

Syllabus
of Four-Year Integrated Teacher Education Programme
Secondary Stage Science Stream (B.Sc.B.Ed.)
Semester Wise

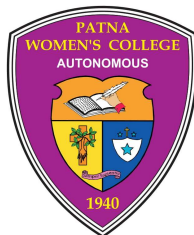
(Based on NEP 2020 & NCTE Regulations 2021)

PATNA WOMEN'S COLLEGE
AUTONOMOUS

A Catholic Minority Institution

PATNA UNIVERSITY

4th cycle NAAC Accredited at 'A⁺⁺' Grade



DEPARTMENT OF EDUCATION

Vision

Rooted in the life, vision, and teachings of Jesus Christ and inspired by Mother Veronica, the foundress of the Apostolic Carmel, Patna Women's College strives to become a center of academic excellence in higher education, social responsibility, and empowerment of women.

Mission Statement

Patna Women's College, the first college for women in Bihar, is committed to the holistic development of women so as to make an effective contribution to the creation of a better society.

To this end, we strive

- To become a center of excellence in higher education for women in an atmosphere of autonomy.
- To excel in teaching-learning, research, and consultancy.
- To provide education that promotes capacity building and holistic development of a person.
- To offer subjects for competency building and motivate/animate a workforce imbued with human values.
- To promote patriotism, communal harmony and cultural integration to maintain a free and peaceful atmosphere on the campus.
- To train the students in creative arts, social service, critical thinking, and leadership in order to make an effective contribution to the creation of a new and value based society.
- To create women leaders and to make them agents of social change.
- To develop skill oriented and value based courses, for the all-round development of individuals.
- To promote academic exchange and academia-industry interface.
- To form young women who are 'always wise' and who will dare to 'go ahead and conquer knowledge' through, competence, commitment, delicate conscience, and compassion.

Programme Outcomes (POs) for ITEP Programme

At the completion of the ITEP programme, the graduates will attain the ability to:

- PO1: Comprehensive Academic & Pedagogical Knowledge:** possess a deep understanding of their chosen discipline as well as proficiency in pedagogical approaches tailored to the secondary school stage.
- PO2: Stage-Specific Competence:** design, deliver, and assess stage appropriate learning experiences for students at the Secondary stage.
- PO3: Reflective & Innovative Teaching:** be reflective practitioners who can integrate technology (ICT) into teaching-learning processes and create innovative learning resources.
- PO4: Inclusive Education & Social Sensitivity:** handle diverse classrooms, including students with disabilities, and promote gender sensitivity, equity, and social cohesion.
- PO5: Cultural & Ethical Grounding:** imbibe Indian values, ethos, and cultural traditions, fostering a sense of national identity while maintaining a global perspective.
- PO6: Work & Research Proficiency:** demonstrate proficiency in teaching-learning management and problem-solving skills in real work environment.
- PO7: Lifelong Learning & Professionalism:** engage with and contribute to the professional community and possess lifelong learning skills.
- PO8: Communication Skills:** communicate effectively for meaningful interaction with parents, colleagues, and the community.

Programme Specific Outcomes (PSOs) for ITEP Programme

At the completion of the programme, in their professional life, the prospective teacher will be able to demonstrate:

- PSO1: Advanced Subject Pedagogical Competence:** in-depth subject knowledge and subject-specific pedagogical skills to teach Secondary stage learners (Classes IX–XII).
- PSO2: Curriculum Planning and Assessment for Secondary Learners:** the ability to design curriculum, plan learning activities and assessment tools aligned with secondary school NCF and board examination requirements.
- PSO3: Learner-centred and Technology-enabled Instruction:** capability to apply learner-centred, inquiry-based and technology-integrated teaching strategies to promote higher-order thinking, problem solving and conceptual understanding among adolescent learners.
- PSO4: Inclusive and Adolescent-sensitive Classroom Practice:** the ability to coordinate with peers and learners to address diverse learning needs, and socio-emotional challenges of secondary stage students.

**SEMESTER WISE STRUCTURE OF ITEP
SCIENCE STREAM (B.Sc.B.Ed.) –SECONDARY**

Semester I

Sl. No	Curricular Components	Discipline	Course Code	Course Title	Credits	External Marks	Internal Marks	Total Marks
1	Foundation of Education	Education	IEDMJC101	Evolution of Indian Education	4	70	30	100
2	Disciplinary (Graduate Major) (Any one)	Botany	IBOMJC101	Microbiology and Phycology	5	70	30	100
		Chemistry	ICHMJC101	Inorganic Chemistry-I				
		Mathematics	IMAMJC101	Calculus (Practical)				
		Physics	IPHMJC101	Mechanics				
		Zoology	IZOMJC101	Non-Chordates I: Protists to Pseudocoelomates				
		Botany	IBOMJC102	Herbal Products: Development and Formulation	3	70	30	100
		Chemistry	ICHMJC102	Basic Analytical Chemistry				
		Mathematics	IMAMJC102	Scilab				
		Physics	IPHMJC102	Physics Workshop Skill				
		Zoology	IZOMJC102	Hematology				
3	Disciplinary (Graduate Minor) (Any one)	Botany	IBOMIC101	Microbes, Lichen and Mycorrhiza	3	70	30	100
		Chemistry	ICHMIC101	Physical Chemistry & Organic Chemistry-I				
		Mathematics	IMAMIC101	Differential Calculus, Set Theory and 2D Geometry				
		Physics	IPHMIC101	Mechanics- I				
		Zoology	IZOMIC101	Non-chordate Diversity				
4	Edu-AEC & VAC	Education	IEDAEC101	Language – I (Hindi)	4	70	30	100
			IEDAEC102	Art Education - I (Collage-Making)	2	35	15	50
			IEDVAC101	Understanding India - I (Indian Ethos and Knowledge Systems)	2	35	15	50
				Total	23			600

Semester II

Sl. No	Curricular Components	Discipline	Course Code	Course Title	Credits	External Marks	Internal Marks	Total Marks
1	Disciplinary (Graduate Major) (Any one)	Botany	IBOMJC203	Biomolecules and Cell Biology	6	70	30	100
		Chemistry	ICHMJC203	Physical Chemistry-I				
		Mathematics	IMAMJC203	Algebra				
		Physics	IPHMJC203	Electricity and Magnetism				
		Zoology	IZOMJC203	Principles of Ecology				
		Botany	IBOMJC204	Plant Physiology	6	70	30	100
		Chemistry	ICHMJC204	Physical Chemistry-II				
		Mathematics	IMAMJC204	Linear Algebra				
		Physics	IPHMJC204	Atomic and Molecular Physics				
		Zoology	IZOMJC204	Principles of Genetics				
2	Disciplinary (Graduate Minor) (Any one)	Botany	IBOMIC202	Algae and Fungi	3	70	30	100
		Chemistry	ICHMIC202	Physical Chemistry & Organic Chemistry-II				
		Mathematics	IMAMIC202	Integral Calculus, Abstract Algebra, 3D Geometry and Vector Analysis				
		Physics	IPHMIC202	Mechanics-II				
		Zoology	IZOMIC202	Chordate Diversity				
3	Edu-AEC & VAC	Education	IEDAEC203	Language-II (English)	4	70	30	100
			IEDAEC204	Teacher and Society	2	35	15	50
			IEDVAC202	Understanding India – II (Indian Ethos and Knowledge Systems)	2	35	15	50
				Total	23			500

Semester III

Sl. No	Curricular Components	Discipline	Course Code	Course Title	Credits	External Marks	Internal Marks	Total Marks
1	Foundation of Education	Education	IEDMJC302	Child Development and Educational Psychology	4	70	30	100
2	Disciplinary (Graduate Major) (Any one)	Botany	IBOMJC305	Mycology and Phytopathology	6	70	30	100
		Chemistry	ICHMJC305	Organic Chemistry-I				
		Mathematics	IMAMJC305	Differential Equations (Practical)				
		Physics	IPHMJC305	Thermal Physics and Thermodynamics (Practical)				
		Zoology	IZOMJC305	Non-chordates II: Coelomates				
		Botany	IBOMJC306	Archegoniate	6	70	30	100
		Chemistry	ICHMJC306	Physical Chemistry-III				
		Mathematics	IMAMJC306	Real Analysis-I				
		Physics	IPHMJC306	Mathematical Physics and Special theory of Relativity				
		Zoology	IZOMJC306	Cell Biology				
3	Disciplinary (Graduate Minor) (Any one)	Botany	IBOMIC303	Archegoniate	3	70	30	100
		Chemistry	ICHMIC303	Physical & Organic Chemistry-III				
		Mathematics	IMAMIC303	Mechanics and Linear Programming				
		Physics	IPHMIC303	Thermal Physics and Thermodynamics				
		Zoology	IZOMIC303	Environmental Hazards and Climate Change				
4	Stage Specific Content-Cum-Pedagogy	Education	IEDSCP301	Basics of Pedagogy at Secondary Stage	4	70	30	100
				Total	23			500

Semester IV

Sl. No	Curricular Components	Discipline	Course Code	Course Title	Credits	External Marks	Internal Marks	Total Marks
1	Foundation of Education	Education	IEDMJC403	Philosophical and Sociological Perspectives of Education-I	4	70	30	100
2	Disciplinary (Graduate Major) (Any one)	Botany	IBOMJC407	Anatomy of Angiosperms	4	70	30	100
		Chemistry	ICHMJC407	Inorganic Chemistry-II				
		Mathematics	IMAMJC407	Riemann Integration and Series of Function (Real Analysis -II)				
		Physics	IPHMJC407	Digital system and Application				
		Zoology	IZOMJC407	Diversity of Chordates				
		Botany	IBOMJC408	Economic Botany	4	70	30	100
		Chemistry	ICHMJC408	Organic Chemistry-II				
		Mathematics	IMAMJC408	Group Theory				
		Physics	IPHMJC408	Waves and Optics				
		Zoology	IZOMJC408	Animal Physiology				
		Botany	IBOMJC409	Basics of Genetics	4	70	30	100
		Chemistry	ICHMJC409	Physical Chemistry-IV				
		Mathematics	IMAMJC409	PDE and System of ODE (Practical)				
		Physics	IPHMJC409	Mathematical Physics and Introduction to Computational Methods (Practical)				
		Zoology	IZOMJC409	Fundamental of Biochemistry				
3	Disciplinary (Graduate Minor) (Any one)	Botany	IBOMIC404	Plant Ecology	3	70	30	100
		Chemistry	ICHMIC404	Physical & Organic Chemistry-IV				
		Mathematics	IMAMIC404	Differential Equations and Statistics				
		Physics	IPHMIC404	Mathematical Physics				
		Zoology	IZOMIC404	Waste Management Technology				
4	Stage Specific Content-Cum-Pedagogy	Education	IEDSCP402	Pedagogy of Mathematics-I	4	70	30	100
			IEDSCP403	Pedagogy of Physical Sciences-I				
			IEDSCP404	Pedagogy of Biological Sciences-I				
				Total	23			600

Semester V

Sl. No	Curricular Components	Discipline	Course Code	Course Title	Credits	External Marks	Internal Marks	Total Marks
1	Disciplinary (Graduate Major) (Any one)	Botany	IBOMJC510	Plant Ecology and Phytogeography	6	70	30	100
		Chemistry	ICHMJC510	Inorganic Chemistry-III				
		Mathematics	IMAMJC510	Numerical Methods (Practical)				
		Physics	IPHMJC510	Classical Mechanics				
		Zoology	IZOMJC510	Comparative Anatomy of Vertebrates				
		Botany	IBOMJC511	Plant Systematics	6	70	30	100
		Chemistry	ICHMJC511	Organic Chemistry-III				
		Mathematics	IMAMJC511	Number Theory				
		Physics	IPHMJC511	Analog System and Applications(Practical)				
		Zoology	IZOMJC511	Endocrinology				
2	Disciplinary (Graduate Minor) (Any one)	Botany	IBOMIC505	Plant Taxonomy	3	70	30	100
		Chemistry	ICHMIC505	Inorganic Chemistry-I				
		Mathematics	IMAMIC505	Partial Differential Equation and Fourier series				
		Physics	IPHMIC505	Electricity and Magnetism				
		Zoology	IZOMIC505	Food and Nutrition				
		Botany	IBOMIC506	Plant Anatomy	3	70	30	100
		Chemistry	ICHMIC506	Physical & Organic Chemistry-V				
		Mathematics	IMAMIC506	Graph Theory and Number Theory				
		Physics	IPHMIC506	Basic Electronics (Practical)				
		Zoology	IZOMIC506	Public Health				
3	Stage Specific Content-Cum-Pedagogy	Education	IEDSCP502	Pedagogy of Mathematics-II	4	70	30	100
			IEDSCP503	Pedagogy of Physical Sciences-II				
			IEDSCP504	Pedagogy of Biological Sciences-II				
4	Edu-AEC	Education	IEDAEC505	Information & Communication Technology (ICT) in Education	2	35	15	50
5	School Experience	Education	IEDSE501	Pre-Internship Practice	2	-	-	50
				Total	26			600

Semester VI

Sl. No	Curricular Components	Discipline	Course Code	Course Title	Credits	External Marks	Internal Marks	Total Marks
1	Foundation of Education	Education	IEDMJC604	Assessment and Evaluation	2	35	15	50
			IEDMJC605	Inclusive Education	2	35	15	50
2	Disciplinary (Graduate Major) (Any one)	Botany	IBOMJC612	Molecular Biology	4	70	30	100
		Chemistry	ICHMJC612	Inorganic Chemistry-IV				
		Mathematics	IMAMJC612	Metric Space and Topology				
		Physics	IPHMJC612	Quantum Mechanics				
		Zoology	IZOMJC612	Biometry				
		Botany	IBOMJC613	Reproductive Biology of Angiosperms	4	70	30	100
		Chemistry	ICHMJC613	Organic Chemistry-IV				
		Mathematics	IMAMJC613	Multivariate Calculus				
		Physics	IPHMJC613	Electromagnetism and Electrodynamics (Practical)				
		Zoology	IZOMJC613	Molecular Biology				
3	Disciplinary (Graduate Minor) (Any one)	Botany	IBOMIC607	Plant Embryology	3	70	30	100
		Chemistry	ICHMIC607	Physical & Organic Chemistry-VI				
		Mathematics	IMAMIC607	Fuzzy Sets, Dynamics				
		Physics	IPHMIC607	Modern Physics				
		Zoology	IZOMIC607	Insect Vectors				
		Botany	IBOMIC608	Plant Physiology	3	70	30	100
		Chemistry	ICHMIC608	Physical & Organic Chemistry-VII				
		Mathematics	IMAMIC608	Theory of Equations and Linear Algebra				
		Physics	IPHMIC608	Waves and Optics (Practical)				
		Zoology	IZOMIC608	Vector Diseases and Control				
4	Stage Specific Content-Cum-Pedagogy	Education	IEDSCP602	Pedagogy of Mathematics-III	4	70	30	100
			IEDSCP603	Pedagogy of Physical Sciences-III				
			IEDSCP604	Pedagogy of Biological Sciences-III				
5	Edu-AEC	Education	IEDAEC606	Mathematical and Quantitative Reasoning	2	35	15	50
6	School Experience	Education	IEDSE602	School Observation	2	-	-	50
				Total	26			700

Semester VII

Sl. No	Curricular Components	Discipline	Course Code	Course Title	Credits	External Marks	Internal Marks	Total Marks
1	Foundation of Education	Education	IEDMJC706	Perspectives on School Leadership and Management	2	35	15	50
			IEDMJC707	Curriculum Planning and Development	2	35	15	50
2	Edu-AEC	Education	IEDAEC707	Art Education–II (Puppetry)	2	35	15	50
			IEDAEC708	Sports, Nutrition and Fitness	2	35	15	50
3	School Experience	Education	IEDSE703	School-Based Research Projects	2	-	-	50
			IEDSE704	Internship in Teaching	10	-	-	250
				Total	20			500

Semester VIII

Sl. No	Curricular Components	Discipline	Course Code	Course Title	Credits	External Marks	Internal Marks	Total Marks
1	Foundation of Education	Education	IEDMJC808	Philosophical and Sociological Perspectives of Education-II	4	70	30	100
			IEDMJC809	Education Policy Analysis	2	35	15	50
2	Foundation of Education (Elective Courses)	Education	IEDMJE801	Emerging Technologies in Education	4	70	30	100
			IEDMJE802	Gender Education				
			IEDMJE803	Guidance and Counselling				
			IEDMJE804	Peace Education				
			IEDMJE805	Education for Sustainable Development				
3	Edu- AEC & VAC	Education	IEDAEC809	Yoga and Understanding Self	2	35	15	50
			IEDVAC803	Citizenship Education, Sustainability and Environmental Education	2	35	15	50
4	School Experience	Education	IEDSE805	Post Internship	2	-	-	50
			IEDSE806	Work Experience	2	-	-	50
5	Community Engagement Service	Education	IEDCES801	Community Engagement and Service	2	35	15	50
				Total	20			500

**Scheme for Paper Setting in Four-Year Integrated Teacher Education Programme Secondary
Stage Science Stream (B.Sc.B.Ed.)**

Semester-end examinations will be conducted for theory papers of 4 and higher credits for 70 marks and theory papers of 2 credits for 35 marks.

Pattern for 4 and Higher Credit Paper (70)				Pattern for 2 Credit Paper (35)			
Types of Question	Number of Question	Marks	Syllabus Coverage	Types of Question	Number of Question	Marks	Syllabus Coverage
MCQ	10	10	Complete	MCQ	5	5	Complete
Short Answer	4	20	Complete	Short Answer	2	10	Complete
Essay Type	4	40	Complete (2 Question from each)	Essay Type	2	20	Complete (2 Question from each)
		70				35	

Questions should be set in English & Hindi both, if applicable.

