh and M. C. Tech; 2e, Willey, 2007

Reference Books:

1. Principle of Optics; Born and Wolf, 4e, Pergamon Press, 1970.

2. Optical Electronics; Ajoy Ghatak and K. Tyagrajan, Cambridge University Press, Cambridge, 1989.

Self-Learning Material

1. NPTEL course by Prof. M R Shenoy Department of Physics, IIT Delhi "Introduction to lasers"
https://www.youtube.com/watch?v=Ab1nxxkgjH8&list=PLp6ek2hDcoNCj_QQA2CmW1JIHAM5aD7o
2. NPTEL course by Prof. Akhilesh Mishra, Department of Physics, IIT Roorkee "Applied Optics"
https://www.youtube.com/watch?v=GQ5XpeS3e3U&list=PLLy_2iUCG87B_Tmfs0y2tR8GNlkyRIKpW

Title	Physics Lab II	Course No.	PHP3XXX
Department	Physics	L-T-P [C]	0-0-6 [3]
Offered for	BSc - BEd (ITEP).	Type	Elective
Prerequisite			

Course Objective

The instructor will:

1. Provide an experimental understanding of solid-state physics, atomic and nuclear physics to observable phenomena.
2. Enable students to understand and experimentally verify the fundamental principles of electronic devices, analog/digital circuits, and optical phenomena.

Learning Outcomes

The students will be able to:

1. Bridge the connecting dots between classical and modern (origin of quantum) physics.
2. Measure and analyze fundamental properties of materials.
3. Understand and design basic electronic components and circuits.

Course Content

1. Solid State Physics

Lattice vibration and phonon

- a. Lattice dynamics kit
- b. Raman Spectroscopy

Ferroic properties

- a. M-H loop
- b. Dielectric constant and Curie temperature of BaTiO₃

Electronic properties

- a. 4-probe resistivity
- b. Hall effect

Resonance properties

- a. Electron Spin Resonance
- b. Paschan Curve

2. Modern Physics

Measurement of fundamental constant

- a. Photoelectric Effect (Planck's constant)
- b. Rydberg Constant

Measurement of e/m Ratio

- a. Millikan oil drop experiment
- b. e/m ratio (Thomson method)

Geiger-Muller (GM) Counter

- a. GM Tube characterization and study of statistical nature of radioactive decay
- b. Gamma ray absorption in the material (Al & Cu)

Interferrometry

- a. Michelson interferometer
- b. Mach-Zender interferometer

Electronics

1. Verification of Kirchhoff's Current Law (KCL) and Kirchhoff's Voltage Law (KVL)
2. Verification of Superposition Theorem
3. Resonance frequency of LCR circuit in series and parallel
4. Study of V-I Characteristics of PN Junction Diode
5. Study of Zener Diode Characteristics and Voltage Regulation
6. Study of BJT Characteristics in Common Emitter (CE) Configuration
7. Study of Transistor as a Switch
8. Construction and Analysis of Single-Stage RC Coupled Amplifier
9. Study of Inverting and Non-Inverting OPAMP Circuits using IC 741

Textbooks:

1. [B.Sc.](#) Practical Physics, C L Arora, S Chand publication
2. Manual provided by IITJ

Reference Books:

1. Advanced Practical Physics, B L Worsnop and H T Flint, Khosla Publishing

Title	Foundations of Nuclear and Particle Physics	Course No.	PHL3XXX
Department	Physics	L-T-P [C]	3-0-0 [3]
Offered for	BSc - BEd (ITEP).	Type	Elective
Prerequisite	None		

Course Objectives

The instructor will

1. Enable students to understand the basic concepts of nuclear structure, stability, and nuclear forces.
2. Explain radioactivity and nuclear reactions with their practical and astrophysical applications.
3. Facilitate a simple understanding of elementary particles and fundamental interactions for teaching purposes.

Learning Outcomes

Students will be able to:

1. Understand and explain the basic concepts of nuclear and particle physics, including nuclear structure, radioactivity, nuclear reactions, and elementary particles
2. Communicate effectively these concepts to school-level physics using simple examples, diagrams, and applications.

Course Content

1. **Nuclear Structure and Properties:**
Nuclear size, mass, density, and radius, angular momentum, spin and parity, binding energy, experimental determination of nuclear properties, Hofstadter's experiment, nuclear forces and their spin dependence, deuteron problem (10 lectures)
2. **Radioactivity and Weak Interactions**
Radioactive disintegration and displacement law, mean life and half-life, α -decay: Quantum tunneling and Geiger-Nuttall law, β -decay and γ -decay (9 lectures)
3. **Nuclear Reactions, Forces and Models:**
Nuclear reactions and mechanisms, Q-value and energy balance, Compound nucleus, Nuclear fission and fusion, Properties of nuclear force, Nucleon-nucleon interaction, Liquid drop model, Bethe-Weizsacker formula, Nucleon mean potential and approximation by solvable potentials, Shell Model. (10 lectures)
4. **Special theory of relativity (STR) and Elementary Particles:**
STR, time dilation and length contraction, Lorentz transformation, Relativistic momentum and energy, Classification of elementary particles, Fundamental interactions in nature, Conservation laws and symmetry principles, Properties of pion, muon, and strange mesons. (10 lectures)

Textbooks

1. Introductory Nuclear Physics, K. S. Krane, Wiley, 1987.
2. Nuclear Physics, S. N. Ghoshal, S. Chand, 2011.

3. Introduction to Elementary Particles, D. Griffiths, Wiley-VCH, 2008.

Reference Books:

1. Cohen, B. L., Concepts of Nuclear Physics, McGraw-Hill, 2017.
2. Burcham, W. E., and Jobes, M., Nuclear and Particle Physics, John Wiley & Sons, 1995.
3. Povh, B., Rith, K., Scholz, C., and Zetsche, F., Particles and Nuclei: An Introduction to Physical Concepts, Springer, 7th edition.

Self-Learning Material

1. NPTEL – H. C. Verma, Nuclear Physics: Fundamentals and Applications
<https://nptel.ac.in/courses/115104043/>
2. MIT OpenCourseWare:
<https://ocw.mit.edu/courses/8-701-introduction-to-nuclear-and-particle-physics-fall-2020/>

Title	Electronics II	Course No.	PH3XXX
Department	Physics	L-T-P [C]	3-0-0 [3]
Offered for	BSc BEd	Type	Elective
Prerequisite	Electronics I		

Course Objective

- Understand number systems and conversions.
- Develop logical reasoning using Boolean algebra.
- Learn logic gates and circuit construction.
- Apply De Morgan's theorem and simplification techniques.
- Enable effective teaching of digital electronics concepts.

Learning Outcomes

Upon successful completion of this course, students will be able to:

- Convert between number systems.
- Perform binary arithmetic.
- Simplify Boolean expressions.
- Construct truth tables and logic circuits.
- Teach digital electronics effectively.

CONTENTS

1. **Number Systems and Binary Arithmetic:** Decimal, Binary, Octal, Hexadecimal number systems, Conversion between number systems, Binary addition and subtraction (10 LECTURES)
2. **Boolean Algebra:** Boolean variables and operations, Laws of Boolean algebra, Simplification techniques, De Morgan's theorem (10 Lectures)
3. **Logic Gates:** AND, OR, NOT gates, NAND and NOR (universal gates), Exclusive OR (XOR), Truth tables, Combination of gates (10 Lectures)
4. **Boolean Function Realizations:** Implementation using logic gates, NAND and NOR realization, Application of De Morgan's theorem (5 Lectures)
5. **Applications:** Applications of digital electronics, Demonstration of logic circuits (4 Lectures)

Textbooks:

1. *Digital Principles and Applications* – Malvino & Leach

Reference Books:

1. *Digital Electronics* – Morris Mano (introductory portions)

Title	Introduction to Material Characterization	Course No.	PH3XXX
Department	Physics	L-T-P [C]	3-0-0 [3]
Offered for	BSc-BEd	Type	Elective
Prerequisite	None		

Course Objectives

The instructor will

1. Introduce the fundamental principles and importance of material characterization
2. Explain structural, optical and electrical characterization techniques for crystalline and amorphous materials.
3. Enable interpretation of experimental data and correlation with material properties.

Learning Outcomes

Upon successful completion of this course, students will be able to:

1. Select appropriate characterization techniques for specific material properties and applications.
2. Analyze and interpret data obtained from structural, microscopic, and spectroscopic methods.
3. Correlate characterization results with structure-property relationships in materials.

CONTENTS

Material Characterization by Diffraction and Electron Microscopy: Introduction and Necessity of Material Characterization: Structural and functional properties of materials, Diffraction based Characterization: Structure of crystalline and non-crystalline materials by x-ray diffraction, indexing of lattice planes and lattice parameter determination, electron and neutron diffraction, small angle scattering, Introduction to Electron Microscopy: Scanning Electron Microscopy (SEM). (13 Lectures)

Characterization of Materials by Microscopy and Spectroscopy: Optical microscopy, Polarization Microscopy, Fluorescence Microscopy, Phase contrast Microscopy, Scanning Tunneling Microscopy (STM) and Atomic Force Microscopy (AFM), Spectroscopic based Characterization: UV-Vis-NIR, FTIR, Photoluminescence. (13 Lectures)

Functional Properties of Materials: Electrical properties: Resistivity (Four probe and Van der Pauw method), Magnetoresistance and Hall effect, Magnetic properties: Magnetization and magnetic moment, Measurement of Magnetization by force and by induction, Magnetic Hysteresis, Magnetic susceptibility, Principles of Electron Paramagnetic Resonance and Nuclear Magnetic Resonance (NMR). (13 Lectures)

Textbooks:

1. Zhang, S., Li, L. and Kumar, A., Materials Characterization Techniques, CRC Press, 2008
2. Mertz, J., Introduction to Optical Microscopy, 2nd Edition, Cambridge University Press, 2019

Reference Books:

1. Yang Leng "Materials Characterization: Introduction to Microscopic and Spectroscopic Methods"
2. Cullity, B. D., and S. R. Stock. Elements of X-Ray Diffraction. 3rd edition.

Self-Learning:

Shankaran, S., Materials Characterization, NPTEL Course Material, Department of Metallurgical & Materials Engineering, Indian Institute of Technology Madras, <http://nptel.ac.in/courses/113106034/>.

MAJOR-WISE COURSE CONTENT

3. Courses In Chemistry

Title	General Chemistry - I	Course No.	CYL1XXX
Department	Chemistry	L-T-P-D [C]	3-0-2-0 [4]
Offered for	BSc-BEd	Type	Core
Prerequisite	None		

Objectives
The Instructor will provide basic understanding of all areas of chemistry: inorganic, organic, and physical chemistry

Learning Outcomes
The students are expected to have the ability to:

1. understand and appreciate the concepts involved in major chemical processes
2. access and interpret information to solve problems

Contents

Inorganic Chemistry: Atomic structure and periodic table, Introduction to Periodicity, general trends, blocks of periodic table, s-block, p-block and d-block elements. Introduction to Acid-base theories and oxidation reduction processes (**13 Lectures**).

Organic Chemistry: Hybridization, atomic and molecular orbitals, structures, IUPAC nomenclatures, Classification of organic compounds and functional groups, electronic and steric effects, organic acid and base, pKa, basics of stereochemistry, representations of small organic molecules (**13 Lectures**).

Physical Chemistry: Kinetics and Thermodynamics: System and Surroundings, State and Path functions, Reversible and irreversible processes, Laws of Thermodynamics, Thermodynamics functions, Rates of reactions, order and Molecularity, Arrhenius Equation (**13 Lectures**).

Laboratory Experiments:
Preparation of a Double Salt; Estimation of percentage of water in metal hydrates.; Determination of rate constant for first order acid catalysed hydrolysis of an ester.; Estimation of sodium carbonate using standardized HCl. Detection of functional groups: chemical and spectroscopic methods, Reduction of ketone/aldehyde

Textbooks

1. J.D. Lee, Concise Inorganic Chemistry, (5th Edition), ELBS, 1996.
2. R.T. Morrison and R.N. Boyd, Organic Chemistry, Prentice Hall of India Pvt. Ltd., 5th Ed., 1990
3. G. Solomons and C. Fryhle, Organic Chemistry, John Wiley & Sons (Asia) Pvt. Ltd.
4. D. A. McQuarrie and J. D. Simons, Physical Chemistry 1st Edn, Viva Books Private Limited, New Delhi, 1998.

References

1. Irving M. Klotz and Robert M. Rosenberg, Chemical Thermodynamics: Basic Concepts and Methods, Wiley, 2008.
2. A.J. Elias, A Collection of Interesting General Chemistry Experiments, Universities Press (1 January 2008).

Online Resource:
NPTEL Course, NOC: Basics in Inorganic Chemistry, IIT Bombay (<https://nptel.ac.in/courses/104101121>)
NPTEL Course, Basic Organic Chemistry, IIT Guwahati (<https://nptel.ac.in/courses/104103071>)

NPTEL Course, NOC: Introduction to Chemical Thermodynamics and Kinetics, IISER Mohali
(<https://nptel.ac.in/courses/104106089>)

Title	General Chemistry - II	Course No.	CYL1XXX
Department	Chemistry	L-T-P [C]	3-0-2 [4]
Offered for	BSc-BEd	Type	Core
Prerequisite	None		

Objectives

The Instructor will:

1. Provide basic understanding of all areas of chemistry: inorganic, organic, and physical
2. Impart depth of knowledge involving chemical principles to apply the concepts in any scientific discipline

Learning Outcomes

The students are expected to have the ability to:

1. understand and appreciate the concepts involved in major chemical processes
2. will demonstrate the ability to access and interpret information to solve problems

Contents

Inorganic Chemistry: Structure and bonding of Molecules: General introduction to the concepts of bonding, the ionic, covalent, coordinate bonding, hydrogen bonding, π -bonding, μ - bond, δ -bond, concept of bond energy; Simple bonding theories of molecules: VSEPR theory, hybridisation, VBT, Limitations of VSEPR and VBT, introduction to Molecular orbital theory, Homonuclear diatomic molecules, heteronuclear diatomic molecules, bond order (**13 Lectures**).

Organic Chemistry: Conformation of cyclic and acyclic molecules, Addition reaction with examples - named reactions, Elimination (E1, E2 and E1Cb) - named reactions, substitution reactions (SN1, SN2, SNi etc) - named reactions, neighbouring group participation, and functional group transformations, examples of rearrangement reactions, aromaticity and reactions of aromatic compounds including heterocyclic examples (13 Lectures).

Physical Chemistry: Introduction to Molecular Spectroscopy: General features, Experimental methods, Linewidths, Pure rotation spectra, Electronic, Vibrational and Magnetic Resonance (MR) spectroscopy and applications (**13 Lectures**).

Laboratory Experiments

Estimation of Water Hardness by EDTA; Iodometric determination of copper using thiosulphate.; Measuring IR and UV spectra for common compounds.; Acid catalyzed esterification: Aspirin synthesis, Determination of optical purity of chiral molecules by polarimeter

Textbooks

1. J. D. Lee, Concise Inorganic Chemistry, (5th Edition), ELBS, 1996.
2. R.T. Morrison and R.N. Boyd, Organic Chemistry, Prentice Hall of India Pvt. Ltd., 5th Ed, 1990
3. G. Solomons and C. Fryhle, Organic Chemistry, John Wiley & Sons (Asia) Pte. Ltd.
4. P.W. Atkins, Julio de Paula, Physical Chemistry, Oxford University Press, 2008.
5. A.J. Elias, A Collection of Interesting General Chemistry Experiments, Universities Press (1 January 2008).

Self-learning Material

NPTEL Course, NOC: Basics in Inorganic Chemistry, IIT Bombay

(<https://nptel.ac.in/courses/104101121>)

NPTEL Course, Basic Organic Chemistry, IIT Guwahati, (<https://nptel.ac.in/courses/104103071>)

NPTEL Course, NOC: Fundamentals of Spectroscopy, NCL Pune, IISER Pune,

(<https://nptel.ac.in/courses/104106122>)

Title	Basics Principles of Chemistry	Course No.	CYL2XX0
Department	Chemistry	L-T-P [C]	3-0-2 [4]
Offered for	B.Sc.-B.Ed.	Type	Core
Prerequisite	Nil		

Objectives

The instructor will:

1. Provide basic understanding of all areas of chemistry: inorganic, organic, and physical.
2. Impart depth of knowledge involving chemical principles to apply concepts in any scientific discipline

Learning Outcomes

The student will be able to

1. Describe the concepts involved in major chemical processes
2. Interpret intermediates to solve reactions and mechanisms

Contents

In-organic Chemistry: Introduction to Organometallic Chemistry, 18 electron rule, Common organometallic ligands and their bonding, Oxidative addition, Reductive elimination, Selective applications. Introduction to Solid State Chemistry; Types of solids, Symmetry in crystals, Bravais lattice, unit cell, X-ray diffraction, Bragg's law, Structure of crystalline solids such as NaCl, Diamond. **(13 Lectures)**

Organic Chemistry: Mechanism and Intermediates: Reaction mechanisms and different methods for their determination, Isomerization, Resonance, Inductive effect, hyperconjugation, structure and reactivity of carbocation including nonclassical carbocation, carbanion, radical, carbene, nitrene, concerted and stepwise mechanism, transition states and intermediates, early and late transition states, exothermic and endothermic reactions with examples. **(13 Lectures)**

Physical Chemistry: Probability. Average, Central Limit Theorem, Binomial distribution, Stirling's approximation, Microstate, Macrostate, NVT, NVE ensemble, Boltzmann distribution, significance of Boltzmann distribution in physical chemistry, Average vs observed quantity, definition of entropy, 2nd law of thermodynamics, heat capacity, Helmholtz and Gibbs free energy. **(13 Lectures)**

Laboratory Experiments:

Extraction: Separation of an Acidic, a Basic and a Neutral Substance, Green Chemistry: A Solvent-Free Aldol Condensation; Solid phase Synthesis and characterization of trans bis glycinato Cu(II); Synthesis and characterization of acetylferrocene from ferrocene; Determination of equilibrium constant by partition method, Determination of free energy from equilibrium constant using UV-visible spectroscopy.

Textbooks

1. J.D. Lee, Concise Inorganic Chemistry, (5th Edition), ELBS, 1996.
2. R.T. Morrison and R.N. Boyd, Organic Chemistry, Prentice Hall of India Pvt. Ltd., 5th Ed, 1990
3. D. A. McQuarrie, Physical Chemistry: A Molecular Approach, Viva Books, 2017.

Reference Books

1. Clayden, J., Greeves, N., and Warren, S., (2012), Organic Chemistry, 2nd Edition, Oxford
2. G. Solomons and C. Fryhle, Organic Chemistry, John Wiley & Sons (Asia) Pte Ltd.

Online Resource:

Basics in Inorganic Chemistry, Prof. Debabrata Maiti, IIT Bombay:

<https://nptel.ac.in/courses/104101121>;

Basic organic Chemistry, Prof. T. Punniyamurthy, IIT Guwahati

<https://nptel.ac.in/courses/104103071>;

Fundamentals of Spectroscopy, NCL Pune, IISER Pune, Prof. Anirban Hazra, Prof. Sayan Bagchi

<https://nptel.ac.in/courses/104106122>

Title	Molecular Structure and Spectroscopy	Course No.	CYL2XX0
Department	Chemistry	L-T-P [C]	3-0-2 [4]
Offered for	B.Sc.-B.Ed.	Type	Core
Prerequisite	Nil		

Objectives

The instructor will:

1. Attempt to provide fundamental aspects of theory in view of foundations of quantum chemistry
2. Discuss a few applications of quantum theory to chemistry
3. Establish the relation between fundamentals of spectroscopy and quantum chemistry

Learning Outcomes

By the end of this lesson, the student will be able to:

1. Describe fundamentals of quantum mechanics and its applications to chemistry
2. Solve and analyze exactly solvable problems and interpret solutions to discuss symmetry, energy levels, spectroscopy, atomic orbitals and spins

Contents

The transition from classical to quantum regime, Uncertainty principle, the Schrödinger equation and its physical interpretation, Time-independent Schrödinger equation, wave functions, operators, commutator algebra and Uncertainty principle, Eigenvalues and Eigenvectors in quantum mechanics (**10 lectures**)

Particle in a one-dimensional box, Measurement outcomes and Fourier series, Postulates and theorems in quantum mechanics, Particle in a three-dimensional box- separation of variables, Wave functions and symmetry in quantum mechanics, Finite square well and tunnelling (**10 lectures**)

Classical Harmonic oscillator, The Harmonic oscillator model for a diatomic molecule and its relation to infrared spectra, Vibrations of diatomic molecules, Harmonic oscillator selection rules (**9 lectures**)

The rigid-rotator model for a diatomic molecule, Angular momentum, Rigid-rotator selection rules, the hydrogen atom solution and atomic orbitals, Introduction to electron spin-Stern-Gerlach experiment, Zeeman effect and spin-orbit coupling, Many-electron systems (**10 lectures**)

Lab Experiments: 1] Determination of lambda max and calculation of transition energy by UV-visible spectroscopy, 2] Determination of force constant of a diatomic molecule using IR, 3] proton NMR spectra of acetone, 4] Calculation of extinction coefficient using Beer Lambert's Law, 5] Effect of solvent polarity on emission spectra, 6] Plotting wave functions using Mathematica.

Textbooks

1. Levine, I. N., (1983), *Quantum Chemistry*, 3rd Edition, Allyn and Bacon

Reference Books

1. McQuarrie, D. A., (1983), *Quantum Mechanics*, 2nd Edition, University Science Books
2. Atkins, P. and Friedman (2005), R., *Molecular Quantum Mechanics*, 4th Edition, Oxford University Press, London

3. Pauling, L., (1985), Introduction to Quantum Mechanics with Applications to Chemistry, Dover Publications Inc.

Self-Learning Material

Datta, A., Quantum Chemistry of Atoms and Molecules, NPTEL Course Material, Department of Chemistry, Indian Institute of Technology Bombay:

<https://www.youtube.com/playlist?list=PLOzRYVm0a65eW1kTGOrjBetXFMI4eaYVi>

Title	Chemistry of Inorganic Compounds	Course No.	CYL2XX0
Department	Chemistry	L-T-P [C]	3-0-2 [4]
Offered for	ITEP (Semester 4)	Type	Core
Prerequisite	Nil		

Objectives

The instructor will:

1. provide knowledge on the main group, transition metal and f block element based important compounds, and their application in practical purposes.

Learning Outcomes

The students will be able to:

1. Describe fundamental aspects of main group, transition metal, lanthanide, and actinide, compounds.
2. Explain the potential of periodic elements in practical applications.

Contents:

Introduction of molecular geometry, symmetry and point groups, hypervalency (6 Lectures)

Main group compounds: Hydrogen and its compounds -ionic, covalent, and metallic hydrides, hydrogen bonding; chemistry of lithium, beryllium, boron, carbon, nitrogen, oxygen and halogen groups; chains, rings, and cage compounds. (13 Lectures)

Compounds of d block elements: descriptive chemistry of transition metals, periodic trends, compounds of various oxidation states of transition metals (8 Lectures)

Chemistry of lanthanides and actinide elements, shift reagents, strong magnets, fluorescence.(4 Lectures)

Introduction to various characterization techniques for inorganic compounds: IR, multinuclear NMR, EPR, Mass. (8 Lectures)

Lab Experiments:

1. Color effects in aqueous systems containing divalent 3d metal ions
2. Synthesis and characterization of bispyridine iodide nitrate
3. Acidic and basic salts: Hydrolysis of salts and its consequences
4. The preparation of two crystalline binary transition metal p-toluenesulfonate salts of $[MII(OH_2)_6]^{2+}$ - $[OTs]^-$ stoichiometry, Where MII = Co and Ni.
5. The preparation of cis- and trans -potassiumdioxalatoaquochromate(III).
6. Preparation and Characterization of Hydroxyapatite.

Textbook

1. Cotton, F.A.; Wilkinson, G.; (2007) Advanced Inorganic Chemistry, Wiley, 6th edition
2. Lee, J.D. (2012), Concise Inorganic Chemistry, Oxford University Press; 6th edition
3. Chemistry of the Elements" Elsevier Science, Author: N. N. Greenwood, A. Earnshaw

Reference Books

1. Housecroft, C and Sharpe, A. G. (2012) Inorganic Chemistry, 4th Edition, Pearson

2. The Chemistry of the p-Block Elements:’ by Prof. A. J. Elias

Self-Learning Material

Balakrishna, M. S., Chemistry of Main Group Elements, NPTEL Course Material, Department of Chemistry, Indian Institute of Technology Bombay, <http://nptel.ac.in/courses/117101105/>

Title	Equilibrium Thermodynamics	Course No.	CYL2XX0
Department	Chemistry	L-T-P [C]	3-0-2 [4]
Offered for	ITEP	Type	Core
Prerequisite	Nil		

Objectives

1. To provide fundamental aspects of Thermodynamics, chemical equilibria and phase equilibria

Learning Outcomes

The students will be able to:

1. Describe thermodynamics, chemical equilibria and phase equilibria
2. Demonstrate the conductivity measurements

Contents

Thermodynamics: Work, heat & energy, First Law of Thermodynamics, Enthalpy, heat capacity, Expansion of ideal gas, Joule-Thomson effect, Zeroth Law of Thermodynamics, changes of enthalpy and entropy in reactions, second law of thermodynamics, spontaneous, irreversible and cyclic process, Carnot theory, entropy changes in various processes, Maxwell's relations, Gibbs-Helmholtz equation, thermodynamics of open system, chemical potential, Third law of thermodynamics, determination of absolute entropies, entropy of real gas, residual entropy (15 lectures)

Chemical Equilibrium: Spontaneous reactions, Standard free energy, law of mass action, Van't Hoff reaction isotherm, De Donder treatment, chemical affinity, Homogeneous equilibria, Temperature and Pressure dependence of equilibrium constant, Van't Hoff equation, Heterogeneous equilibria, Equilibrium constant for reaction involving real gases (5 lectures)

Phase Equilibrium: Phase, Components, Degree of freedom, Gibbs phase rule, One-component systems, High pressure phase diagrams, Two-component systems, Liquid-liquid and liquid-solid equilibria, Eutectic systems, Thermal analysis, Cooling curves, Freezing point diagrams with Congruent and incongruent melting, Three-component solid-liquid systems, Ehrenfest classification of phase transitions. (10 lectures)

Electrochemistry: Faraday's law, Types of conductance, Measurement of equivalent conductance, Variation of conductance with dilution, Kohlrausch's law, Arrhenius theory of electrolyte dissociation, Weak and strong electrolytes, Ostwald's dilution law, Debye-Huckel-Onsager's equation for strong electrolytes, Migration of ions, Transport number, Determination of degree of dissociation, ionic product of water and solubility product of sparingly soluble salts, Conductometric titrations. (9 lectures)

Lab Experiments:

- 1] Determination of phosphoric acid content in soft drink using pH sensor and titrimetric analysis,
- 2] potentiometric titration of ferrous ammonium sulphate using KMnO_4 ,
- 3] Estimation of free alkali present in soaps,
- 4] Determination of PI of amino acid using pH meter,
- 5] Conductometric titration of a strong acid by strong base, 6] Determination of CMC using conductometric titration.