**Continuous Internal Assessment Pattern (CIA)
(Theory and Practical): Maximum Marks Allotted: 30**

Mid Term Test (Marks)		Tutorials/Assignments Quiz/ Seminars (Marks)	Attendance (Marks)	Total Marks
Total	10	15	5	30

Attendance (5 marks) – Marks Calculation

Attendance in Percentage	Marks
96-100	5
92-95	4
88-91	3
84-87	2
80-83	1
Below 80	0

**Continuous Internal Assessment Pattern (CIA)
(Theory and Practical): Maximum Marks Allotted: 15**

Mid Term Test (Marks)		Tutorials/Assignments Quiz/ Seminars (Marks)	Attendance (Marks)	Total Marks
Total	5	7.5	2.5	15

Attendance (2.5 marks) – Marks Calculation

Attendance in Percentage	Marks
96-100	2.5
92-95	2.0
88-91	1.5
84-87	1.0
80-83	0.5
Below 80	0

1st Semester

Evolution of Indian Education

Course Code: IEDMJC101

Course Credit: 04

Theory: 70 Marks

Practicum: 30 Marks

COURSE OUTCOMES

After completion of this course, the prospective teachers will attain the ability to:

CO1: Explain the historical development of education from traditional to modern times in India.

(L2: Understand)

CO2: Analyse the influence of social, political, cultural, and economic factors on the evolution of educational system. (L4: Analyse)

CO3: Evaluate major education commissions, policies and reforms. (L5: Evaluate)

CO4: Explain the contribution of Indian philosophers and their impact on current practices.

(L2: Understand)

UNIT I: Ancient Indian Education upto Vedic Period

- Vision, objectives and teaching and learning process.
- Development of educational institutions: Finances, management and curriculum.
- Guru-Shishya Parampara as depicted in Upanishads.
- Education as depicted in epics: Ramayana and Mahabharata.

UNIT II: Buddhist period to Early Medieval Period

- Vision, objectives and salient features of Buddhist and Jain Education System.
- Teaching and learning process.
- Finance, management and curriculum of educational institutions.
- Educational institutions: Nalanda, Taxila, Vikramshila, Vallabhi, Nadia; famous Guru-Shishya.

UNIT III: Medieval Period to Precolonial Period

- Vision, objectives, brief historical development perspective as well as salient features of education in Medieval Period
- Teaching and learning process; home education, pathshala, gurukuls, makhtab, madarasa.
- Finance, management and curriculum of educational institutions during medieval period.
- Teaching and learning process, salient features, finance, management and curriculum of indigenous education in precolonial period

UNIT IV: Modern Indian Education

- Colonial education in India; Woods Despatch, Macaulay Minutes and Westernization of Indian education.
- Shiksha ka Bhartiyakaran (Indigenous interventions in education); Swadeshi and nationalist attempts of educational reforms with special reference to general contribution of Indian thinkers (Savitribai and Jyotiba Phule, Rabindranath Tagore, Swami Vivekananda, Mahatma Gandhi, Sri Aurobindo, Gijubhai Badheka, Pt. Madanmohan Malaviya, Jiddu Krishnamurti and Dr. Bhima Rao Ambedkar and others) to the education systems of India.

- Education in independent India
 - Overview of Constitutional values and educational provisions.
 - Citizenship Education: Qualities of a good citizen, education for fundamental rights and duties.
 - Overview of 20th century committees, commissions and policies with special reference to Kothari, NEP 1968, NPE 1986, Plan of Action 1992.
 - UEE, SSA, RTE Act 2009: Overview and impact.
 - NEP 2020: vision and implementation for a vibrant India.

Practicum

- Prepare a report highlighting educational reforms with special reference to school education in the light of NEP 2020.
- Critically analyze the concept of good citizen from the perspective of education for democratic citizenship.
- Compare vision, objectives, and salient features of education during different periods.
- Working out a plan to develop awareness, attitude and practices related to Fundamental Rights or fundamental duties or democratic citizenship qualities, execute it in the class and write the details in the form of a report.
- Sharing of student experiences (in groups) related to Indian constitutional values, help them to reshape their concept and enable them to develop vision, mission and objectives for a school and their plan to accomplish the objectives in form of a group report.
- Analyses of current educational strengths and weaknesses of one's own locality and work out a critical report.
- Visit to places of educational significance and value centers and develop a project report.
- Observation of unity and diversity in a social locality and matching it with unity and diversity in the class and work out a plan for awareness for national-emotional integration for class to develop awareness, attitudes, skills, and participatory values, execute it in the class and report the details.
- Any other activity based on the units of the paper in form of written assignment, projects, performance or field work with a detailed report.

Suggestive Readings

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- Sharma, S. (2023). Significance of ancient Indian sciences in contemporary education. National Book Trust. ISBN-13:978-9354919114
- Tagore, R. (1951/2000). What is real education? In D. Prasad. (Ed.) Rabindranath Tagore philosophy of education and painting (pp. 43-50). National Book Trust.

Microbiology and Phycology

Course Code: IBOMJC101

Course Credit: 5

Theory : 40 Marks

Practical : 30 Marks

Practicum: 30 Marks

Course Outcomes

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

CO1: Classify the plant kingdom

CO2: Describe the diversity, structure and importance of viruses and bacteria

CO3: Describe the general account of mycoplasma and diseases caused by them

CO4: Explain the thallus organization, economic importance and the life cycle of various algae

IBOMJC101	
PWC	
Units	Topics to be covered
1	Classification of Plant Kingdoms and their important features (Whittaker 1969)
2	Virus- Discovery, General structure, DNA virus (T-phage); replication (Lytic and lysogenic Cycle), RNA virus- TMV; Economic importance of viruses, Coronavirus (elementary idea)
3	Bacteria – Discovery, General characteristics, Types- archaeobacteria and eubacteria, Reproduction-vegetative, asexual and genetic recombination (conjugation, transformation and transduction); Economic importance of bacteria with reference to their role in agriculture and industry (N ₂ fixation, fermentation and medicine); General account of Mycoplasma and diseases caused by them
4	Algae- General characteristics; Classification; Range of thallus organization and reproduction; Significant contributions of important Phycologists (F.E. Fritsch, G.M. Smith, T.V. Desikachary, H.D. Kumar, M.O.P. Iyengar); Structure, life history, and affinities of the following genera: <i>Nostoc</i> , <i>Volvox</i> , <i>Oedogonium</i> , <i>Chara</i> , <i>Vaucheria</i> , <i>Batrachospermum</i> and <i>Ectocarpus</i> ; Economic importance of algae
	Practical 1. Electron micrographs/Models of viruses – T-Phage and TMV, Line drawings/ Photographs of Lytic and Lysogenic Cycle 2. Types of Bacteria to be observed from photographs 3. Gram staining. 4. Phycology: Study of vegetative and reproductive structures of the forms prescribed in the syllabus through temporary preparations and permanent slides

Reading List :

1. Tortora, G.J., Funke B.R., Case C.L. (2007). Microbiology: An Introduction, Pearson Education. 9th edition.
2. Dubey, R.C., Maheshwari D.K. (2005). A Textbook of Microbiology, S. Chand & Company Ltd. 2nd edition.
3. Willey, J.M., Sherwood L.M., Woolverton C.J. (2011). Prescott's Microbiology, McGraw Hill. 8th edition.
4. Brown, A.E. (2005). Benson's Microbiological Applications, McGraw Hill. 9th edition.
5. Lee, R.E. (2008). Phycology, Cambridge University Press, Cambridge. 4th edition.
6. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West Press, Delhi.
7. Vashishta, B.R., Sinha, A.K. Singh, V.P. (2008). Botany for Degree Students: Algae, S. Chand & Company Ltd. 2nd edition.

Inorganic Chemistry-I

Course Code: ICHMJC101

Course Credit: 5

Theory : 40 Marks

Practical : 30 Marks

Practicum: 30 Marks

Course Outcomes:

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

- CO1:** Understand fundamental properties of atoms, molecules, periodicity of elements in the periodic table and the various states of matter with an emphasis on the particulate nature of matter. Quantum Mechanical Treatments of atoms and molecules.
- CO2:** Understand Fundamentals of acid/base reactions, redox reactions and precipitation reactions.
- CO3:** Analyse the structures and important bonding parameters
- CO4:** Evaluate the idea of a mole and the use of stoichiometry and “gas laws” governing the physical/chemical behaviour of gases.

ICHMJC101:		Inorganic Chemistry-I	
PWC			
Unit	Topics to be covered		
1	Atomic Structure: Recapitulation of Bohr's theory, its limitations and atomic spectrum of hydrogen atom. Wave mechanics: de Broglie equation, Heisenberg's Uncertainty Principle and its significance. Schrödinger's wave equation, significance of ψ and ψ^2 . Quantum numbers and their significance. Normalized and orthogonal wave functions. Sign of wave functions. Radial and angular wave functions for hydrogen atom. Radial and angular distribution curves. Shapes of s, p, d and f orbitals, Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, aufbau principle and its limitations.		
2.	Periodicity of Elements: Periodic properties of the elements with reference to s & p-block. a. Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table. b. Atomic and ionic radii c. Ionization enthalpy, successive ionization enthalpies and factors affecting ionization enthalpy and trends in groups and periods. d. Electron gain enthalpy and trends in groups and periods. e. Electro-negativity, Pauling's/ Allred Rochow's scales, variation of electro negativity with bond order, partial charge, hybridization.		
3.	Chemical Bonding: (i) Ionic bond: General characteristics, size effects, radius ratio rule and its limitations. Packing of ions in crystals. Born-Landé equation (derivation not required) importance of Kapustinskii expression for lattice energy. Madelung constant, Born-Haber cycle and its application, Solvation energy. (ii) Covalent bond: Lewis structure, Valence Bond theory (Heitler-London approach). Energetics of hybridization, equivalent and non-equivalent hybrid orbitals. Bent's rule, Resonance and resonance energy, Molecular orbital theory. Molecular orbital diagrams of diatomic and simple polyatomic molecules N_2 , O_2 , F_2 , CO_2 , NO_2 , and their ions; HCl (idea of s-p mixing and orbital interaction to be given). Formal charge, Valence shell electron pair repulsion theory (VSEPR), shapes of the following simple molecules and ions containing lone pairs and bond pairs of electrons: H_2O , NH_3 , PCl_3 , PCl_5 , SF_6 , ClF_3 , I_3^- , BrF_2^+ , PCl_6^- , ICl_2^- , ICl_4^- and SO_4^{2-} . Multiple bonding (σ and π bond approach) and bond lengths. Covalent character in ionic compounds, polarizing power and polarizability. Fajan's rules and consequences of polarization.		

	Ionic character in covalent compounds: Bond moment and dipole moment. Percentage ionic character from dipole moment and electronegativity difference. (iii)Metallic Bond: Qualitative idea of valence bond and bond theories. Semiconductors and insulators, defects in solids. (iv)Weak Chemical Forces: Vander Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interaction. Hydrogen bonding (theories of hydrogen bonding, valence bond treatment). Effects of weak chemical forces, melting and boiling points, solubility, energetics of dissolution process.
4.	Oxidation- Reduction: Introduction of electro-chemical cell, Recapitulation of oxidation-reduction concept, Balancing of ionic, standard electrode potential and its applications. Balancing of ionic reaction by ion-electron and oxidation number method, The principles involved in redox titrations.
	Practical (A) Titrimetric Analysis I. Calibration and use of apparatus II. Preparation of solutions of titrants of different Molarity/Normality (B) Acid-Base Titrations: Principles of acid-base titrations to be discussed. I. Estimation of sodium carbonate using standardized HCl. II. Estimation of carbonate and hydroxide present together in a mixture. III. Estimation of carbonate and bicarbonate present together in a mixture. IV. Estimation of free alkali present in different soaps/detergents (C) Oxidation-Reduction Titrimetry: Principles of oxidation-reduction titrations (electrode potentials) to be discussed. I. Estimation of Fe(II) and oxalic acid using standardized KMnO₄ solution II. Estimation of oxalic acid and sodium oxalate in a given mixture. III. Estimation of Fe(II) with K₂Cr₂O₇ using internal indicator (diphenylamine, N-phenylanthranilic acid) and discussion of external indicator.

Reading List:

1. Lee J.D., (2010). *Concise Inorganic Chemistry*, Pearson Education
2. Huheey J.E., Keiter E.A., Keiter R.L., Medhi O.K., (2006). *Inorganic Chemistry, Principles of Structure and Reactivity*, Pearson Education.
3. Douglas B.E., Mc Daniel D.H., (1970). *Concepts & Models of Inorganic Chemistry*, Oxford,
4. Shriver D.D., Atkins P., (1994). *Inorganic Chemistry* 2nd Ed., Oxford University Press,.
5. Day M.C., Selbin J., (1962). *Theoretical Inorganic Chemistry*, ACS Publications.
6. Vogel A.I., (2008). *A Textbook of Quantitative Inorganic Analysis*, ELBS.

Calculus (Practical)

Course Code: IMAMJC101

Course Credit: 5

Theory : 40 Marks

Practical : 30 Marks

Practicum: 30 Marks

Course Outcomes:

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

CO1: Sketch the curves in Cartesian and polar coordinate system and understand the ideas of derivatives and their higher order.

CO2: Understand geometrical terminology for angles, triangles, quadrilaterals and circles.

CO3: Provide geometrical and physical explanation of the integral of a vector field over a curve.

CO4: Apply these topics to solve the problems in physics and mechanical engineering.

IMAMJC101 : Calculus (Practical)	
PWC	
Unit	Topics to be covered
1	Higher order derivatives, Leibniz rule and its applications to problems of type $e^{ax+b}\sin x$, $e^{ax+b}\cos x$, $(ax+b)^n\sin x$, $(ax+b)^n\cos x$. Expansion of functions, partial differentiation and Euler's theorem. Concavity and inflection points, asymptotes, curve tracing in Cartesian coordinates, tracing in polar coordinates of standard curves, L'Hospital's rule, applications in business, economics and life sciences.
2	Reduction formulae, derivations and illustrations of reduction formulae of the type $\int \sin^n x \, dx$, $\int \cos^n x \, dx$, $\int \tan^n x \, dx$ and $\int \sec^n x \, dx$, $\int \sin^m x \cos^n x \, dx$, $\int \sin^m x \cos^n x \, dx$, ... etc. Volumes by slicing, disks and washers methods, volumes by cylindrical shells, parametric equations, parameterizing a curve, arc length, arc length of parametric curves, area of surface of revolution.
3	Rotation of axes and second degree equations, classification into conics using the discriminant, polar equations of conics. Sphere and Cylinder.
4	Scalar triple product and vector triple product, product of four vectors, introduction to vector functions, gradient, divergence, curl and their properties, operations with vector-valued functions, limits and continuity of vector functions, differentiation and integration of vector functions, tangent and normal components of acceleration, radial and transverse velocity and acceleration.
	Practicals / Lab work to be performed on a computer List of Practical (using any software) Plotting of graphs of function e^{ax+b} , $\log(ax+b)$, $1/(ax+b)$, $\sin(ax+b)$, $\cos(ax+b)$, $ ax+b $ and to illustrate the effect of a and b on the graph. Plotting the graphs of polynomial of degree 4 and 5, the derivative graph, the second derivative graph and comparing them. Sketching parametric curves (Eg. Trochoid, cycloid, epicycloids, hypocycloid). Matrix operation (addition, multiplication, inverse, transpose). Differentiation, Concept of Dot and Cross product, Gradient, Divergence and Curl

Reading List :

1. Thomas G. B. and Finney R. L. (2005). *Calculus*, 9th Ed., Pearson Education, Delhi.
2. Strauss M. J., Bradley G. L. and Smith K. J. (2007). *Calculus*, 3rd Ed., Dorling Kindersley (India) P. Ltd. (Pearson Education), Delhi, 2007.
3. Anton H., Bivens I. and Davis S. (2002). *Calculus*, 7th Ed., John Wiley and Sons (Asia) P. Ltd., Singapore.
4. Courant R. and John F. (1989). *Introduction to Calculus and Analysis* (Volumes I & II), Springer-Verlag, New York. Inc.
5. Khanna M.L. (2000). *Vector Algebra*, 22nd Ed., T.P.N. & Co., Meerut.
6. Vasishtha A.R. and Sharma S.K. (2005). *Integral Calculus*, 15th Ed., Krishna Prakashan Media (P) Ltd., Meerut.
7. Robert J.T Bell (2018). *An elementary treatise on Coordinate geometry of three Dimension*, 3rd Ed, Macmilan & Co ltd , New York.
8. Prasad Lalji (2015). *Coordinate Geometry of Two Dimension*, Paramount Publications Patna.
9. Prasad Lalji (2015). *Solid Geometry (3D)*, Paramount Publications Patna
10. Prasad Lalji (2015). *Differential Calculus*, Paramount Publications Patna
11. Rahman M.M (2022) *Differential Calculus*, Global Net Publication, New Delhi

Mechanics

Course Code: IPHMJC101

Course Credit: 5

Theory : 40 Marks

Practical : 30 Marks

Practicum: 30 Marks

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

CO1: Study the mathematical techniques for application in Physical problems.

CO2: Develop the concept of divergence, gradient and curl and their physical significance.

CO3: Understand the concepts of collision and reference frames.

CO4: Differentiate between Inertial and Non-inertial frames and study the dynamics of physical systems in Inertial and Non-inertial frames.

IPHMJC101 Mechanics	
Unit	Topics to be covered
1	Calculus: Differentiation. First Order Differential Equations and Integrating Factor. Exact and Inexact differential equation and their solution. Second order differential equation with constant coefficient. Integration, Methods of Integration, Integrals of some Particular Functions.
2	Vector Calculus: Recapitulation of vectors. Scalar and Vector fields, Gradient of a scalar field and its geometrical interpretation. Divergence and curl of a vector field and their physical interpretation Line, surface and volume integrals. Gauss's Divergence theorem, Stokes theorem.
3	Fundamentals of Dynamics: Reference frames. Inertial frames and Non Inertial frames, Centre of Mass. Principle of conservation of linear and angular momentum. Collisions: Elastic and inelastic collisions between particles. Centre of Mass and Laboratory frames.
4	Central Force Motion: Central and non-central forces with examples. Properties of central forces. Kepler's Laws of Planetary motion. Non-Inertial Systems: Fictitious forces. Uniformly rotating frame. Centrifugal force. Coriolis force.
	Practical: At least 05 experiments from the following: 1. To determine the height of a building using a Sextant. 2. To determine the thickness of a given glass piece with a Spherometer. 3. To determine the elastic Constants of a wire by Searle's method. 4. To determine the value of g using Bar Pendulum. 5. To determine the value of g using Kater's Pendulum. 6. To determine the Moment of Inertia of a Flywheel. 7. To determine the Modulus of Rigidity of a Wire by dynamical method. 8. To determine the Modulus of Rigidity of a Wire by Barton's apparatus. 9. To determine the Young's Modulus by flexure of beam. 10. To determine the moment of inertia by bifilar suspension.

Reading List:

1. Kleppner D., Kolenkow R. J. (1973). *An introduction to mechanics*, McGraw-Hill.
2. Kittel C., Knight W., et.al. (2007). *Mechanics*, Berkeley Physics, vol.1, Tata McGraw-Hill.
3. Resnick, Halliday and Walker (2008). *Physics*, Wiley, 8/e.
4. Fowles G. R. and Cassiday G.L. (2005). *Cengage Learning*.
5. Feynman R. P., Leighton R. B., Sands M. (2008). *Feynman Lectures*, Vol.I, Pearson Education.
6. Mathur D. S. (2000). *Mechanics*, S. Chand and Company Limited.
7. Sears F. W, Zemansky M. W., Young H.D. (1986). *University Physics*. 13/e, Addison Wesley.
8. Jewett J. W., Serway R.A. (2010). *Physics for scientists and Engineers with Modern Phys.*, Cengage Learning.
9. Spiegel M.R. (2006). *Theoretical Mechanics*, Tata McGraw Hill.
10. Flint B.L. and Worsnop H.T. (1971). *Advanced Practical Physics for students*, Asia Publishing House.
12. Panigrahi S. & Mallick B. (2015). *Engineering Practical Physics*, Cengage Learning India Pvt. Ltd.
13. Squires G.L. (2015). *Practical Physics*. 4th Edition, Cambridge University Press.
14. Prakash I. & Ramakrishna (2011). *A Text Book of Practical Physics*, 11th Edn, Kitab Mahal

Non-Chordates I: Protists to Pseudocoelomates

Course Code: IZOMJC101

Course Credit: 5

Theory : 40 Marks

Practical : 30 Marks

Practicum: 30 Marks

Course Outcome:

On completion of the course students will be able to:

- CO1** – Learn & interpret the importance of taxonomy and classify Protista, Porifera, Cnidaria, Platyhelminthes and Nematelminthes.
- CO2** – Understand and explain the economic importance and describe the life cycle and pathogenicity of *P. vivax*, *E. histolytica*, *Schistosoma haematobium*, *Taenia solium*, *Ascaris lumbricoides* and *Wuchereria bancrofti*.
- CO3** – Appreciate the diversity and complexities exhibited by non-chordates and familiarize with the morphology, anatomy and functioning of different groups of non-chordates.
- CO4** – Critically analyze the organization, complexity, and adaptations in parasitic Nematelminthes and Platyhelminthes, Affinities and Evolutionary significance of Ctenophora and to enhance collaborative learning through Practical sessions, Assignments and Projects.

Units	Syllabus
1	Protista: General characteristics & Classification up to orders, Locomotion and Reproduction in Protista. Life cycle and Pathogenicity of <i>Plasmodium vivax</i> and <i>Entamoeba histolytica</i> .
2	Porifera: General characteristics and Classification up to orders, Canal system, Spicules in sponges. Cnidaria: General characteristics and Classification up to orders, Metagenesis in <i>Obelia</i> , Polymorphism in Cnidaria, Corals and coral reefs. Ctenophora: General characteristics, Affinities and Evolutionary significance.
3	Platyhelminthes: General characteristics and Classification up to orders, Life cycle and pathogenicity of <i>Schistosoma haematobium</i> and <i>Taenia solium</i> , Parasitic adaptations in Platyhelminthes.

4	Nemathelminthes: General characteristics and Classification up to orders, Life cycle and pathogenicity of <i>Ascaris lumbricoides</i> and <i>Wuchereria bancrofti</i>, Parasitic adaptations in Nemathelminthes.
	Practical: 1. Study of WM of <i>Paramecium</i>, Binary fission & Conjugation in <i>Paramecium</i>. 2. Examination of pond water collected from different places for diversity in Protista. 3. Study of <i>Sycon</i> (T.S. and L.S.), <i>Hyalonema</i>, <i>Euplectella</i> 4. Study of <i>Obelia</i>, <i>Physalia</i>, <i>Aurelia</i>, <i>Tubipora</i>, <i>Alcyonium</i>, <i>Metridium</i>, <i>Fungia</i>, <i>Meandrina</i>, <i>Madrepora</i>. 5. One specimen / slide of any Ctenophore. 6. Study of adult <i>Schistosoma haematobium</i>, <i>Taenia solium</i> and their Life cycles (Slides / Photographs). 7. Study of adult <i>Ascaris lumbricoides</i> and its life stages (Slides / Photographs). 8. To submit a Project Report on any related topic from the syllabus. Note: Classification to be followed from “Ruppert and Barnes (2006) <i>Invertebrate Zoology</i>, 8th edition, Holt Saunders International Edition”.

Suggested Reading List:

1. Ruppert and Barnes, R.D. (2006). *Invertebrate Zoology*, VIII Edition. Holt Saunders International Edition.
2. Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). *The Invertebrates: A New Synthesis*, III Edition, Blackwell Science
3. Barrington, E.J.W. (1979). *Invertebrate Structure and Functions*. II Edition, E.L.B.S. and Nelson.
4. Verma P S, Jordan E L. (2009). *Invertebrate Zoology*. S. Chand publishers
5. Brusca R C (2016). *Invertebrates*. Published by Sinauer Associates, an imprint of Oxford University Press

Herbal Products: Development and Formulation

Course Code: IBOMJC102

Course Credit: 3

Theory : 40 Marks

Practical : 30 Marks

Practicum: 30 Marks

Course Outcomes

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

- CO1: Gain comprehensive understanding of medicinal plants, their therapeutic properties.
- CO2: Acquire knowledge for self-employment with the increasing global demand for herbal and natural products.
- CO3: Acquire knowledge about the formulation and manufacturing of herbal products.
- CO4: Enhance their skills in herbal product formulation.

IBOMJC102	
Herbal Products: Development and Formulation	
PWC	
Unit	Topics to be covered
1	Fundamentals of Herbal Medicine: History and philosophy of herbal medicine, Plant identification and classification and pharmacognosy Different systems of herbal medicine (Ayurveda, Unani, etc.)
2	Herbal Product Formulation: Basic principles of formulation, Preservatives and other additives, Safety and regulatory considerations
3	Advanced Herbal Medicine: Clinical applications of specific herbs, Interactions between herbs and drugs
4	Good Manufacturing Practices (GMP) for herbal products, Quality control, procedures, Packaging and labelling
	Practical 1. Extraction and Detection of Phytocompounds 2. Formulation of herbal products

Reading List:

1. NPCS-Board of Consultants & Engineers (January 2021), The Complete Book on Organic Farming and Production of Organic Compost (2nd Revised Edition).
2. Saikat Sen, Raja Chakraborty (Sept 2019), Herbal Medicine in India: Indigenous Knowledge, Practice, Innovation and its Value.
3. Karta Purkh Singh Khalsa, Michael Tierra (1 January 2016), The Way of Ayurvedic Herbs: The Most Complete Guide to Natural Healing and Health with Traditional Ayurvedic Herbalism.
4. Althea Press (November 2014), The Practical Herbal Medicine Handbook: Your Quick Reference Guide to Healing Herbs & Remedies.

Basic Analytical Chemistry

Course Code: ICHMJC102

Course Credit: 3

Theory : 40 Marks

Practical : 30 Marks

Practicum: 30 Marks

Course Outcomes:

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

CO1: Handle analytical data and determine composition and pH of soil, which can be useful in agriculture.

CO2: Do quantitative analysis of metal ions in water.

CO3: Understand the theories of reaction rates and catalysts, Zeolites

CO4: Estimate macro nutrients using Flame photometry.

ICHMJC102 : Basic Analytical Chemistry	
PWC	
Units	Topics to be covered
1	Introduction: Introduction to Analytical Chemistry and its interdisciplinary nature. Concept of sampling. Importance of accuracy, precision and sources of error in analytical measurements. Presentation of experimental data and results, from the point of view of significant figures.
2	Analysis of soil: Composition of soil, Concept of pH and its measurement, Complexometric titrations, Chelation, Chelating agents, use of indicators. Estimation of Calcium and Magnesium ions in soil sample by complexometric titration.
3	Analysis of water: Definition of pure water, sources of water, water sampling methods, water purification methods. Determination of pH, acidity and alkalinity of a water sample. Determination of dissolved oxygen (DO) of a water sample. Rain Water harvesting & its recharging.
4	Catalysis: General principles and properties of catalysts, homogenous catalysis (catalytic steps and examples) and heterogenous catalysis (catalytic steps and examples). Application of zeolites as catalysts.
	Practical 1. Analysis of Water (i) Determination of pH of water (ii) Total soluble salt (iii) Dissolved Oxygen (iv) Estimation of calcium & magnesium (v) Qualitative detection of nitrate & phosphate. 2. Analysis of Soil (i) Determination of pH of soil. (ii) Total soluble salt (iii) Estimation of calcium & magnesium (iv) Qualitative detection of nitrate & phosphate

Reading List:

1. Willard H. H., (1988). *Instrumental Methods of Analysis*, CBS Publishers,.
2. Skoog D.A., Leary J.J., (1992). *Instrumental Methods of Analysis*, Saunders College Publications, New York,
3. Skoog D.A., West D.M., Holler F.J., (1992). *Fundamentals of Analytical Chemistry* 6th Ed., Saunders College Publishing, Fort Worth,
4. Harris D. C., (2007). *Quantitative Chemical Analysis* 7th Ed., W. H. Freeman and Co., New York,
5. Dean J. A., (2007). *Analytical Chemistry Handbook*, McGraw Hill,
6. Day R. A., Underwood A. L., (1991). *Quantitative Analysis*, Prentice Hall of India,
7. Freifelder D., (1982). *Physical Biochemistry* 2nd Ed., W.H. Freeman and Co., N.Y.
8. Cooper T.G., (Ed.) (1977). *The Tools of Biochemistry*, John Wiley and Sons, N.Y.
9. Svehla G., (1996). *Vogel's Qualitative Inorganic Analysis* 7th Ed., Prentice Hall,
10. Mendham J., Denney R.C., Barnes J.D., Thomas M.J.K., (2007). *Vogel's Quantitative Chemical Analysis* 6th Ed., Prentice Hall,.
11. Robinson J.W., (1995). *Undergraduate Instrumental Analysis* 5th Ed., Marcel Dekker, Inc., New York

Scilab

Course Code: IMAMJC102

Course Credit: 3

Theory : 40 Marks

Practical : 30 Marks

Practicum: 30 Marks

Course Outcomes:

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

CO 1: Understand the Scilab and apply commands in Scilab.

CO 2: Build Scilab functions, develop the ideas how Applied Mathematics can be applied and generalized through Scilab.

CO 3: Use looping in Scilab and Plot graphs.

CO 4: Develop skills to write programme in Scilab.

IMAMJC102 : Scilab	
PWC	
Units	Topics to be covered
1	Introduction to Scilab , What is Scilab downloading and installing scilab, a quick tested of Scilab . The general environment, The editor, Command line, Working directory, comments, Command Window, graphics window, window management and workspace customization, Variables assignments, the scilab menu bar. Introduction to Scalars & Vectors, initializing vectors in scilab, mathematical operation on vectors, relational operations on vectors,
2	Display array in terms of matrices and vectors, Displaying output data, arithmetic operators for matrices, basic matrix processing, data file, Scilab functions, Built in functions, Elementary mathematical functions, mathematical function on scalars, complex numbers, trigonometric functions, inverse trigonometric functions, hyperbolic functions. Introduction to polynomials, creating polynomials, basic polynomial command, finding roots of polynomial, polynomial arithmetic. 2D and 3D plotting,.
3	Relational and logical operators, Branching Statements and program design, Loops, the while loop, for loop, Tests, Conditional statements.
4	Developing the skills of writing a program, Differentiation, and integration Concept of Dot and Cross product, Solution of system of Linear equations & Determinant. Solving first order differential equations.

Reading List :

1. H. Ramchandran, A.S.Nair. (2011) Scilab (A free software to Matlab): S. Chand and Company.
2. M. Affouf (2012), ISBN: 978-1479203444 ,Scilab by example
3. Scilab for very beginners. - www.scilab-enterprises.com
4. Chouhan Devendra and Dolas Uday(2022), Basic Programming Concepts of Scilab, Orange Books Publication.

Physics Workshop Skill

Course Code: IPHMJC102

Course Credit: 3

Theory : 40 Marks

Practical : 30 Marks

Practicum: 30 Marks

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

CO1: Visualize the problem and also think methodically, independently and draw a logical conclusions.

CO2: Use modern techniques, decent Equipments and scientific measuring units.

CO3: Describe the methodology of science and the relationship between observation and theory.

CO4: Develop the proficiency in the acquisition of data using a variety of laboratory Instruments and in the analysis and interpretation of such data.

IPHMJC102 Physics Workshop Skill	
Unit	Topics to be covered
1	Introduction: Measuring units. Conversion to SI and CGS unit. Familiarization with meter scale, Vernier calliper, Screw gauge and Spherometer their utility. Measure the dimension of a solid block, Archimedes Principle, Voltage, Current, Power, Electrical & Electronic Skills.
	Practical (Hands on Training) 1. Measurement of volume of a cylinder using vernier caliper. 2. Measurement of thickness of thin wire using screw gauge. 3. Measurement of volume of irregular solid using Archimedes principle. 4. Study of Travelling Microscope. 5. To determine the acceleration due to gravity using a simple pendulum. 6. Use of Fuse & MCB 7. Installing a new Plug. 8. Use of multimeter / Soldering of electrical circuit. 9. Repair an electric cord/ iron/ kettle. 10. Study of Regulator power supply of a building.

Reading List:

1. Theraja B. L. *A text book in Electrical Technology*, S. Chand and Company.
2. Say M.G. *Performance and design of AC machines*, ELBS Edn.
3. John K.C. (2010). *Mechanical workshop practice*, PHI Learning Pvt. Ltd.
4. Black Bruce J. (2005). *Workshop Processes, Practices and Materials*, 3rd Edn., Editor Newnes [ISBN: 0750660732].
5. Smyth Lawrence, Hennessy Liam. *New Engineering Technology*, The Educational Company of Ireland [ISBN: 0861674480]

Hematology

Course Code: IZOMJC102

Course Credit: 3

Theory : 40 Marks

Practical : 30 Marks

Practicum: 30 Marks

Course Outcome:

On completion of the course students will be able to:

CO 1 – Explain the composition of Blood, Total RBC count, Total Leukocyte Count (TLC) and Differential Leukocyte Count (DLC)

CO 2 – Explain the concept of Platelet count, Erythrocyte Sedimentary Rate (ESR), Packed Cell Volume (PCV)

CO 3 – Describe the ABO Blood groups, Estimation of Haemoglobin

CO 4 – Prepare the Hemin crystals, Determine the Bleeding and Clotting time.

Units	Syllabus
1	Blood composition, Total RBC count, Total Leukocyte Count (TLC) and Differential Leukocyte Count (DLC) using Leishman's stain.
2	Platelet count using Hemocytometer, Erythrocyte Sedimentary Rate (ESR), Packed Cell Volume (PCV).
3	Determination of ABO Blood group, Estimation of Haemoglobin using Sahli's Haemoglobinometer.
4	Preparation of Hemin crystals. Bleeding and Clotting time.
	Practical: 1. Determination of ABO Blood group. 2. Estimation of Haemoglobin using Sahli's Haemoglobinometer. 3. Preparation of Hemin crystals. 4. Bleeding and Clotting time. 5. Estimation of Hematocrit value in Blood sample. 6. Enumeration of RBC and WBC. 7. Preparation of Blood smear and Differential Leukocyte Count (DLC) using Leishman's stain. 8. Platelet count using hemocytometer. 9. Erythrocyte Sedimentary Rate (ESR), Packed Cell Volume (PCV).

Suggested Reading List:

1. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. HarcourtAsia PTE Ltd. W.B. Saunders Company.
2. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition John Wiley & sons,
3. Victor P. Eroschenko. (2008). DiFiore's Atlas of Histology with Functional correlations. XII Edition. Lippincott W. & Wilkins.
4. Vander A, Sherman J. and Luciano D. (2014). Vander's Human Physiology: The Mechanism of Body Function. XIII Edition, McGraw Hills
5. Geetha N. (2014). Textbook of Medical Physiology. Paras Medical Publisher.

Microbes, Lichen and Mycorrhiza

Course Code: IBOMIC101

Course Credit: 3

Theory : 40 Marks

Practical : 30 Marks

Practicum: 30 Marks

Course Outcomes

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

- CO1: Know about viruses and its types
- CO2: Know about structure and reproduction of bacteria
- CO3: Get the knowledge about importance of bacteria
- CO4: Study of growth forms and significance of lichen and mycorrhiza

IBOMIC101 PWC		Microbes, Lichen and Mycorrhiza
Unit	Topics to be covered	
1	Viruses – Discovery, general structure, DNA virus (T-phage); Replication (Lytic and lysogenic cycle); RNA virus (TMV); Economic importance	
2	Bacteria – Discovery, General characteristics and cell structure; Reproduction – vegetative, asexual and genetic recombination (conjugation, transformation and transduction)	
3	Economic importance of bacteria with reference to their role in agriculture and industry (N ₂ fixation, fermentation and medicine)	
4	Lichens- General account, reproduction and significance; Mycorrhizae: ectomycorrhizae and endomycorrhizae and their significance	
	Practical 1. Study of growth forms of Mycorrhizae; ectomycorrhiza and endomycorrhiza through photographs. 2. Models and micro photographs of viruses and bacteria 3. Gram staining	

Reading List :

1. Tortora, G.J., Funke B.R., Case C.L. (2007). Microbiology: An Introduction, Pearson Education. 9th edition.
2. Dubey, R.C., Maheshwari D.K. (2005). A Textbook of Microbiology, S. Chand & Company Ltd. 2nd edition.
3. Willey, J.M., Sherwood L.M., Woolverton C.J. (2011). Prescott's Microbiology, McGraw Hill. 8th edition.
4. Brown, A.E. (2005). Benson's Microbiological Applications, McGraw Hill. 9th edition.
5. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley & Sons (Asia) Singapore. 4th edition.

Physical Chemistry & Organic Chemistry-I

Course Code: ICHMIC101
Course Credit: 3

Theory : 40 Marks
Practical : 30 Marks
Practicum: 30 Marks

Course Outcomes:

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

CO1: Understand the basic quantum chemistry and atomic structures of atoms.