Textbook

1. Atkins, P.W.; Paula, J.de. (2014), Atkin's Physical Chemistry Ed., 10th Edition, Oxford University Press.
2. Levine, R. N. Physical Chemistry, sixth Ed., Mc Grow Hill

3. Ball, D. W. (2017), Physical Chemistry, 2nd Edition, Cengage Learning, India.
4. Castellan, G. W. (2004), Physical Chemistry, 4th Edition, Narosa.

Reference Books

1. Kapoor, K.L. (2015), A Textbook of Physical Chemistry, Vol 1, 6th Edition, McGraw Hill Education.
2. Puri, Sharma and Pathania (2013), Principles of Physical Chemistry, 46th Edition, Vishal Publishing
3. S. Glasstone, An Introduction to Electrochemistry, East-West Press Pvt. Ltd., New Delhi, 2007.

Self-Learning Material

Basic Thermodynamics, Dr. Suman Chakroborty, NPTEL
<https://nptel.ac.in/courses/112105123> Sangaranarayanan, M.V., Electrochemistry, Department of Chemistry, IIT Madras; <https://nptel.ac.in/courses/104106129>

Title	Separation and Structural Elucidation of Organic Compounds	Course No.	CYL2XX0
Department	Chemistry	L-T-P [C]	3-0-2 [4]
Offered for	B.Sc.-B.Ed.	Type	Core
Prerequisite	Nil		

Objectives

The instructor will:

1. teach basic aspects of isolation and purification techniques, spectroscopic methods, important analytical tools in academic research, chemical and pharmaceutical industries for isolation and identification of organic molecules.
2. teach elucidation of structures of organic compounds using in-depth analysis of different spectroscopic data.
3. provide a practical knowledge of organic chemistry.

Learning Outcomes

The students are expected to have the ability to:

1. determine the structures of known/unknown organic molecules utilizing several spectroscopic techniques mentioned in the content.
2. carry out simple synthetic organic transformations, isolate, purification and characterization of the reaction products
3. be familiarized with physical data (melting point, boiling point, flash point, etc.), toxicity, health effects, reactivity, storage, disposal, and spill-handling procedures.

Contents

Purification Techniques: Crystallization, steam and vacuum distillation, fractional distillation, sublimation, differential extraction, thin layer chromatography (TLC), column chromatography, HPLC (3 lectures)

Infrared Spectroscopy: Introduction to IR spectroscopy, Modes of stretching and bending, stretching frequencies of different organic functional groups, Effects of structural and conformational environment (3 lectures)

Ultraviolet-Visible Spectroscopy: Studies on conjugated and extended conjugated systems, analysis and interpretation of UV-Visible spectroscopic data, Application in mechanistic studies (3 lectures)

Mass Spectrometry: Principles of mass spectrometry, Different ionization techniques (EI, CI, ESI etc.), GC-MS, HRMS, LC-MS and MS-MS techniques, Fragmentation and rearrangement of different classes of organic molecules, Isotope effects, Identification of known/unknown organic compounds (6 lectures)

Nuclear Magnetic Resonance Spectroscopy: Chemical shifts of different organic functional groups in ^1H and ^{13}C NMR, origin and interpretation of coupling constant, introduction to the principle and interpretation of DEPT, COSY, NOESY, NOE techniques, Structural elucidation of organic compounds (14 lectures)

Identification and Mechanistic Studies: Application of all above techniques in the structural elucidation of unknown organic compounds and investigation of organic reaction mechanisms (10 lectures)

Lab Experiments:

- 1] Melting point measurement of a given organic compound;

- 2] Identification of an organic compound by HRMS;
- 3] Identification of functional group present using IR spectroscopy;
- 4] Identification of organic compound using NMR spectroscopy;
- 5] Purification of an organic compounds via recrystallization;
- 6] Carbon-Carbon bond formation reaction (Wittig reaction).

Textbooks

1. Donald L. Pavia, Gary M. Lampman, George S. Kriz, James A. Vyvyan: Introduction to Spectroscopy, 4th Edition, Brookes Cole, 2008.
2. Robert M. Silverstein, Francis X. Webster, David Kiemle: Spectrometric identification of organic compounds, 7th Edition, Wiley, 2005.

Reference Books

1. Harald Gunther: NMR spectroscopy, Basic principles, concepts, and applications in chemistry, 2nd Ed., Wiley, 2001 (reprint)
2. Timothy Claridge: High Resolution NMR Techniques in Organic Chemistry, 2nd Ed. Elsevier, 2009

Self Learning Material

<http://nptel.ac.in/courses/104103071/26>

Title	Organic Reactions and Mechanisms	Course No.	CYL3XX0
Department	Chemistry	L-T-P [C]	3-0-0 [3]
Offered for	BSc BEd	Type	Elective
Pre-requisite	None		

Objective

The instructor will:

1. To give students a better insight into the mechanism of diverse set of organic reactions
2. To broaden their knowledge in fundamental organic chemistry with regard to efficiency and selectivity of organic reactions.

Learning Outcomes

The students are expected to:

1. The students are expected to be able to draw mechanisms for complex reactions
2. Understand and predict the orbital interactions involved in organic reactions

Contents

Introduction: reaction mechanism and its need, methods of determination the reaction mechanism, transition states and intermediates, crossover experiments and examples, molecular orbital interaction of common functional groups (**7 lectures**).

Acid and base catalysis: the pK_a scale and its interpretation, pK_a of acids; pK_b (pK_aH) of bases, general and specific acid-base catalysis (**3 lectures**).

Classification of reactions: Substitution, elimination, and addition reactions, aromaticity and aromatic substitution reactions (**9 lectures**).

Selectivity in organic reactions: chemoselectivity, regioselectivity, stereoselective and stereospecific reactions, enantioselectivity, diastereoselectivity, chiral pool synthesis (**8 lectures**).

Radical Chemistry: Basics of radicals, radical initiators, radical halogenation of alkanes, radical name reactions (**5 lectures**).

Rearrangements and migrations: cationic rearrangements, carbanionic rearrangements, carbene/carbenoid-based rearrangements (**7 lectures**).

Text Books:

1. Sykes, P., (2013), A Guidebook to Mechanism in Organic Chemistry, 6th Edition, Longman
2. Clayden, J., Greeves, N., and Warren, S., (2012), Organic Chemistry, 2nd Edition, Oxford
3. Carey, F.A., and Sundberg, R.J., (2007) Advanced Organic Chemistry, Part A: Structure and Mechanisms, 4th Edition, Plenum

References:

1. Gossmann, R.B., (2008), The Art of Writing Reasonable Organic Reaction Mechanism, Springer

Self-learning Material:

1. Sunoj,R.B., Organic Reaction Mechanism, NPTEL Course Material, Department of Chemistry, Indian Institute of Technology Bombay, <http://nptel.ac.in/courses/104101005/>

Title	Main Group and Bioinorganic Chemistry	Course No.	CYL3XX0
Department	Chemistry	L-T-P [C]	3-0-0 [3]
Offered for	BSc. BEd	Type	Elective
Prerequisite	Nil		

Objectives

The Instructor will:

1. Give better insight into chemistry of main group elements and bioinorganic chemistry
2. Provide broad knowledge about properties and applications of compounds of main group elements and metal ions essential in biological systems.

Learning Outcomes

The students are expected to have the ability to:

1. Appreciate chemistry of elements essential in biological systems.
2. Understand structure and bonding concepts in chemistry of s- and p-block elements and systematic understanding of their chemical reactivity

Contents

Chemistry of main group elements: Molecular Geometry and Symmetry, hypervalency, Synthesis, structure and bonding in polyhedral boranes and carboranes, Wade's Rules, electron count, Isolobal analogy. B-N, P-N, S-N unit containing compounds. Compounds of Silicon, Zeolites. Hydrides, halides, oxides, nitrides of s- and p- block elements. Allotropes of Carbon, introduction to carbenes and their heavier analogues. Chemistry of halogens and Noble gases, Chemistry of s-block elements. Organometallic compounds of main group elements. **(15 Lectures)**

Spectroscopic Characterization: NMR, FT-IR, Raman, Mass etc. **(4 Lectures)**

Applications of main group compounds: Frustrated Lewis pairs and small molecule activation, Synthetic uses of main group complexes, Oxidizing/reducing agents. Precursors for materials deposition. Deposition of thin films of materials, with a strong focus on Chemical Vapour Deposition (CVD) and ALD. PET and SPECT imaging. **(8 Lectures)**

Bioinorganic Chemistry: Transition metals in biology - their occurrence and function, active-site structure, Metalloenzymes; O₂ binding properties of heme (hemoglobin and myoglobin) and non-heme proteins hemocyanin & hemerythrin), co-operativity effect, Bohr Effect; representative synthetic models of heme and nonheme systems. Electron transfer proteins - active site structure and functions of ferredoxin, rubredoxin and cytochromes, and their comparisons. Metals in medicine. **(12 Lectures)**

Textbook

1. Huheey, J. E., (2008), *Inorganic Chemistry*, 4th edition, Pearson
2. Housecroft, C. E., and Sharpe, A. G., (2012), *Inorganic Chemistry*, 4th Edition, Pearson
3. Miessler G. L., (2014), *Inorganic Chemistry*, 4th edition, Pearson

Reference Books

1. S. J. Lippard (1994) Principles of Bioinorganic Chemistry, University Science Books.
2. Norman, N. C., (2014), *Periodicity and the p-Block Elements*, Oxford Primer Nos. 51, 2nd Edition, Oxford University Press
3. Atkins, P. (2010) *Inorganic Chemistry*, 5th Edition, Oxford University Press

Self Learning Material

Ray, D., *Bioinorganic Chemistry*, NPTEL Course Material, Department of Chemistry, Indian Institute of Technology, Kharagpur, <http://nptel.ac.in/courses/104105031/>

Title	Physical Organic Chemistry	Course No.	CYL3XX0
Department	Chemistry	L-T-P [C]	3-0-0 [3]
Offered for	BSc. BEd	Type	Elective
Pre-requisite	Nil		

Objective
The instructor will:

- To provide physical concepts of organic chemistry
- To provide knowledge in pericyclic and photochemical reactions

Learning Outcomes
The students are expected to:

- Be able to understand the course of organic reactions with regard to physical concepts and stereochemical models
- Develop an in-depth knowledge with mechanistic understanding in pericyclic and photochemical reactions and apply those in the synthesis of organic compounds

Contents
Introduction: Brief review of basic physical organic concepts (**2 lectures**).
Stereoelectronic Effects: Participation of sigma and pi bonds in transition state, Orbital symmetry and frontier orbitals, Hammond's Postulate, Hammett Plot, Curtin-Hammett principle (**6 lectures**).
Stereochemical Models: Cram Model, Felkin-Anh Model, Chelation Model, Zimmerman-Traxler Model (**7 lectures**).
Pericyclic Reactions: Introduction of pericyclic reactions, Classifications, Cycloaddition, Electrocyclic, Sigmatropic, Group transfer reactions (**14 lectures**).
Photochemistry: Basic principles of photochemistry, Retinal isomerization, Photochemical reaction of cyclic and acyclic carbonyl compounds, including enones and dienones, photochemistry of alkenes, dienes, aromatic compounds (**10 lectures**).

Text Books:

- Anslyn, E. V. and Dougherty, D. A., (2006), Modern Physical Organic Chemistry, University Science Books
- Singh, J. and Singh, J., (2012), Photochemistry and Pericyclic Reactions, 3rd Edition. New Age

References:

- Smith, M. B., (2016), March's Advanced Organic Chemistry, 7th Edition. Wiley
- Carey, F. A. and Sundberg, R. J., (2007), Advanced Organic Chemistry Part A: Structure and Mechanisms, 5th Edition. Springer
- Carey, F. A. and Sundberg, R. J. (2007), Advanced Organic Chemistry Part B: Reactions and Synthesis, 5th Edition. Springer

Self-learning Material:

1. Singh, N.D. P., Organic Chemistry and Pericyclic Reactions, NPTEL Course material, Department of Chemistry, Indian Institute of Technology Kharagpur, <http://www.nptel.ac.in/courses/104105071/>

Title	Quantum Chemistry and Applications	Course No.	CYL3XX0
Department	Chemistry	L-T-P [C]	3-0-0 [3]
Offered for	BSc. BEd	Type	Elective
Prerequisite	Nil		

Objectives

The Instructor will:

1. provide an advanced level understanding of quantum chemistry
2. Will show a few applications of quantum mechanics to chemistry

Learning Outcomes

The students are expected to have the ability to:

1. understand quantum mechanics and interpret chemistry problems at the atomistic level
2. apply quantum chemistry to problems in chemistry

Contents

Fundamentals: Old Quantum theory, Correspondence principle, Bohr-Sommerfeld quantization, Wave-particle duality, Stern-Gerlach experiment

Mathematical Formalism: Operators, Eigenfunctions and eigenvalues, Operators in quantum mechanics, expectation values, Theorems of Quantum Mechanics, Commuting and non-commuting operators, Angular momentum

Exactly Solvable Problems: Time independent and time dependent wave equation, Particle confined to infinite and finite potential wells, Harmonic oscillator, Rigid rotor, Hydrogen atom

Approximation Methods: Variational principle, Perturbation theory, Energy and wavefunction corrections

Quantum Chemistry: Spin, Many-electron problems, Hartree-Fock method, Born-Oppenheimer approximation

Textbook

1. Quantum Chemistry, I. N. Levine, 7th Edition, PEARSON (2016).

Reference Books

1. Quantum Chemistry, D. A. McQuarrie, Viva Student edition (2016).
2. Modern Quantum Chemistry, A. Szabo and N. S. Ostlund, Dover Books (1996).

Title	Coordination and Organometallic Chemistry	Course No.	CYL3XX0
Department	Chemistry	L-T-P [C]	3-0-0 [3]
Offered for	BSc BEd	Type	Elective
Prerequisite	Nil		

Objectives

The Instructor will:

1. Provide background to basic concepts and key knowledge base of Coordination and Organometallic Chemistry.

Learning Outcomes

The students are expected to have the ability to:

1. Understand the bonding fundamentals for both coordination compounds, predicting geometries of simple molecules.
2. Appreciate the fundamentals of organometallic chemistry.

Contents

Introduction: Coordination geometry, coordination numbers, ligands, isomerism, thermodynamic stability, step-wise and overall binding constant, chelate and macrocyclic effect. **(3 Lectures)**

Theories of Bonding: VBT, CFT, MOT and their limitations; splitting of d-orbitals. Spectral and magnetic properties; Color of complexes, term symbols, selection rules for electronic transitions, Orgel and TS diagram, and Nephelauxetic effect, magnetochemistry, Jahn-Teller theorem. **(11 Lectures)**

Inorganic reactions and mechanisms, hydrolysis reactions, substitution reactions trans-effect; isomerization reactions; metal-metal bonding, cluster compounds **(5 Lectures)**

Transition metal organometallics: Introduction: various sigma/pi donor acceptor ligands, 18 electron rule isolobal analogie. Metal carbonyls, metal phosphines, olefin and acetylene complexes, alkyls and allyl complexes, metallocenes, carbenes and NHC complexes Major reaction types – oxidative addition, reductive elimination, migratory insertion, elimination isomerization and rearrangement reactions. **(12 Lectures)**

Chemistry of f-block elements: Introduction, Structure and bonding, Shift reagents, strong magnets, Luminescence, Separation and Extraction Techniques. Organometallic compounds of f-block elements: synthesis structure bonding and properties **(5 Lectures)**

Organometallic compounds in medicinal and material chemistry **(3 Lectures)**

Textbook

1. Huheey, J.E. Keiter, E. A.; Keiter, R. L.; Medhi, O.K.; (2006), Inorganic Chemistry, Pearson; 4th edition
2. Cotton, F. A.; Wilkinson, G.; Basic Inorganic Chemistry (2007), Wiley; 3rd edition

Reference Books

1. Housecroft, C and Sharpe, A. G. (2012) Inorganic Chemistry, 4th Edition, Pearson
2. Gupta, B. D.; Elias, A. J. Basic Organometallic Chemistry, 2 nd edition, Universities

Press (India) Private Limited

Self-Learning Material

1. Maiti, D., Basics in Inorganic Chemistry, NPTEL Course Material, Department of Chemistry, Indian Institute of Technology, Bombay, <https://www.youtube.com/watch?v=0ofu2inFF0k&list>

Title	Numerical Methods and Group Theory	Course No.	CYL3XX0
Department	Chemistry	L-T-P [C]	3-0-0 [3]
Offered for	BSc. BEd	Type	Elective
Prerequisite	Nil		

Objectives

1. Basic mathematics and numerical techniques required for Chemistry students
2. Knowledge on error analysis to be used for laboratory courses
3. Provide the fundamentals of group theory to understand structure, chemical bonding and spectroscopy

Learning Outcomes

1. Ability to analyze data and perform error analysis on the data
2. Ability to understand and appreciate the mathematical and group theoretical concepts behind chemical theories

Course Content

Mathematical Concepts: Vectors and Vector spaces, Operators, Orthogonal and Unitary matrices, Diagonalization, Matrix eigenvalue problems, Systems of linear algebraic equations, Determinants, Ordinary and partial differential equations, Fourier and Laplace transformation

Numerical Methods: Errors in Data, Absolute and relative errors, Distribution of Errors, Central Limit Theorem, Linear regression and correlation, Interpolation, Roots of Equations, Algorithms for Matrix

Group Theory: Symmetry elements and Point Groups, Group postulates and definitions, Group multiplication tables, Subgroups and cosets, Symmetry classes and conjugates, Reducible and irreducible representations, Representations and character tables, Group theory and quantum mechanics, Group theory and chemical bonding, Applications of group theory to structures and spectroscopy, Group theory and crystal symmetry

Text Books

1. Kreyszig, E., (2011) *Advanced Engineering Mathematics*, 9th Ed., Wiley
2. Cotton, F. A., (2008) *Chemical Applications of Group Theory*, 3rd Ed., Wiley India

Reference Books:

1. Louis, L., (1991) *A Practical Guide to Data Analysis for Physical Science students*, Cambridge University Press
2. Louis, L., (2005) *Mathematics for Science Students*, Cambridge University Press
3. Arfken, W. and Harris, P. (2012) *Mathematical Methods for Physicists*, 7th Ed., Elsevier
4. Bishop, D. M., (1993), *Group Theory and Chemistry*, 2nd Ed., Dover Publications, New York

Online Course Material:

1. Iyengar, S. R. K., *Numerical Methods and Computation*, NPTEL course material, Department of Mathematics, IIT Delhi
(<https://www.youtube.com/watch?v=88ys5Zl0lSg&list=PL6E313980EF23CA6E>)
2. Chandra, M., *Chemical Applications of Symmetry and Group Theory*, NPTEL course material, Department of Chemistry, IIT Kanpur

(https://www.youtube.com/watch?v=Av9f25sqLG0&list=PLj_Alq7xw30knZPTpa9whzqiSn_RZ_HGWP)

Title	Organic Synthesis	Course No.	CYL3XXX
Department	Chemistry	L-T-P [C]	3-0-0 [3]
Offered for	BSc. BEd	Type	Elective
Pre-requisite	Nil		

Objective

The instructor will:

1. To provide an understanding of diverse chemical reactions and their application in synthesis
2. To provide knowledge of key aspects of retrosynthesis of simple-to-complex organic molecules.

Learning Outcomes

The students are expected to:

1. Acquire the knowledge and skills required to strategize and plan organic synthesis,
2. Develop an understanding of total synthesis of organic molecules.

Contents

Functional group interconversions and Name reactions (**10 lectures**).

Transition metal catalyzed cross-coupling reactions, Oxidative addition, reductive elimination, transmetallation, migratory insertion etc. (**9 lectures**).

oxidations and reductions in organic synthesis, different reagents, oxidation states, name reactions on redox processes (**8 lectures**).

Application of carbanions in organic synthesis, alkylation of enolates, enamines and hydrazones, alkylation of heteroatom stabilized anions, organometallic reagents and their application in synthesis (**7 lectures**).

Strategy and design of organic synthesis, concepts of synthetic equivalents and Umpolung (**5 lectures**).

Text Books:

1. Warren,S., and Wyatt.P., (2008), Organic Synthesis: The Disconnection Approach, 2nd Edition, Wiley-VCH
2. Nicolaou,K.C., Sorensen,E.J., (1996), Classics in Total Synthesis: Targets, Strategies and Methods, 1st Edition, Wiley-VCH
3. Carey,F.A., Sundberg,R.J., (2007), Advanced Organic Chemistry, Part B: Reactions and Synthesis, 5th Edition, Plenum

References:

1. Clayden,J., Greeves,N., and Warren,S., (2012) Organic Chemistry, 2nd Ed., Oxford
2. Carruthers, W., (1989), Some Modern Methods in Organic Synthesis, Cambridge

Self-Learning Material

1. Punniyamurthy,T., Principles of Organic Synthesis, NPTEL Course Material, Department of Chemistry, Indian Institute of Technology Guwahati, <http://www.nptel.ac.in/courses/104103022/>

Title	Industrial Catalysis	Course No.	CYL3XX0
Department	Chemistry	L-T-P [C]	3-0-0 [3]
Offered for	BSc. BEd	Type	Elective
Prerequisite	Nil		

Objectives

The Instructor will:

1. Impart knowledge on Catalysis and its importance.
2. Teach practical applications of catalysts applied in industry.

Learning Outcomes

1. The learners are expected to gain knowledge of independent thinking in designing, characterizing and fine tuning of catalysts suitable for potential catalytic transformations.
2. Learners will be able to translate fundamental catalytic knowledge to develop technology for industrial processes.
3. Learners will have an update on current trends and challenges of catalysis towards industrial application.

Contents

Introduction: Definition and concepts of catalysis, Activity, TOF, TON, selectivity, Homogeneous vs heterogeneous and biocatalysis **(4 lectures)**

Homogeneous catalyzed Industrial processes: Hydrogenation, hydroformylation, carbonylation, wacker synthesis, oxo synthesis, C-C coupling reactions, Oligomerisation of ethylene (SHOP process), adiponitrile synthesis, polymerization, metathesis, Asymmetric catalysis, Monsanto L DOPA process, S-Naproxen, L-menthol **(14 Lectures)**

Industrial processes with Biocatalysts: Acrylamide, aspartame synthesis, pharmaceuticals, herbicides. **(4 Lectures)**

Heterogeneously catalyzed processes: Fischer Tropsch synthesis, water gas shift reaction, methanol synthesis, oxidation of propene. Refinery processes and petrochemistry. **(11 Lectures)**

Electrochemical reactions, methanol oxidation. Catalytic processes with renewable materials, biofuels, biorefinery, phase transfer catalysis, catalysis reactor **(6 Lectures)**

Textbook

Hagen, J. Industrial Catalysis: A Practical Approach

Reference Book

Bhaduri S.; Mukesh, D. Homogeneous Catalysis: Mechanisms and Industrial Applications

Self-Learning Material

Industrial homogeneous Catalysis: Principles and Mechanisms by prof. debabrataMaiti, IIT Bombay, https://www.youtube.com/watch?v=GzXpURcjJwE&list=PL_uPpV3UHww2wyLk3XpR7LBqbR_2k1Fi0

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Title	Heterocyclic Compounds and Applications	Course No.	CYL6XXX
Department	Chemistry	L-T-P [C]	3-0-0 [3]
Offered for	BSc. BEd	Type	Elective
Pre-requisite	Nil		

Objective

The instructor will:

1. Provide insight into the fundamental reactivity and synthesis of heterocycles, and
2. Broaden their knowledge in the field of heterocyclic chemistry with regard to its application in the synthesis of natural products and pharmaceuticals.

Learning Outcomes

Students will be able to:

1. Understand the basic heterocyclic principles and apply different types of organic reactions in the synthesis of small heterocyclic compounds.
2. Learn the applications of modern organic synthetic tools in the efficient synthesis of heterocycles.
3. Design and propose routes for the synthesis of natural products and pharmaceuticals based on heterocycles.

Contents

Introduction: Importance of heterocyclic compounds, Nomenclature of heterocyclic ring systems (**3 lectures**).

Three-membered Heterocycles: Structure, reactivity and synthesis of Oxirane, Thiirane, and Aziridine (**3 lectures**).

Four-membered Heterocycles: Structure, reactivity and synthesis of four membered Heterocycles such as Oxetane, Thietane and Azetine (**3 lectures**).

Five-membered Heterocycles: Structure, reactivity and synthesis of five membered Heterocycles such as Pyrrole and pyrrolidine, Thiophene and tetrahydrothiophene, Furan and tetrahydrofuran, chemistry of Pyrazole, Imidazole, Oxazole, Thiazole (**10 lectures**).