CO2: Understand the chemical bonding from the valence bond model and molecular orbital theory.

CO3: Understand the fundamentals of electronic structure and bonding in conjugated and aromatic system.

CO4: The reactivity and stability of an organic molecule based on structure, including conformation stereochemistry and mechanism for organic reactions.

ICHMIC101 : Physical Chemistry & Organic Chemistry-I	
PWC	
Unit	Topics to covered
1	Physical Chemistry Atomic Structure: Bohr's theory and its limitations, Heisenberg Uncertainty principle. Dual behaviour of matter and radiation, de-Broglie's relation. Hydrogen atom spectra. Need of a new approach to Atomic structure. Significance of quantum numbers, orbital angular momentum, and quantum numbers m_l and m_s . Shapes of s, p and d atomic orbitals, nodal planes. Discovery of spin, spin quantum number (s) and magnetic spin quantum number (m_s). Relative energies of atomic orbitals, Anomalous electronic configurations. Rules for filling electrons in various orbitals, electronic configurations of the atoms. Stability of half-filled and completely filled Subshell, concept of exchange energy.
2	Inorganic Chemistry Chemical Bonding and Molecular Structure Ionic Bonding: General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. (no derivation), polarizing power and polarizability. Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character. Covalent bonding: Valence Bond Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR (H_2O , NH_3 , PCl_5 , SF_6 , ClF_3 , SF_4). Hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements. Concept of resonance and resonating structures in various inorganic compounds. MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for s-s, s-p and p-p combinations of atomic orbitals, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods.
3	Organic Chemistry Fundamentals of Organic Chemistry: Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis. Reaction intermediates: Carbocations, Carbanions and free radicals. Electrophiles and nucleophiles Aromaticity: Benzenoids and Hückel's rule.

4	Stereochemistry: Conformations with respect to ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations. Concept of chirality (upto two carbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds). Threo and erythro; D and L; cis - trans nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E / Z Nomenclature (for upto two C=C systems).
	Practical Inorganic Chemistry - Volumetric Analysis Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture. Estimation of oxalic acid by titrating it with KMnO_4. Estimation of water of crystallization in Mohr's salt by titrating with KMnO_4. Estimation of Fe (II) ions by titrating it with $\text{K}_2\text{Cr}_2\text{O}_7$ using internal indicator. Organic Chemistry Purification of OC by crystallisation (from water and alcohol) and distillation. Criteria of purity: Determination of M.pt./B.pt. Detection of elements (N, S, Cl, Br, I) in organic compounds

Reading List:

1. Lee J. D., (2010). *A new Concise Inorganic Chemistry*, E L. B. S.17
2. Cotton F. A., Wilkinson G., (2007). *Basic Inorganic Chemistry*, John Wiley.
3. Douglas Mc Daniel, Alexader (1970). *Concepts and Models in Inorganic Chemistry*, John Wiley.
4. Huheey James E., Keiter Ellen, Keiter Richard (2006). *Inorganic Chemistry: Principles of Structure and Reactivity*, Pearson Publication.
5. Graham Solomon T. W., *Organic Chemistry*, John Wiley and Sons.
6. Sykes Peter (2011). *A Guide Book to Mechanism in Organic Chemistry*, Orient Longman.
7. Eliel E. L., (2005). *Stereochemistry of Carbon Compounds*, Tata McGraw Hill.
8. Finar I. L., (2014). *Organic Chemistry (Vol. I & II)*, E. L. B. S.
9. Morrison R. T., Boyd R. N., (2007). *Organic Chemistry*, Prentice Hall.
10. Bahl Arun, Bahl B. S., (2012). *Advanced Organic Chemistry*, S. Chand
11. Atkins Overton, Rourke Weller, Armstrong Shriver, Atkins, (1994). *Inorganic Chemistry*, Oxford
12. Vogel A.I., (2014). *Vogel's Qualitative Inorganic Analysis*, Prentice Hall, 7th Edition.
13. Vogel A.I., (2014). *Vogel's Quantitative Chemical Analysis*, Prentice Hall, 6th Edition.
14. Vogel A.I., (2014). *Textbook of Practical Organic Chemistry*, Prentice Hall, 5th edition.
15. Mann F. G., Saunders B. C., (1960). *Practical Organic Chemistry*, Orient Longman.

Differential Calculus, Set Theory and 2D Geometry

Course Code: IMAMIC101

Course Credit: 3

Theory : 70 Marks

Practical : -

Practicum: 30 Marks

Course Outcomes:

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

CO1: Gain knowledge about Successive differentiation, Leibniz's theorem with some of its mathematical applications and approximating a given function by means of a polynomial in x using Taylor's or Maclaurin's Theorem.

CO2: Develop the skills to estimate the change in the value of a function when the independent variable undergoes a change.

CO3: Advance knowledge related to fundamental concepts of Set theory

CO4: Learn about Two Dimensional Geometry with applications.

IMAMIC101 : PWC		Differential Calculus, Set theory and 2D Geometry
Units	Topics to be covered	
1	Successive differentiation, Leibnitz theorem, Rolle's Theorem, Expansion of functions (in Taylor's and Maclaurin's series)	
2	Partial differentiation, Homogeneous functions and Euler's theorem, Indeterminate forms: L'Hospital's Rule	
3	De Morgan's law, Cartesian product, Equivalence relation, Partition of set Equivalence class, Fundamental theorem of equivalence relation, Functions and their compositions, Set functions.	
4	System of circles, Orthogonal circles, Co-axial circles, Parabola, Ellipse and Hyperbola: their standard equations, Equations of tangent and normal, General equation of the second degree, Conditions for different type of conic sections.	

Reading List :

1. Gupta A. D., Prasad S. B. & A. B. B. Lal (1989). *Degree Level Analytical Geometry of Two Dimensions*, Bharti Bhawan Patna
2. Mishra S. K., Gupta A. D. & Prasad S. B. (1993). *Degree Level Differential Calculus*, Bharti Bhawan Patna.
3. Prasad Lalji (2010). *Degree Set Theory*, Paramount Publications Patna.
4. Prasad Gorakh (2021), *Integral Calculus*, Rashmi Kansal (Pothisala).
5. Prasad Lalji (2015). *Differential Calculus*, Paramount Publications Patna.

Mechanics- I

Course Code: IPHMIC101

Course Credit: 3

Theory : 40 Marks

Practical : 30 Marks

Practicum: 30 Marks

Course Outcomes:

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

CO1: Study the mathematical techniques for application in Physical problems.

CO2: Develop the concept of divergence, gradient and curl and their physical significance and applications.

CO3: Differentiate between Inertial and Non-inertial frames and study the dynamics of physical systems in Inertial and Non-inertial frames.

CO4: Gather knowledge about rigid body motion.

IPHMIC101 : Mechanics-I	
Unit	Topics to be covered
1	Calculus: Differentiation. First Order Differential Equations and Integrating Factor, Exact and Inexact differential equation and their solution, Integration, Methods of Integration.
2	Vector Calculus: Recapitulation of vectors. Scalar and Vector fields, Gradient of a scalar field Divergence and curl of a vector field Line, surface and volume integrals. (elementary knowledge)
3	Fundamentals of Dynamics: Reference frames, Inertial and non-inertial frames, Review of Newton's Laws of Motion, Principle of conservation of linear and angular momentum.
4	Rigid Body Dynamics: Rigid body, moment of inertia, parallel and perpendicular axis theorem, Kinetic energy and potential energy of purely rotating body.
	Practical: At least 05 experiments from the following: 1. To determine the height of a building using a Sextant. 2. Measurement of length of a rod using vernier caliper. 3. Measurement the volume of a hollow Cylinder using Vernier Caliper. 4. Measurement of diameter of thin wire using screw gauge. 5. To determine the acceleration due to gravity using a simple pendulum. 6. To determine the relative density of a solid soluble in water by a specific gravity bottle. 7. To determine the specific gravity of a liquid by a specific gravity bottle. 8. To determine the Young's modulus of the material of the given wire by Vernier Apparatus. 9. To determine the Young's modulus by Koenig method. 10. To determine the moment of inertia by bifilar suspension.

Reading List:

1. Kleppner D., Kolenkow R. J. (1973). *An introduction to mechanics*, McGraw-Hill.
2. Kittel C., Knight W., et.al. (2007). *Mechanics*, Berkeley Physics, vol.1, Tata McGraw-Hill.
3. Resnick, Halliday and Walker (2008). *Physics*, Wiley, 8/e.
4. Fowles G. R. and Cassiday G.L. (2005). *Cengage Learning*.
5. Feynman R. P., Leighton R. B., Sands M. (2008). *Feynman Lectures*, Vol.I, Pearson Education.
6. Mathur D. S. (2000). *Mechanics*, S. Chand and Company Limited.
7. Sears F. W, Zemansky M. W., Young H.D. (1986). *University Physics*. 13/e, Addison Wesley.
8. Jewett J. W., Serway R.A. (2010). *Physics for scientists and Engineers with Modern Phys.*, Cengage Learning.
9. Spiegel M.R. (2006). *Theoretical Mechanics*, Tata McGraw Hill.
10. Flint B.L. and Worsnop H.T. (1971). *Advanced Practical Physics for students*, Asia Publishing House.
12. Panigrahi S. & Mallick B. (2015). *Engineering Practical Physics*, Cengage Learning India Pvt. Ltd.
13. Squires G.L. (2015). *Practical Physics*. 4th Edition, Cambridge University Press.
14. Prakash I. & Ramakrishna (2011). *A Text Book of Practical Physics*, 11th Edn, Kitab Mahal

Non - chordate Diversity

Course Code: IZOMIC101

Course Credit: 3

Theory : 40 Marks

Practical : 30 Marks

Practicum: 30 Marks

Course Outcomes:

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

On completion of the course students will be able to:

CO1 - Understand and describe the features of Protista, Porifera and Radiata.

CO2 - Understand and describe the features of Acoelomates and Pseudocoelomates and Coelomate – Protostomes.

CO3 - Understand and describe the features of Arthropoda, Social life in insects with respect to Honey bees and Termites.

CO4 - Understand and describe the features of Mollusca and Echinodermata, Process of Pearl Formation, Torsion in Gastropoda and Water Vascular system in Starfish.

Units	Syllabus
1	Protista: General characters of Protozoa, Life cycle of <i>Plasmodium</i> . Porifera: General characters and Canal system in Porifera. Radiata: General characters and Polymorphism of Cnidarians.
2	Acoelomates: General characters of Helminthes, Life cycle of <i>Taenia solium</i> . Pseudocoelomates: General characters of Nematelminthes, Parasitic adaptations in Nematodes, Life cycle and pathogenicity of <i>Wuchereria bancrofti</i> . Coelomate – Protostomes: General characters of Annelida, Metamerism.
3	Arthropoda: General characters, Mouthparts of Insects, Compoundeye, Social life in insects with respect to Honey bees and Termites.
4	Mollusca: General characters of Mollusca, Pearl Formation, Torsion in Gastropoda. Coelomate – Deuterostomes: General characters of Echinodermata, Water Vascular system in Starfish.
	Practical: 1. Study of following specimens: <i>Sycon, Physalia, Tubipora, Metridium, Taenia, Ascaris, Nereis, Aphrodite, Leech, Peripatus, Limulus, Eupagurus, Julus, Scolopendra, Chiton, Octopus, Asterias and Antedon.</i> 2. Study of following Permanent Slides: <i>Euglena, Noctiluca, Paramecium</i> , Cross section of <i>Sycon</i> , T.S. of <i>Ascaris</i> (male and female). T.S. of Earthworm passing through pharynx, gizzard, Larval forms of Echinodermata 3. Temporary mounts of <i>Daphnia / Cyclops / Mysis</i> 4. Project on assigned topic related to the Syllabus

Suggested Reading List:

1. Barnes, R.D. (1992). Invertebrate Zoology. Saunders College Pub. USA.
2. Ruppert, Fox and Barnes (2006) Invertebrate Zoology. A functional Evolutionary Approach 7th Edition, Thomson Books/Cole
3. Campbell & Reece (2005). Biology, Pearson Education, (Singapore) Pvt. Ltd.
4. Raven, P. H. and Johnson, G. B. (2004). Biology, 6th edition, Tata McGraw Hill Publications. New Delhi.

Language 1 (Hindi)

Course Code: IEDAEC101
Course Credit: 04

Theory: 70 Marks
Practicum: 30 Marks

पाठ्यक्रम प्रतिफल

इस पाठ्यक्रम के पश्चात छात्र-शिक्षक सक्षम होंगे कि वे:

- CO1: हिन्दी भाषा, समाज-संस्कृति और संप्रेषण के सम्बन्धों का उदाहरणों सहित विश्लेषण कर सकें। (L4: विश्लेषण)
- CO2: हिन्दी के ध्वनि-तत्त्वों, रूपिम संरचना (मूल रूप, उपरूप), शब्द-निर्माण तथा वाक्य-विन्यास के प्रमुख घटकों को पाठ-उदाहरणों में पहचान कर सकें। (L3: उपयोग)
- CO3: श्रवण, वाचन, पठन और लेखन आधारित गतिविधियों के माध्यम से सुव्यवस्थित मौखिक तथा लिखित अभिव्यक्ति प्रस्तुत कर सकें। (L2: बोध)
- CO4: पाठ, संवाद और लिखित सामग्री की तार्किकता, औचित्य और स्पष्टता के आधार पर आलोचनात्मक मूल्यांकन करके सुधार-सुझाव दे सकें। (L5: मूल्यांकन)

अन्विति - I: भाषा, संप्रेषण और संज्ञान

- भाषा का अर्थ, परिभाषा, विशेषताएँ, कार्य; भाषा के विविध रूप; भाषा संप्रेषण का साधन तथा संज्ञान का माध्यम
- भाषा, संस्कृति और समाज; भाषा भिन्नता; भाषा बनाम बोली; संवैधानिक परिप्रेक्ष्य में भाषाएँ; भाषा-नीति, भाषा-मानकीकरण; भारत में द्विभाषिक/बहुभाषिकता
- संप्रेषण का अर्थ, प्रकृति व प्रक्रिया; प्रकार - औपचारिक/अनौपचारिक, लिखित/मौखिक, वाचिक/अवाचिक; संप्रेषण की बाधाएँ; प्रभावी संप्रेषण की विशेषताएँ एवं कारक; नई तकनीकें

अन्विति - II: हिन्दी भाषा - घटक, संरचना और कार्य

- ध्वनि-विज्ञान एवं लिपि-बोध: हिन्दी ध्वनियाँ, स्वर-व्यंजन, उच्चारण-स्थान एवं उच्चारण-प्रयत्न; देवनागरी लिपि, मात्रा, संयुक्ताक्षर, नुक्ता, ध्वनि-लिपि संबंध तथा बलाघात, स्वर, ठहराव और लय जैसे अधिखण्डीय तत्व
- रूप-विज्ञान एवं शब्द-निर्माण: रूपिम, मूल रूप, उपसर्ग तथा प्रत्यय, समास, संधि, द्विविक्ति आदि द्वारा शब्द-निर्माण; तत्सम, तद्भव, देशज, विदेशज, पर्याय और विलोम शब्दों का सन्दर्भानुसार प्रयोग
- वाक्य-विन्यास एवं वाक्य-भेद: शब्द-भेद - संज्ञा, सर्वनाम, विशेषण, क्रिया, क्रियाविशेषण, सम्बन्धबोधक, समुच्चयबोधक, विस्मयादिबोधक; वाक्य-प्रकार - सरल, संयुक्त और मिश्र वाक्य, वाक्य-रचना - कर्ता-कर्म-क्रिया संबंध तथा पुरुष, वचन और लिंग के सामंजस्य के आधार पर शुद्ध एवं स्पष्ट वाक्य-रचना

- अर्थ-विज्ञान एवं प्रयोजन-विज्ञान: शब्दार्थ, वाक्यार्थ, बहुअर्थकता, समानार्थकता, निहितार्थ, संकेतार्थ तथा प्रसंगानुसार अर्थ-परिवर्तन

अन्विति - III: श्रवण और वाचन कौशल

- श्रवण का अर्थ, सुनना और श्रवण में अंतर, श्रवण के उप-कौशल, आदर्श श्रोता के गुण तथा प्रभावी श्रवण-रणनीतियाँ
- श्रवण-बोध - पाठ्यक्रम-अनुरूप श्रवण, रिकॉर्डेड भाषण/पाठ; उच्चारण/लहजे की विविधता; नोट-निर्माण
- वाचन कौशल का अर्थ, स्वरूप और परिभाषा, पठन और वाचन में अंतर, वाचन के प्रकार, वाचन के उप-कौशल; संस्कृति का प्रभाव; स्वर-नियंत्रण, उच्चारण
- गतिविधियाँ - स्थितिजन्य वार्तालाप, भूमिका निर्वहन; भाषण, वाद-विवाद, चर्चा, कहानी-कथन, उदाहरण/दृष्टान्त

अन्विति- IV: आलोचनात्मक चिंतन और शैक्षणिक लेखन

- आलोचनात्मक चिंतन का अर्थ, आवश्यकता, प्रश्न करने की प्रवृत्ति, मान्यताओं एवं मूल्यों का पुनर्परीक्षण तथा तार्किक निर्णय-क्षमता का विकास
- समस्या-समाधान - समस्या का अवलोकन, समस्या-निर्धारण स्पष्ट वर्णन, तुलना, विश्लेषण, प्रमाणों का मूल्यांकन तथा निष्कर्ष-निर्माण
- शैक्षणिक लेखन का अर्थ, उद्देश्य, भाषा-शैली और घटक; शैक्षणिक लेखन का विकास; शैक्षणिक-लेखन-कौशल विकसित करने हेतु गतिविधियाँ
- आलोचनात्मक, विश्लेषणात्मक और व्याख्यात्मक चिंतन-कौशलों का विकास

प्रायोगिक कार्य

- एक चयनित गद्य रचना का अध्ययन कर उसकी आलोचनात्मक समीक्षा प्रस्तुत करना।
- रिकॉर्डेड वीडियो के आधार पर स्वर, उच्चारण एवं उच्चारण-शुद्धता का विश्लेषण, अभ्यास तथा प्रतिवेदन तैयार करना।
- शैक्षिक/सामाजिक समस्या का अवलोकन कर समस्या का निर्धारण, वर्णन तथा उसके आधार पर मूल्यांकनात्मक प्रतिवेदन (रिपोर्ट) तैयार करना।

संदर्भ पुस्तक

- केन्द्रीय हिन्दी निदेशालय. (2016). *हिन्दी वर्तनी का मानकीकरण* (संशोधित संस्करण). नई दिल्ली: शिक्षा मंत्रालय, भारत सरकार.
- केन्द्रीय हिन्दी निदेशालय. (वर्ष अनिर्दिष्ट). *मानक हिन्दी व्याकरण* (श्रृंखला/संदर्भ-ग्रंथ). नई दिल्ली: केन्द्रीय हिन्दी निदेशालय, भारत सरकार.

- तिवारी, भोलानाथ. (1996). *भाषा विज्ञान*. नई दिल्ली: किताब महल.
- तिवारी, भोलानाथ. (2004). *हिन्दी भाषा और भाषा-विज्ञान*. नई दिल्ली: किताब महल.
- वाजपेयी, किशोरीदास. (1962). *हिन्दी शब्दानुशासन*. इलाहाबाद: लोकभारती प्रकाशन.
- शुक्ल, रामचन्द्र. (2007). *हिन्दी निबन्ध* (सम्पा. संस्करण). वाराणसी: नागरी प्रचारिणी सभा.
- द्विवेदी, हजारीप्रसाद. (2010). *निबन्ध संचय*. नई दिल्ली: राजकमल प्रकाशन.
- केन्द्रीय माध्यमिक शिक्षा बोर्ड (CBSE). (2019). *हिन्दी (कोर्स-A/कोर्स-B): अध्यापक संदर्शिका/समर्थन सामग्री* (प्रासंगिक संस्करण). नई दिल्ली: CBSE.
- राष्ट्रीय शैक्षिक अनुसंधान और प्रशिक्षण परिषद (NCERT). (2018). *हिन्दी व्याकरण और रचना* (माध्यमिक स्तर हेतु संदर्भ). नई दिल्ली: NCERT.
- भारत सरकार, शिक्षा मंत्रालय. (2020). *राष्ट्रीय शिक्षा नीति 2020*. नई दिल्ली: शिक्षा मंत्रालय, भारत सरकार.

Art Education – I (Collage-Making)

Course Code: IEDAEC102

Course Credit: 02

Theory: 35 Marks

Practicum: 15 Marks

COURSE OUTCOMES

After completion of this course, the prospective teachers will attain the ability to:

CO1: Articulate the importance and the role of aesthetics and art in education. (L2: Understand)

CO2: Apply collage techniques by producing 2D and 3D compositions using diverse materials. (L3: Apply)

CO3: Create an expressive self-portrait collage, supported by preparatory sketches, ideation sheets, and a finished artwork. (L6: Create)

CO4: Plan and present an art exhibition, layouts, artwork displays, and reflective reports on the process. (L6: Create)

UNIT I: Understanding the importance of Aesthetics and Art in Education

Students will collectively view and engage in a series of artworks closely, share and analyze their observations, and draw their own understanding of the artwork.

- Introduction to art and aesthetics.
- Visual Thinking Strategy (VTS) activity.
- Learning art forms (Tikuli, Madhubani, Patna Kalam, Tribal Art and others) - any one.
- Art as Self-Expression and its application in education.

UNIT II: Designing and presenting Paper Collage and Expressive Self-Portrait

- Introduction to collage and its medium (newspaper, fabric, ribbon, coins, feathers and others).
- Manipulating paper in different ways and creating 2-D composition of paper collage; Creating visual texture, physical texture and patterns using techniques like Decoupage, Photomontage, And 3-D.
- Introduction to paper sculpture and its techniques (3-D techniques like paper - cutting, paper folding, clay, paper-mache), making paper stand.
- Sketching and drawing activity (self- portrait, poster, calligraphy). Expressive self- portrait drawing and collage.
- Designing, planning and setting up an art exhibition.

Practicum

- Observe selected artworks and participate in a guided Visual Thinking Strategy (VTS) discussion and submit a brief reflection on art in learning.
- Explore any one traditional art form and create a small artwork with a short note on its classroom use.
- Experiment with different collage materials and paper-manipulation techniques and prepare a technique practice sheet.
- Design and create one theme-based two-dimensional paper collage.
- Create a small composition demonstrating visual texture, physical texture and pattern using collage techniques.
- Maintain an observation sketchbook with a minimum of eight to ten sketches related to self and facial expressions.

- Create one expressive self-portrait using drawing and collage to communicate personal identity and emotions.
- Produce one paper-based three-dimensional artwork using cutting, folding, paper-mâché and/or clay.
- Design one poster or calligraphy work on an educational theme for visual communication.
- Collaboratively prepare an exhibition plan including theme, layout and display sequence.
- Write an individual reflective report on learning through art and its application in classroom practice.
- Any other activity based on the units of the paper in form of written assignment, projects, performance or field work with a detailed report

Suggested Readings

- मानव संसाधन विकास मंत्रालय. (2019). कला समेकित अधिगम. एनसीईआरटी. ISBN 978-93-5292-212-3
- Mukherjee, B. (1947). Teaching of Art to Children. The Visva-bharati Quarterly, XIII(1&2), 161-168. <http://www.new.dli.ernet.in/handle/2015/238056>
- Veerswar, P. & Sharma, N. (2001). Aesthetics. Krishna Prakashan Media.
- Sharma, L.C. (1980). A brief history of Indian painting. Goal publishing house.
- Chandok, A. (2015). Art and education. Nirmal Publishing House.
- Prasad, D. (1998). Art as the basis of education. NBT.
- Ghosh, S. (2020). Madhubani painting-vibrant folk art of Mithila. Art and Design Review, 8(2), 61-78.
- Mishra, S. (2021). Journey of folk art: The case of Mithila painting of Bihar. Journal of Engineering Technologies and Innovative Research, 8(3), 61-78.
- Art 21. (2009, Sep 26). Arturo Herrera: artist [Video]. You Tube. <https://www.youtube.com/watch?v=Oagx3NZ5HU>
- Easel Stories. (2018, Sep 18). G. Subramanian: Collage artist [Video]. You Tube <https://www.youtube.com/watch?v=ioRRi9R4680>
- JR. (2020, Feb 28). JR's Face to face project [Video]. You Tube <https://www.youtube.com/watch?v=4uG0G6Jog4>
- Marcapaperscissor. (2016, Feb 28). Mare Paper Scissor Cut collage Artist [Video]. You Tube. <https://www.youtube.com/watch?v=WgRZIWI-Oh0>
- Planning templates for exhibition
- Handouts out on Collage techniques and artist examples Works of Deborah Roberts, William Kentridge, Wangechi Mutu, etc.

Understanding India - I (Indian Ethos and Knowledge Systems)

Course Code: IEDVAC101

Course Credit: 02

Theory: 35 Marks

Practicum: 15 Marks

COURSE OUTCOMES

After completion of this course, the prospective teachers will attain the ability to:

- CO1: Explain the origin, meaning, scope, and relevance of the Indian Knowledge System and assess its importance in contemporary society. (L5: Evaluate)
- CO2: Describe art, literature, and heritage and differentiate between classical and folk traditions. (L2: Understand)
- CO3: Examine the structure of ancient Indian polity, law, and economy and relate their principles to modern governance and economic practices. (L3: Apply)
- CO4: Evaluate indigenous approaches to environmental sustainability, health, and wellness. (L5: Evaluate)

UNIT I: Introduction to Knowledge and Culture of India

- Indian Knowledge System: Origin, meaning, scope and its relevance; need to revisit our ancient knowledge, traditions, and culture.
- Initiatives to preserve and promote traditional knowledge.
- Classical and folk dance, vocal music in ancient and mediaeval times.
- Painting, sculpture and architecture in ancient and mediaeval times.
- Indian literature: A diverse and rich heritage.

UNIT II: Polity, Economy, Environmental Knowledge and Human Health

- Ancient Indian government: Kingship, oligarchies, republics, and local administration.
- Basics of Law: Dharma and its sources, and criminal justice; Chanakyaniti and its relevance.
- Economy: Urbanization, trade, commerce, and temple economy during ancient period; Arthashastra: Ancient Indian economic thought and its relevance.
- Understanding equilibrium between society & environment: Society's perceptions of natural resources like forest, land, water and animals.
- Sustainable architecture & urban planning: Best practices from indigenous knowledge, community-led efforts, etc.
- India's health tradition: Ayurveda, Siddha, Ashtavaidya, Unani, and other schools of thought; Lessons from Sushruta Samhita and Charaka Samhita
- Mental health in ancient India: concept of mind, Dhyana, mind-body relationship, Ayurveda, Yoga Darshan, Atman, etc.

Practicum

- Prepare a short concept note explaining the origin, meaning, scope and contemporary relevance of the Indian Knowledge System.
- Write a reflective note on the need to revisit ancient Indian knowledge, traditions and cultural practices in present times.
- Prepare a brief report on national or community-based initiatives taken to preserve and promote traditional knowledge.
- Document and present any one classical or folk art form (dance, music, painting, sculpture or architecture) highlighting its cultural significance.
- Prepare a short review of any one genre or text of Indian literature to reflect its diversity and heritage.
- Develop a comparative chart on ancient Indian systems of governance, law and economy and relate them to contemporary India.
- Prepare a case-based note on trade, urbanization, temple economy and its relevance in today's economic thought.
- Write an analytical note on the relationship between polity, law and economy in present-day India.
- Prepare a field-based or secondary-data report on indigenous practices promoting environmental balance and sustainable living.
- Document best practices of sustainable architecture or community-led environmental initiatives rooted in traditional knowledge.
- Prepare a brief illustrated report on Indian health traditions such as Ayurveda, Siddha, Unani or Yoga and their relevance today.
- Write a reflective note on ancient Indian perspectives of mental health, mind-body relationship and well-being.
- Any other activity based on the units of the paper in form of written assignment, projects, performance or field work with a detailed report.

Suggestive Readings

- धर्मपाल २०१० भारत की परंपरा, पुनर्मुद्रित ट्रस्ट
- मुखर्जी, राधा कुमुद २०२० (प्राचीन भारत) १३ वां संस्करण, राजकमल प्रकाशन
- योग स्वस्थ जीने का तरीका, 2018 एनसीईआरटी
- विद्यालंकार, स० २०१४ भारतीय संस्कृति का विकास. श्री सरस्वती सदन, रोहिणी
- शर्मा. रा. २०१५ भारतीय इतिहास एक पुनर्विचार हिंदी माध्यम कार्यान्वयन, दिल्ली विश्वविद्यालय
- सरकार. सु. २०१७ आधुनिक भारत राजकमल प्रकाशन
- Altekar, A.S. (2009). Education in Ancient India. New Delhi: Gyan Publishing House. (Originally published in 1944 by Osmania University Nand Kishore & Bros.
- Dominik, W. (2001). The roots of ayurveda. Penguin Classics.
- Mahadevan, B., Bhat, R.V. & Nagendra, P.R.N. (2021). Introduction to Indian knowledge system: Concepts and applications. PHI Learning Pvt. Ltd.
- Nehru, J (1946). The Discovery of India. UK:Meridian Books. Reprinted (2008) by Penguin

- Sinha, A. (1998). Design of settlements in the vastu shastras. *Journal of Cultural Geography*, 17(2), 27-41
- Swami Suparnananda (2016). *The Cultural Heritage of India (Vol. 2)*. The Rama Krishna Mission Institute of Culture.
- Tachikawa, M. (1971). A sixth-century manual of Indian logic. A translation of the *Nyayapravesa*. *Journal of Indian Philosophy*, 1(2), 111-145.
- Tripathi, S. (2011). Ancient maritime trade of the eastern Indian littoral. *Current Science*, 100(7), 1076-1086.

2nd Semester

Biomolecules and Cell Biology

Course Code: IBOMJC203

Course Credit: 6

Theory : 40 Marks

Practical : 30 Marks

Practicum: 30 Marks

Course Outcomes

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

CO1: Describe the structure and properties of biomolecules

CO2: Explain the classification, properties and functions of enzymes

CO3: Describe cell wall, cell membrane and the structure, chemistry and functions of cellular organelles

CO4: Explain the eukaryotic cell cycle, mitotic and meiotic cell divisions; and regulation of cell cycle

<u>IBOMJC203</u>		Biomolecules and Cell Biology
PWC		
Unit s	Topics to be covered	
1	Biomolecules: Types, structure and functions of carbohydrates, amino acids, proteins, lipids and nucleic acid	
2	Enzymes: Classification, nomenclature, physio-chemical properties, mechanism of action and regulation	
3	Cell: Cell theory, Characteristics of prokaryotic and eukaryotic cells; Origin of eukaryotic cell (Endosymbiotic theory); Cell wall and Cell membrane, structure and function of cell organelles: nucleus (including nucleolus and chromatin), mitochondria, ribosomes, golgi apparatus, endoplasmic reticulum, lysosomes, plastids and vacuoles	
4	Cell division: Mitosis and Meiosis; Cell cycle and its regulation	
	Practical 1. Estimation of organic acid and fatty acid by titration 2. Estimation of protein and sugar by spectrophotometry 3. Detection of tannin, alkaloid and flavonoid in the given plant sample 4. Separation of amino acids by paper chromatography technique 5. Study of cell and its organelles with the help of photographs 6. Study of different stages of mitosis and meiosis temporary preparations and permanent slides	

Reading List :

1. Lehninger (2015). Biochemistry, Kalyani Publishers. 2nd edition.
2. Satyanarayana, U., Chakrapani, U. (2011). Biochemistry, Books & Allied (P) Ltd. 3rd edition.
3. Boyer, R. (2004). Modern Experimental Biochemistry, Pearson Education. 3rd edition.
4. Nelson, D.L., Cox, M.M. (2008). Lehninger Principles of Biochemistry, W. H. Freeman and Company. 5th edition.
5. Karp, G. (2010). Cell Biology, John Wiley & Sons, U.S.A. 6th edition.
6. De. Robertis, E.D.P., De. Robertis Jr., E.M.F. (2005). Cell and Molecular Biology, Lippincott, Williams & Wilkins. 8th edition.
7. Cooper, G.M. and Hausman, R. E. (2009) The Cell: A Molecular Approach, Sinauer Associates INC Publisher. 5th edition.

Physical Chemistry-I

Course Code: ICHMJC203

Course Credit: 6

Theory : 40 Marks

Practical : 30 Marks

Practicum: 30 Marks

Course Outcomes

After completion of these courses, students will be able to:

- CO1:** Understand the structure of solids in its influence on physico-chemical properties, phase relations, chemical synthesis, reaction kinetics as well as characterization methods.
- CO2:** Evaluate mathematical expressions for different properties of gas, liquid and solids and understand their physical significance.
- CO3:** Understand the crystal structure and calculate related properties of cubic systems.
- CO4:** Learn surface- and interfacial phenomena.

ICHMJC203:		Physical Chemistry-I	
PWC			
Units	Topics to be covered		
1	Gaseous state: Kinetic molecular model of a gas: postulates and derivation of the kinetic gas equation; collision frequency; collision diameter; mean free path and viscosity of gases, including their temperature and pressure dependence, relation between mean free path and coefficient of viscosity, calculation of ζ from η ; variation of viscosity with temperature and pressure. Maxwell distribution and its use in evaluating molecular velocities (average, root mean square and most probable) and average kinetic energy, law of equipartition of energy, degree of freedom and molecular basis of heat capacities. Behaviour of real gases: Deviations from ideal gas behaviour, compressibility factor, Z, and its variation with pressure and temperature for different gases. Causes of deviation from ideal behaviour. van der Waals equation of state, its derivation and application in explaining real gas behaviour, calculation of Boyle temperature. Isotherms of real gases and their comparison with van der Waals' isotherms, continuity of states, critical state, relation between critical constants and van der Waals' constants, law of corresponding states.		
2	Liquid state: Qualitative treatment of the structure of the liquid state; physical properties of liquids; vapour pressure, surface tension and coefficient of viscosity, and their determination. Effect of addition of various solutes on surface tension and viscosity. Explanation of cleansing action of detergents. Temperature variation of viscosity of liquids and comparison with that of gases.		
3	Solid state: Nature of the solid, law of constancy of interfacial angles, law of rational indices, Miller indices, Weiss indices, elementary ideas of symmetry, symmetry elements and symmetry operations, qualitative idea of point and space groups, seven crystal systems and fourteen Bravais lattices; X-ray diffraction, Bragg's law, a simple account of rotating crystal method and powder pattern method. Analysis of powder diffraction patterns of NaCl, CsCl and KCl.		
4	Surface chemistry: Physical adsorption, chemisorption, adsorption isotherms (Langmuir and Freundlich). Nature of adsorbed state. Qualitative discussion of BET.		

	Practical 1. Surface tension measurements using stalagmometer. - Determine the surface tension by - Drop number - Drop weight method. - Study the variation of surface tension with different concentration of detergent solutions. Determine CMC. 2. Viscosity measurement using Ostwald's viscometer. - Determination of co-efficient of viscosity of an unknown aqueous solution. - Study the variation of co-efficient of viscosity with different concentration of Poly Vinyl Alcohol (PVA) and determine molar of PVA. - Study the variation of viscosity with different concentration of sugar solutions. 3. Molecular weight determination: - Determination of molecular weight of volatile liquid by Victor Meyer's method. 4. pH metry: - Study the effect of addition of HCl/NaOH on pH to the solutions of acetic acid, sodium acetate and their mixtures. - Preparation of buffer solutions of different pH values i. Sodium acetate-acetic acid ii. Ammonium chloride-ammonium hydroxide - pH metric titration of - Strong acid with strong base, - Weak acid with strong base. Determination of dissociation constant of a weak acid.
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Reading List:

- Atkins P., De Paula J., (2006). *Atkins' Physical Chemistry* Ed., Oxford University Press 13
- Ball D. W., (2007), *Physical Chemistry* Thomson Press, India.
- Castellan G. W., (2004). *Physical Chemistry* 4th Ed. Narosa.
- Mortimer R. G., (2009). *Physical Chemistry* 3rd Ed. Elsevier: NOIDA, UP.
- Khosla B. D., Garg V. C., Gulati A. (2011). *Senior Practical Physical Chemistry*, R. Chand & Co.: New Delhi.
- Garland C. W., Nibler J. W., Shoemaker D. P., (2003). *Experiments in Physical Chemistry* 8th Ed.; McGraw-Hill: New York.
- Halpern A. M., Mc Bane G. C., (2003). *Experimental Physical Chemistry* 3rd Ed.; W.H. Freeman & Co.: New York.