Six-membered Heterocycles: Structure, reactivity and synthesis of Six membered Heterocycles: Pyridine and Piperidine, pyran and Tetrahydropyran, pyridones, Pyridine-N-oxides (**10 lectures**).

Polycyclic heterocycles: Structure, reactivity and synthesis of Indole, Quinoline and Isoquinoline, Coumarins and Chromones, benzimidazole and benzoxazole (**6 lectures**).

Modern Methods: Synthesis of heterocycles using modern sustainable methods (**4 lectures**).

Text Books:

1. J. A. Joule and K. Mills, Heterocyclic Chemistry, 5th Ed., Wiley, 2010.

References:

1. R. K. Bansal, Heterocyclic Chemistry, 5th Ed., New Age International Private Limited, 2017.

Self-Learning Material

1. NPTEL Lectures : Heterocyclic Chemistry- <http://nptel.ac.in/courses/104105034/>

Title	Principles of Spectroscopy	Course No.	CYL3XX0
Department	Chemistry	L-T-P [C]	3-0-0 [3]
Offered for	BSc. BEd	Type	Elective
Prerequisite	Nil		

Objectives

The Instructor will:

1. Introduce a few spectroscopic methods used as analytical techniques in various fields of science and engineering.
2. Provide theoretical background of these methods along with their instrumentation and some applications.

Learning Outcomes

The students are expected to have the ability to:

1. Understand the theoretical background of various spectroscopic techniques
2. Connect quantum mechanics and spectroscopy to interpret experimental findings in research.

Contents

Fundamentals: Time-dependent perturbation theory, Interaction of radiation with matter, Intensity of a Transition - Transition Dipole Moment, Fermi's golden rule; Einstein treatment, Lasers and line shapes and line broadening, Laser spectroscopy; Spectroscopic Timescales, Selection rule for photon-molecule interaction, Continuous wave and Fourier Transform spectroscopy, Sensitivity and resolution of spectrum, Instrumentation, Dispersive spectrometers, Fourier Transform spectrometers (**10 lectures**)

Rotational Spectroscopy: Linear Motion and Rotational Motion, Diatomic Rigid Rotor, Derivation of selection rules for microwave spectra, Isotope effect, Degeneracy, Intensity of Rotational Lines, Non-Rigid Rotor, Polyatomic Molecules (**5 lectures**)

Vibrational Spectroscopy: Simple harmonic oscillator, Selection rules, Anharmonicity and its effects, Rotational-vibrational spectra, Normal modes of Vibration, FT-IR Spectroscopy, Raman spectroscopy (**7 lectures**)

Electronic spectroscopy: Basic principle, Symmetry and Term Symbols, Born-Oppenheimer approximation, vibrational coarse and rotational fine structures, Vibrational Progression, Pre-dissociation, Selection rules from transition moment integral - Spin selection, Laporte selection, Frank-Condon principle. Jablonski diagram, various photophysical processes, quantum yield expression, Chromophores, Types of electronic transition, Effect of conjugation and solvent. (**8 lectures**)

Magnetic resonance Spectroscopy, Origin of spin and magnetic moment, Zeeman splitting and gyromagnetic ratio, Electron and nuclear spin resonance, Instrumentation, NMR chemical shift and spin-spin coupling, introduction to AB, AX, AMX spin system, 1D 1H and 13 NMR experiments, Pulse sequences; Methods of relaxation, Double resonance techniques; EPR - Instrumentation, First Derivative Spectra, Electron-nuclear hyperfine interaction, theory of first order EPR spectra, analysis of 1st Order spectra, example of EPR spectra of organic radicals and transition metal complexes. (**9 lectures**)

Textbook

1. Banwell, C. N., (1994), Fundamentals of Molecular Spectroscopy, 3rd Edition, Tata McGraw-Hill Book Company.

2. Bernath, P. F., (2005), Spectra of Atoms and Molecules, 2nd Edition, Oxford University Press

Reference Books

1. Gunther, H., (1995), NMR Spectroscopy, 2nd Edition, Wiley
2. Atkin's Physical Chemistry., Peter Atkins, Julio De Paula, 7th Edition, Oxford (2022).

Title	Statistical Thermodynamics	Course No.	CYL3XXX
Department	Chemistry	L-T-P [C]	3-0-0 [3]
Offered for	BSc. BEd	Type	Elective
Prerequisite	Nil		

Objectives

The Instructor will:

1. Provide the connection between microscopic theory and thermodynamics.
2. Describe how complex phenomena can be transferred into simple models.

Learning Outcomes

The students are expected to:

1. Predict properties of many-body systems starting from its microscopic constituents and their interactions
2. Connect microscopic theory to chemical reaction

Contents

Mathematical foundation: Probability theory, Permutation and combination, Conditional probability and independent events, Random variables and their probability distribution, Central limit theorem, Binomial distribution, Stirling's approximation, Method of Lagrange multiplier; Statistics of scientific measurement, Error, Maximum likelihood method, Curve fitting, Least square fit; Dirac delta function, Uniform distribution and Dirac delta function, Partial differential equation, equation of continuity (11 lectures)

Statistical thermodynamics: Equivalence of Ensembles, Boltzmann distribution, Entropy, partition functions; Applications of canonical ensemble, 1D Ising model, Ideal and real gas, Sackur Tetrode equation, Estimation of thermodynamic function, Energy landscape from distribution, Dimensionality reduction using AI; Maxwell-Boltzmann distribution, Phase space, Ergodicity, Liouville's Theorem, classical fluids, Pair correlation functions, Response functions, Energy and fluctuations, Heat capacity, compressibility, Linear response theory, Time-Correlation Functions, Rare events, Transition state theory (15 lectures)

Stochastic processes and Brownian motion: Langevin Equation, Fluctuation-Dissipation Theorem, Diffusion, Friction, and Viscosity, Stokes-Einstein relation, Green-Kubo relations, Noise and Markov process, Markov State Model and AI, Applications in biological systems (13 lectures)

Textbook

1. Tulsı Dass and Satish K Sharma, Mathematical Methods in Classical and Quantum Physics, Universities Press 1998.
2. D. A. McQuarrie and John D Simon, Physical Chemistry, 1st Ed, Viva Books, India 2013.
3. Chandler, D., Introduction to Modern Statistical Mechanics, 1st Edition, Oxford University Press, 1987.

Reference Book

1. R Shankar, Basic Training in Mathematics, Springer, 2006.
2. Robert Zwanzig, Non equilibrium Statistical Mechanics, Oxford University Press, 2001.
3. William Feller, An Introduction to Probability Theory and Its Applications, Volume 1, John Wiley and Sons
4. L. D. Landau and E. M. Lifshitz, Statistical Physics, 3rd edition, part1,

Self-Learning Material

1. Fundamentals of Statistical Thermodynamics Chemistry and Biochemistry, by Prof Nand Kishore, IIT Bombay (<https://nptel.ac.in/courses/104101139>)
2. Course Introduction Basic Statistical Mechanics by Biman Bagchi

https://www.youtube.com/watch?v=M_dhvmM2fml&list=PLOzRYVm0a65en9rkAeG_KDhh4thVEu5Od

Title	Solid State and Material Chemistry	Course No.	CYL3XX0
Department	Chemistry	L-T-P [C]	3-0-0 [3]
Offered for	BSc. BEd	Type	Elective
Prerequisite	Nil		

Objectives

The Instructor will:

1. Provide an overview of the relationships between molecular or solid state structures and material properties.
2. Provide an interdisciplinary understanding of solid state chemistry which aims to provide an understanding of how molecular structure affects the properties of materials.

Learning Outcomes

The students are expected to have the ability to:

1. Obtain required knowledge for understanding material science problems and structure of solids.
2. Develop insight into electronic structure of crystals and compare it with the electronic structure of nanomaterials, chemical-physical fundamentals as well as basic method of characterisation of solids.

Contents

Structure of Solids: Crystalline and Amorphous, diffraction techniques, symmetry and point groups, packing in solids, classification, lattice energy, bonding, structures: NaCl, TiO₂, ZnS, wurtzite, Perovskite, covalent and ionic solids. **(10 Lectures)**

Crystal defects: non-stoichiometry, cluster, diffusion, Fick's Law and Kirkendall effect, Identification of defects using microscopic techniques. **(5 Lectures)**

Solid state reaction: Chemical and Physical Methods of preparation, reactivity of solids, decomposition mechanism, single crystal growth and thin film deposition. **(10 Lectures)**

Band theory: Intrinsic and extrinsic semiconductors, insulators, density of states, Dielectrics, Hall effect, Thomson, Peltier and Seebeck effects. **(Lectures 8)**

Properties of Solids: Magnetic, Electrical and Optical properties, Different type of Magnetism and Superconductivity, Introduction to nanomaterials and properties. **(Lectures 6)**

Textbooks

1. West, A.R., (2015), *Solid State Chemistry and Its Applications*, 2nd edition, John Wiley & Sons
2. Lesley E Smart and Elaine E Moore, (2005), *Solid State Chemistry: An Introduction*, 3rd Edition, Taylor and Francis

Reference Books

1. Cheetham, A.K. and Day, P., (1997), *Solid State Chemistry Compounds*, 2nd Edition, Clarendon Press, Oxford
2. Harry R. Allcock, (2008), *Introduction to Materials Chemistry*, 1st Edition, Wiley.

Self Learning Material

Subramaniam, A, *Structure of Materials*, NPTEL Course Material, Department of Materials Science and Engineering, Indian Institute of Technology Kanpur, <http://nptel.ac.in/courses/113104014/16>

COURSE CONTENT

4. Courses Offered For BEd

Title	Evolution of Indian Education	Course No.	EDL1XXX
Department	CET	L-T-P[C]	3-0-0 [3]
Offered for	BSc BEd (Semester 1)	Type	Core
Prerequisite	Nil		

Objectives

- To develop an understanding about the evolution of education systems and practices in India from the ancient period to the contemporary times
- To orient students to the contribution of Indian thinkers in the evolution of Indian Education system
- To develop a historical sensibility in assessing the impact of educational processes and changes

Learning Outcomes

- Students will be able discuss the genesis, vision, and evolution of education in ancient India to the contemporary India,
- The course will enable students to contextualize their preparation to be a teacher as well as to understand how institutional characteristics of education are shaped by history.

Lecture Modules/Contents (39 Lectures)

1. **Introduction:** Importance of History of Education; Overview of Indigenous Knowledge Traditions and Models; Contributions of Indian Science and Knowledge Systems **(5 Lectures)**
2. **Education in Ancient India:** Vision, objectives and salient features of key historical epochs (Vedic Period, Buddhist and Jain period; Traditions of music, art, etc. **(7 lectures)**
3. **Education from the Gupta Period to the Colonial Period:** Features and transformations of teaching-learning process; finance and management of education institutions **(6 lectures)**
4. **Education during the Colonial Period:** Institutional transformations, ideas of 'modernity', Swadeshi and nationalist experiments by Indian reformers and thinkers **(8 lectures)**
5. **Education in Independent India:** The organization of school and higher education in India after Independence; Education for citizenship, Constitutional Values and Education Provisions, Landmark Education Policy Documents (NEPs 1968, 1986 (PoA 1992), 2020; RTE 2008; NCF 2005, 2023), Role of NGOs in shaping policy (eg. ASER Reports) **(8 lectures)**
6. **Contemporary concerns and issues in Indian Education:** Education for entrepreneurship and innovation; Discourses of skill development, training and employability; Phygital and other hybrid models of education delivery **(5 lectures)**

Textbook

1. Sarangapani, P. M., & Pappu, R. (Eds.). (2019). *Handbook of Education Systems in South Asia*. Springer Singapore.
2. Kumar, K. (2005). *Political agenda of education: A study of colonialist and nationalist ideas*. SAGE Publications India.

References

1. Dharampal. *The Beautiful Tree: Indigenous Education in the Eighteenth Century*. New Delhi: Biblia Impex Private, 1983.
2. Scharfe, H. (2018). *Education in ancient India* (Vol. 16). Brill.
3. Khilnani, Sunil (1999). *The idea of India*. Farrar, Straus and Giroux, New York

4. Jain, M., Mehendale, A., Mukhopadhyay, R., Sarangapani, P. M., & Winch, C. (Eds.). (2018). *School education in India: Market, state and quality*. Taylor & Francis.

5. Naik, J.P. & Nurullah, S. (1974). *A Student's History of Education in India*: Macmillan; Delhi

Online Resources

Mohanty, Atasi. Education for Sustainable Development <https://nptel.ac.in/courses/109105190>

Title	Language I - Hindi (हिंदी)	Course No.	LAL1XXX
Department	School of Liberal Arts	L-T-P [C]	3-0-0 [3]
Offered for	BSc BEd (Semester 1)	Type	Core
Prerequisite	Nil		

उद्देश्य / Objectives

- छात्रों को हिंदी भाषा में कौशल और प्रभावी भाषा शिक्षण के लिए शैक्षणिक उपकरणों का प्रशिक्षण देना / To train students into language skills in Hindi Language and pedagogical tools for effective language teaching
- आलोचनात्मक सोच, मौखिक क्षमता, शब्दावली निर्माण और प्रभावी मौखिक और लिखित संचार विकसित करने के लिए साहित्य का उपयोग करना / To use literature to develop critical thinking, verbal ability, vocabulary building, and effective oral and written communication
- विभिन्न प्रकार के लेखन कौशल सिखाना: तकनीकी और गैर-तकनीकी जैसे रिपोर्ट लेखन, रचनात्मक लेखन, सारांश और पैराग्राफ लेखन / To teach different types of writing skills: technical and non-technical such as report writing, creative writing, summary and paragraph writing

शैक्षणिक प्रतिफल Learning Outcomes:

- हिंदी भाषा में प्रभावी मौखिक और लिखित संचार / Effective verbal and written communication in Hindi language
- सहकर्मी शिक्षा के माध्यम से आलोचनात्मक सोच और आलोचनात्मक लेखन की क्षमता / Ability for critical thinking and critical writing through peer learning
- कक्षा में सीखे गए ज्ञान को दैनिक संचार गतिविधि में एकीकृत करने की क्षमता, और फलस्वरूप, सीखने को चिंतनशील और अनुभवात्मक बनाना / Ability to integrate classroom learning into an everyday communicative activity, and thus, making the learning both reflective and experiential

पाठ्यक्रम/Course Contents

परिचय (7 व्याख्यान) / Introduction (7 Lectures)

पाठ्यक्रम का परिचय; भारत की भाषाई बहुलवाद और सांस्कृतिक विविधता; राजभाषा(ओं) की अवधारणा; भाषा और सांस्कृतिक पहचान; भाषा और उसकी लिंग प्रकृति; भाषा, शक्ति और आधिपत्य

Introduction to the course; Linguistic pluralism and cultural diversity of India; the concept of official language(s); Language and cultural identity; Language and its gender(ed) nature; Language, power and Hegemony

रोजमर्रा का संचार (10 व्याख्यान) / Everyday Communication (10 Lectures)

प्रभावी मौखिक संचार के लिए भूमिका-खेल और परिस्थितियाँ; दी गई परिस्थितियों के अनुसार बातचीत; सुनने और समझने का कौशल; संचार कौशल विकसित करने के लिए चयनित विषयों पर समूह चर्चा; प्रसिद्ध भाषणों को सुनना/समझना; मौखिक और गैर-मौखिक अभिव्यक्ति; शारीरिक भाषा, बुनियादी ध्वन्यात्मकता/उच्चारण शिष्टाचार

Role-play and situations for effective verbal communication; conversations as per given situations; listening and comprehension skills; Group Discussion on selected topics to develop communication skills;

listening/comprehending famous speeches; verbal and non-verbal expression; Body Language, Basic Phonetics/Pronunciation etiquette

साहित्य के माध्यम से भाषा सीखना (10 व्याख्यान) / Learning Language through Literature (10 Lectures)

प्रेमचंद की छोटी कहानियाँ जैसे "ईदगाह", "बड़े घर की बेटी", "पूस की रात", "बूढ़ी काकी", "कफन" आदि पढ़ना; भाषा और साहित्यिक कौशल सीखने के लिए महादेवी वर्मा, सूर्यकांत त्रिपाठी निराला और अन्य हिंदी लेखकों को पढ़ना; निबंध लेखन और आलोचनात्मक सोच; भाषा के रचनात्मक उपयोग को समझने के लिए कविताएँ पढ़ना और सुनना; कविताएँ लिखना; पैराग्राफ लिखना; सारांश बनाना; हिंदी में रचनात्मक लेखन; कबीरदास की चयनित कविताएँ: "पोथी पढ़ि पढ़ि जग मुआ", "गुरु गोबिंद दो खड़े", "पत्थर पूजे हरि मिले," "कस्तूरी कुंडल बसे", "जल में कुम्भ, कुम्भ में जल है" सुभद्रा कुमारी चौहान की कविताएँ: "जलियाँवाला बाग में बसंत", "मेरा बचपन", "ये कदम्ब का पेड़", महादेवी वर्मा की कविता: "मैं नीर भरी दुख की बदली", सूर्यकांत त्रिपाठी निराला की कविता "वह तोड़ती पत्थर"

Reading short stories of Premchand such as "Eidgah", "Bade Ghar Ki Beti", "Poos Ki Raat", "Boodhi Kaaki", "Kafan" etc. Reading Mahadevi Verma, Suryakant Tripathi Nirala, and other Hindi writers to learn language and literary skills; Essay writing and critical thinking; Reading and Reciting Poems to understand creative usage of language; composing poems; writing paragraphs; summarizing; creative writing in Hindi; Kabirdas's selected poems: "Pothi Padhi Padhi Jag Mua", "Guru Gobind Do Khade", "Paathar Pooje Hari Mile," "Kastoori Kundal Base", "Jal Mein Kumbh, Kumbh Mein Jal Hai" Subhadra Kumari Chauhan's poems: "Jallianwala Bagh Mein Basant", "Mera Bachpan", "Yeh Kadamb Ka Ped" Mahadevi Verma's poem: "Main Neer Bhari Dukh Ki Badli", Suryakant Tripathi Nirala's poem "Vah Todti Patthar"

अनुवाद (12 व्याख्यान) / Translation (12 Lectures)

अनुवाद क्या है? बहुभाषी दुनिया में अनुवाद की आवश्यकता; तकनीकी और गैर-तकनीकी अनुवाद; अंतर-भाषा और आंतरिक भाषा अनुवाद; प्रभावी संचार के लिए अंग्रेजी से हिंदी और इसके विपरीत अनुवाद अभ्यास; रचनात्मक अनुवाद और अभ्यास
What is translation? Need for translation in a multilingual world; Technical and non-technical translation; inter and intra translation; Translation exercises from English to Hindi and vice-versa for effective communication; creative translation and exercises

पाठ्यपुस्तक / Textbooks

कोर्स के लिए सभी पठन सामग्री रचनात्मक और आलोचनात्मक सोच को बढ़ावा देगी और इसमें शामिल होंगे: समाचार पत्रिकाएँ, प्रसिद्ध भाषण, जीवनी, उपन्यास, गैर-काल्पनिक साहित्य और फिल्म से अंश/कथाएँ, शब्द खेल और पहेलियाँ, जिन्हें प्रशिक्षकों द्वारा संकलित किया जाएगा और छात्रों के साथ साझा किया जाएगा।

All reading material for the course will enhance both creative and critical thinking and will include the repertoire- newspaper articles, famous speeches, biographies, passages/narratives from fiction, non-fiction and film, word games and puzzles and will be compiled by the instructors and shared with the students.

संदर्भ पुस्तकें / Reference Books

1. "हिंदी साहित्य का सरल इतिहास" - विष्णुनाथ त्रिपाठी, ओरिएंट ब्लैकस्वान / "Hindi Sahitya Ka Saral Itihas" by Vishwanath Tripathi, Orient BlackSwan
2. "हिंदी साहित्य का इतिहास" - डॉ. नागेंद्र, मयूर पब्लिकेशंस / "Hindi Sahitya Ka Itihas" by Dr. Nagendra, Mayur Publications
3. "आधुनिक हिंदी कविता: एक संकलन" - विद्या निवास मिश्र, इंडियाना यूनिवर्सिटी प्रेस / "Modern Hindi Poetry: An Anthology" by Vidya Niwas Mishra, Indiana University Press
4. "साहित्य की पहचान" - नामवर सिंह, राजकमल प्रकाशन, दिल्ली / "Sahitya ki Pahchan" by Namvar Singh, Rajkamal Prakashan, Delhi
5. "हिंदी" - काचरू, यमुना, जॉन बेन्जामिन्स, फिलाडेल्फिया / "Hindi" by Kachru, Yamuna, John Benjamins, Philadelphia

Self-learning Material

<http://premchand.co.in/stories>; <https://www.rekhta.org/poets/harivanshrai-bachchan/all>

Title	Understanding India (Indian Ethos and Knowledge Systems) - I	Course No.	MSL1XXX
Department	School of Management and Entrepreneurship	L-T-P [C]	2-0-0 [2]
Offered for	BSc BEd (Semester 1)	Type	Core
Prerequisite	None		

Objectives

This course aims to introduce indigenous knowledge in the educational curriculum formally. The course consists of sessions that:

- introduce students to the contributions by India to Foundational knowledge, Science, Engineering & Technology, and Humanities & Social Sciences through a structured classification
- introduce students to the thinking patterns and the knowledge repository created by the thinkers and practitioners of yore and many generations that provides great value
- enable the current generation to understand the thought processes and frameworks, and synthesize new knowledge

Learning Outcomes

The course enables participants to:

- develop an early appreciation of the Indian ethos and knowledge system
- appreciate the matter being discussed with contextual reference

Contents

Part I: Indian Knowledge System: An Introduction

- Indian Knowledge System: An Overview (4 sessions) - Importance of Ancient Knowledge, Defining Indian Knowledge System, The IKS Corpus – A classification framework, Caturdaśa-Vidyāsthāna, Historicity of IKS, Some Unique Aspects of IKS, Discover IKS exercises on topic
- The Vedic Corpus (4 sessions) - Introduction to Vedas, The Four Vedas, Vedāṅgas, Vedic Life: Distinctive Features, Discover IKS exercises on topic
- Philosophical Systems (4 sessions) - Indian Philosophical Systems – Development and Unique features, Vedic Schools of Philosophy, Non-Vedic Philosophical, Discover IKS exercises on topic
- Wisdom through the Ages (4 sessions) - Purāṇas – An encyclopedic work, Itihāsa as a source of Wisdom, Rāmāyaṇa – Key issues and messages, Mahābhārata – A sourcebook for worldly wisdom, Nīti-śāstras – Collection of snippets of Wisdom, Subhāṣitas – A collection of insights from various text, the knowledge systems of India as practiced by Farmers, Artisans, and Forest Dwellers, Discover IKS exercises on topic

Part II: Foundational Concepts relevant for Science, Engineering, and Technology Applications

- Linguistics (4 sessions) - Components of a Language, Pāṇini's work on Sanskrit Grammar, Phonetics in Sanskrit, Four Stages of Speech, Role of Sanskrit in Natural Language Processing, Indian Language Families, Introduction to Dravidian family of languages, Discover IKS exercises on topic
- Number System and Units of Measurement (4 sessions) - Number System in India – Historical Evidence, Salient features of the Indian Numeral System, Unique approaches to represent numbers, Measurements for time, distance, and weight, Piṅgala and the Binary system, Discover IKS exercises on topic
- Knowledge: Framework and Classification (4 sessions) - The Knowledge Triangle, Prameya, Paramana, Samsaya, Framework for Establishing Valid Knowledge, Deductive/Inductive Logic

Framework, Potential Fallacies in the Reasoning Process, Established Tenets in a Field of Study, Discover IKS exercises on topic

Pedagogy

The course will be delivered through lectures, participative discussion of research articles, and student presentations. Evaluation of course shall be based on individual and group assessment methods such as assignments, projects etc. including an end-term examination. Each topic shall have discovered IKS Exercises for the students to work on and present.

Text Book

Mahadevan, B., Bhat, Vinayak Rajat, Nagendra Pavana R. N., (2022) Introduction to Indian Knowledge System: Concepts and Applications, PHI Learning Pvt. Ltd.

Recommended Readings

- Rao, S. S. (2006). Indigenous knowledge organization: An Indian scenario. *International Journal of Information Management*, 26(3), 224-233.
- Beer, S. (1994). May the whole earth be happy: Loka Samastat Sukhino Bhavantu. *Interfaces*, 24(4), 83-93.
- Danino, M. (2010). *The lost river: On the trail of the Sarasvatī*. Penguin Books India.
- Matilal, B. K. (2008). *Logic, Language and Reality: Indian Philosophies and Contemporary Issues (Vol. 2)*. Motilal Banarsidass.
- Matilal, B. K. (2001). *Introducing Indian Logic*. *Indian Logic: a Reader*, 183-215.
- Kumar, R., & Prakash, O. (Eds.). (2023). *Language Studies in India: Cognition, Structure, Variation*. Springer Nature.
- Satguru Sivaya Subramuniyaswam (2008) *Tirukkural: The American English and Modern Tamil Translations of an Ethical Masterpiece*, (<https://www.himalayanacademy.com/media/books/tirukural/tirukural.pdf> available in link as on March 30, 2024)
- Bose, D. M., Sen, S. N., & Subbarayappa, B. V. (1971). *A concise history of science in India*. A concise history of science in India.
- Bag, A. K. (2015). Ideas and Researches on Physical Concepts in India. *Indian Journal of History of Science*, 50(3), 361-409.
- Bag, A. K. (1982). Technology in India in the eighteenth-nineteenth century. *Indian journal of history of science*, 17(1), 82-90.
- Bag, A. K. (2018). Indo-European Encounter and Features of Modern Science in Pre-Colonial & Colonial India. *Indian Journal of History of Science*, 53, T1-T20.
- Mishra, L. C. (Ed.). (2003). *Scientific basis for Ayurvedic therapies*. CRC press.
- https://en.wikipedia.org/wiki/Siddha_medicine
- *Siddha Medicine by Ramon Martinez Lopez* (Ref: <https://www.amazon.in/Siddha-Medicine-Ramon-Martinez-Lopez/dp/1519302002>)
- Dutta, A. K. (2016). Was there sophisticated mathematics during Vedic Age. An anthology of disparate technical thoughts at a popular level (ed. A. Chaudhuri), ISIREA.
- Bidyāranya, S., & Singh, A. N. (1962). *History of Hindu mathematics: a source book*. (No Title).
- Joseph, G. G. (2016). *Indian mathematics: Engaging with the world from ancient to modern times*. World scientific.
- Amma, T. S. (1999). *Geometry in ancient and medieval India*. Motilal Banarsidass Publ.