Algebra

Course Code: IMAMJC203

Course Credit: 6

Theory : 70 Marks

Practical : -

Practicum: 30 Marks

Course Outcomes:

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

CO1: Learn various set theoretic concepts, divisibility and Euclidean algorithm, principles of mathematical induction and fundamental theorem of arithmetic.

CO2: Learn various notions related to fuzzy sets and their recent applications.

CO3: Solve systems of linear equations and apply various concepts related to linear transformations and their applications to real world problems.

CO4: Gain knowledge about different trigonometric identities.

<u>IMAMJC203</u> : Algebra	
PWC	
Units	Topics to be covered
1	Polar representation of complex numbers, n^{th} roots of unity, Complex argument, De-Moivre's theorem for rational indices and its applications. Hyperbolic Functions, Summation of series, Gregory series.
2	Cartesian products of sets, Equivalence relations, Functions, Composition of functions, Invertible functions, One to one correspondence and cardinality of a set, Countable and uncountable sets, Well-ordering property of positive integers, Division algorithm, Divisibility and Euclidean algorithm, Congruence relation between integers, Principles of Mathematical Induction, statement of Fundamental Theorem of Arithmetic.
3	Fuzzy Sets and its types, Characteristics of fuzzy set, Equality, Containment, Union & Intersection of Fuzzy sets, Height, Core, Support, Normal fuzzy set, Nucleus, Convex fuzzy sets and its algebra, product and difference.
4	Solution of a systems of linear equations by matrix methods, row reduction and echelon forms, Rank of a matrix, vector equations, the matrix equation $Ax=b$, solution sets of linear systems, applications of linear systems, linear independence. Transpose, Adjoint and inverse of a matrix with properties, characterizations of invertible matrices. , Eigen values, Eigen Vectors and Characteristic Equation of a matrix, Cayley Hamilton theorem (statement and problem only).

Reading List :

1. Andreescu T. and Andrica D. (2006). *Complex Numbers from A to Z*, Birkhauser
2. Goodaire E. G. and Parmenter M. M. (2005). *Discrete Mathematics with Graph Theory*, 3rd Ed., Pearson Education (Singapore) P. Ltd., Indian Reprint.
3. Lay D. C. (2007). *Linear Algebra and its Applications*, 3rd Ed., Pearson Education Asia, Indian Reprint.
4. Singh Surjeet (1997). *Linear Algebra*, 1st Ed., Vikas Publishing House Pvt. Ltd., Noida.
5. Singh Vinit K. (2015). *Introduction to Matrix Theory*, 1st Ed., Narosa Publishing House, New Delhi.
6. H. J. Zimmermann, Fuzzy Set theory and its Applications.
7. Pundir S.K (2015) Fuzzy Sets and their applications, 7th Ed, Pragati Prakashan, Meerut
8. Lalji Prasad, Higher Trigonometry by Paramount Publications.

Electricity and Magnetism

Course Code: IPHMJC203

Course Credit: 6

Theory : 40 Marks

Practical : 30 Marks

Practicum: 30 Marks

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

CO1: Understand Gauss's law in Electrostatics and its applications and Laplace' and Poisson's equations.

CO2: Enhance the knowledge of electricity and its relation with magnetic effects.

CO3: Analyze the concept of mutual inductance and Faraday's law of electromagnetic induction.

CO4: Acquire knowledge in the content areas of A.C. circuit and understand the relation between R, L and C .

IPHMJC203 Electricity and Magnetism	
Unit	Topics to be covered
1	Electric Field and Electric Potential: Electric field: Electric field lines. Electric flux. Gauss' Law with applications, Conservative nature of Electrostatic Field. Laplace's and Poisson equations. Conductors in an electrostatic Field. Capacitance of a system of charged conductors
2	(a) Magnetic Field: Magnetic force between current elements and definition of Magnetic Field B , Biot-Savart's Law and its simple applications. (b)Magnetic Properties of Matter: Magnetization vector (M). Magnetic Intensity(H). Magnetic Susceptibility and permeability. Relation between B, H, M , Classification of Magnetic Materials.
3	Electromagnetic Induction: Faraday's Law, Faraday's experiment on electromagnetism, Lenz's Law. Self-Inductance and Mutual Inductance. Relation between self and mutual inductance.
4	Alternating Current Circuits: Average value or mean value over one cycle, Root mean square value, Reactance and Impedance. Circuit containing resistance only, Circuit containing inductance only, Circuit containing capacitance only, Circuit containing resistor, inductor and capacitor in series, Sharpness of Resonance in series LCR, Q Factor.
	Practical : At least 05 experiments from the following: 1. To verify Ohm's Law using an ammeter, voltmeter and a resistance box. 2. To verify Ohm's Law using an ammeter and meter bridge. 3. To determine the resistivity of the material of the given wire by Post Office Box. 4. To compare the emfs of two cells using a stretched wire potentiometer. 5. To compare the capacitance using a De Sauty's Bridge.

	6. To compare the magnetic moments of two bar magnets by null method. 7. To determine self inductance of a coil by Andersons bridge. 8. To study the condition of resonance for a series LCR circuit and to determine its resonant frequency. 9. To determine the value of Earth's magnetic field B_H and the magnetic moment M of the given magnet using deflection and vibration magnetometers. 10. To draw the B-H curve for iron and to determine the energy loss due to hysteresis.
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Reading List :

1. Mahajan S. and Choudhury (2012). *Electricity, Magnetism & Electromagnetic Theory*, Tata McGraw.
2. Purcell Edward M. (1986). *Electricity and Magnetism*, McGraw-Hill Education.
3. Griffiths D.J. (1998). *Introduction to Electrodynamics*, 3rdEdn., Benjamin Cummings.
4. Feynman R.P., Leighton R.B., Sands M. (2008). *Feynman Lectures*, Vol.2, Pearson Education.
5. Sadiku M.N.O. (2010). *Elements of Electromagnetics*, Oxford University Press.
6. Fewkes J.H. & Yarwood J. (1991). *Electricity and Magnetism*, Vol. I, Oxford Univ. Press.
7. Tewary R. K. *Electricity and Magnetism*.

Principles of Ecology

Course Code: IZOMJC203
Course Credit: 6

Theory : 40 Marks
Practical : 30 Marks
Practicum: 30 Marks

Course Outcome:

On completion of the course students will be able to:

- CO1** – Understand and relate the key concepts in Ecology with emphasis on historical perspective, role of physical factors and Concept of Limiting factors.
- CO2** – Understand and explain the population attributes; Population growth models and Population interactions and describe the Community characteristics and Ecological Succession.
- CO3** – Understand and describe the different Ecosystems, Food chains, Energy flow & Efficiency, Biogeochemical cycles.
- CO4** – Learn and relate the application of the Basic Principles of Ecology in Wildlife conservation and management.

Units	Syllabus
1	Introduction to Ecology: History of Ecology, Autecology and Synecology, Levels of organization, Study of physical factors, Laws of limiting factors, Applied Ecology, Ecology in Wildlife conservation and management.
2	Population: Unitary and Modular populations, Unique and group attributes of population, Density, Natality, Mortality, Age ratio, Sex ratio, Dispersal and dispersion, Life tables, Fecundity tables, Survivorship curves, Exponential and Logistic growth: Equation and patterns, r and K strategies, Population regulation: Density-dependent and Independent factors, Population interactions, Examples of Gause's Principle with laboratory and field, Lotka-Volterra equation for Competition and Predation, Functional and Numerical responses.
3	Community: Community characteristics, Species richness, Dominance, diversity, Abundance, Vertical stratification, Ecotone, and Edge effect, Ecological succession, General concepts & Theories pertaining to Climax community, Hydrarch succession, Bioindicators.
4	Ecosystem: Types of Ecosystems, Pond ecosystem in detail, Linear and Y-shaped food chains, Food webs, Ecological pyramids, Energy flow through an ecosystem and Ecological efficiencies, Rain water harvesting and conservation strategies, General concepts of Nutrient and Biogeochemical cycle and Human Modified Ecosystem.

	Practical: 1. Study of Life tables and Plotting of Survivorship curves of different types from the hypothetical / real data provided. 2. Determination of Population density in a natural / hypothetical community by Quadrature method and calculation of Shannon- Weiner Diversity index for the same community. 3. Study of an Aquatic ecosystem: Phytoplankton and Zooplankton, Measurement of area, determination of pH, and Dissolved Oxygen content (Winkler's method) 4. Report on a visit to National Park / Biodiversity Park / Wild life Sanctuary / Wetland.
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Suggested Reading List:

1. Colin Vaux, P. A. (1993). Ecology. II Edition. Wiley, John and Sons, Inc.
2. Krebs, C. J. (2001). Ecology. VI Edition. Benjamin Cummings.
3. Odum, E.P., (2008). Fundamentals of Ecology. Indian Edition. Brooks/Cole
4. Robert Leo Smith Ecology and field biology Harper and Row publisher
5. Ricklefs, R.E., (2000). Ecology. V Edition. Chiron Press

Plant Physiology

Course Code: IBOMJC204

Course Credit: 6

Theory : 40 Marks

Practical : 30 Marks

Practicum: 30 Marks

Course Outcomes

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

CO1: Understand water relation of plants with respect to various physiological processes

CO2: Know about the mineral nutrition

CO3: Classify aerobic and anaerobic respiration, significance of respiration and photosynthesis

CO4: Understand dormancy and germination in plants; learn about types and roles of phytohormones

IBOMJC204 PWC		Plant Physiology
Unit	Topics to be covered	
1.	Plant water relationship: Imbibition, diffusion and osmosis; Water Potential and its components; Active and passive transport of water and solutes; Ascent of sap; Transpiration and factors affecting transpiration, mechanism of stomatal movement and factors controlling it Transport of organic substances, path of translocation, mechanism of translocation	
2.	Mineral nutrition: Macro and micronutrients and their role in plant nutrition; nutrient uptake and transport mechanisms. role of carriers	
3.	Phytohormones: Discovery, chemical nature (basic structure), bioassay and physiological roles of Auxin, Gibberellins, Cytokinin, Absciscic acid, Ethylene	
4.	Physiology of flowering: Photoperiodism and vernalization; Plant movements, plant growth	
	Practical: 1. Determination of the rate of transpiration by using Farmer's Potometer 2. Determination of the amount of water absorbed and transpired by a plant, using T/A apparatus 3. To compare the rate of imbibition of oily and starchy seeds 4. Study of effect of sugar concentrations on leaf cell by plasmolytic method Demonstration experiments 1. Bell jar experiment 2. Demonstration of osmosis using potato	

Reading List :

- Hopkins, W.G. and Huner, A. (2009). Introduction to Plant Physiology, John Wiley and Sons. India Pvt. Ltd. 4th edition.
- Taiz, L., Zeiger, E. (2002). Plant Physiology, Panima Pub. Corp. 3rd edition.
- Jain, V. K. (2014). Fundamentals of Plant Physiology, S. Chand. 16th Revised edition
- Verma, V. (2016). Plant Physiology, Athena Academic. 2nd edition.
- Mazumdar, B.C. (2005). Photoperiodism and Vernalization in Plants, Daya Publishing House. 1st edition.
- Mukherjee, S., Gosh, A.K. (2006). Plant Physiology, New Central Book Agency (P) Ltd. 1st edition.
- Salisbury, F.B., Ross, C.W. (1992). Plant Physiology, Cengage Learning. 4th edition.

Physical Chemistry-II

Course Code: ICHMJC204

Course Credit: 6

Theory : 40 Marks

Practical : 30 Marks

Practicum : 30 Marks

Course Outcomes:

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

CO1: Gain the knowledge of different types of cells, their working, and applications

CO2: Rate law and rate of reaction, theories of reaction rates and catalysts; both chemical and enzymatic

CO3: Understand the rate law and rate of reaction, theories of reaction rates and catalysts; both chemical and enzymatic.

CO4: Gain the knowledge of photochemical reactions.

ICHMJC204 : Physical Chemistry-II	
PWC	
Units	Topics to be covered
1	Electrochemistry-II: Electromotive force of a cell and its measurement, Nernst equation; Standard electrode (reduction) potential and its application to different kinds of half-cells. Application of EMF measurements in determining - free energy, enthalpy, and entropy of a cell reaction, - equilibrium constants, and pH values, using hydrogen, quinone-hydroquinone. Concentration cells with and without transference, liquid junction potential; determination of activity coefficients and transference numbers.
2	Chemical Kinetics: Order and molecularity of a reaction, rate laws in terms of the advancement of a reaction, differential and integrated form of rate expressions up to second order reactions, experimental methods of the determination of rate laws, kinetics of complex reactions (integrated rate expressions up to first order only): - Opposing reactions - parallel reactions and - consecutive reactions and their differential rate equations (steady-state approximation in reaction mechanisms) chain reactions. Temperature dependence of reaction rates; Arrhenius equation; activation energy. Collision theory of reaction rates, Lindemann mechanism, qualitative treatment of the theory of absolute reaction rates
3	Catalysis: Types of catalyst, specificity and selectivity, mechanisms of catalyzed reactions at solid surfaces. Enzyme catalysis, Michaelis-Menten mechanism, acid-base catalysis.
4	Photochemistry: Characteristics of electromagnetic radiation, Lambert-Beer's law and its limitations, physical significance of absorption coefficients. Law of photochemistry, quantum yield, examples of low and high quantum yields, photochemical equilibrium and the differential rate of photochemical reactions, photosensitized reactions, quenching. Role of photochemical reactions in biochemical processes, chemiluminescence
	Practical Conductometry: - Determination of cell constant - Determination of conductivity, molar conductivity, degree of dissociation and dissociation constant of a weak acid. - Perform the following conductometric titrations: - Strong acid vs strong base

	ii. Weak acid vs strong base iii. Mixture of strong acid and weak acid vs strong base iv. Strong acid vs weak base Chemical Kinetics: IV. Study the kinetics of the following reactions. 1. Iodide-persulphate reaction (i) Initial rate method; (ii) Integrated rate method 2. Acid hydrolysis of methyl acetate with hydrochloric acid. 3. Saponification of ethyl acetate. Comparison of the strengths of HCl and H ₂ SO ₄ by studying kinetics of hydrolysis of methyl acetate.
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Reading List:

1. Atkins P., De Paula J., (2010). *Physical Chemistry* 9th Ed., Oxford University Press.
2. Castellan G. W., (2004). *Physical Chemistry*, 4th Ed., Narosa.
3. Mc Quarrie D. A., Simon J. D., (2004). *Molecular Thermodynamics*, Viva BooksPvt. Ltd.: New Delhi.
4. Engel T., Reid P., (2012). *Physical Chemistry* 3rd Ed., Prentice-Hall.
5. Assael M. J., Goodwin A. R. H., Stamatoudis M., Wakeham W. A., Will S., (2011). *Commonly Asked Questions in Thermodynamics*. CRC Press: NY.
6. Zundhal S.S., (2011). *Chemistry concepts and applications* Cengage India.
7. Ball D. W., (2012). *Physical Chemistry* Cengage India.
8. Mortimer R. G., (2009). *Physical Chemistry* 3rd Ed., Elsevier: NOIDA, UP.
9. Levine I. N., (2011). *Physical Chemistry* 6th Ed., Tata McGraw-Hill.
10. Metz C. R., (2009). *Physical Chemistry* 2nd Ed., Tata McGraw-Hill.
11. Khosla B. D., Garg V. C., Gulati A., (2011). *Senior Practical Physical Chemistry*, R. Chand & Co.: New Delhi. 25
12. Garland C. W., Nibler J. W., Shoemaker D. P., (2003). *Experiments in Physical Chemistry* 8th Ed.; McGraw-Hill: New York.
13. Halpern A. M., Mc Bane G. C., (2003). *Experimental Physical Chemistry* 3rd Ed.; W.H. Freeman & Co.: New York.

Linear Algebra

Course Code: IMAMJC204

Course Credit: 6

Theory : 70 Marks

Practical : -

Practicum: 30 Marks

Course Outcomes:

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

CO1: Define Vector spaces, subspaces and some related concepts.

CO2: Learn linear transformations and its matrix representation including applications, isomorphism theorems and change of coordinate matrix.

CO3: Learn properties of dual spaces and determine matrix in the dual basis.

CO4: Relate matrices and linear transformations, compute Eigen values and Eigen vectors of linear transformations.

IMAMJC204: Linear Algebra	
Unit	Topics to be covered
1	Vector spaces, subspaces, Subspaces of R^n , algebra of subspaces, quotient spaces, linear combination of vectors, linear span, linear dependence and independence, basis and dimension, dimension of subspaces and its properties.
2	Linear transformations, null space, range, rank and nullity of a linear transformation, rank nullity theorem, matrix representation of a linear transformation, algebra of linear transformations. Isomorphisms, Isomorphism theorems, invertibility and isomorphisms, change of coordinate matrix
3	Dual spaces, dual basis, double dual, transpose of a linear transformation and its matrix in the dual basis, annihilators.
4	Eigen spaces of a linear operator, diagonalizability, invariant subspaces and Cayley-Hamilton theorem, the minimal polynomial for a linear operator Inner product spaces and norms, Gram-Schmidt orthogonalization process, orthogonal complements, Bessel's inequality.

Reading List :

1. Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence (2004). *Linear Algebra*, 4th Ed., Prentice-Hall of India Pvt. Ltd., New Delhi.
2. Lang S. (2005). *Introduction to Linear Algebra*, 2nd Ed., Springer.
3. Strang Gilbert (2007). *Linear Algebra and its Applications*, Thomson.
4. Kumaresan S. (1999). *Linear Algebra- A Geometric Approach*, Prentice Hall of India.
5. Hoffman Kenneth, Kunze Ray Alden (1971). *Linear Algebra*, 2nd Ed., Prentice-Hall of India Pvt. Ltd.
6. Prasad Lalji (2016). *Linear Algebra*, Paramount Publications, Patna

Atomic and Molecular Physics

Course Code: IPHMJC204

Course Credit: 6

Theory : 70 Marks

Practical : -

Practicum: 30 Marks

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

CO1: Learn about Atomic spectroscopy of one and two valence electron atoms.

CO2: Gain knowledge about change in behavior of atoms in external applied electric and magnetic field.

CO3: Understand the Rotational, vibrational spectra of molecules.

CO4: Study the Principle, working and applications of Laser and particle accelerators.

IPHMJC204 Atomic and Molecular Physics	
Unit	Topics to be Covered
1	Atomic Models: Rutherford Scattering, Bohr's Atomic model, Fine structure of hydrogen lines, Bohr-Sommerfeld atomic model, Total Angular Momentum, Vector Atom Model, Quantum numbers associated with the atom, Spin Quantization.
2	Atom in Magnetic Field: Electron Angular Momentum, Space Quantization, Electron Spin and Spin Angular Momentum, Stern-Gerlach Experiment, Normal and Anomalous Zeeman Effect for single electron system: Electron Magnetic Moment, Energy of an atomic system in Magnetic field, Paschen- Back effect, Gyroscopic Ratio & Bohr-Magneton, Origin of X-ray spectra.
3	Molecular Physics: Molecular spectra vs atomic spectra, Pure rotational and vibrational-rotational spectra of diatomic molecules, Pure Rotational Spectra, Pure Vibrational Spectra, Molecule as Harmonic Oscillator, Anharmonic Oscillator, Isotopic Shift of Vibrational Level.
4	(a) Laser: Spontaneous and Stimulated emissions, Metastable states, Einstein's A & B coefficients, Pumping scheme and Population Inversion, Ruby Laser, He-Ne Laser, Applications of Laser. (b) Particle Accelerators: Cyclotron, Betatron, Measurement of e/m.

Reading List:

1. B. H. Bransden and C. J. Joachain, *Physics of Atoms and Molecules*, Pearson
2. I. N. Levine, *Quantum Chemistry*, Prentice Hall
3. L. D. Landau and E. M. Lifshitz, *Quantum Mechanics*, Pergamon Press
4. M. Karplus and R. N. Porter, *Atoms and Molecules: An Introduction for Students of Physical Chemistry*, W. A. Benjamin
5. P. W. Atkins and R. S. Friedman, *Molecular Quantum Mechanics*, Oxford University Press
6. W. A. Harrison, *Applied Quantum Mechanics*, World Scientific
7. J. Foot, *Atomic Physics*, Oxford University Press
8. G. Woodgate, *Elementary Atomic Structure*, Oxford University Press.
9. A.K. Ghatak and K. Thyagrajan, *Lasers: Fundamentals and Applications*, Springer

Principles of Genetics

Course Code: IZOMJC204

Course Credit: 6

Theory : 40 Marks

Practical : 30 Marks

Practicum: 30 Marks

Course Outcome:

On completion of the course students will be able to:

CO 1 - To explain and discuss the genetic variation through linkage and crossing over.

CO 2 - To describe sex-linked, sex limited and sex influenced inheritance.

CO 3 - To understand the Concept behind genetic disorder, gene mutations and molecularbasis of mutations and to explain the criteria for extra-chromosomal inheritance.

CO 4 - To describe the molecular mechanisms of recombination in bacteria and to explainand distinguish the concept of transposable genetic elements in prokaryotes and eukaryotes. Solve genetic based problems.

Units	Syllabus
1	Inheritance and Sex Determination: Principles of inheritance incomplete dominance and co-dominance; multiple alleles, lethal alleles, Epistasis, Pleiotropy, Sex-linked, Sex limited and Sex influenced inheritance; Chromosomal Mechanism of sex determination in <i>Drosophila</i> and man. Linkage, Crossing Over and Chromosomal Mapping.
2	Mutations: Numerical and Structural chromosomal aberration, Molecular basis of gene mutations and various chemical mutagens.
3	Extra-chromosomal Inheritance: Criteria for extra-chromosomal inheritance, Antibiotic resistance in <i>Chlamydomonas</i> , Maternal effects.
4	Recombination in Bacteria: Transformation, Transduction, Conjugation in Bacteria, Molecular mechanisms of recombination including different models of recombination. Transposable Genetic Elements: Transposons in bacteria, Ac-Ds elements in maize and P elements in <i>Drosophila</i> .
	Practicals: 1. To study the Mendelian laws and gene interactions. 2. Chi-square analyses using seeds/beads/ <i>Drosophila</i> . 3. Linkage maps based on data from <i>Drosophila</i> crosses. 4. Study of human karyotype (normal and abnormal) based on photographs. 5. Pedigree analysis of some human inherited traits.

Suggested Reading List:

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). *Principles of Genetics*. VIII Edition. Wiley India
2. Snustad, D.P., Simmons, M.J. (2009). *Principles of Genetics*. V Edition. John Wiley and Sons Inc
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). *Concepts of Genetics*. X Edition. Benjamin Cummings
4. Russell, P. J. (2009). *Genetics- A Molecular Approach*. III Edition. Benjamin Cummings
5. Fletcher H. and Hickey I. (2015). *Genetics*. IV Edition. GS, Taylor and Francis Group, New York and London

Algae and Fungi

Course Code: IBOMIC202

Course Credit: 3

Theory : 40 Marks

Practical : 30 Marks

Practicum: 30 Marks

Course Outcomes

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

- CO1:** Know about characteristic features of algae and fungi
- CO2:** Know about range of thallus organization of algae and fungi
- CO3:** Get the knowledge of different classes of algae and fungi
- CO4:** Know the life cycle of the specified algae and fungi along with their ecological and economical importance

IBOMIC202 PWC		Algae and Fungi
Unit	Topics to be covered	
1	Algae: General characteristics; Range of thallus organization and Classification of algae; Economic importance of algae	
2	Morphology and life cycles of the following genera: <i>Nostoc</i> , <i>Oedogonium</i> , <i>Ectocarpus</i> , <i>Batrachospermum</i>	
3	Fungi: General characteristics, range of thallus organization, nutrition, reproduction and classification	
4	Morphology, Structure and life cycle of <i>Peziza</i> and <i>Puccinia</i>	
	Practical 1. Study of vegetative and reproductive structures of <i>Nostoc</i> , <i>Oedogonium</i> , <i>Ectocarpus</i> , <i>Batrachospermum</i> through temporary preparations and permanent slides 2. Study of vegetative and reproductive structures of <i>Peziza</i> and <i>Puccinia</i> through temporary preparations and permanent slides	

Reading List:

1. Lee, R.E. (2008). Phycology, Cambridge University Press, Cambridge. 4th edition.
2. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West Press, Delhi.
3. Vashishta, B.R., Sinha, A.K. Singh, V.P. (2008). Botany for Degree Students: Algae, S. Chand & Company Ltd. 2nd edition.
4. Vashishta, B.R. Sinha, A.K. (2007). Botany for Degree Students: Fungi, S. Chand & Company Ltd.
5. Narayanasamy P. (2002). Microbial Plant Pathogens and Crop Disease Management, Oxford & IBH Pub. Co. Pvt. Ltd.
6. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley & Sons, Inc.
7. Agrios, G.N. (2006). Plant Pathology, Academic Press.

Physical Chemistry & Organic Chemistry – II

Course Code: ICHMIC202
Course Credit: 3

Theory : 40 Marks
Practical : 30 Marks
Practicum: 30 Marks

Course Outcomes:

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

- CO1:** Understand application of mathematical tools to calculate thermodynamic properties and physical phenomena associated to chemical thermodynamics and its relationship with thermodynamic quantities.
- CO2:** Understand relationship between microscopic properties of molecules with macroscopic thermodynamic observables and derivation of rate equations from mechanistic data.
- CO3:** Analysis how to predict the outcome of organic reactions using a basic understanding of the general reactivity of functional groups and mechanism.
- CO4:** Analysis the reactivity patterns of conjugated and aromatic molecules

ICHMIC202 : Physical Chemistry & Organic Chemistry - II	
PWC	
	Topics to be covered
1	Physical Chemistry Chemical Energetics: Review of thermodynamics and the Laws of Thermodynamics. Important principles and definitions of thermochemistry. Concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature – Kirchhoff's equation.
2	Chemical Equilibrium: Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between G and G° , Le-Chatelier's principle. Relationships between K_p , K_c and K_x for reactions involving ideal gases. Ionic Equilibria: Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle
3	Organic Chemistry-I Aliphatic Hydrocarbons: Functional group approach for the following reactions (preparations physical property & chemical reactions) to be studied with mechanism in context to their structure. Alkanes: Preparation: Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, Grignard reagent. Reactions: Free radical Substitution: Halogenation. Alkenes: Preparation: Elimination reactions: Dehydration of alcohols and dehydrohalogenation of alkyl halides (Saytzeff's rule); cis alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction). Reactions: cis-addition (alk. KMnO_4) and trans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis.

	Alkynes: Preparation: Acetylene from CaC_2 and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides. Reactions: formation of metal acetylides and acidity of alkynes, addition of bromine and alkaline KMnO_4, ozonolysis and oxidation with hot alk. KMnO_4. Hydration to form carbonyl compounds
4	Aromatic hydrocarbons <i>Preparation of Benzene:</i> from phenol, acetylene, benzene sulphonic acid and by decarboxylation. <i>Physical and Chemical Properties of Benzene:</i> Electrophilic substitution reactions: nitration, halogenation sulphonation. Friedel-Craft's reaction (alkylation and acylation) Side chain oxidation of alkyl benzenes.
	Practical Physical Chemistry Thermochemistry 1. Determination of heat capacity of calorimeter for different volumes. 2. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide. 3. Determination of enthalpy of ionization of acetic acid. 4. Determination of integral enthalpy of solution of salts (KNO_3, NH_4Cl). Ionic equilibria pH measurements a) Measurement of pH of different solutions like aerated drinks, fruit juices, shampoos and soaps (use dilute solutions of soaps and shampoos to prevent damage to the glass electrode) using pH-meter. b) Preparation of buffer solutions & measurement of pH: (i) Sodium acetate-acetic acid (ii) Ammonium chloride-ammonium hydroxide. Organic Chemistry 1. Preparations, recrystallisation, determination of melting point and calculation of quantitative yields of the following compounds: (a) Nitration of Phenol/Aniline by green approach (b) Benzoylation of amines/phenols

Reading List:

1. Graham Solomons T. W., *Organic Chemistry*, John Wiley and Sons.
2. Peter Sykes, (2011). *A Guide Book to Mechanism in Organic Chemistry*, Orient Longman.
3. Finar I.L., (2014). *Organic Chemistry* (Vol. I & II), E. L. B. S.
4. Morrison R. T., Boyd R. N., (2007). *Organic Chemistry*, Prentice Hall.
5. Arun Bahl, Bahl B. S., (2012). *Advanced Organic Chemistry*, S. Chand.
6. Barrow G. M., (2007). *Physical Chemistry* Tata McGraw Hill.
7. Castellan G. W., (2004). *Physical Chemistry* 4th Edn. Narosa.
8. Kotz J. C., Treichel P. M., Townsend J. R., (2009). *General Chemistry* Cengage Learning India Pvt. Ltd., New Delhi.
9. Mahan B. H., (1998). *University Chemistry* 3rd Ed. Narosa.
10. Petrucci R. H., (1985). *General Chemistry* 5th Ed. Macmillan Publishing Co.: New York.
11. Vogel A.I., (2014). *Textbook of Practical Organic Chemistry*, 5th edition, Prentice-Hall.
12. Mann F. G., Saunders B. C., (1960). *Practical Organic Chemistry*, Orient Longman.
13. Khosla B.D., *Senior Practical Physical Chemistry*, Chand R. & Co.

Integral Calculus, Abstract Algebra, 3D Geometry and Vector Analysis

Course Code: IMAMIC202

Course Credit: 3

Theory : 70 Marks

Practical : -

Practicum: 30 Marks

Course Outcomes:

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

CO1: Gain knowledge about Beta and Gamma functions and develop the skills to estimate the change in the value of a function when the independent variable undergoes a change.

CO2: Advance knowledge related to fundamental concepts of Group theory.

CO3: Learn about Three-Dimensional Geometry with applications.

CO4: Compute dot product and cross product and gain knowledge about the concept of Gradient, Divergence and Curl.

IMAMIC202 : Integral Calculus, Abstract Algebra, 3D Geometry and Vector Analysis PWC	
Units	Topics to be covered
1	Reduction formula, Beta and Gamma functions, Double and triple integration, Change of order of integration.
2	Definition and examples of Group, Abelian and Non-abelian group, Uniqueness of Identity element in a group, Cancellation laws for groups, Subgroup, Cyclic group, Ring, Integral domain, Field: their definitions, examples, and basic properties
3	Direction cosine and direction ratios, Angle between two lines, Equation of plane in different forms, skew lines and shortest distance, Equation of sphere and tangent plane.
4	Product of three and four vectors, Gradient, Divergence, curl and their properties.

Reading List :

1. Gupta A. D. & Prasad S. B. (1991). *Degree Level Analytical Geometry of Three Dimensions*, Bharti Bhawan Patna
2. Prasad Lalji (2015). *Vector Analysis*, Paramount Publications, Patna.
3. Narayan Shanti & Mittal P. K. (2007). *Integral Calculus*, S. Chand & Company Ltd., New Delhi.
4. Prasad Lalji (2015). *Integral Calculus*, Paramount Publications, Patna.
5. Prasad Gorakh (2021), *Integral Calculus*, Rashi Kansal(Pothisala).
6. Kumar R. (2020), *Abstract Algebra (Group Theory)*, Vardhaman Publications.
7. Kumar R. (2020), *Abstract Algebra (Ring Theory)*, Vardhaman Publications.

Mechanics-II

Course Code: IPHMIC202

Course Credit: 3

Theory : 40 Marks

Practical : 30 Marks

Practicum: 30 Marks

Course Outcomes:

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

CO1: Enhance knowledge about collision and elastic properties of solids.

CO2: Understand the concept of central force motion.

CO3: Understand the concepts of fictitious forces and their applications in practical situations.

CO4: To get an idea of postulates of special theory of relativity and their implications.

IPHMIC202: Mechanics-II (Practical)	
Unit	Topics to be covered
1	Collisions: Elastics and inelastic collision between particles. Elasticity: Hooke's law. Stress-Strain diagram. Young modulus. Modulus of rigidity.
2	Central force Motion: Central and non-central forces with examples. Properties of central forces. Kepler's Laws of Planetary motion.
3	Non-Inertial Systems: Non-inertial frames and fictitious forces. centrifugal force, Coriolis force and its applications.
4	Special Theory of Relativity: Michelson-Morley Experiment, Postulates of Special Theory of Relativity, Lorentz Transformations, Lorentz contraction, Time dilation, Variation of mass with velocity, Mass energy equivalence relation.
	Practical : At least 05 experiments from the following: 1. To determine the thickness of a given glass piece by spherometer. 2. To determine the value of g using Bar Pendulum. 3. To determine the value of g using Kater's Pendulum. 4. To determine the Moment of Inertia of a Flywheel. 5. To determine the Modulus of Rigidity of a Wire by dynamical method. 6. To determine the Modulus of Rigidity of a Wire by Barton's apparatus. 7. To determine the Young's Modulus by flexure of beam. 8. To determine the elastic Constants of a wire by Searle's method. 9. To determine the surface tension by Fergusson method. 10. To determine the surface tension by Quincke's method.

Reading List :

1. Kleppner D., Kolenkow R. J. (1973). *An introduction to mechanics*, McGraw-Hill.
2. Kittel C., Knight W., et.al. (2007). *Mechanics*, Berkeley Physics, vol.1, Tata McGraw-Hill.
3. Resnick, Halliday and Walker (2008). *Physics*, Wiley, 8/e.
4. Fowles G. R. and Cassiday G.L. (2005). *Cengage Learning*.
5. Feynman R. P., Leighton R. B., Sands M. (2008). *Feynman Lectures*, Vol.I, Pearson Education.
6. Mathur D. S. (2000). *Mechanics*, S.Chand and Company Limited.
7. Sears F. W, Zemansky M. W., Young H.D. (1986). *University Physics*. 13/e, Addison Wesley.
8. Jewett J. W., Serway R. A. (2010). *Physics for scientists and Engineers with Modern Phys.*, Cengage Learning.
9. Spiegel M.R. (2006). *Theoretical Mechanics*, Tata McGraw Hill.
10. Flint B.L. and Worsnop H.T. (1971). *Advanced Practical Physics for students*, Asia Publishing House.
11. Nelson Michael and Ogborn Jon M. (1985). *Advanced level Physics Practicals*, 4th Edition, Heinemann Educational Publishers.
12. Panigrahi S. & Mallick B. (2015). *Engineering Practical Physics*, Cengage Learning India Pvt. Ltd.
13. Squires G.L. (2015). *Practical Physics*. 4th Edition, Cambridge University Press.
14. Prakash I. & Ramakrishna (2011). *A Text Book of Practical Physics*, 11th Edn, Kitab Mahal.

Chordate Diversity

Course Code: IZOMIC202

Course Credit: 3

Theory : 40 Marks

Practical : 30 Marks

Practicum: 30 Marks

Course Outcomes:

On completion of the course students will be able to:

- CO1** - Understand and describe the Salient features of Pisces, Migration of Fishes and Parental Care.
- CO2** - Understand and describe the General characters of Amphibia, Adaptations for terrestrial life, Parental care in Amphibia.
- CO3** - Understand and describe the General Characters of Reptiles and Aves, Origin of reptiles, Terrestrial adaptation in Reptiles, Origin of birds, Flight adaptations in birds.
- CO4** - Understand and describe the General Characters of Mammalia, Early evolution of Mammals and Dentition in mammals.

Units	Syllabus
1	Protochordata: Salient features Pisces: General Characters, Migration of Fishes, Parental Care
2	Amphibia: General characters, Adaptations for terrestrial life, Parental care in Amphibia.
3	Reptiles: General Characters, Origin of reptiles, Terrestrial adaptation in Reptiles. Aves: General Characters, Origin of birds, Migration of birds, Flight adaptations.
4	Mammalia: General Characters, early evolution of mammals; Dentition in mammals.
	Practicals: 1. Study of following specimens: Chordates: <i>Balanoglossus</i> , <i>Amphioxus</i> , <i>Petromyzon</i> , <i>Hippocampus</i> , <i>Exocoetus</i> , <i>Ichthyophis</i> , <i>Salamander</i> , <i>Alytes</i> , <i>Draco</i> , <i>Uromastix</i> , <i>Naja</i> , <i>Viper</i> , <i>Archaeopteryx</i> (Picture chart), Parrot, Hen, Sparrow, Squirrel, and Bat. 2. Study of following permanent Slides: Placoid, Cycloid and Ctenoid scales. 3. Identification of Poisonous and Non-poisonous snakes 4. Parental care in animals.