- Kolachana, A., Mahesh, K., & Ramasubramanian, K. (Eds.). (2019). Studies in Indian mathematics and astronomy: selected articles of Kripa Shankar Shukla. Springer Singapore.
- Collected Writings of Shri Dharmapal (<https://www.dharampal.net/publications>)
 - Volume I -Indian Science and Technology in the Eighteenth Century
 - Volume II -Civil Disobedience in Indian Tradition
 - Volume III -The Beautiful Tree: Indigenous Indian Education in the Eighteenth Century
 - Volume IV - Panchayat Raj and India's Polity
 - Volume V- Essays on Tradition, Recovery and Freedom
- A History of Hindu Chemistry Vol. 1. Internet Archive. Retrieved April 03 2024.
- A History Of Hindu Chemistry,Vol. 2. Internet Archive. Retrieved April 03 2024
- R., T. A History of Hindu Chemistry from the Earliest Times to the Middle of the Sixteenth Century A.D., with Sanskrit Texts, Variants, Translation and Illustrations. Nature 68, 51–52 (1903). <https://doi.org/10.1038/068051a0>
- History of Ancient India (Set of 11 Volumes), 2023, Edited By: Dilip K. Chakrabarti, Publisher: Aryan Books International

Title	Art Education: Elements of Theatre Making	Course No.	LAL1XXX
Department	School of Liberal Arts	L-T-P [C]	1-0-2 [2]
Offered for	BSc BEd (Semester 1)	Type	Elective
Prerequisite	None		

Course Objectives

- Generate an idea of theatre: its history, aesthetics, social significance and contemporary practice
- Understand the significance of theatre as a medium for education and introduction to contemporary theatre-in-education practices
- Develop basic knowledge and skills in script-writing, acting, blocking, stage design, sound design, light design, costume design and production management
- Enhance confidence, communication, coordination, teamwork and presentation skills through collaborative theatre practice

Learning outcomes

- Knowledge of theatre as an art form: history, aesthetics and social significance
- Understand theatre's importance as a medium for education
- Acquire practical knowledge and basic skills in script-writing, acting, stage design, sound design, light design, costume design and production management
- Develop confidence, creativity, coordination, adaptability, and problem-solving aptitude through immersive theatrical experiences

Course Contents

Topic 1: Introduction to Theatre and its role in Education (5 Lectures)

An overview of theatre history, different forms/genres of theatre globally and the power of performative storytelling. Introducing the different elements of theatre making and the roles designed to manage these different elements. Understanding the significance of theatre as a medium for education and knowledge of contemporary theatre-in-education practices.

Topic 2: Script-writing and Dramaturgy (2 Lectures & 6 Studio Hours)

Different kinds of dramatic plots and structures will be analyzed and discussed. Understanding concepts related to preparing the performance text: playwriting, character-development, plot-design, editing, adaptation and incorporating stage directions. Students will write or adapt a short stageable dramatic piece in groups.

Topic 3: Acting Techniques and Character Development (3 Lectures & 6 Studio Hours)

Different approaches to acting will be analyzed and discussed with special emphasis on Stanislavsky's method. Concepts like 'character-analysis', 'emotional memory', 'gestus', 'psycho-physical acting' will be introduced. Students will learn various skills like voice projection/modulation, play-reading, dialogue delivery, recitation, facial and physical gestures, movements and coordination. The students will analyze a given character and develop methods to enact the character.

Topic 4: Theatre Design (4 Lectures & 6 Studio Hours)

Understanding different aspects of theatrical design including direction, stage-design, light-design and sound-design. Students will learn various concepts and practical techniques relating to theatrical design. They will work hands-on in groups to formulate a design for a given dramatic piece.

Topic 5: Collaborative Production (10 Studio Hours)

The course will culminate in the creation of a short theatrical performance in front of an audience. Through this the students will understand the production management roles, coordination, cooperation and teamwork needed to develop and stage a performance. They will also showcase their newly learnt theatrical skills and immerse in a collaborative creative process.

Pedagogy

The course will be delivered through lectures, demonstrations, workshops and Practical tasks. Evaluation can be based on writing assignments, practical projects (process, product and/or reflection), performance, script creation, documentation or presentation. The students might be required to work outside designated hours of the course to fulfill the given practical assignments.

Reference Text Books and Articles

- Stanislavsky, Constantin. *An Actor Prepares* London: Bloomsbury, 1937.
- Brecht, Bertolt. *On Theatre* London: Bloomsbury, 2018.
- Boleslavsky, Richard. *Acting: The First Six Lessons*. London: Routledge, 2013
- Zimmerman, Suzi. *Introduction to Theatre Arts (Vol I & II)* New York: Meriwether Publication, 2007.
- Spolin, Viola. *Theatre Games for the Classroom: A Teacher's Handbook*. Northwestern University Press, 1986.
- Bhatia, Nandi. *Modern Indian Theatre: A Reader*. Oxford: Oxford University Press, 2011.
- Boal, Augusto. *Theatre of the Oppressed*. New York: Theatre Communications Group, 1993.
- Dawson, Kathryn and Lee, Bridget Keeger. *Drama-Based-Pedagogy: Activating Learning Across the Curriculum*. Chicago: University of Chicago, 2018.

Online Resources

- Youtube Short Lecture Series titled "An Actor's Work: Stanislavsky for Actors". Youtube Link: https://youtube.com/playlist?list=PL0gfVPKadSLyH68Mjp-e9v6_RVovv6111&si=YLP2sryKTI5rRHup
- Lecture Series Titled "Introduction to Theatre and Dramatic Arts" by Missouri State University. Youtube Link: https://www.youtube.com/watch?v=ELP95UxEHQ&list=PLdLiRaajwSXTBmnGHra9kCNm3z_74KhvO
- Swayam Course on "Introduction to Modern Indian Drama" by Prof. Kiran Keshavamurthy". Link: https://onlinecourses.nptel.ac.in/noc20_hs34/preview

Title	Art Education: Methods and Materials in Visual Art	Course No.	LAL1XXX
Department	School of Liberal Arts	L-T-P [C]	1-0-2 [2]
Offered for	BSc BEd (Semester 1)	Type	Elective
Prerequisite	None		

Course Objective

- To understand and appreciate art in a deeper sense and realise the importance of Art in education
- To explore various methods and materials used in art making.
- To foster an understanding of the relationship between form, content, and materiality in art making.
- To develop students' problem-solving skills and creative thinking through hands-on projects and assignments.
- To enhance imagination and aesthetic sensibility

Learning Outcomes

By the end of this course, students will be able to

- Appreciate and understand the significance of art in education.
- Develop aesthetic sensibility and learn how to appreciate artworks.
- Through hands-on activities, students will learn how various mediums collaborate in art.
- Compose and produce expressive artworks (2D and 3D) such as self-portraits, landscapes, and collages.
- Learn fundamental skills such as drawing, painting, modelling, carving, casting, and assembling while exploring unconventional and mixed-media approaches to visual arts.
- Learn how to display or present their artwork.

Contents

Topic 1: Introduction to the Role of Art and Aesthetics in Education (5 Lectures)

Students will explore the world of Art and aesthetics in education through various activities, discussions, and dialogues. students will collectively view a series of artworks and critically analyse and observe. Through this process, students will start making connections and develop an appreciation for the aesthetic means of daily life. Additionally, this course will help students develop their aesthetic judgment and learn how to recognise and awaken emotions through art.

Topic 2: Methods and Material Exploration (3 Lectures 8 studio hours)

To investigate traditional and contemporary techniques, tools, and mediums across various artistic disciplines, like drawing, painting, cutting, printmaking, and mixed media. Through hands-on experiments, research, and critical analysis, students will comprehensively understand how different materials and processes can be used to convey artistic concepts and expressions effectively.

Topic 3: Mixed Media Art Practice: (3 Lectures 8 studio hours)

Through hands-on activities, students will produce artworks using various art materials, such as charcoal, graphite, ink, acrylic paint, oil paint, clay, plaster, found objects, and digital media. Students will explore the properties and possibilities of each material through guided exercises and experimentation.

Topic 4: Material Experiments: (3 Lectures 8 studio hours)

Students will experiment and document their process and findings through sketchbooks, journals, or digital portfolios. This involves exploring unfamiliar uses of familiar materials or experimenting with alternative techniques and processes.

Topic 5: Reflection and Exhibition (4 studio hours)

Culminate the course with a final exhibition or portfolio review where students showcase their artworks created throughout the semester. The exhibition allows students to celebrate their achievements, share their creative journey with others, and receive feedback from peers and instructors.

Pedagogy

The course will be delivered through lectures, demonstrations, and practical tasks.

Reference Text Books and Articles

- Klee, Paul. (1968), *Pedagogical Sketchbook*, New York, N.Y: Faber & Faber Publisher.
- John Berger. (1972), *Ways of Seeing*, based on the BBC television series with John Berger, Published by British Broadcasting Corporation, London, ISBN 0563122447 and Penguin Books, London.
- Mayer, R., & Sheehan, S. (1991). *The Artist's Handbook of Materials and Techniques*. Viking.
- The Grove Encyclopedia of Materials and Techniques in Art. (2008). United Kingdom: Oxford University Press.

Online Resources

https://onlinecourses.nptel.ac.in/noc22_hs133/preview

Title	Language II - English	Course No.	LAL1XXX
Department	School of Liberal Arts	L-T-P[C]	3-0-0 [3]
Offered for	BSc-BEd (Semester 2)	Type	Core
Prerequisite	None		

Objectives:

1. To enhance reading, listening, speaking and writing skills of the students in the English Language
2. To improve their study skills and ability to write for academic and professional purposes
3. To encourage and develop critical thinking ability

Learning Outcomes:

At the end of the course, the students will be able to:

1. Write different types of paragraphs frequently used in scientific writing
2. Read academic texts for specific and global information and make notes
3. Listen to academic lectures and take notes
4. Participate in academic and general conversations and make presentations on familiar topics
5. Write professional e-mails, reports, and blogs without much difficulty

Course Content: Lectures (39)

Introduction (5 lectures)

Introduction to the course; Grammatical and comprehension ability; introduction to critical thinking

Listening and Speaking (17 lectures)

Listening to academic lectures and making notes; Listening for specific information and listening for meaningful observation; Participating in conversations; Asking questions; responding to questions; making presentations; Listening comprehension exercises; Listening and note-taking using Outline method; Listening and Summarising; Listening and comprehending while watching an audio-visual clip

Reading and Writing (17 lectures)

Introduction to reading techniques: Skimming and Scanning; Critical analysis of literary, cultural and scientific texts; Reading and note-taking; How to closely read different types of writings such as academic, technical, literary and analyse them; Basic grammatical skills such as sentence construction, syntax, punctuation and vocabulary enhancement; Email writing; Paragraph Writing; Summarizing; Essential Parts of an Academic Essay

Textbook

Reading materials for the course will be curated to enhance both creative and critical thinking and will include newspaper articles, famous speeches, biographies, passages /narratives from fiction, nonfiction, poetry, and film.

Reference Books

1. Bolton. D. (2008). *English Grammar in Steps: English Grammar presented, explained and practiced in context*. Orient Longman. New Delhi: India

2. Wren PC, Martin H. (2018) *High School English Grammar & Composition. Revised by N.D.V. Prasad Rao.* S Chand Publishing Blackie. ELT Books, New Delhi: India.
3. Hewings, Martin (2012) *Cambridge Academic English.*
4. Davis, Jason and Rhonda Liss (2012) *Effective Academic Writing.* Oxford University Press.

Online Course Material

1. Iqbal, Ayesha. *English Language for Competitive Examinations.* NPTEL Course Material, Department of Humanities and Social Sciences, Indian Institute of Technology-Madras, <https://nptel.ac.in/courses/109106116/>
2. Choudhary, Shreesh. *Better Spoken English.* NPTEL Course Material, Department of Humanities and Social Sciences, Indian Institute of Technology-Madras, <https://nptel.ac.in/courses/109106067/>.
3. <http://www.uefap.com>
4. <https://owl.purdue.edu/owl/>

Title	Understanding India (Indian Ethos and Knowledge Systems) - II	Course No.	MSL1XXX
Department	School of Management and Entrepreneurship	L-T-P-D [C]	2-0-0-0 [2]
Offered for	BSc-BEd (ITEP)	Type	Core
Prerequisite	Understanding India (Indian Ethos and Knowledge Systems) - I		

Objectives

This course aims to introduce indigenous knowledge in the educational curriculum formally. The course consists of sessions that:

- introduce students to the contributions by India to Foundational knowledge, Science, Engineering & Technology, and Humanities & Social Sciences through a structured classification
- introduce students to the thinking patterns and the knowledge repository created by the thinkers and practitioners of yore and many generations that provides great value
- enable the current generation to understand the thought processes and frameworks, and synthesize new knowledge

Learning Outcomes

The course enables participants to:

- develop an early appreciation of the Indian ethos and knowledge system
- appreciate the matter being discussed with contextual reference

Contents

Part III: Science, Engineering and Technology in IKS

- Mathematics (4 sessions) - Unique Aspects of Indian Mathematics, Great Mathematicians and their contributions, Arithmetic, Geometry, Trigonometry, Algebra, Binary Mathematics and Combinatorial Problems, Discover IKS exercises on topic
- Astronomy (4 sessions) - Unique Aspects of Indian Astronomy, Historical Development of Astronomy in India, The Celestial Coordinate System, Elements of the Indian Calendar, Āryabhaṭīya and the Siddhāntic Tradition, Pañcāṅga – The Indian Calendar System, Astronomical Instruments (Yantras), Discover IKS exercises on topic
- Engineering and Technology: Metals and Metalworking (4 sessions) - The Indian Science and Technology (S&T) Heritage, Mining and Ore Extraction, Metals and Metalworking Technology, Iron and Steel in India, Lost Wax Casting of Idols and Artefacts, Apparatuses used for extraction of metallic components, Discover IKS exercises on topic
- Engineering and Technology: Other Applications (4 sessions) - Literary Sources for Science and Technology, Physical Structures in India, Irrigation and Water Management, Dyes and Painting Technology, Surgical Techniques, Shipbuilding, Sixty-four Art Forms, Status of Indigenous S&T, Discover IKS exercises on topic
- Town Planning and Architecture (4 sessions) - Arthasastra on Town Planning, 1 Indian Architecture – A historical perspective, Vāstu-śāstra – The Science of Architecture, Town Planning, Unitary Buildings, Temple Architecture, Indo-Saracenic architecture, Discover IKS exercises on topic

Part IV: Humanities and Social Sciences in IKS

- Health, Wellness and Psychology (4 sessions) - Āyurveda – Definition of health, Tri-doṣas – Relationship to Health, Disease Management, Yoga way of life – Relevance to health and wellness, Indian Approach to Psychology, The Tri-guna System, The Body–Mind–Intellect–Consciousness Complex, Consciousness – The true nature of an individual, Siddha Medicine, Discover IKS exercises on topic

- Governance and Public Administration (4 sessions) - Arthaśāstra – Governance and Administration, Vidura-niti – Advice to a King, The Administrative Set-up, Relevance of Arthaśāstra, Public Administration – Perspectives from the Epics, Discover IKS exercises on topic

Pedagogy

The course will be delivered through lectures, participative discussion of research articles, and student presentations. Evaluation of course shall be based on individual and group assessment methods such as assignments, projects etc. including an end-term examination. Each topic shall have discovered IKS Exercises for the students to work on and present.

Text Book

Mahadevan, B., Bhat, Vinayak Rajat, Nagendra Pavana R. N., (2022) Introduction to Indian Knowledge System: Concepts and Applications, PHI Learning Pvt. Ltd.

Recommended Readings

- Rao, S. S. (2006). Indigenous knowledge organization: An Indian scenario. *International Journal of Information Management*, 26(3), 224-233.
- Beer, S. (1994). May the whole earth be happy: Loka Samastat Sukhino Bhavantu. *Interfaces*, 24(4), 83-93.
- Danino, M. (2010). *The lost river: On the trail of the Sarasvatī*. Penguin Books India.
- Matilal, B. K. (2008). *Logic, Language and Reality: Indian Philosophies and Contemporary Issues (Vol. 2)*. Motilal Banarsidass.
- Matilal, B. K. (2001). *Introducing Indian Logic*. *Indian Logic: a Reader*, 183-215.
- Kumar, R., & Prakash, O. (Eds.). (2023). *Language Studies in India: Cognition, Structure, Variation*. Springer Nature.
- Satguru Sivaya Subramuniyaswam (2008) *Tirukkural: The American English and Modern Tamil Translations of an Ethical Masterpiece*, (<https://www.himalayanacademy.com/media/books/tirukural/tirukural.pdf> available in link as on March 30, 2024)
- Bose, D. M., Sen, S. N., & Subbarayappa, B. V. (1971). *A concise history of science in India*. A concise history of science in India.
- Bag, A. K. (2015). Ideas and Researches on Physical Concepts in India. *Indian Journal of History of Science*, 50(3), 361-409.
- Bag, A. K. (1982). Technology in India in the eighteenth-nineteenth century. *Indian journal of history of science*, 17(1), 82-90.
- Bag, A. K. (2018). Indo-European Encounter and Features of Modern Science in Pre-Colonial & Colonial India. *Indian Journal of History of Science*, 53, T1-T20.
- Mishra, L. C. (Ed.). (2003). *Scientific basis for Ayurvedic therapies*. CRC press.
- https://en.wikipedia.org/wiki/Siddha_medicine
- *Siddha Medicine by Ramon Martinez Lopez (Ref: <https://www.amazon.in/Siddha-Medicine-Ramon-Martinez-Lopez/dp/1519302002>)*
- Dutta, A. K. (2016). Was there sophisticated mathematics during Vedic Age. An anthology of disparate technical thoughts at a popular level (ed. A. Chaudhuri), ISIREA.
- Bidyāraṇya, S., & Singh, A. N. (1962). *History of Hindu mathematics: a source book*. (No Title).
- Joseph, G. G. (2016). *Indian mathematics: Engaging with the world from ancient to modern times*. World scientific.
- Amma, T. S. (1999). *Geometry in ancient and medieval India*. Motilal Banarsidass Publ.

- Kolachana, A., Mahesh, K., & Ramasubramanian, K. (Eds.). (2019). *Studies in Indian mathematics and astronomy: selected articles of Kripa Shankar Shukla*. Springer Singapore.
- Collected Writings of Shri Dharmapal (<https://www.dharampal.net/publications>)
 - Volume I -Indian Science and Technology in the Eighteenth Century
 - Volume II -Civil Disobedience in Indian Tradition
 - Volume III -The Beautiful Tree: Indigenous Indian Education in the Eighteenth Century
 - Volume IV - Panchayat Raj and India's Polity
 - Volume V- Essays on Tradition, Recovery and Freedom
- A History of Hindu Chemistry Vol. 1. Internet Archive. Retrieved April 03 2024.
- A History Of Hindu Chemistry,Vol. 2. Internet Archive. Retrieved April 03 2024
- R., T. A History of Hindu Chemistry from the Earliest Times to the Middle of the Sixteenth Century A.D., with Sanskrit Texts, Variants, Translation and Illustrations. *Nature* 68, 51–52 (1903).
<https://doi.org/10.1038/068051a0>
- *History of Ancient India* (Set of 11 Volumes), 2023, Edited By: Dilip K. Chakrabarti, Publisher: Aryan Books International

Title	Teacher and Society	Number	EDL1XXX
Department	CET	L-T-P-D [C]	2-0-0-0 [2]
Offered for	BSc-BEd (Semester 2)	Type	Core
Prerequisite	Nil		

Objectives

1. To explore the multiple identities of a teacher (personal, professional, institutional, policy constructions etc.) and its overlap with the teaching-learning process
2. To introduce students to the ethical dimensions of a teacher's role in Indian society and its links to democratic citizenship and nation-building
3. To inculcate a sensitivity in the students to the needs of learners from diverse cultural, linguistic, gender, social and economic backgrounds as well as those who are differently abled

Learning Outcomes

1. The ability to conceptualize how the agency of teachers is shaped by individual, contextual, and structural dimensions
2. Creation of a professional sensibility that will contribute to their future professional practice, including the creation of positive learning environments.
3. The ability to critically reflect on personal and collective practice so as to improve learning and teaching

Course Contents

1. The social construction of teaching as a profession: Understanding the personal and social dimensions of a teacher's identity; Teaching and Professionalism- History, aspirations, expectations; Teaching and Mentorship (7 lectures)
2. The ethical elements of teaching as a profession: Teacher's values, beliefs and philosophies; the teacher and the state: teaching, citizenship-education and nation-building; Reflexive practice (7 lectures)
3. The agency of teachers: Individual, cultural and structural dimensions of teacher agency; Pedagogical content knowledge; Challenges in the way of fostering teacher agency; performativity, non-academic engagements; Policy and Practice gaps (7 Lectures)
4. Contemporary issues around the teacher as a professional: New political economy of teaching; Technology adoption, 'digital divide and inequalities' and teaching 'digital natives', etc. (7 lectures)

Textbooks

1. Razzack, A., Sarangapani, P. and Jain, M. 2023 (eds). Education, Teaching and Learning: Histories, Cultures, Conversations, New Delhi: Orient Blackswan
2. Zeichner, K. M., & Liston, D. P. (2013). Reflective teaching: An introduction. Routledge.

Reference Books

1. Bruner, J. (1996). Folk pedagogy. In The culture of education (pp. 44-65). Cambridge: Harvard University Press.
2. Sriprakash, A. (2012). Pedagogies for development – the politics and practice of Child Centered Education in India. Dordrecht: Springer Publication

Online Resources

Cope, William. Learning, Knowledge and Human Development.
<https://www.coursera.org/learn/learning-knowledge-human-development>

Title	Design and Computational Thinking	Number	EDL1XXX
Department	CET	L-T-P-D [C]	1-0-4
Offered for	BSc-BEd (Semester 2)	Type	Core
Prerequisite	Nil		

***Will be updated soon**

Objectives

Introduce the students to

1. Thinking holistically, taking into consideration different stakeholders' perspectives
2. Understand the context, and identify and define a problem
3. Methods of ideation, prototyping solutions and gathering user feedback
4. Introduce to the foundational concepts, practices, and perspectives of Computational Thinking (CT)
5. Enable pre-service teachers to reflect on and apply CT practices and perspectives using block-based programming tools like Scratch in the context of their own teaching.

Learning Outcomes

The students will be able to

1. Apply the method of design thinking to everyday challenges in and outside the classroom.
2. Come up with compelling ideas and solutions.
3. Demonstrate core CT concepts (e.g., sequences, loops, operators, variables) and CT practices (e.g., incremental development, debugging) by designing and implementing simple interactive programs using block-based programming platforms like Scratch
4. Articulate how CT can be meaningfully integrated into pedagogy

Contents

Design Thinking

- **Introduction to Design Thinking:** Applicability of design thinking to different situations; Case studies; Overview of the process: Understanding context, developing empathy, problem statement, ideation, prototyping, testing and critiques, iteration towards a workable solution. [1 hour lecture, 4 practical hours]
- **Discovery and definition:** Understanding the problem context; Asking questions to identify the right problem; Identifying stakeholders; Stakeholder or user personas - developing empathy by observation and interviews; Identifying constraints and requirements; Framing a problem without introducing bias; "How might we..." [2 hour lecture, 8 practical hours]
- **Exploration and ideation:** Mind maps; Thinking visually; Collaborative ideation–whiteboards, digital whiteboard tools (Google Jamboard, Mural, Miro, etc.); Synthesis of ideas; Evaluating ideas from the perspective of constraints, requirements, and feasibility. [2 hour lecture, 6 practical hours]
- **Prototyping:** Introduction to prototyping; Importance of prototyping; Types of prototyping - low to high fidelity; Prototyping for products, services, and experiences; Making prototypes–physical, digital, role-playing; Prototype key use cases; Elevator pitch and Poster presentation. [1 hour lecture, 6 practical hours]

- **Validation:** Taking user feedback on the prototype for key use cases; the Think-Aloud protocol; Refining the prototype based on feedback and insights gained; Iterating. [1 hour lecture, 4 practical hours]

Computational Thinking

- **Introduction to CT in Education:** Computational Thinking: Concepts, Practices, Perspectives; Understanding CT beyond coding; Introduction to Scratch (or any block-based programming platform) as a learning tool [2 Lecture Hours, 4 Lab Hours]
- **CT Concepts (Hands-on Activities on Block-based platform):** Sequences & Loops: Understanding sequences, loops, and events through interactive storytelling and design; Conditionals: Decision-making using branching logic; Parallelism: Simultaneous execution in animations; Operators & Variables: Data manipulation in simple games [2 Lecture Hour, 8 Lab Hours]
- **CT Practices:** Designing & Debugging with Scratch: Incremental Development & Testing, Building projects in small steps; Debugging, Identifying and fixing errors; Abstraction & Modularization, Breaking problems into smaller parts [1 Lecture Hour, 4 Lab Hours]
- **CT Perspectives (Reflection & Application in Teaching):** Computational Identity, Creative Expression with CT; CT in Pedagogy, Brainstorming lesson ideas integrating CT in teaching [1 Lecture Hour, 4 Lab Hours]
- **Mini-Project:** Project Exhibition [4 Lab Hours]

References and Textbooks

1. Tim Brown, "Change by Design" Revised and updated edition, Harper Business, 2019
2. IDEO.org, "The Field Guide to Human-Centered Design" 1st edition, IDEO.org, 2015
3. Don Norman, "The Design of Everyday Things," 2nd Edition, Basic Books, 2013
4. Denning, P. J., & Tedre, M. (2019). Computational thinking. Mit Press.