Suggested Reading List:

1. Barnes, R.D. (1992). Invertebrate Zoology. Saunders College Pub. USA.
2. Ruppert, Fox, and Barnes (2006) Invertebrate Zoology. A functional Evolutionary Approach 7th Edition, Thomson Books/Cole
3. Campbell & Reece (2005). Biology, Pearson Education, (Singapore) Pvt. Ltd.
4. Kardong, K. V. (2002). Vertebrates Comparative Anatomy. Function and Evolution. Tata McGraw Hill Publishing Company. New Delhi.
5. Raven, P. H. and Johnson, G. B. (2004). Biology, 6th edition, Tata McGraw Hill Publications. New Delh.

Language-II (English)

Course Code: IEDAEC203
Course Credit: 04

Theory: 70 Marks
Practicum: 30 Marks

COURSE OUTCOMES

After completion of this course, the prospective teachers will attain the ability to:

- CO1: Describe the process of language acquisition from mother tongue to other languages
(L2: Understand)
- CO2: Design learner-centred language learning activities for multilingual classrooms.
(L6: Create)
- CO3: Apply basic grammatical knowledge and communication skills (listening, speaking, reading and writing) for effective academic and classroom communication. (L3: Apply)
- CO4: Explain the components of critical thinking and critical reading and their role in higher-order cognitive development. (L2: Understand)

Unit I: Language, Society and Learning

- Meaning, nature and functions of language; language as a medium of communication and learning.
- Mother tongue, first language, second language and other languages; language acquisition and language learning.
- Bilingualism and multilingualism; importance of multilingual classrooms in India.
- Language, culture, identity and gender; constitutional provisions and language-related recommendations of NEP 2020.

Unit II: Basic Grammar and Language Structure

- Speech sounds: vowels and consonants; pronunciation, stress and intonation.
- Parts of speech; grammatical categories and common errors in grammar.
- Word formation: prefix, suffix, compounding and vocabulary building.
- Sentence structure: subject, predicate, phrase, clause; simple, compound and complex sentences; meaning in context.

Unit III: Basic Communication Skills

- Listening skills and listening comprehension.
- Speaking skills: pronunciation, fluency, classroom interaction and presentation skills.
- Reading skills: loud reading, silent reading, skimming, scanning and reading comprehension.
- Writing skills: sentence writing, paragraph writing, letter, notice, report, summary and paraphrasing.

Unit IV: Critical Reading and Thinking Skills

- Meaning and importance of critical thinking and critical reading.
- Identifying main idea, supporting details, fact and opinion.
- Identifying bias, stereotypes, assumptions and misleading information in texts.

- Higher-order thinking skills: analysing, evaluating, creating and problem-solving through classroom activities.

Practicum

- Conduct a short field-based survey on bi-/multilingual practices in their surroundings and prepare a brief analytical report linking language, identity and power.
- Prepare a comparative chart on language and dialect features found in their local context and present it in class.
- Write a reflective note on their mother tongue and additional language learning experiences in relation to schooling.
- Record and analyse speech samples to identify vowels, consonants and suprasegmental features such as stress and intonation.
- Prepare a word-formation and vocabulary-building worksheet using affixation, compounding and reduplication.
- Analyse given texts to identify sentence types, grammatical categories and speech acts and submit a short report.
- Perform guided listening and pronunciation activities and maintain a brief listening and pronunciation practice log.
- Complete a reading comprehension task and prepare a short written summary and paraphrase of the given text.
- Deliver a short oral presentation and submit one structured written composition demonstrating effective writing skills.
- Any other activity based on the units of the paper in form of written assignment, projects, performance or field work with a detailed report.

Suggested Readings

- Agnihotri, R. K., & Khanna, A. L. (Eds.). (1994). *Second Language Acquisition: Socio-cultural and Linguistic Aspects of English in India*. New Delhi: Sage Publications.
- Annamalai, E. (2001). *Managing Multilingualism in India: Political and Linguistic Manifestations*. New Delhi/Thousand Oaks/London: Sage.
- Balasubramanian, T. (2015). *A Textbook of English Phonetics for Indian Students*. Delhi: Macmillan.
- Cook, V. (2016). *Second Language Learning and Language Teaching* (5th ed.). London: Routledge.
- Crystal, D. (2003). *The Cambridge Encyclopedia of the English Language* (2nd ed.). Cambridge: Cambridge University Press.
- Fromkin, Victoria, Rodman, Robert, & Hyams, Nina. (2018). *An Introduction to Language* (11th ed.). Boston, MA: Cengage Learning.
- Government of India, Ministry of Education. (2020). *National Education Policy 2020*. New Delhi: Ministry of Education, Government of India.
- Gupta, R. S., & Kapoor, Kapil (Eds.). (1991). *English in India: Issues and Problems*. Delhi: Academic Foundation.
- Kachru, Braj B. (1983). *The Indianization of English: The English Language in India*. Delhi: Oxford University Press.

- Krishnaswamy, N., & Krishnaswamy, Lalitha. (2006). *The Story of English in India*. New Delhi: Foundation Books (Cambridge University Press India).
- Kumaravadivelu, B. (2006). *Understanding Language Teaching: From Method to Postmethod*. Mahwah, NJ: Lawrence Erlbaum Associates.
- Ladefoged, P., & Johnson, K. (2015). *A Course in Phonetics* (7th ed.). Boston, MA: Cengage Learning.
- Levinson, S. C. (1983). *Pragmatics*. Cambridge: Cambridge University Press.
- Lightbown, P. M., & Spada, N. (2021). *How Languages are Learned* (5th ed.). Oxford: Oxford University Press.
- National Council of Educational Research and Training. (2023). *National Curriculum Framework for School Education 2023*. New Delhi: NCERT.
- Paul, R., & Elder, L. (2019). *The Miniature Guide to Critical Thinking: Concepts and Tools* (8th ed.). Lanham, MD: Rowman & Littlefield.
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- Quirk, R., Greenbaum, S., Leech, G., & Svartvik, J. (1985). *A Comprehensive Grammar of the English Language*. London: Longman.
- Roach, P. (2009). *English Phonetics and Phonology: A Practical Course* (4th ed.). Cambridge: Cambridge University Press.
- Searle, J. R. (1969). *Speech Acts: An Essay in the Philosophy of Language*. Cambridge: Cambridge University Press.
- Sethi, J., & Dhamija, P. V. (2006). *A Course in Phonetics and Spoken English* (2nd ed.). New Delhi: Prentice-Hall of India.
- Swales, John M., & Feak, Christine B. (2012). *Academic Writing for Graduate Students: Essential Tasks and Skills* (3rd ed.). Ann Arbor, MI: University of Michigan Press.
- Wardhaugh, R., & Fuller, J. M. (2021). *An Introduction to Sociolinguistics* (8th ed.). Hoboken, NJ: Wiley-Blackwell.
- Yule, G. (2020). *The Study of Language* (7th ed.). Cambridge: Cambridge University Press.
- Yule, George. (2020). *The Study of Language* (7th ed.). Cambridge: Cambridge

Teacher and Society

Course Code: IEDAEC204

Course Credit: 02

Theory: 35 Marks

Practicum: 15 Marks

COURSE OUTCOMES

After completion of this course, the prospective teachers will attain the ability to:

- CO1: Explain the professional roles of teachers in terms of qualifications, attitude, aptitude and experience. (L2: Understand)
- CO2: Apply reflective practices, collaborative approaches and care-based pedagogy in classroom and school contexts. (L3: Application)
- CO3: Explain the personal, social, cultural and professional dimensions of a teacher, including holistic development, ethics of care and teacher agency. (L2: Understand)
- CO4: Critically evaluate educational policies, practices and reforms in relation to equity, inclusion, professional ethics and social responsibility. (L5: Evaluate)

UNIT I: Understanding and Nurturing the Teacher: Exploring the Personal and Professional Teacher

- Exploring the social context of teacher: Teacher beliefs, values and aspirations, diverse identities, social contexts and commitment to learning and education.
- Teacher as a professional: Qualifications, attitude, aptitude, experience.
- The reflective practitioner: Nurturing the professional competencies through collaborative and collective engagement with self, others, and the social context.
- Teaching: One profession many roles.
- Holistic teacher development: Nurturing the Panchakoshas.
- Developing pedagogy of ethics of care in education.

UNIT II: Teacher Agency and Architecting New India

- Teachers' agency: Individual, cultural and structural dimensions; challenges and issues: Performativity, non-academic engagements, systemic apathy, policy and practices.
- Role of teacher in shaping the educational policy, practice, and reforms; teacher discourses, philosophy, relationships and networks.
- Being a critical teacher: Raising debates around rapid technological advancement and impact on individual, family, and social life; teacher's roles in the era of 'globalization' and the reconstructed nationalism, shaping the socio-political milieu and impact on the social psyche, growing materialistic urge, sensory drives, and the gradual deterioration of the individual and societal character.

Practicum

- Take up a case study of any one teacher education institution.
- Write a biography of any one of your favourite teachers/ educationists.
- Prepare a reflective profile of yourselves as teachers highlighting their beliefs, values, aspirations, identities and commitment to learning

- Conduct an interview with a practicing teacher and prepare a brief report on professional qualifications, attitude, aptitude and experiences.
- Maintain a short reflective journal on your collaborative and self-learning experiences as emerging reflective practitioners.
- Prepare a role-based presentation on the multiple roles of teachers beyond classroom teaching.
- Design a short personal development plan integrating the concept of Panchakoshas for holistic teacher development.
- Analyse a classroom or school-based situation and propose strategies using the pedagogy of care.
- Prepare a short position paper on the role of teachers in educational policy, reforms and professional decision-making.
- Document a case study on teacher agency highlighting individual, cultural and structural challenges faced in schools.
- Write a critical reflection on the impact of technology on learners, families and society from a teacher's perspective.
- Prepare a concept note on the changing role of teachers in the context of globalization, nationalism and contemporary socio-political challenges.
- Any other activity based on the units of the paper in form of written assignment, projects, performance or field work with a detailed report.

Suggested Readings

- National Council for Teacher Education. (2009). *National Curriculum Framework for Teacher Education: Towards Preparing Professional and Humane Teacher*. New Delhi: NCTE.
- Government of India, Ministry of Education. (2020). *National Education Policy 2020*. New Delhi: Ministry of Education.
- National Council of Educational Research and Training. (2023). *National Curriculum Framework for School Education 2023*. New Delhi: NCERT.
- Kumar, K. (2005). *Political Agenda of Education: A Study of Colonialist and Nationalist Ideas*. New Delhi: Sage Publications India.
- Kumar, K. (2010). *Culture, Democracy and Education: Essays on Indian Education*. New Delhi: Sage Publications India.
- Sadgopal, A. (2013). *India's National Education Policy 2020: A Critical Review* (selected essays/articles). New Delhi: (Various Indian publishers/journals; course compilation).
- Krishnamurti, J. (1953/2015). *Education and the Significance of Life*. Chennai: Krishnamurti Foundation India.
- Tagore, R. (1996). *Siksha* (selected writings on education). Kolkata: Visva-Bharati (or any standard collected edition).
- Gandhi, M. K. (1951/2012). *Basic Education* (Nai Talim: selected writings). Ahmedabad: Navajivan Publishing House.

- Radhakrishnan, S. (1953/2016). *Education and Society* (selected speeches/writings). New Delhi: (any standard collected edition).
- Aurobindo, S. (1972/2003). *A System of National Education* (and selected writings on education). Pondicherry: Sri Aurobindo Ashram Press.
- Swami Gambhirananda (Trans.). (1957/2013). *Taittiriya Upanishad* (for Panchakosha sections). Kolkata: Advaita Ashrama.
- Noddings, N. (2013). *Caring: A Relational Approach to Ethics and Moral Education* (2nd ed.). Berkeley, CA: University of California Press.
- Schon, D. A. (1983). *The Reflective Practitioner: How Professionals Think in Action*. New York, NY: Basic Books.
- Freire, P. (1970/2005). *Pedagogy of the Oppressed* (30th anniversary ed.). New York, NY: Continuum.

Understanding India - II (Indian Ethos And Knowledge Systems)

Course Code: IEDVAC202

Course Credit: 02

Theory: 35 Marks

Practicum: 15 Marks

COURSE OUTCOMES

After completion of this course, the prospective teachers will attain the ability to:

- CO1: Apply ethical and spiritual principles of Indian knowledge traditions in personal life, professional conduct and social situations. (L3: Application)
- CO2: Explain the basic ideas of Indian ethics, spirituality, culture, lifestyle, science, technology and linguistic traditions. (L2: Understand)
- CO3: Propose practical strategies to develop well-being, self-leadership and social responsibility inspired by Indian knowledge systems. (L6: Create)
- CO4: Examine the contribution of Indian traditions to science, technology, astronomy, linguistics and economic life. (L5: Evaluate)

UNIT I: Philosophy, Ethics, Values, Culture and Lifestyle

- Vaisheshika, Nyaya, Samkhya, Yoga, Mimamsa and Vedanta (interpretation in Advaita, Vishishtadvaita, Dvaita traditions), Jain, Buddhist, and Charvak traditions – theory and the major thinkers.
- Ethics, morality, and social dilemma (including self-leadership) and their relevance in today's time; Value of Indian spirituality; Spirituality and social responsibility; importance of spirituality in current times.
- Using ethics in a technologically volatile world: leading an ethical and modern life; practical Vedanta for well-being (mindfulness, inter-connectedness, society-self relationship, etc.)
- Cultural aspects: Food (regional cuisines, ayurvedic diet, food and festival, vegetarianism, Jainism in food, food and hospitality, and globalization), clothes (traditional Indian clothing, textile arts, religious costumes, clothing status, clothing and gender, globalization in clothing), sports (traditional Indian sports, martial arts, sports and gender, sports and globalization).
- The lifestyle of Yoga; adapting ancient lifestyle – A path towards longevity.

UNIT II: Scientific & Linguistic Traditions

- Arithmetic and logic.
- Natural sciences: math, physics, metallurgy, and chemistry.
- Astronomy: India's contributions to the world; Indian notions of time and space.
- Technology in the economy: agriculture, transportation, etc.
- History of linguistics in India (conceptualizing ancient Indian linguistics, oral traditions, etc.).
- Language as Culture: Evolution of languages over the years & language as building blocks to different cultures and society.

Practicum

- Prepare a comparative concept map of major Indian schools of philosophy (Vaishesika, Nyaya, Samkhya, Yoga, Mimamsa, Vedanta, Jain, Buddhist and Charvak) highlighting key ideas and thinkers.
- Prepare a short analytical note comparing Advaita, Vishishtadvaita and Dvaita Vedanta in relation to human life and values.
- Analyse a real-life ethical or social dilemma (including self-leadership) and present ethical decision-making strategies for today's context.
- Write a reflective note on spirituality, social responsibility and practical Vedanta practices for personal well-being.
- Prepare a project on Indian lifestyle and culture through food, clothing and sports with reference to gender and globalization.
- Document any one traditional Indian sport, martial art or yogic lifestyle practice and explain its relevance for health and longevity.
- Prepare a brief illustrated report on Indian contributions to science, technology, mathematics, astronomy and metallurgy.
- Develop a short presentation on Indian notions of time and space and their relevance to contemporary scientific understanding.
- Prepare a case-based study showing the role of traditional technologies in agriculture, transport or economy.
- Prepare a timeline and short report on the history of linguistic traditions in India and the role of oral traditions.
- Write a reflective note on the relationship between language, identity, culture and history in contemporary Indian society.
- Any other activity based on the units of the paper in form of written assignment, projects, performance or field work with a detailed report.

Suggested Readings

- Dasgupt, Surendranath. (1991). *A History of Indian Philosophy* (Vols. I–V). Delhi: Motilal Banarsidass.
- Chatterjee, Satischandra, & Dutta, Dharendra Mohan. (2016). *An Introduction to Indian Philosophy* (8th ed.). New Delhi: University of Calcutta (Indian reprint/standard edition).
- Radhakrishnan, S. (2008). *Indian Philosophy* (Vols. I–II). New Delhi: Oxford University Press.
- Matilal, Bimal Krishna. (2002). *The Character of Logic in India*. New Delhi: Munshiram Manoharlal.
- Bhattacharya, Ramkrishna. (2011). *Studies on the Cārvāka/Lokāyata*. London/New Delhi: Anthem Press.
- गम्भीरानन्द, स्वामी (अनु.). (2013). *तैत्तिरीय उपनिषद्* (भाष्य/टीका सहित मानक संस्करण). कोलकाता: अद्वैत आश्रम.

- शंकराचार्य. (2012). *ब्रह्मसूत्र-भाष्य* (शांकरभाष्य; मानक संस्करण). वाराणसी/दिल्ली: चौखम्बा/मोतिलाल बनारसीदास (कोई एक मानक संस्करण).
- रामानुजाचार्य. (2011). *श्रीभाष्य* (ब्रह्मसूत्र पर; चयनित/मानक संस्करण). चेन्नै/वाराणसी: (कोई मानक संस्करण).
- Madhvacharya. (1994). *Brahma-Sūtra Bhāṣya* (standard English/critical edition or translation). Delhi: Motilal Banarsidass.
- व्यास. (2016). *पतञ्जलि योगसूत्र* (भाष्य/टीका सहित). गोरखपुर: गीताप्रेस.
- Dharmapāla, B. (Ed./Trans.). (1995). *Dhammapada* (English translation with notes). Colombo/Delhi: (standard edition).
- Goyal, S. R. (1987). *Jainism in Ancient India: Its Origin, Development and Spread*. Delhi: Munshiram Manoharlal.
- Achaya, K. T. (1994). *Indian Food: A Historical Companion*. Delhi: Oxford University Press.
- Srinivasan, Sharada, & Ranganathan, Srinivas. (2004). *India's Legendary Wootz Steel: An Advanced Material of the Ancient World*. Bangalore: National Institute of Advanced Studies (NIAS).
- Cardona, George. (1997). *Pāṇini: His Work and Its Traditions* (Vol. I). Delhi: Motilal Banarsidass.