Online Resource for Computational Thinking:

Scratch in Practice <https://sip.scratch.mit.edu/scratchathome/>
Code.org: <https://code.org/students>

Notes for Instructors:

- This lab course should include hands-on tasks in the lab sessions where PSTs will engage with concepts from their major/minor subjects (Mathematics, Physics, Chemistry), with a focus on contextualizing DT and CT within disciplinary content.
- The instructor(s) should ensure connection and integration of DT and CT. The tasks, activities, and assignments related to the teaching-learning challenges or situations addressed in the DT module should be continued to the CT module and then expanded to diverse teaching-learning situations to make the relationship between DT and CT explicit.
- The transition from DT to CT and the related tasks would incrementally flow from solutions to specific teaching-learning challenges to generalizable solutions for related as well as diverse T-L challenges. The students will first extend the same problem they addressed through DT lens to the CT lens, and eventually expand the problem-solution space to different T-L challenges.

- The following activities are highly recommended: Case studies, Lesson-planning exercises where learners toggle between exploratory DT and abstract CT, Reflection on when each form of thinking is appropriate, Designing solutions for challenges in STEM teaching-learning.

Course Title	Child Development & Educational Psychology	Course No.	LAL2XXX
School	SoLA	L-T-P-C	3-0-2 [4]
Offered for	BSc BEd (Semester3)	Type	Core
Pre-requisite	None		

Objectives

1. To develop a basic understanding of child development milestones.
2. To explain various aspects of child development, such as physical, cognitive, emotional, and moral development.
3. To explain the basics of educational psychology.
4. To understand the dynamics of learning and teaching in the classroom context

Learning Outcomes

The students will be able to

1. Understand the basics of child development, including various theories and models.
2. Examine various aspects (e.g., physical, cognitive, emotional, moral) of child development.
3. Analyze the role of socio-cultural context in child development.
4. Apply various learning approaches in Indian classroom settings.
5. Apply knowledge in planning and managing classes.

Contents

Introduction to child development: Historical perspectives; Principles of development; Brief overview of stages in human development; Work of Freud, Piaget, Vygotsky, Erikson, Kohlberg, Kakar, other Indian Perspective, etc., related to child development. (10 Lectures)

Development across various domains: Physical development, Cognitive development, Language development, Socio-Emotional development, Moral development, Development in Neurodivergent Population. (9 Lectures)

Basics of educational psychology: Introduction to learning, teaching, and educational psychology; Education and cultural diversity; Individual differences and learning. (5 Lectures)

Various approaches to learning: Behavioural views of learning; Cognitive learning; Complex Cognitive Processes; Constructivism and interactive learning; Social cognitive views, Bronfenbrenner Ecological Framework. (10 Lectures)

Learning and teaching in the classroom: Motivation in Learning and Teaching; Technology and Instruction Planning, Managing the classroom; Classroom assessment. (5 Lectures)

Suggested Practicum

1. Examine the pattern of play activities in childhood.
2. Analysis of a book based on a child story, such as Totto-Chan, Swami and friends.
3. Compare the daily life of two children from different socio-economic status.
4. Cognitive/intelligence assessment of a child.
5. Spending a day in a school and writing a report about classroom functioning.
6. Interviews with students to explore the school's sensitivity to socio-cultural inclusiveness.
7. Interview of teachers on children's learning problems, especially for underachievers.

Text Book

1. Hurlock, E. (2017). *Child development, 6th edition*. New Delhi: Tata McGraw Hill.
2. Woolfolk, A. & Usher, E. L. (2023). *Educational psychology, 15th edition*. Pearson

Reference Books

3. Berk, L. E. & Meyers, A. B. (2019). *Child development, 10th edition*. Pearson.
4. Santrock, J. W. (2011). *Educational Psychology, 5th edition*. Pearson.
5. Long, M. (2000). *The psychology of education*. Routledge.
6. Miller, P. H. (2011). *Theories of developmental psychology*. Worth Publishers.

Online Reading Materials

https://ugcmoocs.inflibnet.ac.in/index.php/courses/view_ug/207

Course Title	Basics of Pedagogy at the Secondary Stage	Course No.	EDL2XXX
Department	CET	(L-T-P)	3-0-2 [4]
Offered for	BSc BEd (Semester3)	Type	Core
Prerequisite	None		

Objectives

1. To establish a foundational understanding of the principles and concepts of pedagogy in relation to secondary stage of education (classes IX to XII)
2. To develop an understanding of the cognitive, social, and emotional development of adolescents and its implications for teaching and learning.
3. To introduce fundamental pedagogical principles for effective teaching at the secondary stage, assessment techniques, and classroom management strategies.

Learning Outcomes

At the end of the course, the students will be able to

1. Explain the key theories of learning and their implications for secondary education.
2. Identify the unique capabilities and strengths of secondary stage learner
3. Design teaching--activities activities informed by student-centered and inclusive pedagogy
4. Demonstrate the application of digital tools for assessments suitable for the secondary stage

Contents

- I. Understanding Secondary Stage Learners (7 Lectures):** The Physical, Mental, Social and Emotional Growth of learners at this stage; Cognitive theories of learning and models; psychological and social orientations; social and academic lives of learners; management of conflict and challenges
- II. Foundations of Pedagogy at the Secondary Stage (6 Lectures)** Definition, scope and importance of pedagogy; Classification of Pedagogy w.r.t. Social aims (Inclusive Pedagogy, Culturally relevant Pedagogy, Dialogic and Socratic Pedagogy, Critical Pedagogy)
- III. Strategies for Teaching and Learning (7 Lectures):** Pedagogical Approaches for Effective learning (Constructivist, Cognitivist, Collaborative, Inquiry-based based learning; Active-learning based; Art-integrated; Sports-integrated)
- IV. Assessment (6 Lectures):** Types (Formative, Summative, Diagnostic, Performance-based), Rubrics, Portfolios and Peer Assessment; Feedback mechanisms)
- V. Role of Technology in Pedagogy, Assessment and Classroom Management (7 Lectures)** (Digital tools and resources for teaching, learning and assessment, blended learning and flipped classrooms, Learning Management Systems, Ethical considerations in using technology)
- VI. Reflective Practices and Professional Development (7 Lectures)** (Importance of reflective practice in teaching, Techniques for self-assessment and peer feedback, Continuous professional development for teachers, Building a teaching portfolio)

Practical Sessions (26 Hours)

The following are some suggestions for practical sessions. The list is not exhaustive.

1. Policy and Curriculum Analysis with respect to the concerned subject.
2. Analysis and Reflection on the Qualities of an 'Innovative Teacher' in Context of National Professional Standards for Teachers (NPST) and National Mentoring Mission (NMM).

3. Evaluation of different platforms such as National Teacher's Portal, NISHTHA, DIKSHA, and SWAYAM for an online course and prepare a report.
4. Designing a Lesson Plan (Project-based or Inquiry-based)
5. Develop teaching learning strategies to address the needs of diverse learners in the context of gender, equity and inclusion and prepare a PowerPoint presentation.
6. Case-study analysis of the challenges faced by secondary stage learners
7. Any other relevant tasks assigned by the instructor

Textbook

1. Mangal, S. K., and Mangal, S. (2019). *Learning and teaching*. PHI Learning Pvt. Ltd.
2. Gage, N. L. (2009). *A conception of teaching*. Springer Science & Business Media LLC

References

1. Little, A., & Wolf, A. (1996). *Assessment in transition: learning, monitoring and selection in international perspective*. Pergamon.
2. Bloom, B. S. (1984) *Taxonomy of educational objectives*. Longman.

Online Resources

Education: Concept, Nature and Perspectives

https://onlinecourses.swayam2.ac.in/nou25_ed12/preview

Course Title	Mathematical and Quantitative Reasoning	Course No	EDL3XXX
Department	CET	Structure (L-T-P) [C]	2-0-0 [2]
Offered for	BSc BEd (Semester 3)	Type	Core
Pre-requisite	None		

Objectives

The instructor will:

1. Develop the knowledge and capacities required to analyze, interpret, and communicate quantitative data in education to deduce conclusions using numerical and graphical representations.
2. Enable learners to think critically about data and use quantitative reasoning to solve real-life problems.

Learning Outcomes

At the end of the course, the students will be able to:

1. Interpret numerical and graphical representations (e.g., formulas, graphs, and tables) to draw evidence-based conclusions.
2. Analyze educational data (e.g., enrolment data, survey data, or assessment results) to support pedagogical decision-making.
3. Apply mathematical reasoning to solve real-world quantitative problems and justify solutions using appropriate mathematical and statistical reasoning.

Contents

1. **Introduction to mathematical and quantitative reasoning (6 lectures):** Nature and scope, Significance; Types and use of quantitative reasoning; Mathematization
2. **Data Analysis & Interpretation (11 lectures):** Data types and data visualization (bar diagram, histogram, pie charts); Measures of central tendency, measures of dispersion; Statistical analysis of data in educational context and its applications; Learning analytics (LA): concept, types, levels, and its applications in educational context (e.g., LA Dashboards).
3. **Data in Education (9 lectures):** Data and Sources of Data; School enrolment data: Gross Enrolment Ratio (GER), Net Enrolment Ratio (NER), Dropout rate, Measures of literacy; Indian census: Data elements; Nationwide and International sample surveys or tests: National Achievement Survey (NAS), ASER, PISA; UDISE data

Textbooks

1. Spiegel, M.R. Theory and Problems of Statistics McGraw Hill Book, London
2. Ross, S. M. (2010). Introductory Statistics. Netherlands: Elsevier Science.

References

1. Madison, B. L., & Steen, L. A. (Eds.). (2008). Calculation Vs. Context: Quantitative Literacy and Its Implications for Teacher Education: June 22-24, 2007, Wingspread Conference Center, Racine, Wisconsin. Mathematical Association of America.

2. Duraisamy, P. (2012). Statistics on Education: Advantages and Limitations for Studies on Social Groups. <https://learnos.files.wordpress.com/2012/10/statistics-education-iids-seminar-duraisamy.doc>
3. Steen, L. A. (2001). Mathematics and democracy: The case for quantitative literacy. National Council on Education and the Disciplines.

Online Resources

Probability and Statistics By Prof. Somesh Kumar, IIT Kharagpur
https://onlinecourses.nptel.ac.in/noc21_ma74/preview

Course Title	Philosophical and Sociological Perspectives on Education- I	Course No.	LAL2XXX
Department	SoLA	Structure (L-T-P)	3-0-2 [4]
Offered for	BSc BEd (Semester 4)	Type	Core
Pre-requisite	None		

Objectives

1. To explore the concept, nature, aim and scope of educational practice
2. To understand the relationship between society, philosophy and education

Learning Outcomes

The students will be able to:

1. Examine the nature of knowledge, human beings and society in the context of educational practice
2. Analyze the views of prominent thinkers of education both from India and the West.

Contents

Society, Human Nature and Education (6 lectures): Theories of Human Nature (Dualism, Physicalism, Embodied Approaches, Hemisphere hypothesis); Aims of Education and Organization of Society

Indian Perspectives on Education (6 lectures): Vedic, Buddhist, Jain, Sikh and Islamic traditions. Major schools of philosophy such as Samkhya, Yoga, Nyaya, Vaisheshika and Vedanta

Western Perspectives on Education (6 lectures): Idealism, Pragmatism, Naturalism, Progressivism, Cognitive-Behaviourism, Constructivism

Indian Thinkers (8 lectures): Swami Vivekananda, Sri Aurobindo Ghosh, Gurudev Rabindranath Tagore, J. Krishnamurti, Mahatma Gandhi, Savitribai Phule

Western Thinkers (7 lectures): J. Rousseau, Maria Montessori, John Dewey, Paulo Freire, Ivan Illich

Value Education (6 lectures): Value Education and educational policies, Education for Peace and Wellbeing, Indian constitutional values, Values for 21st century related to technology and sustainability.

Practicum (26 Hours)

The Practicum Component will include

- Tasks including various forms like writing small paragraphs/brief notes, conceptualizations on specific terms etc. related to philosophy and sociology of education
- Presentations of student experiences (in groups) related to readings on/texts by key thinkers on topics related to the vision, mission and objectives for school education at the secondary stage, along with the creation of a group report to how these aspects may be realized in implementation.

- Identification and reporting of Indian perspectives related to educational aims, student-teacher characteristics, methods, evaluation procedure, convocation etc. based on a critical study of the life and thoughts of thinkers.
- Other relevant activities as designed by the instructor

Text Book

1. Brubacher, J. S. (2022). Modern philosophies of education. Nation Press
2. A.S. Altekar (2009) Education in Ancient India. Gyan Books.

Reference Books

1. Roy Palmer et al (2001) Fifty Major Thinkers on Education Routledge
2. Mrinal Miri(2014) Philosophy and Education, OUP
3. Bailey, R., Carr, D., & Barrow, R. (2010). The Sage handbook of philosophy of education.
4. Padma M. Sarangapani and Rekha Pappu Handbook of Education Systems in South Asia' Springer Nature 2021

Online Reading Materials

1. <https://www.philosophyofeducation.org/Ethics-Web-Resources>

Course Title	Content-cum-Pedagogy of Physical Sciences at the Secondary Stage-I	Course No.	EDL2XXX
Department	CET	Structure (L-T-P)	3-0-2 [4]
Offered for	BSc BEd (Semester 4)	Type	Core
Pre-requisite		None	
<p>Objectives</p> <ol style="list-style-type: none"> 1. To enable students to understand the nature and scope of physical sciences as well as the aims and objectives of teaching physical sciences (including its linkages with other disciplines). 2. To relate the physical sciences to technology, society, humanity and sustainable development. 3. To introduce the foundations of designing teaching--learning approaches in science education at the secondary stage with a focus on designing teaching--learning activities for grades 9-10. <p>Learning Outcomes</p> <p>At the end of the course the students will be able to:</p> <ol style="list-style-type: none"> 1. Explain the nature, scope and importance of physical sciences. 2. Illustrate the aims and objectives of teaching physical sciences for the sustainable development of society. 3. Analyze the integration of physical sciences with other subjects at the secondary stage. 4. Demonstrate various pedagogical approaches and methods of teaching the physical sciences. <p>Contents</p> <p>1. The Nature, Scope and Historical Perspective of Physical Sciences (3 lectures): Fundamental concepts, laws, and scientific reasoning; Historical development and scientific revolutions: major contributions from Indian (ancient and modern) and other scientists; physical sciences and society: technology, environment, and sustainable development.</p> <p>2. Aims and Objectives of Teaching Physical Sciences (3 lectures): Aims and purposes for individual and society; Learning outcomes and competencies expected at the secondary level; integration and interdisciplinary linkages: STEAM, connection with other school subjects; values in physical sciences teaching: scientific attitude, scientific temper, critical thinking, ethics, and appreciation of alternative knowledge systems, etc.</p> <p>3. Pedagogical Aspects of Physical Sciences (7 lectures): Developing higher-order thinking skills: critical, creative, decision-making, and reflective thinking. Pedagogical Approaches and their implications: Inductive–deductive, constructivist, experiential learning, integrated pedagogy (art-, sports-integrated, STEAM). Methods of teaching and learning in Physical Sciences: Learner-centric, inquiry-based, activity-based, collaborative and cooperative learning; lecture-cum-demonstration, experimentation, project-based learning; concept mapping, dialogic teaching.</p>			

Illustrative teaching of selected topics from grades 9–10: Mechanics, materials and matter, energy conservation, chemical systems, electricity & magnetism, sound and light, etc.

Suggested Practicum (26 Hours)

1. Prepare reflective notes or posters on contributions in the Physical Sciences across different eras, including works of Indian and Western scientists, with specific attention to female scientists; value integration or interdisciplinary connections may also be explored. (2 hours)
2. Trace the treatment of any object/artifact/food etc. in different knowledge systems and its integration in secondary stage science education. (2 hours)
3. Develop concept maps or learning trajectories for key concepts in physical sciences at secondary stage. (2 hours)
4. Design a lesson plan to support student talk with teacher talk moves (2 hours)
5. Student thinking and learning: Identify learner misconceptions and design strategies to scaffold understanding or Design an activity to make thinking visible with a model (2 hours)
6. Demonstrate multiple pedagogical approaches (inquiry-based, activity-based, collaborative, project-based, experiential, STEAM integrated, collaborative or cooperative learning, etc) for Grade 9–10. (10 hours)
7. Compare and demonstrate two pedagogical approaches of your choice (e.g., inquiry-based, activity-based, project-based, experiential, collaborative/cooperative learning, STEAM-integrated). Prepare a brief classroom demonstration for Grade 9–10 Physical Sciences to illustrate the differences in how each approach shapes the teaching–learning process. (2 hours)
8. Observe and analyze physical sciences classrooms or videos, focusing on learner reasoning and engagement. (4 hours)

Textbook

Pedagogy of Science: Physical Science Part 1, NCERT, https://ncert.nic.in/desm/pdf/phy_sci_part1.pdf

References

1. Hetherington, L., Graham, L., & Moore, D. (Eds.). (2024). Learning to teach science in the secondary school: A companion to school experience (5th ed.). Routledge.
2. Padalkar, S., Ramchand, M., Shaikh, R., & Vijaysimha, I. (2023). Science education: Developing pedagogical content knowledge. Routledge India.
3. Windschitl, M., Thompson, J. J., & Braaten, M. L. (2018). Ambitious science teaching. Harvard Education Press.
4. Woolcott, G., & Whannell, R. (Eds.). (2017). Teaching secondary science: Theory and practice. Cambridge University Press.
5. National Steering Committee for National Curriculum Frameworks, (2023). Draft National Curriculum Framework for School Education.
6. NCERT Textbooks, Science for Class 9 and 10.

Online Resources

1. BES-141 Pedagogy of Science (https://onlinecourses.swayam2.ac.in/nou25_ed03/preview)

Course Title	Content-cum-Pedagogy of Mathematics at the Secondary Stage-I	Course No.	EDL2XXX
Department	CET	Structure (L-T-P)	3-0-2 [4]
Offered for	BSc BEd (Semester 4)	Type	Core
Pre-requisite		None	
<p>Objectives</p> <p>1. To introduce the foundations of designing teaching--learning approaches in mathematics education at the secondary stage with a focus on designing teaching--learning activities for grades 9-12.</p> <p>Learning Outcomes</p> <p>After completion of the course, student-teachers will be able to:</p> <ol style="list-style-type: none"> 1. Explain the nature and structure of mathematical knowledge and its role in human development. 2. Formulate lesson-specific learning objectives for mathematics teaching in the secondary stage 3. Identify learner misconceptions and apply instructional strategies to facilitate conceptual understanding. 4. Demonstrate activity-based pedagogical approaches for teaching topics from Grades 9–12 5. Integrate values in mathematics teaching including contributions by Indian mathematicians. <p>Contents</p> <p>Nature, Aims and Scope of Mathematics: Mathematics as a way of thinking; Axioms, Postulates, Conjectures, Proofs in Mathematics, inductive–deductive reasoning, theorems, mathematical modeling; nature and structure of mathematical knowledge; Indian contributions and historical perspectives to mathematics (3 lectures)</p> <p>Mathematical Thinking and Learner Cognition: How learners construct meaning; typical misconceptions (fractions, algebraic variables, geometry, probability and statistics, calculus, etc.); conflict generation, hypothetical learning trajectories, diagnosing errors; scaffolding and questioning for reasoning (3 lectures)</p> <p>Pedagogical Approaches in Mathematics: Learner-centric and participative teaching methods for higher order thinking; heuristic, discovery, and problem-posing methods; use of manipulatives and multiple representations; dialogic and inquiry-based teaching; integrated pedagogy (with other subjects of the secondary stage) (4 lectures)</p> <p>Teaching Core Concepts of Secondary Mathematics: Illustrative teaching of key topics across Grades 9–12: Number systems, linear equations, geometry proofs, data handling through exploration and reasoning (3 lectures)</p>			

Practicum (26 hours)

1. Design and demonstrate approaches and techniques of teaching–learning Mathematics: inductive–deductive, analytical–synthetical, heuristic, problem-solving, constructivist, blended and experiential learning; oral, written, drill work, homework design, self-study, group study, supervised study, concept-mapping, learning, integrated STEAM learning (art, sports, games etc.); diverse pedagogical possibilities and affordances; learner-centered participative methods (lecture-cum-demonstration, laboratory, project-based learning) for topics from Grades 9-12 (14 hours)
2. Prepare diagnostic worksheets and analyze learner responses for misconceptions (4 hours)
3. Construct a concept-map or learning trajectory for secondary-stage topics. (4 hours)
4. Observe and reflect on a mathematics classroom or video lesson, focusing on learner reasoning / analysis of textbook lessons (2 hours)
5. Develop strategy to connect any three topics for value inculcation in teaching of Mathematics (eg. honesty, precision, perseverance, collaboration, aesthetics; designing value-integrated activities; linking mathematical ideas to social, environmental, and ethical contexts) / Prepare a poster or reflective note on value integration / Indian contribution in mathematics / biographical sketch of an Indian mathematician (2 hours)

Textbooks

NCERT (2012). Pedagogy of Mathematics. New Delhi: National Council of Educational Research and Training.

NCERT (2006–2023). Mathematics Textbooks for Classes IX–XII.

Reference Material

1. Krantz, S. G. (2015). How to teach mathematics (3rd ed.). American Mathematical Society.
2. NCERT (2016). A Handbook for Designing Mathematics Laboratory in Schools
3. Haggarty, L. (Ed.). (2002). Teaching mathematics in secondary schools: A reader. Psychology Press.
4. Zhang, S., Yao, Y., & Pan, H. (2023). The Pedagogy of Secondary-School Mathematics. Springer.
5. Goos, M., Stillman, G., Herbert, S., & Geiger, V. (2020). Teaching secondary school mathematics:
6. Research and practice for the 21st century. Routledge.

Course Title	Content-cum-Pedagogy of Mathematics at the Secondary Stage-II	Course No.	EDL 3XXX
Department	CET	Structure (L-T-P-C)	1-0-2 [2]
Offered for	BSc BEd (Semester 5)	Type	Core
Pre-requisite		None	
<p>Objectives</p> <ol style="list-style-type: none"> To impart the fundamentals of learning resources in mathematics. To develop an understanding of planning for teaching mathematics. To introduce innovative teaching in mathematics. <p>Learning Outcomes</p> <ol style="list-style-type: none"> Analyse the print, ICT-based, and community-based teaching-learning resources for Mathematics education. Design unit plans and lesson plans for both in-person and online Mathematics classrooms. Develop innovative pedagogical approaches to make Mathematics teaching more inclusive and accessible. <p>Contents</p> <p>1. Learning Resources in Mathematics (5 lectures): Teaching-learning aids in mathematics; Print, ICT resources, and emerging technologies in Mathematics; Community resources and handling hurdles in utilising resources; Open Education Resources.</p> <p>2. Planning for Teaching-Learning Mathematics (6 lectures): Unit planning (For example: analysis for identification of axioms, concepts, rules, formulas, theorems, corollaries); Lesson designing (e.g., inductive-deductive, lecture cum demonstration, problem-solving); Preparing learners for lifelong learning and informal learning in Mathematics (1 lecture); ICT-integrated lessons based on TPACK framework; Applications of GeoGebra, Desmos, PhET simulations, spreadsheets.</p> <p>3. Innovative teaching and ICT integration in Mathematics (2 lectures): Virtual labs; Design of e-content, videos, interactive presentations; Inclusive digital strategies; Hackathon and Mathematics.</p> <p>Suggested Practicum (26 Hours)</p> <ol style="list-style-type: none"> Develop a detailed matrix of four teaching-learning aids for teaching any chapter from a secondary-stage Mathematics textbook. The aids may be procured, developed, or adapted from materials available in the immediate environment, and at least one of the four aids should be a digital resource. Design a lesson plan for teaching any chapter from a secondary-stage Mathematics textbook. Clearly identify the key elements of lesson design. Present the instructional sequence in the form of a 			

flowchart showing how these components would be transacted in a real classroom, incorporating innovative teaching strategies wherever appropriate.

3. Critically evaluate at least three hours of lectures from an online Mathematics course (MOOC) and prepare a 1500-word report reflecting on what you learned about planning and designing MOOCs.

4. Identify and review at least two informal learning resources that promote lifelong learning in Mathematics. Working in groups, analyse how these resources communicate mathematics concepts for lifelong learning and how they make learning innovative, inclusive, and relevant beyond formal classrooms. Drawing on this review, propose an innovative pedagogy for teaching Mathematics that could be implemented in your local context. Present your analysis and proposed pedagogy in a report.

5. Organise a Hackathon in which student groups identify topics from the secondary-level Mathematics curriculum that could be taught effectively through a hackathon format. Each group should select one topic and explore how a hackathon-based approach could connect the concept to real-world problems, products, or technologies, as well as interdisciplinary knowledge and innovation. Present the proposed approach through a workflow diagram or concept map.

6. Optional activity proposed by the instructor.

Text Book

1. NCERT. 2012. *Pedagogy of Mathematics: A Textbook for BEd*. National Council of Education Research and Training
2. NCERT Textbooks, Mathematics for Class IX and X
3. NCERT. Textbooks, Mathematics for Class XI and XII

Online resources

1. BES-143 Pedagogy of Mathematics
(https://onlinecourses.swayam2.ac.in/e-learning/preview/nou26_ed12) (in Hindi)

Course Title	Content-cum-Pedagogy of Physical Sciences at the Secondary Stage-II	Course No.	EDL 3XXX
Center	CET	Structure (L-T-P-C)	1-0-2 [2]
Offered for	BSc BEd(Semester 5)	Type	Core
Pre-requisite		None	
<p>Objectives</p> <ol style="list-style-type: none"> To impart the fundamentals of teaching-learning resources in the physical sciences. To develop an understanding of planning for teaching in physical sciences. To introduce innovative teaching in physical sciences. <p>Learning Outcomes</p> <ol style="list-style-type: none"> Analyse the print, ICT-based, and community-based teaching-learning resources for Physics education. Design unit plans and lesson plans for both in-person and online Physics classrooms. Develop innovative pedagogical approaches to make Physics teaching more inclusive and accessible. <p>Contents</p> <ol style="list-style-type: none"> Teaching Learning Resources (5 lectures): Teaching-learning aids in physical science; Print, ICT resources, and emerging technologies in Physical Science; Learning resources from immediate environment and community resources; Open Education Resources. Planning for Teaching in Physical Sciences (6 lectures): Pedagogical analysis of content; Elements of a Physical Science lesson; Planning and organising activities and (virtual) lab work; Unit planning and lesson designing; Preparing learners for lifelong learning and informal learning in Physics; ICT-integrated lessons based on TPACK framework. Innovative teaching in Physical Science (2 lectures): Virtual labs, Innovation labs, and tinkering; Hackathon and Physical Science. <p>Suggested Practicum (26 Hours)</p> <ol style="list-style-type: none"> Develop a detailed matrix of four teaching-learning aids for teaching any chapter from a secondary-stage Science textbook. The aids may be procured, developed, or adapted from materials available in the immediate environment, and at least one of the four aids should be a digital resource. Design a lesson plan for teaching any chapter from a secondary-stage Science textbook. Clearly identify the key elements of lesson design. Present the instructional sequence in the form of a flowchart showing how these components would be transacted in a real classroom, incorporating innovative teaching strategies wherever appropriate. Critically evaluate at least three hours of lectures from an online Physics course (MOOC) and prepare a 1500-word report reflecting on what you learned about planning and designing MOOCs. 			

4. Identify and review at least two informal learning resources that promote lifelong learning in Physics. Working in groups, analyse how these resources communicate physics concepts for lifelong learning and how they make learning innovative, inclusive, and relevant beyond formal classrooms. Drawing on this review, propose an innovative pedagogy for teaching Physics that could be implemented in your local context. Present your analysis and proposed pedagogy in a report .
5. Organise a Hackathon in which student groups identify topics from the secondary-level Physics curriculum that could be taught effectively through a hackathon format. Each group should select one topic and explore how a hackathon-based approach could connect the concept to real-world problems, products, or technologies, as well as interdisciplinary knowledge and innovation. Present the proposed approach through a workflow diagram or concept map
6. Optional activity proposed by the instructor.

Text Book

1. NCERT Textbooks, Pedagogy of Science (Physical Science): Part I and II
2. NCERT Textbooks, Physics for Class XI and XII
3. NCERT Textbooks, Science for Class IX and X

Reference Books

1. Borg, J., & Galea, P. (Eds.). (2023). *Physics teacher education: More about what matters*. Springer.
<https://link.springer.com/book/10.1007/978-3-031-44312-1>
2. Fischer, H.E., & Girwidz, R. (Eds.). (2021). *Physics education*. Springer.
<https://link.springer.com/book/10.1007/978-3-030-87391-2>
3. Taşar, M.F., & Heron, P.E.L. (Eds.). (2024). *The international handbook of Physics education research: Teaching Physics*. AIP Publishing.

Online resources

1. BES-141 Pedagogy of Science
(https://onlinecourses.swayam2.ac.in/e-learning/preview/nou26_ed03)

Course Title	ICT in Education	Course No	EDL3XXX
Department	CET	Structure (L-T-P) [C]	2-0-2 [2]
Offered for	BSc BEd (Semester 5)	Type	Core
Pre-requisite	None		

Objectives

The instructor will:

1. Orient the learners about the need for and importance of ICT in education.
2. Help students to adapt ICTs in line with educational aims and principles.
3. Provide exposure to students to the various approaches and stages towards the use of ICT in education

Learning Outcomes

At the end of the course the students will be able to:

1. Explain the concept, nature, and scope of ICT in education.
2. Describe the importance of various emerging technologies in education.
3. Demonstrate the use of various technological tools for improving teaching-learning-assessment processes.

Contents

Introduction to ICT in Education (8 lectures): Instructional Technology and ICT in Education (Scope, Meaning and Difference); Scope of ICT- Teaching, learning, Assessment, Educational Administration; Instructional Design: Models (e.g., ADDIE, ASSURE) and Instructional Frameworks (e.g., Gagné's Nine Events of Instruction, Multimedia Principles, etc.); Educational Technology: Challenges and Approaches

Digital and Emerging Technologies in Education (8 lectures): E-learning: Concept, modalities (online, blended), and technological platforms (LMS, Virtual Labs, MOOCs); Open Education Resources (Creative Commons, Concept, and application); Immersive and intelligent technologies (AR, VR, AI) and technology-enabled instructional strategies (e.g., Gamification); Generative AI in Education; Ethical issues & safety in ICT

ICT in Teaching, Learning & Assessment (10 lectures):

Technological Pedagogical Content Knowledge (TPACK) framework, Technology Integration Matrix (TIM); Evaluation of ICT Tools: Pedagogical Affordance, Pedagogical Utility and Relative Advantage; Implications of Learning Theories for ICT in Education: Behaviourism, Cognitivism & Constructivism; Domain-specific ICT tools (e.g., GeoGebra, PhET, Falstad, Stellarium, etc.); Online and offline assessment tools (Rubrics, survey tools, test generators, reflective journal, question bank, portfolios, etc.)

Suggested Practicum (26 Hours)

1. Create classroom instructional materials informed by instructional design principles on any topic of your choice from Physics, Chemistry, or Mathematics at the secondary stage. (6 hours)
2. Prepare a 5 to 7-minutes video demonstrating application of AR/VR/XR/AI/Gamification in teaching-learning. (4 hours)

3. Explore MOOCs in the area of interest and curate MOOCs to support development of skills or competencies in that area and prepare a curated MOOC list. (4 hours)
4. Design assessment activities or tasks using ICT-enabled tools (including emerging technologies like AI, XR) (4 hours)
5. Develop short instructional videos on any 2-3 topics of students' choice from Physics, Chemistry, or Mathematics at the secondary stage and compare which tool is best suited to a given type of content or subject. They may be released under Open Educational Resources (OERs) with an appropriate Creative Commons Licence (4 hours)
6. Design a lesson plan informed by the TPACK framework. (4 hours)

Textbook

Hughes, J. E. & Roblyer, M. D. (2022). Integrating educational technology into teaching (9th ed.). Boston, MA: Pearson.

References

1. Reiser, R. A., & Dempsey, J. V. (Eds.) (2018). Trends and issues in instructional design and technology (4th ed.). Boston, MA: Pearson Education, Inc.
2. Januszewski, A. (2008). Educational technology: A definition with commentary. Routledge. 2nd Edition
3. Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. Teachers college record, 108(6), 1017-1054.
4. Koehler, M. J., Mishra, P., & Cain, W. (2013). What is technological pedagogical content knowledge (TPACK)?. Journal of education, 193(3), 13-19.
5. UNESCO ICT Competency Framework for Teachers.
<https://unesdoc.unesco.org/ark:/48223/pf0000265721>
6. International Society for Technology in Education (ISTE) Standards for Educators.
<https://iste.org/standards/educators>
7. National curriculum framework for school education 2023. Ministry of Education, Government of India.

Online Resources

1. Designing learner-centric e-learning in STEM disciplines
<https://www.youtube.com/playlist?list=PLOzRYVm0a65du0KAxcv8R7wzAUBzqB8zp>
2. Educational Technology and ICT, SWAYAM
https://onlinecourses.nptel.ac.in/noc26_hs53/preview

Course Title	Pre-Internship Practice	Course No.	EDL3XXX
Department	CET	Structure (L-T-P-D)	1-0-4 (3)
Offered for	BSc BEd (Semester 5)	Type	Core
Prerequisite	None		

Objectives

The instructor will:

1. Enable students to identify the various pedagogic practices, classroom management skills and assessment tools
2. Provide strategies for the observation of demonstration lessons transacted by other teachers
3. Guide students in developing lesson plans and transacting them using appropriate pedagogies and learning resources.
4. Create opportunities for students to develop and practice teaching skills in a guided environment in preparation for the school internship.

Learning Outcomes

After completion of the course, student teachers will be able to:

1. Demonstrate knowledge of pedagogic practices, classroom management skills, and assessment tools required for school internship
2. Observe classroom practices scientifically
3. Create lessons plans and relevant Teaching Learning Materials (TLMs),

Content (13 lectures)

1. Different pedagogic approaches (storytelling, art- integrated, sports-integrated, project-based, use of digital tools and applications in pedagogy)
2. Introduction to curriculum planning and lesson development (Mapping the National Curriculum Frameworks, Stage-specific competencies for the secondary stage to specific classroom transactions, types of lesson plans)
3. Understanding the classroom, paradigms of classroom observation
4. Teaching Learning Materials, their importance and usage
5. Classroom Assessment Practices and Tools (Summative, Formative) Approaches to classroom management, Inclusiveness in school education

Practicum (52 Hours)

1. Observation of the lesson demonstrated by teacher educators/experts in the institute.
2. Lesson planning
3. Designing guided activities, including a laboratory for each class/subject based on learning outcomes.

4. Preparation of a Portfolio (for self-work) that the student-teacher will use to keep all her/his work. (Digital and Physical Portfolio)
5. Participate in discussions/reflective sessions for conceptualizing teaching-learning Practices.
6. Exploring available learning resources and educational videos (Open Education Resources, Licensing)
7. Developing local, low-cost, and innovative Teaching Learning Materials
8. Reading and reflecting on inspiring books on pedagogic practices
9. Micro-teaching
10. And any other activity as suggested by the Instructor

Textbook

Cohen, L., Manion, L., Morrison, K., & Wyse, D. (2010). *A guide to teaching practice*. Routledge.

Reference

Prakasha, G. S., & Kenneth, A. (Eds.). (2023). *Teacher education: An analytical approach to internship practices around the world*. Taylor & Francis

Online Resources

Understanding the School System and Classroom Management Skills.
https://onlinecourses.swayam2.ac.in/e-learning/preview/ini26_ed04

Course Title	Content Cum Pedagogy of Mathematics at Secondary Stage- III	Course No.	EDL 3XXX
Department/School	CET	Structure (L-T-P[C])	1-0-2 [2]
Offered for	BSc BEd (Semester 6)	Type	Core
Pre-requisite	None		
<p>Objectives</p> <ol style="list-style-type: none"> To understand 21st-century skills and AI integration in Mathematics education. To understand assessment and evaluation practices in Mathematics education. To develop research and reflective practices in Mathematics education. <p>Learning Outcomes</p> <p>By the end of this course, students should be able to:</p> <ol style="list-style-type: none"> Apply 21st-century skills and AI tools in Mathematics teaching-learning. Design and use assessment and evaluation practices in Mathematics education. Conduct reflective and evidence-based practices for improving Mathematics teaching-learning. <p>Lecture Modules/Contents</p> <ol style="list-style-type: none"> 21st Century Skills and AI Integration in Mathematics Education (5 lectures): Teaching and learning Mathematics from psychological, sociological, and philosophical perspectives; Professional competencies and the role of Mathematics teachers in facilitating learning; Creating dynamic and learner-centred environments for Mathematics education; AI integration in Mathematics teaching-learning; Use cases of AI tools in teaching Mathematics. Assessment for Learning in Mathematics (4 lectures): Organisation of assessment in mathematics; Construction of types of questions in Mathematics; Considerations for the marking of different types of questions in mathematics; Concept of holistic progress card and assessment of mathematical aspects of students; AI-based assessment in Mathematics. Research and Innovative Practices in Mathematics (4 lectures): Paradigms in Mathematics Education Research; Equity research in mathematics education; Action research in Mathematics education; AI-enabled research and practices in teaching-learning of Mathematics; Ethical and pedagogical considerations in the use of AI for Mathematics education. <p>Suggested Practicum (26 Hours)</p> <ol style="list-style-type: none"> Develop an AI-supported teaching-learning module for a selected Mathematics concept at secondary stage, integrating 21st century skills, learner-centred activities, and digital resources. Develop and pilot a rubric-based performance assessment tool for evaluating Mathematics learning, including observation, feedback, and reflective analysis. Use AI tools to redesign a Mathematics learning activity, and critically analyse the ethical, pedagogical, and learner-related implications of AI integration through a reflective report. 			

4. Identify and explore emerging AI tools for Mathematics teaching and learning beyond those discussed in class; implement and test them with a sample of learners; and develop a case study report analysing their pedagogical effectiveness, learner engagement, limitations, and scope for classroom integration.
5. Explore and compare AI-based assessment tools for Mathematics education, pilot their use with a sample of learners, and prepare a group report analysing their effectiveness, reliability, feedback mechanisms, and pedagogical implications.
6. Identify a teaching-learning problem related to Mathematics education in your surrounding context, plan and conduct a collaborative action research study, and prepare a report based on evidence-based and reflective practices.
7. Any other activity as recommended by the teacher.

Text Book

Geraniou, E., Crisan, C., & Mavrikis, M. (Eds.) (2026). *Digital Technology and Artificial Intelligence in Mathematics Education Assessment*. Routledge.

Reference Books

1. Richard, P.R., Velez, M.P., & Vaerenbergh, S.V. (Eds.) (2022). *Mathematics Education in the age of Artificial Intelligence: How Artificial Intelligence can serve mathematical human learning*. Springer Nature.
2. Cotton, T; Jagdev, M; Kaur, B; Wright, P. (2024). *Towards a socially just mathematics curriculum*. Routledge.

Online resources

1. BES-143 Pedagogy of Mathematics
(https://onlinecourses.swayam2.ac.in/e-learning/preview/nou26_ed12) (in Hindi)

Course Title	Content Cum Pedagogy of Physical Sciences at Secondary Stage- III	Course No.	EDL 3XXX
Department/School	CET	Structure (L-T-P[C])	1-0-2 [2]
Offered for	BSc BEd (Semester 6)	Type	Core
Pre-requisite	None		
<p>Objectives</p> <ol style="list-style-type: none"> To understand 21st-century skills and AI integration in Physical Sciences education. To understand assessment and evaluation practices in Physical Sciences. To develop research and reflective practices in Physical Sciences education. <p>Learning Outcomes</p> <p>By the end of this course, students should be able to:</p> <ol style="list-style-type: none"> Apply 21st-century skills and AI tools in Physical Sciences teaching-learning. Design and use assessment and evaluation practices in Physical Sciences education. Conduct reflective and evidence-based practices for improving Physical Sciences teaching-learning. <p>Lecture Modules/Contents</p> <ol style="list-style-type: none"> 21st Century Skills and AI Integration in Physical Sciences Education (5 lectures): Teaching and learning Physical Sciences from psychological, sociological, and philosophical perspectives; Professional competencies and the role of physical science teachers in facilitating learning; creating dynamic and learner-centred environments for Physical Sciences education; AI integration in Physical Sciences teaching-learning; Use cases of AI tools in teaching Physics. Assessment and Evaluation (4 lectures): Learning outcome-based assessment; Performance assessment in Physical Sciences; Tools and techniques of assessment and evaluation in Physical Sciences; AI-based assessment in Physical Sciences. Research and Innovative Practices in Physical Sciences (4 lectures): Paradigms in Physical Science Education Research; Action research in Physical Sciences education; AI-enabled research and practices in teaching-learning of Physical Sciences; Reflective practices and professional development of Physical Sciences teachers; Ethical and pedagogical considerations in the use of AI for Physical Sciences education. <p>Suggested Practicum (26 Hours)</p> <ol style="list-style-type: none"> Develop an AI-supported teaching-learning module for a selected Physics concept at secondary stage, integrating 21st century skills, learner-centred activities, and digital resources. 			

2. Develop and pilot a rubric-based performance assessment tool for evaluating laboratory skills in Physical Sciences, including observation, feedback, and reflective analysis.
3. Use AI tools to redesign a Physical Sciences learning activity, and critically analyse the ethical, pedagogical, and learner-related implications of AI integration through a reflective report.
4. Identify and explore emerging AI tools for Physical Sciences teaching and learning beyond those discussed in class; implement and test them with a sample of learners; and develop a case study report analysing their pedagogical effectiveness, learner engagement, limitations, and scope for classroom integration.
5. Explore and compare AI-based assessment tools for Physical Sciences education, pilot their use with a sample of learners, and prepare a group report analysing their effectiveness, reliability, feedback mechanisms, and pedagogical implications.
6. Identify a teaching-learning problem related to Physical Sciences education in your surrounding context, plan and conduct a collaborative action research study, and prepare a report based on evidence-based and reflective practices.
7. Any other activity as recommended by the instructor.

Text Book

Almarode, J., Fisher, D., Frey, N., & Hattie, J. (2018). *Visible learning for Science, Grades K-12: What works best to optimise student learning*. Corwin, SAGE.

Reference Books

1. Lederman, N.G., Zeidler, D.L., Lederman, J.S. [Vol III] (Eds.) (2023). *Handbook of research on Science education*. Routledge.
2. Ouyang, F., Jiao, P., McLaren, B.M., Alavi, A.H. (Eds.) (2022). *Artificial intelligence in STEM education: The paradigmatic shifts in research, education, and technology*. Taylor & Francis.

Online resources

1. BES-141 Pedagogy of Science
(https://onlinecourses.swayam2.ac.in/e-learning/preview/nou26_ed03)

Course Title	School Observation	Course No.	EDL30XX
Department	CET	Structure (L-T-P-D)	1-0-2 (2)
Offered for	BSc BEd (Semester 6)	Type	Core
Prerequisite	None		

Objectives

The instructor will:

1. Acquaint students to various schooling systems (urban, rural, tribal, IB, Govt, private).
2. Provide strategies for students to study and analyze the interpersonal relationship among all school stakeholders.
3. Guide students in observing and understanding the infrastructural facilities and administrative structures in schools such as labs, libraries, mid-day meal facility, HR etc.
4. Help students understand the pedagogy and various assessment processes in different school systems.

Learning Outcomes

After completion of the course, students will be able to:

1. Describe various schooling systems and their unique characteristics.
2. Summarize the processes, practices, and overall environment of the observed schools.
3. Establish rapport with the different stakeholders within a school system.
4. Analyze various assessment processes adopted for the holistic development of children.

Content (Lectures)

Preparation for School Observation: The purpose and scope of school observation, Ethical guidelines for observing a school environment, Introductions to different types of schooling systems, Understanding school ecosystems (infrastructure, administration, relationships) **(13 lectures)**

Practicum (As suggested by NCTE) (26 hours)

1. Observation of 3 types of secondary schools to understand the various schooling systems.
2. Observation of the availability and usage of library resources, laboratories (Atal Tinkering Lab, Physics, Chemistry, Biology, Mathematics, Languages, Social Science, Computer), sports facilities, and art and music learning facilities, and provisions for CWSN/Divyang children
3. Analysis of administrative processes, office management, and the overall school discipline.
4. Study the provision of other student support services- guidance and counselling, NCC, NSS, health and wellness programme.

Observing Classroom and pedagogical processes

5. Collection of information about the demography of students in classes IX to XII and understand the linkage of the secondary stage with the middle stage and higher education through interaction with teachers, students and staff.
6. Interaction with School heads and subject teachers to understand how students are evaluated by following different tools and techniques of evaluation, how examinations are conducted, how answers are assessed, and how the result is communicated to parents in at least two different types of schools
7. Develop classroom observation template to observe classroom activities, the teaching methodologies employed, and the use of ICT and teaching-learning materials (TLMs).
8. Observation of school processes and transactions of the curriculum through experiential learning and prepare a report.
9. Interaction with teachers and students and report on implementing ten bag-less days and internship opportunities to learn vocational subjects.

Post-School Observation Session

10. Group-wise presentation of the school profile
11. Discussion and Feedback
12. Reflection on the understanding of various types of schooling systems.

Textbook

Wragg, E. C. 1999. Introduction to Classroom observation. London:Routledge (2nd Edition)

Online Resource:

SWAYAM Course: Understanding School System and Classroom Management Skills. Dr. Poonam Jaiswal.

Course Title	Assessment and Evaluation	Course No.	EDL3XXX
Center	CET	Structure (L-T-P) [C]	1-0-2 [2]
Offered for	BSc BEd (Semester 6)	Type	Core
Prerequisite	EDL2XXX Basics of Pedagogy at the Secondary Stage		

Objectives

The instructor will equip student teachers with the knowledge and capacities required to:

1. Develop and implement approaches for formative, competency-based, multidimensional (relating to all domains of learning), and subject-specific assessment
2. Develop assessment for generic learning outcomes such as problem solving, critical thinking, creative thinking, communication skills, judgement and decision making, ethical and moral reasoning etc.

Learning Outcomes

At the end of the course, the students will be able to:

1. Use different approaches to assess and evaluate student performance, including informal and formal diagnostic, formative, and summative assessment strategies aligned with the expected learning outcomes
2. Develop approaches to provide timely, effective, and appropriate feedback to learners about their performance relative to the expected learning outcomes and plan to bridge the gap in student learning levels
3. Prepare holistic progress cards of students based on school-based and 360-degree assessments (e.g., assessed through self-assessment and peer assessment, project-based and inquiry-based learning, role plays, group work, portfolios, etc.)

Content

1. **Assessment and Education (3 lectures)**

Assessment and Evaluation: Concept of Measurement, Assessment, Examination, and Evaluation; Learning outcomes and assessment, Taxonomy of Objectives (Revised) and Implications
Forms of assessment: Formative, Summative, diagnostic, prognostic; Internal and External assessment; Authentic Assessment, Online Assessment

2. **Process of Assessment and Evaluation (6 lectures)**

Approaches to assess and evaluate student performance: Time-bound; closed/open-book; problem-based; practical assignment reports; observation of practical skills; individual and group project reports; oral presentations; viva-voce; computerized adaptive testing; peer and self-assessment etc.
Assessing Higher Order Thinking Abilities: Problem solving, critical thinking, creative thinking, communication skills, judgement and decision making, ethical and moral reasoning
Tools and Techniques: Observation, rating scale, check list, anecdotes, interviews, self-assessment and peer assessment, rubrics, focus group discussions, validity and reliability of assessments

3. **Analysis and Interpretation (4 lectures)**

Analysis of students' performance and scores: credit and grading; Graphical representation; Designing constructive feedback based on interpretation

Reporting student's performance: 360-degree progress reports, portfolios, PTA meetings, qualitative reporting based on the observations, descriptive indicators in report-cards.

Suggested Practicum (Practicum: 26 Hours)

1. Review of various education commissions, Policies and reports and NCF 2005 to get a brief view of the recommendations on Assessment and Evaluation. (4 hours)
2. Examine the assessment-related recommendations of National Education Policy 2020 and discuss their implications for classroom practices, competency-based assessment, and holistic progress reporting. (2 hours)
3. Develop a unit test for a selected school subject using a Table of Specifications, ensuring alignment between learning outcomes, content areas, and cognitive levels. (2 hours)
4. Construct and administer any one assessment tool (rating scale, checklist, observation schedule, anecdotal record, etc.) to study student participation, behaviour, or classroom processes, followed by interpretation of findings. (2 hours)
5. Analyze question papers from different school boards to examine patterns related to learning outcomes, cognitive demand, question types, and assessment practices. (2 hours)
6. Preparing format of 360-degree report Card. (4 hours)
7. Review NCERT learning outcomes for selected subject areas and design assessment tasks/tools aligned with those learning outcomes (4 hours)
8. Conduct interviews with teachers and students to understand existing assessment practices, challenges, and perceptions regarding evaluation, followed by a group presentation/report. (6 hours)

Textbook

1. McMillan, J.H. (2010) Classroom Assessment: Principles and Practice for Effective Standards-Based Instruction, Pearson
2. Aggarwal, J.C. (2005) Essentials of Examination System: Evaluation, Tests and Measurement, Vikas Publishing House, New Delhi.

Reference

1. Gronlund, N.E. (2003) Measurement and Evaluation in Teaching, Macmillan
2. Linn, R.L. & Miller, D.M. (2005). Measurement and assessment in teaching (9th ed.). NJ: Pearson
3. Miller, D. M., Linn, R.L. & Gronlund, N.E. (2021) Measurement and Assessment in Teaching, 11th edition, Pearson
4. Brookhart, S.M. (2017) How to Give Effective Feedback to Your Students (2nd ed.), ASCD, Alexandria.
5. NCERT (2007) National Focus Group Paper on Examination Reforms
6. NCERT (2023). National Curriculum Framework, 2023. NCERT, New Delhi: India.

Online Resources

BES-127: Assessment for Learning, Swayam

https://onlinecourses.swayam2.ac.in/e-learning/preview/nou26_ed06

Course Title	Inclusive Education	Course No.	EDL3XXX
Department	CET	Structure (L-T-P [C])	2-0-0[2]
Offered for	BSc BEd (Semester 6)	Type	Core
Prerequisite	None		

Objectives

The instructor will:

- Orient students to the approaches to bridging gender and social category gaps in terms of participation rates and student learning levels at all levels of school education.
- Expose students to the strategies pursued and required to improve participation and learning levels of children from various groups considered as Socio-Economically Disadvantaged Groups (SEDGs)

Learning Outcomes

After completion of this course, student teachers will be able to:

- Identify barriers to the inclusion and equal participation in education of children with disabilities and other SEDGs in the regular schooling process and enable them to achieve the defined learning outcomes,
- Evaluate the accessibility of school infrastructure for all students, including learners with disabilities,
- Design activities that help the provision of individualized learning environment and learning activities/resources

Contents

I. Inclusion and Education : Clarity of various terms and phrases associated with Inclusive Education in the Indian Context; Shift of Perspective from Disability to Inclusivity (Integrated Education, Special Education, Impairment and Disability, Assessment and Evaluation, Curriculum, adaptation, modification and differentiation, universal design of learning); Shifting Paradigms from Bio centric to Human Rights, Introductory reference of Policies/Acts with reference to educational implications for Children with Disabilities: Right to Education Act, 2009/ 2012, RPWD Act, 2016, UNCRPD, National Trust Act, 1999, National Educational Policy, 2020.[9 Lectures]

I. Children with Disabilities and Marginalized Groups: Nature and needs of children with sensory impairments: Cognitive impairments and intellectual disability, physical disabilities, cerebral palsy, multiple disabilities; Specific needs of children with behavioral, emotional learning disabilities; Educational needs of children belonging to Marginalized Groups.[9 Lectures]

I. Pedagogical Issues: Meeting the specific needs of Children with Disabilities with special reference to education and opportunities for participating in arts, sports, and vocation-related activities; Making

school buildings and compounds as well as other facilities barrier free and accessible; Supporting the learning activities and resources for individualized learning environment; Assistive devices, appropriate technology-based tools and language-appropriate teaching-learning materials for inclusivity; Designing strategies of assessment for inclusive classrooms.[8 Lectures]

Text Book

1. Corbett, J. (2002). *Supporting inclusive education*. Routledge.
2. Hegarty, S., & Alur, M. (Eds.). (2002). *Education & children with special needs: From segregation to inclusion*. Sage.

Reference Books

Florian, L. (2013). *The SAGE handbook of special education*. Sage.

Online Course Material

Equitable and Inclusive Education

(https://onlinecourses.swayam2.ac.in/e-learning/preview/ini26_ed02)

Course Title	Perspectives on School Leadership and Management	Course No.	EDL4XXX
Department	CET	Structure (L-T-P)	3-0-0 [3]
Offered for	BSc BEd (Semester 7)	Type	Core
Prerequisite	None		

Objectives

The instructor will

- Promote an understanding of the school system, its nuances, the social, cultural, and political contexts to build a strong foundation of knowledge and skills required for school leaders
- Enable students to understand the diverse stakeholders who establish priorities and improve school practices.

Learning Outcomes

After completion of the course, students will be able to:

- Describe the diversity of schools in India, its structure, its governance, issues, challenges and school leadership needs,
- Critically examine the different leadership theories and practices and its relationship with the governance structures, the autonomy and accountability mechanisms and the larger educational policy context,
- Reflect critically on school-based data for reflection and improvement
- Develop school vision, mission, goals, and School Development Plans.

Content

Understanding Indian School System : School as a normative organization vis-a-vis school as a socio-emotional-cultural space for learning; Studying the diversity of schools in India (their structure, governance, socio-political and cultural context, funding, management, autonomy and accountability mechanisms, support systems); Relationship between school leadership and school diversity issues, challenges, and needs; Engagement with diversity discourses, educational policies, reforms and practices and role in developing inclusive schools. **(13 Lectures)**

Understanding School Leadership: School Leadership (concept as defined, and concept as practiced); Being a School Leader (exploring the multiple roles and responsibilities, issues and challenges of school leadership in the Indian context); What works in schools(sharing National and International best practices on School leadership) **(13 Lectures)**

Schools as Learning Organizations: Role of School Leadership Schools as motivating learning spaces; Developing inspiring school ethos; Schools as learning organization (*promoting personal mastery, examining mental models, and developing a shared vision, team learning and a system's thinking perspective*); Development of a shared vision and shaping of the school culture (*Use of data for school improvement focused on students' learning, addressing equity challenges, and building an equitable school culture that promotes excellence for all*); Nurturing school belongingness (*engaging students, teachers, staff, parents,*

SMC, and community in the formulation of a whole school development plan); Designing professional and collaborative learning opportunities for self and others (teachers, parents, and SMC members) and improving teaching and learning. (13 Lectures)

Textbook

1. Bush, T., & Bell, L. (Eds.). (2002). *The principles and practice of educational management*. Sage.
2. Mythili, N. (2024). *School Leadership in India: Styles, Behaviours, Functions and Practices* (1st ed.). Routledge India.

References:

1. Northouse, Peter G. *Leadership: Theory and practice*. Sage publications, 2025.
2. Varghese, N.V., Mangalagiri, A., & Mathew, A. (Eds.). (2023). *Quality and Inclusion in Education: The Persisting Challenges* (1st ed.). Routledge India.

Online Resources

School Organization: Administration and Management
(https://onlinecourses.swayam2.ac.in/e-learning/preview/cec26_ed13)

Course Title	Curriculum Planning and Development for Secondary Stage	Course No.	EDL4XXX
Department	CET	Structure (L-T-P-C)	3-0-0 [3]
Offered for	BSc BEd (Semester 7)	Type	Core
Pre-requisite	None		
<p>Objectives</p> <ol style="list-style-type: none"> To understand the meaning and types of curriculum. To understand curriculum planning and development. To develop skills for curriculum implementation and evaluation. <p>Learning Outcomes</p> <p>By the end of this course, students should be able to:</p> <ol style="list-style-type: none"> Discuss the aims of education, curriculum, and curricular areas. Explain the processes and concerns of curriculum planning and development. Demonstrate curriculum implementation and evaluation through teaching-learning and assessment practices. <p>Lecture Modules/Contents</p> <ol style="list-style-type: none"> 1. Education and Curriculum (10 lectures): Types of Curricula: subject-centred, activity-centred, environmental-centred, community-centred; Relationship and difference between curriculum, curriculum framework, syllabus and textbooks. 2. Developing the Curriculum (14 lectures): Basic principles of curriculum development; Concerns for developing the curriculum – aims to be achieved, structure and nature, different perspectives on learning and their implications for curriculum development, socio-cultural aspects and aspirations of society, value transitions, social efficiency and needs, environmental concerns, gender concerns, inclusiveness, and technological advancement; Impact of globalisation. 3. Approaches, Planning, and Implementation (15 lectures): Approaches to Curriculum Development: Learner and activity-centred, constructivist, and knowledge construction; Curriculum planning as a cyclic process; Curriculum Implementation: operationalising curriculum into learning situations, converting curriculum into syllabus, curriculum engagement activities, role of school at regional, state and national level for implementation; Role of teachers in operationalising and evaluating the curriculum with special reference to: textbooks and teachers' handbooks, source books, workbooks and manuals, other learning material <p>Text Book</p> <ol style="list-style-type: none"> Flinders, D.J., & Thornton, S.J. (Eds.) (2022). <i>The curriculum studies reader</i>. Routledge. Kumar, K. <i>What is Worth Teaching?</i> Orient Blackswan. 			

Reference Books

1. Vaughan, K.P., & Nunez, I. (Eds.) (2023). *Enacting praxis: How educators embody curriculum studies*. De Gruyter Brill.
2. Tyler, R.W. (2013). *Basic principles of curriculum and instruction*. The University of Chicago Press.

Online resources

Foundation of curriculum planning.

https://onlinecourses.swayam2.ac.in/e-learning/preview/ini25_ed01

Course Title	Sports and Fitness Education	Course No.	EDL4XXX
Department	CET	Structure (L-T-P [C])	1-0-2 [2]
Offered for	BSc BEd (Semester 7)	Type	Core
Prerequisite	None		

Objectives

The instructor will:

- Develop a comprehensive and holistic understanding about the concept of health, its various dimensions, and determinants.
- Trace the evolution of Health and Physical Education, historical development of the discipline with special reference to Indian Education and its relation to other subjects.
- Highlights the importance of physical fitness policies, programs and services addressing health initiatives in school context

Learning Outcomes

After completion of this course the students will be able to:

- Analyze the concept of holistic health, its various dimensions, determinants and its enactment in various policies and programmes
- Develop positive attitude towards health physical education and yoga as individual,
- Demonstrate the skills for physical fitness, learn correct postural habits and activities for its development, and the practice of yogasana and meditation,

Contents

1. **Evolution of Health and Physical Education:** Health and Physical Education; Place in School Curriculum; Status of Health and Physical Education in Indian school education. **(3 Lectures)**
2. **Health Education:** Concept, dimensions, and determinants of health with special to India; Understanding the body system and its functions; Common health problems and diseases (causes, prevention and cure, immunization and first aid), Impact of Physical activities, games, sports and yoga on different body systems; Food and nutrition, nutrients and their functions. **(4 Lectures)**
3. **Games and Fitness:** Physical fitness and its components: athletics, Rhythmic activities, gymnastics, and their impact on health; Development of physical fitness; Fundamentals skills of sports; Safety and security; First Aid: Need and Principles **(3 Lectures)**
4. **Policies, Programmes and Assessment.** School Health Programme: school health services, health-promoting schools, global school health initiatives; policies, child-protection and sports activities (POCSO, RPWD etc.) Health performance testing and reporting in games and sports **(3 Lectures)**

Suggested Practicum (26 Hours)

- Analysis of important indicators of health and wellbeing of children

- Survey on understanding local food related matters, and understanding the importance of the right to food.
- Analysis of NEP, 2020 with reference to Games Oriented Education.
- Planning activities for development of physical fitness
- Planning for the organization of games and sports tournaments
- Learning and performing basic yogic activities, asanas, and pranayama, Kriyas and Meditation.
- Planning for the celebration of yoga day, yoga week.
- Arranging reflective dialogues on Serials and related videos.
- Preparation of inventories on myths on exercises and different types of food.
- Preparation of First Aid kit.
- Any other activity as recommended by the Instructor

Text Books:

1. Agashe, S. R. (2013). *Introduction to physical education, fitness and sports*. Khel Sahitya Kendra.
2. Rawson, E. S., Branch, J. D., & Stephenson, T. J. (2024). *Williams' nutrition for health, fitness & sport* (13th ed.). McGraw Hill.

Reference Book

Gupta, M. C. (2012). *Physical Fitness and Health*. Khel Sahitya Kendra

Online Course Materials

Principles of Health and Fitness Management.

(https://onlinecourses.swayam2.ac.in/e-learning/preview/cec26_ed11)

Course Title	Internship	Course No.	EDD4XXX
Department	CET	Structure (L-T-P)	10 credits
Offered for	BSc BEd (Semester 7)	Type	Core
Prerequisite	None		

Objectives

During the internship, student teachers are placed in schools in groups as an integral part of all school activities. This provides them with the opportunity to:

1. Get intensive experience in all aspects of teaching at the secondary stage- preparation, planning, developing/ collecting/localizing Teaching Learning Materials, classroom transactions, assessment, reflection, and review of their experience.
2. Be exposed to situations where they can observe different roles played by the teacher in the field, which they will also have to undergo.

After completing the internship, student teachers will be ready to take up a teacher's responsibility independently.

Learning Outcomes:

On completion of the school internship, student teachers will be able to:

1. Describe the overall functioning of the school, the different roles played by a teacher in the school, the importance of teacher-student relationships for effective teaching and the contributions of different stakeholders in the school ecosystem.
2. Apply different pedagogies learnt in real-life classrooms and create appropriate teaching-learning materials.
3. Plan and execute school activities (assembly, celebrations, cultural programmes).
4. Create student portfolios and comprehensive 360-degree (holistic) progress reports.
5. Maintain different types of records as required by the school system
6. Conduct action research for the situations/problems faced during their school internship experience.

Suggested Structure

12 weeks of school internship (in preferably two schools) as per NCTE norms, such that students are able to transact 40+40 lessons

Suggested Activities for Students

1. Meet the subject-based mentors, collect timetables of classes IX to XII and develop a scheme of lessons from the syllabus to be covered during the internship.
2. Get acquainted with the school within 2-3 days. Observe classroom teaching of school teachers.
3. Plan and transact minimum 80 lessons (40+40), including 4 stray lessons (2+2). Stray lessons are class appropriate lessons on any topic(s) to be transacted by student teachers as per their convenience to build up confidence gradually. The last 5 lessons in each pedagogy course may be transacted using lesson notes.
 - Lesson plans should include the components to develop critical and reflective thinking, problem-solving, differential learning, synthesis, and application of knowledge in real-life situations.
 - Lesson plans must promote education for sustainability, including equity, environment, global citizenship, pride and rootedness in Indian knowledge systems and character building.
4. Participate in post-lesson discussions with peers, mentor(s) and teacher educators.
5. Observe peer lessons and discuss with the group.
6. Conduct laboratory activities (Atal Tinkering Lab, Physics, Chemistry, Biology, Mathematics, Languages, Social Science, Computer), sports, and arts and crafts activities.
7. Participate in student support services- guidance and counselling, NCC, NSS, health and wellness programme.
8. Create teaching-learning materials, including ICT tools for opted pedagogic courses.
9. Plan assessment, prepare material and formative and summative assessment tools, and analyze the results.
10. Prepare and conduct diagnostic tests to identify learning difficulties, analyze data and prepare the learning enhancement plan.
11. Experience classes as a substitute teacher.
12. Participate in library functioning and literary activities.
13. Participate in teacher development and training activities.
14. Organize school assemblies and other events (cultural, sports, yoga, and other development activities).
15. Attend Parents-Teachers Association (PTA) meetings if held during the internship.
16. Attend School Management Committee (SMC) meeting if held during the internship.

17. Study the process of parent and community engagement for the school development programme.
18. Conduct action research /case study.
19. Prepare a sample student portfolio
20. Write a reflective diary daily and prepare a report of each activity.

Reference

1. NCERT. 2014. *Basics of Education*. Delhi
2. NCTE. Suggestive Syllabus on School Experience Programme ([NCTE School experience Document](#))

Course Title	School Based Research Project	Course no.	EDD4XXX
Department	CET	Structure	2 credits
Offered for	BSc BEd (Semester 7)	Type	Core
Prerequisite	None		

Objectives

The instructor will:

1. Assist students in identifying the research problem and develop a suitable plan of action.
2. Devise strategies to help students develop critical-thinking, problem-solving, collaboration and ethical decision making-skills
3. Guide students develop and use tools and techniques for collection of relevant data.

Learning Outcomes

After completion of the course, students will be able to:

1. Present a problem-statement and a suitable research design for their school-based research.
2. Demonstrate proficiency in developing a suitable intervention to address the problem and using tools and techniques for data collection.
3. Communicate their experiences from the school-based research through reports and presentation

Mode of Transaction

1. Discussions with faculty mentor, school head, mentor-teachers in the school(s) and peers for identification of the problem and development of the intervention(s).
2. Finalize the school-based research project proposal outline through discussion with faculty mentor and mentor-teacher (at the school).
3. Literature review on the identified problem, in conjunction with interaction with relevant stakeholders, and field visits.
4. Conceptualization and execution of the intervention
5. Presentation and Submission of project report

Content (As suggested by NCTE): The research problem mayl be taken from the day-to-day teaching-learning process of the school. Some of the significant areas may cover:

- Learning progress and outcomes in different subjects
- School-based assessment
- Learners' diversity and inclusion
- Participation in arts, games, sports
- Any other suitable topic decided through discussion with faculty mentor and mentor-teacher

Course Title	Philosophical and Sociological Perspectives on Education-II	Course No.	EDL4XXX
Department	CET	Structure (L-T-P [C])	(3-0-2[4])
Offered for	BSc BEd (Semester 8)	Type	Core
Prerequisite	None		

Objectives

The instructor will

- Encourage students to explore the relationship between social structures and educational provision.
- Expose students to the study of the social behavior of individuals, groups, and societies

Learning Outcomes

After completion of this course, student teachers will be able to:

- analyze the main agents of socialization, such as family, school, community and peer groups; and different aspects of social stratification
- assess the impact of culture on education
- identify the close relationship between education and modernization, as well as the factors and constraints related to social change.

Contents

1. **Education and Society:** History, Society and Education; Educational sociology and social perspective of education: meaning and functions; Education as a Social System (*defining society, social behavior, status, institution, ideology, socialization, social system, social values and norms, conflict, modernization*); Understanding the relation between individual and group behavior with special reference to the purpose of education (**13 Lectures**)
2. **Education and Social Change:** Factors affecting Education and Social Change (technology, social and educational movements, curricular innovations, value conflict, legal provisions, etc.); Constitution of India and Education; Social Mobility(**13 Lectures**)
3. **Education, Culture and Socialization:** Education, Culture and Socialization; Social Welfare, Social Reform Movements in the 19th century, Educational Policies, Acts and Initiatives towards decoloniality(**13 Lectures**)

Suggested Practicum (26 Hours)

1. Observation and critical reflection on 'textbook culture' in schools (how textbooks determine every activity of teacher and learner in the school),
2. Observing the process of knowledge construction by children in structured and unstructured environments to appreciate their learning processes and nature.

3. A critical analysis of Constitution of India in the context of process of Education in India / Educational Policies / Educational Commissions)
4. Critically observing nearby society/ locality in groups of 4-5 students and sharing observations related to cultural/ social influences on educational practice.
5. Analyzing the social purpose of NEP, 2020
6. Any other activity as recommended by the instructor

Text Book

1. Ballentine, Jeanne H., Hammack, Floyd M., 2012. *The Sociology of Education: A Systematic Analysis*. Pearson, Boston.
2. Nambissan, G. B., & Srinivasa Rao, S. (2013). *Sociology of education in India: Changing contours and emerging concerns*. Oxford University Press.

Reference Books

3. Jain, M., Mehendale, A., Mukhopadhyay, R., Sarangapani, P. M., & Winch, C. (Eds.). (2018). *School education in India: Market, state and quality*. Taylor & Francis.
4. Razzack, A., Sarangapani, P. & Jain, M. (Eds). (2023). *Education, teaching, and learning: discourses, cultures, conversations*. Orient Blackswan.
5. Kumar, K. (2004). *What is worth teaching?*. Orient Blackswan.

Online Course Materials

Sociology of Education (https://onlinecourses.swayam2.ac.in/cec23_ed09/preview)

Course Title	Education Policy Analysis	Course No.	EDL4XXX
Department	CET	Structure (L-T-P [C])	(3-0-0[3])
Offered for	BSc BEd (Semester 8)	Type	Core
Prerequisite	Nil		

Objectives

The instructor will orient students to the theoretical frameworks and methodology that will help assess and evaluate the effectiveness of policies at the national, state and programme levels

Learning Outcomes

After completion of this course, student teachers will be able to:

- discuss knowledge and capacity to engage in education policy analysis and evaluate their effectiveness,
- explain processes involved in policy analysis
- compare the potential policy options, rank them and choose the most effective option that could address issues and problems confronting school education.

Contents

1. **Planning an Educational Policy:** Purpose and Dimensions of an Educational Policy at local and Global level, Philosophical and Sociological Perspective of planning an Educational Policy, Historical development of Educational Policies in India, Basic steps involved in planning, Constitutional provision for Policy on Education(**13 Lectures**)
2. **Educational Policies in India:** Methods of Policy Analysis, Education Commissions, Committees and Policies since Independence: 1968, 1986 (Modified in 1992), 2020 (**13 Lectures**)
3. **Implementation of an Educational Policy:** Mechanisms of Policy Implementation, Programme of action and implementation, Role of different Organizations / Groups: Legislature/ Judiciary/ Political Will and Parties/ Voluntary Organizations/ Non-governmental organizations (NGOs)/ Pressure Groups/ Public; Challenges for Implementation (**13 Lectures**)

Text Book

Srinivasan, M. V. (2019). Education in Contemporary India. Pearson India.

References

1. National Education Policy 2020. Available at:
https://www.education.gov.in/sites/upload_files/mhrd/files/NEP_Final_English_0.pdf
2. National Education Policy 1986 (as modified in 1992). Available at:
https://www.education.gov.in/sites/upload_files/mhrd/files/document-reports/NPE86-mod92.pdf

3. National Education Policy 1968. Available at:
https://www.education.gov.in/sites/upload_files/mhrd/files/document-reports/NPE-1968.pdf

Online Course Materials

1. Social Policy and Planning.
(https://onlinecourses.swayam2.ac.in/e-learning/preview/ini26_hs36)
2. National Education Policy and Institution Building
(https://onlinecourses.swayam2.ac.in/e-learning/preview/ntr26_ed26)

Course Title	Yoga and Understanding Self	Course No.	EDL4XXX
Department	CET	Structure (L-T-P [C])	(1-0-2[2])
Offered for	BSc BEd (Semester 8)	Type	Core
Prerequisite	Nil		

Objectives

The instructor will:

1. Focus on the benefits of Yoga for healthy living and the importance of the practice of yoga for promoting physical, emotional, intellectual, social and spiritual wellbeing
2. Highlight the importance of being mindful of self (body, mind, emotions, thoughts, and actions) and the importance of these aspects in becoming an effective teacher.

Learning Outcomes

After completion of the course, the students will be able to

- explain the importance of Yoga and how it helps an individual in understanding Self,
- describe the importance of practicing Yoga Asana,
- practice basic Yoga Asanas/ Kriyas.

Contents

I. **Philosophy and Historical Perspective of Yoga:** Theories of the self and Philosophy of Yoga, Brief history and development of Yoga (Classical Yoga, Post Classical Yoga and Modern Period); Importance of Yoga for healthy living, Yoga and its relevance in the modern times; Traditions in Yoga. **(3 Lectures)**

I. **Schools of Yoga:** Different streams \schools of Yoga (Gnana, Bhakthi, Karma), Construction of Yoga Practice for all round development, Principals of Yoga: - Ahimsa, Satya, Asteya, Brachmacharya, Aparigraha, Shoucha, Santhosha, Tapas, swadyaya and Isvara Paridhana **(5 lectures)**

I. **Modern Principles of Yoga and Meditation:** Modern Principles: Human Body as a holistic entity; Dhāraṇa & Dhyāna, etc; Meditation: Its Importance, Types, and Process; Pranayama: its importance, types and process; Yoga as a Way of life for peace, harmony, health, love and happiness; Yoga in Indian philosophy for understanding Self **(5 lectures)**

Suggested Practicum (26 Hours)

Practice of Basic Yogasanas/ Kriyas.

Text Books

1. Basavaraddi, I. V. (2015). Yoga: Its origin, history and development. Retrieved from:<https://yoga.ayush.gov.in/Yoga-History/>

2. Iyengar, B. K. S. (1966). Light on Yoga. Retrieved from:
<https://iyogaprops.com.au/product/light-on-yoga/>

Reference Books

Pandey, D. S. (2018). Patanjalyogadarshanam. Chaukhambha Sanskrit Pratishtan.

Online Course Materials

NPTEL Course: Yoga and Positive Psychology for Managing Career and Life
https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_mg14

Course Title	Citizenship Education, Sustainability, and Environmental Education	Course No.	EDL4XXX
Department	CET	Structure (L-T-P [C])	(3-0-0[3])
Offered for	BSc BEd (Semester 8)	Type	Core
Prerequisite	Nil		

Objectives

The instructor will:

1. Orient student teachers to the constitutional foundations of citizenship, ideas of global citizenship and the philosophical history of *Vasudhaiva Kutumbakam*.
2. Develop awareness of sustainability and sustainable development across economic, social, and environmental dimensions.
3. Enable student teachers to understand environmental challenges and the role of education in addressing climate change, environmental degradation, and conservation.

Learning Outcomes

After completion of this course, student teachers will be able to:

1. Explain the concept of citizenship and citizenship education.
2. Discuss the idea of sustainability and approaches to sustainable development.
3. Demonstrate awareness of environmental issues and strategies to mitigate climate change and environmental degradation.

Contents

1. Citizenship Education

Concept and aims of citizenship and citizenship education; concept and aims of global citizenship and global citizenship education; concept of *Vasudhaiva Kutumbakam* and its importance in developing a holistic perspective toward local and global communities.

(13 lectures)

2. Sustainability

Concept of sustainability in various fields of human activity; approaches to achieving sustainable development in its economic, social, and environmental dimensions; Sustainable Development Goals (SDGs) and their aftermath; sustainable management of natural resources; school and community-based sustainability initiatives; education for sustainable development.

(13 Lectures)

3. Environmental Education

Environmental issues and challenges; mitigating climate change, environmental degradation, and pollution; initiatives for waste management, biodiversity conservation, forest and wildlife protection; approaches to environmental education; role of mass media and technology in environmental

awareness; role of governmental and non-governmental organizations; school and community-based environmental education activities. (13 lectures)

Text Book

1. Sharma, N. (2025). Education for Sustainability and Global Citizenship: Intercultural, Ethical, and Justice-based Approaches. Bloomsbury Academic.

References

1. Vasudhaiva Kutumbakam: relevance of India's Ancient Thinking to Contemporary Strategic Reality" (1st ed.). (2020). New Delhi, India: Aryan Books International.
2. Ellis M. (2015). The Critical Global Educator: Global Citizenship Education as Sustainable Development. Routledge.
3. Mulligan. M. (2017). Introduction to Sustainability. Taylor and Francis.
4. Tarozzi. M., & Torres. C.A. (2016). Global Citizenship Education and the Crises of Multiculturalism: Comparative Perspectives. Bloomsbury Publishing.

Online Course Materials

1. Education for Sustainable Development (IIT Kharagpur):
<https://nptel.ac.in/courses/109105190>

Course Title	Post Internship (Review and Analysis)	Course No.	EDP4XXX
Department	CET	Structure (L-T-P)[C]	0-0-4 [2]
Offered for	BSc BEd (Semester 8)	Type	Core
Prerequisite	Internship		

Objectives

The instructor will:

1. Help student-teachers consolidate and reflect upon their learning from the school internship experience
2. Guide students in critically analysing their teaching practices and understanding the functioning of the school ecosystem.
3. Facilitate sharing of internship experiences, innovative teaching practices, and artefacts among peers.

Learning Outcomes

After completion of the course, students will be able to:

1. Develop comprehensive understanding of the school ecosystem
2. Describe their learning from internship with the peers and teacher educators
3. Reflect on school internship, sharing their learning experiences on each activity undertaken.

Practicum

1. Presentation of Reflective Journal Summary – “My Learning Journey” by each student-teacher.
2. Gallery walk / exhibition displaying Teaching Learning Materials (TLMs), artefacts, and documentation of school activities undertaken during internship.
3. Sharing of best teaching practices through presentations, videos, or digital portfolios.
4. Conducting a survey to collect local stories and rhymes from parents and community members, particularly for the foundational stage.
5. Organizing training workshops for parents and community members to encourage participation as volunteers in children’s learning.
6. Organizing a Parents / Community Mela or Fair showcasing homemade Teaching Learning Materials.
7. Participation in discussion and feedback sessions on internship learning
8. Any other activity as decided by the instructor

Textbook

Prakasha, G. S., & Kenneth, A. (Eds.). (2023). Teacher education: An analytical approach to internship practices around the world. Taylor & Francis

Online Resource:

Understanding the School System and Classroom Management Skills.
https://onlinecourses.swayam2.ac.in/e-learning/preview/ini26_ed04

Course Title	Creating Teaching-Learning Material	Course No.	EDL4XXX
Center	CET	Structure (L-T-P) [C]	2-0-2 [3]
Offered for	BSc BEd (Semester 8)	Type	Core
Prerequisite	None		
<p>Objectives</p> <ol style="list-style-type: none"> To develop understanding about the role and importance of Teaching Learning Materials (TLMs) and work education in school learning. To enable student teachers to design and develop innovative, low-cost, contextual, and inclusive TLMs <p>Learning Outcomes</p> <p>The students will be able to:</p> <ol style="list-style-type: none"> Design and develop appropriate TLMs for different learners at the secondary stage. Create low-cost, contextual, and inclusive learning resources using local materials and technologies. Integrate work experience, indigenous knowledge, and vocational practices into teaching-learning processes. <p>Content</p> <p>Understanding Learners Across Developmental Stages [8 lectures]: How children learn at different developmental stages, Characteristics of learners at foundational, preparatory, middle, and secondary stages, Role of TLMs in supporting age-appropriate learning</p> <p>Educational Toys and Teaching Learning Materials [9 lectures]: Educational value of toys, educational kits, games in learning, Traditional and contemporary TLMs from different regions of India, Use of indigenous and local learning resources in classrooms</p> <p>TLMs for Diverse Learners and Inclusive Education [9 lectures]: Individual differences in learning, TLMs for visual, auditory, and kinesthetic learners, Designing inclusive TLMs for CWSN and diverse classroom needs</p> <p>Practicum (26 hours)</p> <ul style="list-style-type: none"> Field visit for interaction with local artisans, craftspeople, and entrepreneurs. Observe Traditional work practices and their integration into local technologies and ideas. Analysis of available local specific, indigenous learning resources, including toys and their use in the learning-teaching process Development of at least two low-cost learning resources as per the local contexts (secondary) and presentation/exhibition Prepare the manual of TLM highlighting the objectives that will be achieved by its use, the material used, the process of its development and its use during classroom transactions. <p>Textbooks</p>			

Mayer, R. E. (2021). *Multimedia learning* (3rd ed.). Cambridge University Press.
Dale, E. (1969). *Audiovisual methods in teaching* (3rd ed.). Holt, Rinehart and Winston.
Central Board of Secondary Education. (2020). *Handbook of inclusive education*. CBSE.

Online Resources

NPTEL (2025). Educational technology [MOOC]. https://onlinecourses.nptel.ac.in/noc25_hs13/preview

Course Title	Community Engagement and Service	Course No.	EDN4XXX
Department/School	CET	Structure (L-T-P)	0-0-4 [2]
Offered for	BSc BEd (Semester 8)	Type	Core
Prerequisite	None		

Objectives

The instructor will:

1. Expose student teachers to socio-economic realities of communities so that classroom learning is enriched by lived experiences and real-world problem-solving.
2. Build capacity to mobilize community participation in school-related activities and address issues of education, gender equity, health, and lifelong learning.
3. Develop social leadership through active community service, advocacy, and collaborative action on social, cultural, and educational challenges.

Learning Outcomes

At the end of the course, the students will be able to:

1. Identify socio-economic issues in the community and propose contextually relevant solutions in collaboration with community members.
2. Mobilize community participation in school-related activities and development initiatives through campaigns, street plays, prabhat-pheris, and advocacy.
3. Demonstrate social leadership, active citizenship, and respect for traditional knowledge and local practices.

Suggested Activities:

1. Preparation for community services (In the institution) (8 hours)

- Orientation of student teachers on Community Engagement & Services through discussion and group activities. (2 hours)
- Workshop for developing tools for different activities during the programme (survey tools, activity plans, and field diaries). (6 hours)

2. Engagement with the community (36 hours)

Students will be divided into smaller groups. They would participate in the planned activities with defined roles for seven days on a rotation basis. These activities include:

- Participation of student teachers in activities undertaken under the National Service Scheme (NSS), New India Literacy Programme, Student mentoring initiatives, etc.
- Survey of community resources for supporting school activities.
- Study of the situation regarding school dropout and reasons (Stage wise).
- Survey of specific settlement to assess the situation about non-literates in the settlement and conceptualize activities to address the illiteracy in the settlement,
- Training of local youth in First Aid and other relevant interventions,
- Assessment of the situation about Health and wellness of children in a locality,
- Creating awareness of the importance of sustainable development, and making the community members aware of the need to support initiatives to ensure environmental protection, creating

awareness of rainwater harvesting, mentoring school students with learning deficits, guidance and counselling to school students etc.)

- Learning community indigenous practices for a sustainable environment or sustainable living
- Visit and interact with local artisans and craftspeople.
- Any other activity as suggested by the instructor

3. **Reflection and Reporting (In the institution) (8 hours)**

Group presentations, experience sharing, portfolio/report submission, and faculty-led debriefing on community engagement learnings.

5. Cross-listed Electives for Art Education

Course Title	Music and Technology: Bridging Art & Innovation	Course No.	LAL4XXX
Department	School of Liberal Arts	Structure (L-T-P [C])	1-0-2 [2]
Offered for	-	Type	
Prerequisite	None		

Course Objectives

- To facilitate the appreciation and understanding of the evolution of music through various technological advancements.
- To comprehend the foundational principles of interaction with digital platforms, focusing on the ever-evolving interplay between music and technology.
- To foster a collaborative and innovative learning environment where students can dissect, discuss, and experiment with emerging musical technologies.

Learning Outcomes

- Students will understand and appreciate the interconnectedness between music and technology, the historical and cultural context of music and how technology has influenced its evolution.
- Students will recognise and articulate the principles of digital music interactions, and understand various tools and technologies used in the creation of musical compositions and performances.
- Students will gain a holistic understanding of how technological advancements have transformed the realm of performing arts, shaping the creation, distribution, and consumption of music.

Course Content

Topic 1: Introduction to music technology, the transition from analogue to digital, history and evolution of music technology, the role of technology in music, an overview of digital instruments, diverse musical genres and their relation with technology, the impact of digital intervention on music creation, distribution and archival. (3 Lectures & 6 Studio Hours)

Topic 2: Interaction with music technology, editing and mixing, creating a balanced mix, synthetic sound, and technology integration in music and performance. (5 Lectures & 10 Studio Hours)

Topic 3: Software and hardware resources used for performance and interactive music installations, exploring the potential of immersive and emerging technologies. Hands-on project from ideation to realisation. (5 Lectures & 10 Studio Hours)

Pedagogy: This course will employ a combination of hands-on demonstrations and practical assignments, encouraging active student engagement. Evaluation in this course will revolve around the completion of both individual and collaborative projects.

Reference Books:

- Rowe, R. (1992). Interactive music systems: machine listening and composing. MIT Press.
- Rambarran, S. (2021). Virtual Music: Sound, Music, and Image in the Digital Era. Bloomsbury Publishing.
- Paul, C. (2023). Digital art. Thames & Hudson.

Online Course Materials

- <https://online.berklee.edu/takenote/how-do-i-become-an-electronic-music-producer/>
- <https://www.coursera.org/specializations/electronic-music-production>

Title	Theatre in Education and Care	Number	LAL4XXX
Department	School of Liberal Arts	L-T-P/St [C]	1-0-2 [2]
Offered for	-	Type	Elective
Prerequisite	None		

Objectives

- Impart knowledge about traditional theatre practices that have historically provided education and care.
- Analyse instances of modern community/care-based/theatre in education practices to understand how theatre can be conceptualised and specifically designed for specific contexts of education and care.
- Introducing the students to the role of the facilitator and explaining ethical issues involved in education and care-based theatre practices.
- Develop through practical workshops and community engagement theatre and communication/coordination skills required to design and implement theatre modules for specific education and care contexts.

Learning outcomes

- Develop knowledge of care-based and theatre in education practices worldwide and understand how theatre can be conceptualised as a specific medium for education and care.
- Acquire basic concepts and practical skills required for designing theatre modules for specific contexts of care or education.
- Developing the ability to interplay between theory and practice, action and critical reflection.

Contents

Topic 1: Introduction to traditions of theatrical education and care (2 Lectures & 4 Studio Hours)

- Overview of performance traditions across the globe historically providing education and care to individuals and communities.
- Assignment: Research and present on any care or education-based tradition of theatre making.

Topic 2: Analysing instances of modern community/care-based/theatre in education practices to understand how theatre can be conceptualised and specifically designed for education and care in specific contexts. (3 Lectures & 6 Studio Hours)

- Study of the aesthetics and functioning of education and care-based modern theatre practices.
- Assignment: Research and present on any modern community/applied/care-based/theatre in education practice.

Topic 3: Understanding the role of the facilitator and ethical issues involved in designing education and care-based theatre. (3 Lectures & 5 Studio Hours)

- Exploration of care ethics as involved in education and care-based theatre practice

- Assignment: Research and Design a small module for education or care-based theatre practice in collaboration with a community, keeping in mind the ethical issues involved.

Topic 4: Exploring care-aesthetics as integral to performance creation. (2 Lectures & 5 Studio Hours)

- Exploring a care-based idea of aesthetics informing narrative, representational and structural elements of performance making.
- Assignment: Research and find possible strategies to realise care aesthetics in a specific context of education or care-based theatre module.

Topic 5: Performance Creation (3 Lectures & 6 Studio Hours)

- Design and create a brief education or care-based performance working in a simulated community environment.
- Assignment: Collaboratively produce and perform a brief education or care-based theatrical performance.

Instruction and Evaluation

The course will be delivered through lectures, demonstrations, workshops and practical tasks. Evaluation can be based on an essay, practical project (process, product and/or reflection), performance, script creation, documentation or presentation.

Textbook

- Prentki, Tim and Abraham, Nichola (eds.). *Applied Theatre Reader 2nd edition*. London: Routledge, 2020.
- Preston, Sheila. *Applied Theatre: Facilitation: Pedagogies, Practices, Resilience*. New York: Meuthen Drama, 2016.

References

- Saxton, Juliana and Prendergast, Monica. *Applied Theatre - International Case Studies and Challenges for Practice*. Chicago: University of Chicago Press, 2016.
- Stuart Fisher, Amanda. *Performing Care*. Manchester: Manchester University Press, 2020.
- Boal, Augusto. *Theatre of the Oppressed*. New York: Theatre Communications Group, 1993.
- Dawson, Kathryn and Lee, Bridget Keeger. *Drama-Based-Pedagogy: Activating Learning Across the Curriculum*. Chicago: University of Chicago, 2018.

Course Title	Mixed Media Art	Course No.	LAL4XXX
Department	School of Liberal Arts	L-T-P/St [C]	1-0-2 [2]
Offered for	-	Type	Elective
Prerequisite	None		

Course Objectives

- Exploring New Art Forms is an interdisciplinary course that delves into emerging and innovative artistic expressions that challenge traditional boundaries.
- This course aims to broaden artistic horizons by examining contemporary art's latest trends, technologies, and creative processes.

Learning Outcomes

- Students will have gained a comprehensive understanding of the ever-evolving landscape of digital art and developed the skills to engage with and contribute to the world of new artistic expressions.
- Students will comprehend New Media artwork's historical context and fundamentals.
- Students will understand the art behind science and the science behind the art. They will also see the creative potential of the software.

Contents

Topic 1: Understand the evolution of art forms: Explore the historical context of art and its dynamic evolution from traditional media to contemporary digital and interactive platforms. (4 Lectures & 4 Studio Hours)

Topic 2: Engage with diverse art practices: Investigate a wide range of new art forms, including digital art, virtual reality, interactive installations, bio art, street art, and more, to gain insights into the diversity of contemporary artistic expressions. (4 Lectures, 6 Studio Hours)

Topic 3: Synthesis between art and technology: Formulate ideas and Develop critical thinking skills to evaluate and discuss the concepts, theories, and ideas that underlie new art forms. (5 Lectures, 8 Studio Hours)

Topic 4: Create an artwork: Completed artwork in the digital format and post it online, and if relevant, include documentation of the project's making. (8 Studio Hours).

Pedagogy

This course is delivered through lectures, discussions, workshops, guest presentations, and field trips. Students will be encouraged to engage in creative projects and critical discussions, fostering a dynamic and interactive learning environment.

Reference Books:

- Shanken, E. A. (2009). Art and electronic media.
- Paul, C. (2023). Digital art. Thames & Hudson.
- Lev Manovich, The Language of New Media (Cambridge, MA: The MIT Press, 2001).
- Jay David Bolter and Richard Grusin, Remediation: Understanding New Media (Cambridge, MA: The MIT Press, 2000).
- Oliver Grau, Virtual Art from Illusion to Immersion (Cambridge, MA: The MIT Press, 2003).
- Henry Jenkins, Convergence Culture: Where Old and New Media Collide (New York: New York University Press, 2006)

Online Course Materials

- <https://www.coursera.org/learn/art-activity>
- <https://www.udemy.com/topic/digital-art/>

Title	Handmade Paper Making	Number	LAL4XXX
Department	School of Liberal Arts	L-T-P/St [C]	1-0-2 [2]
Offered for		Type	Elective
Prerequisite	None		

Objectives

- Develop practical skills in handmade paper creation techniques.
- Foster creative expression through unique handmade paper creations.
- Raise awareness about sustainability and eco-friendly paper production practices.

Learning Outcomes

- Develop proficiency in the fundamental techniques of handmade paper making.
- Create aesthetically pleasing handmade paper artefacts through artistic experimentation.
- Apply knowledge of paper-making to produce personalised and innovative artefacts.

Contents

Topic 1: Introduction (3 Lectures)

- History and significance of handmade paper
- Basic equipment and safety guidelines
- Introduction to different types of fibres

Topic 2: Fiber Preparation (2 Lectures, 4 Studio Hours)

- Selecting and preparing fibres for paper making
- Hands-on experience in breaking down fibres and creating pulp

Topic 3: Sheet Formation (2 Lectures, 4 Studio Hours)

- Techniques for hand-sheet formation
- Experimenting with additives and textures

Topic 4: Pressing and Drying (2 Lectures, 4 Studio Hours)

- Proper pressing and drying techniques for quality paper
- Troubleshooting common issues during pressing and drying

Topic 5: Surface Treatments (2 Lectures, 4 Studio Hours)

- Introduction to surface treatments and embellishments
- Exploring techniques like sizing, coating, and coloring

Topic 6: Artistic Expression (2 Lectures, 4 Studio Hours)

- Encouraging creativity through handmade paper artefacts
- Exploring artistic forms like paper sculpture and collage

Topic 7: Final Projects (6 Studio Hours)

- Showcasing and presenting students' best handmade paper artefacts
- Reflection on the learning journey and personal growth

References:

- Hiebert, H. (2000). The Papermaker's Companion: The Ultimate Guide to Making and Using Handmade Paper. Storey Publishing.
- Studley, V. (1991). The Art and Craft of Handmade Paper. Dover Publications.

Online Resources: <https://www.dsource.in/course/handmade-paper-making/paper-making>

Title	Learning to Weave	Number	LAL4XXX
Department	School of Liberal Arts	L-T-P/St [C]	1-0-2 [2]
Offered for		Type	Elective
Prerequisite	None		
<p>Objectives</p> <ul style="list-style-type: none"> ● Develop foundational weaving skills through hands-on practice and experimentation. ● Explore various weaving techniques and patterns to expand creative possibilities. ● Foster an understanding of the cultural and historical significance of weaving. <p>Learning Outcomes</p> <ul style="list-style-type: none"> ● Acquire proficiency in basic weaving techniques and processes. ● Create woven pieces showcasing various patterns, textures, and designs. <p>Contents</p> <p>Topic 1: Introduction to Weaving (5 Lectures)</p> <ul style="list-style-type: none"> ● Understanding the history and cultural significance of handloom weaving. ● Overview of different types of handlooms and their components. ● Introduction to basic weaving terminology and concepts. <p>Topic 2: Weaving Techniques and Patterns (4 Lectures & 8 Studio Hours)</p> <ul style="list-style-type: none"> ● Hands-on practice setting up and operating a handloom. ● Learning fundamental weaving techniques, such as plain weave and twill. ● Exploring different pattern weaves, such as herringbone and overshot. ● Experimenting with colour combinations and yarn choices to create diverse patterns. <p>Topic 3: Design and Project Development (4 Lectures & 8 Studio Hours)</p> <ul style="list-style-type: none"> ● Understanding design principles and elements in weaving. ● Exploring different methods of drafting and designing weaving patterns. ● Planning and developing individual weaving projects based on personal creativity and interests. ● Guidance on yarn selection, warp calculation, and project planning. <p>Topic 4: Project Execution and Finishing (10 Studio Hours)</p> <ul style="list-style-type: none"> ● Dedicated time for participants to weave their individual projects. ● Troubleshooting and guidance on weaving, yarn tension, and selvedge control. ● Techniques for finishing woven textiles, such as washing, pressing, and hemming. ● Sharing and showcasing completed projects, with opportunities for feedback and discussion. <p>Textbook Banerjee, D. (2022). The Beginner's Handbook of Indian Handloom Weaving. Handloom Foundation</p> <p>References:</p>			

Patrick, J. (2010). *The Weaver's Idea Book: Creative Cloth on a Rigid Heddle Loom*. Loveland, CO: Interweave Press.

Online Resources: <https://heddlecraft.com/on-line-weaving-education.html>

<https://www.schoolofsweetgeorgia.com/weaving/>

Title	Basics of Pottery	Number	LAL4XXX
Department	School of Liberal Arts	L-T-P/St [C]	1-0-2 [2]
Offered for		Type	Elective
Prerequisite	None		

Objectives

- Develop fundamental pottery skills, including wheel throwing and hand-building techniques.
- Explore various glazing and surface decoration techniques to enhance pottery creations.
- Gain a comprehensive understanding of pottery materials, tools, and processes.

Learning Outcomes

- Develop foundational pottery skills and techniques through hands-on practice.
- Create unique and functional pottery pieces demonstrating craftsmanship and creativity.

Contents

- **Topic 1:** Introduction to the art of pottery, its historical significance, and cultural relevance. Demonstration of basic pottery techniques such as hand-building and wheel throwing. (2 lecture and 4 lab hours)
- **Topic 2:** Familiarization with pottery tools, equipment, and materials. Hands-on practice in hand-building techniques, including pinch pots, coil building, and slab construction. (4 lecture and 8 lab hours)
- **Topic 3:** Instruction and practice in wheel throwing, focusing on centring, shaping, and trimming. Exploration of surface decoration techniques, such as carving, slip trailing, and sgraffito. (4 lecture and 8 lab hours)
- **Factorial 4:** Glazing and Firing: Understanding different types of glazes and their application methods. Experimentation with glazing techniques and colour combinations. Introduction to kiln firing processes and understanding firing temperatures. (3 lectures and 6 lab hours)

Pedagogy:

The course is designed in order to plan and execute individual pottery projects, incorporating learned techniques. After the complete lab session, we will take feedback from instructors on project development and execution. Exhibition of completed pottery pieces, showcasing students' creativity and craftsmanship.

Textbook

Atkin, J. (2017). *Beginner's Guide to Pottery and Ceramics*. Search Press.

References:

Fox, M. (2020). My Life As a Potter. Harbour Publishing.

Online resources

Pottery course - Udemy™ Official Site Udemy <https://www.udemy.com › pottery › online-course>

Title	Material manifestation: Mural and casting	Number	LAL4XXX
Department	School of Liberal Arts	L-T-P/St [C]	1-0-2 [2]
Offered for		Type	Elective
Prerequisite	None		

Objectives

- Developing a broad idea using various mural techniques, including different surface development styles.
- Develop fundamental casting skills, including sand, cement casting, tiles and mirror work, and fresco bruno/ secco.
- Explore various surface creation techniques, including low and medium reliefs.
- Gain a comprehensive understanding of various materials, tools, and processes.

Learning Outcomes

- Develop foundational casting skills and techniques through hands-on practice.
- Create frescos on different relief surfaces.
- Arrangement of different pieces in multiple order and create a meaningful composition.

Contents

- **Topic 1:** Introduction to material manifestation. Nurture various materials and get familiar with their use on the surface. Develop a clear vision of negative and positive spaces of relief making. Demonstration of basics of relief casting and its techniques. (4 lectures and 6 lab hours)
- **Topic 2:** Getting experience with various tools, equipment, and materials. Hands-on practice in material application techniques, including using binders according to materials, surface development, and colour application. (4 lecture and 10 lab hours)
- **Topic 3:** Planning and executing group/collaborative projects, incorporating learned techniques. Introducing execution processes such as wall mounting, pedestal display, free-standing and assembled displays of completed pieces. (5 lectures and 10 lab hours)

Pedagogy

The course is designed in order to introduce students to the transit of artistic creativity and practice with the various mediums and tool/s. The course will also go through various mechanisms of casting and backing techniques, along with visual and practical demonstrations. The course will contain a creative

dimension wherein students will work on creating their own narrative, symbolism, abstract vision, or any historical replication.

Textbook

- Bose, N. (1999). *Vision & creation*. Visva-Bharati Publication Department.

References

- Herringham, C. J. P. (1915). *Ajanta frescoes: Being reproductions in colour and monochrome of frescoes in some of the caves at Ajanta after copies taken in the years 1909-1911*. Oxford University Press.
- Roettgen, S. (1997). *Italian frescoes: The early Renaissance, 1400-1470*. Abbeville Press.
- Agarwala, R. A. (n.d.). *Wall painting from Central India*. Exotic India Art.
- Agarwala, R. A. (2002). *Bundi: The city of painted walls*. Aryan Books International.

Online resources

- [How To Make A Fresco Painting - with Artist Georges Le ...YouTubehttps://www.youtube.com › watch](https://www.youtube.com/watch)
- [Easy Cement Casting - How to Make a Unique SculptureYouTubehttps://www.youtube.com › watch](https://www.youtube.com/watch)

Title	Film making	Number	LAL4XXX
Department	School of Liberal Arts	L-T-P/St [C]	1-0-2 [2]
Offered for		Type	Elective
Prerequisite	None		
<p>Objectives</p> <ul style="list-style-type: none"> • Foster creativity and storytelling skills through practical filmmaking experiences. • Develop technical proficiency in using film equipment and editing software. • Enhance teamwork, communication, and project management abilities through collaborative filmmaking. <p>Learning outcomes</p> <ul style="list-style-type: none"> • Acquire fundamental knowledge and skills in scriptwriting, cinematography, and editing. • Gain a deeper understanding of visual storytelling techniques and narrative structure. <p>Content</p> <p>Topic 1: Introduction to Filmmaking (3 lectures and 2 studio hours)</p> <ul style="list-style-type: none"> • Overview of the filmmaking process and its key components. • Assignment: Write a short script for a one-minute film. <p>Topic 2: Practical Filmmaking Techniques (4 lectures and 6 studio hours)</p> <ul style="list-style-type: none"> • Hands-on experience with camera operation, lighting, and sound recording. • Assignment: Shoot and edit a short scene to practice technical skills. <p>Topic 3: Storytelling and Editing (4 lectures and 8 studio hours)</p> <ul style="list-style-type: none"> • Exploration of narrative structure, shot composition, and editing techniques. • Assignment: Edit a sequence of provided footage to create a cohesive story. <p>Topic 4: Collaboration and Film Production (2 lectures and 10 studio hours)</p> <ul style="list-style-type: none"> • Team-based film production, including roles and responsibilities. • Assignment: Collaborate with peers to produce a short film, from pre-production to post-production. <p>Textbook Ascher, S. & Pincus, E.. 2013. The Filmmaker's Handbook: A Comprehensive Guide for the Digital Age. Plume</p> <p>Online resources: https://industrialscripts.com/filmmaking-resources/ https://vimeo.com/blog/category/video-school?ref=storyhunter.com</p>			

Course Title	Interactive Art	Course No.	LAL4XXX
Department	School of Liberal Arts	L-T-P/St [C]	1-0-2 [2]
Offered for	-	Type	Elective
Prerequisite	None		

Course Objectives

- Understand the fundamentals of interactive art, emphasising the dynamic relationship between art and technology.
- Acquire practical skills to design and develop interactive art projects.

Learning Outcomes

- Students will comprehend interactive artwork's historical context and fundamentals.
- Students will employ design thinking to conceptualise and plan interactive art projects.
- Students will cultivate familiarity with diverse tools and technologies for crafting interactive artworks.

Contents

Topic 1: Interactive art. History of interactive art and motivations. Discussion on successful interactive art installations. Interaction techniques. Designing engaging interfaces, interactions and spaces. User experience in interactive art (4 lecture hours, 4 studio hours)

Topic 2: Tools and Technologies for interactive artwork. Introduction to software and hardware for interactive installations. Selecting the appropriate technology for an interactive artwork. (5 lecture hours, 10 studio hours)

Topic 3: Application of design thinking process to create an interactive art project. Hands-on sessions for building interactive art projects. Completion of interactive art projects for public showcase or exhibition. (4 lecture hours, 12 studio hours)

Pedagogy: This course will be conducted through demonstrations and practical assignments, allowing students to engage in hands-on projects actively. Assessment for the course will be centred around both individual and group projects.

Textbook

Shanken, E. A. (2009). Art and electronic media.

Reference:

Paul, C. (2023). Digital art. Thames & Hudson.

Online Course Materials

<https://www.coursera.org/learn/art-activity>

<https://www.udemy.com/topic/digital-art/>