INVERTIS
UNIVERSITY BAREILLY

SEMESTER - V

BASICS OF PHYSICAL CHEMISTRY I	
Course Code: BEB506	**Credit:** 04 (L-3, T-1, P-0)
Contact Hours: 60	**MM:** 100 (Int.: 30 + Ext.: 70)

Course Outline

Unit I: Gaseous State

- Kinetic molecular theory of gases: postulates, kinetic gas equation; derivation of gas laws.
- Maxwell distribution and its use in evaluating molecular velocities (average, root mean square and most probable) and average kinetic energy,
- Collision diameter; collision frequency; mean free path and viscosity of gases, including their temperature and pressure dependence, relation between mean free path and coefficient of viscosity,
- Deviations from ideal gas behaviour, Causes of deviation from ideal behaviour. compressibility factor (Z), Effect of temperature on deviations.
- Van der Waals equation of state, its derivation and application in explaining real gas behaviour, continuity of states, Joule Thomson effect.

Unit II: Liquid State

- Physical properties of liquids; vapour pressure, surface tension and coefficient of viscosity and their determination.
- Temperature variation of viscosity of liquids and comparison with that of gases.
- pH scale, common ion effect; dissociation constants of mono-, di- and tri- protic acids.
- Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts

Unit III: Ionic Equilibria

- Buffer solutions; derivation of Henderson equation and its applications; buffer capacity, buffer action and applications of buffers in analytical chemistry and biochemical processes in the human body.
- Solubility and solubility product of sparingly soluble salts Theory of acid - base indicators; selection of indicators and their limitations.

Unit IV: Thermodynamics - I

- Thermodynamic terms, laws of thermodynamics.
- First law: relation between heat capacities, calculations of q, w, U and H for reversible, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions.
- Second Law: Concept of entropy; carnot cycle; statement of the second law of thermodynamics; molecular and statistical interpretation of entropy. Calculation of entropy change for reversible and irreversible processes.

Unit V: Thermodynamics - II

- Partial molar quantities, dependence thermodynamic parameters on composition; Gibbs-Duhem equation, chemical potential of ideal mixtures, change in thermodynamic functions in mixing of ideal gases.
- Free Energy Functions-Gibbs and Helmholtz energy; variation of S, G, A with T, V, P; Free energy change and spontaneity Gibbs-Helmholtz equation; Maxwell relations; thermodynamic equation of state.
- Effect of temperature (Kirchoff's equations) and pressure on enthalpy of reactions. Adiabatic flame temperature, explosion temperature.

Suggested Reading:

1. Atkins, P. W., & Paula, J. de. (2006). Atkin's physical chemistry (8th ed.). Oxford University Press.
2. Castellan, G. W. (2004). Physical chemistry (4th ed.). Narosa Publishing House.
3. Laidler, K. J., & Meiser, J. M. (1999). Physical chemistry (3rd ed.). Houghton Mifflin Company.
4. Puri, B. R., Sharma, L. R., & Pathania, M. S. (1998). Principles of physical chemistry (37th ed.). Shoban Lal Nagin Chand & Co.
5. Rakshit, P. C. (1988). Physical chemistry (5th ed.; 4th reprint, 1997). Sarat Book House.

DIFFERENTIAL EQUATIONS	
Course Code: BEB507	**Credit:** 04 (L-3, T-1, P-0)
Contact Hours: 60	**MM:** 100 (Int.: 30 + Ext.: 70)

Course Outline

Unit I: Introduction to Differential Equations

- Formation of Differential Equations: Definition, order, degree, and methods of formation.
- Equations of First Order and First Degree:
  - Separation of Variables Method
  - Homogeneous Equations
  - Linear Equations
  - Exact Equations

Unit II: Advanced First Order Differential Equations

- Differential Equations of the First Order but Not of the First Degree:
  - Clairaut's Equations
  - Singular Solutions
- Simultaneous Linear Differential Equations with Constant Coefficients

Unit III: Second Order Linear Differential Equations

- Linear Differential Equations of the Second Order:
  - Homogeneous Linear Differential Equations
  - Methods of Solution, including Variation of Parameters
- Series Solutions of Second Order Differential Equations: Power series method.

Unit IV: Special Functions and Partial Differential Equations

- Legendre and Bessel Functions: Definitions, properties, and applications (Pn and Jn only).
- Partial Differential Equations:
  - Order, Degree, and Formation of Partial Differential Equations
  - Partial Differential Equations of the First Order
    - Lagrange's Equations
    - Charpit's General Method
- Linear Partial Differential Equations with Constant Coefficients

Suggested Reading:

1. Ghosh, A. (2016). Differential Equations and Their Applications. New Delhi: Cengage Learning India.
2. Gupta, R. K., & Sharma, S. (2018). Differential Equations. New Delhi: PHI.
3. Jain, P. C., & Iyengar, S. R. K. (2018). Advanced Engineering Mathematics. New Delhi: Narosa Publishing House.
4. Kumar, S. (2020). Differential Equations: Theory and Applications. New Delhi: Wiley India.
5. Malik, S. C., & Savita, (2014). Differential Equations. New Delhi: Wiley India.
6. Ramana, B. V. (2017). Higher Engineering Mathematics. New Delhi: Tata McGraw-Hill Education.
7. Singh, S. (2017). Differential Equations. New Delhi: Tata McGraw-Hill Education.

ATOMIC AND NUCLEAR PHYSICS	
Course Code: BEB508	**Credit:** 04 (L-3, T-1, P-0)
Contact Hours: 60	**MM:** 100 (Int.: 30 + Ext.: 70)

Course Outline

Unit I: Atomic Physics

- Introduction to atomic models
  - Bohr's atom model
  - Summerfield's relativistic atom model
  - Vector atom model
  - Quantum numbers associated with the vector atom model
- L-S and j-j couplings
- Magnetic dipole moment due to orbital motion of the electron
- Magnetic dipole moment due to spin, Stern-Gerlach experiment

Unit II: Nuclear Physics

- General Properties of the Nucleus
- Mass defect, binding energy, semi empirical mass formula charges, Size, Spin and Magnetic moment
- Elementary idea of Nuclear Forces Nuclear Models: Liquid drop model and Shell model & magic numbers

Unit III: Natural Radioactivity

- Fundamental laws of radioactivity
- Soddy-Fajan's displacement law and law of radioactive disintegration
- Basic ideas about α, β and γ decay
- Theory & applications of fission & fusion (Qualitative)

Unit IV: Accelerators and Detectors

- Van-de Graff Generator
- Cyclotron
- Betatron,
- GM counter, Scintillation counter and Neutron detectors

Suggested Reading:

Textbook

1. Beiser, A. (1987). Concepts of modern physics. McGraw-Hill Book Company.
2. Littlefield, T. A., & Thoreley, N. (n.d.). Atomic and nuclear physics. Engineering Language Book Society.

Reference Books

1. Banwell, C. N. (n.d.). Molecular spectroscopy. McGraw-Hill.
2. Ghoshal, S. N. (n.d.). Nuclear physics. S. Chand & Co.
3. Kaplan, I. (n.d.). Nuclear physics. Oxford University Press.
4. Omar, M. A. (1999). Elementary solid-state physics: Principles and applications. Pearson Education.
5. Tayal, D. C. (n.d.). Nuclear physics. Himalaya Publishing House.

ECONOMIC ZOOLOGY, MICROBIOLOGY AND IMMUNOLOGY	
Course Code: BEB509	**Credit:** 04 (L-3, T-1, P-0)
Contact Hours: 60	**MM:** 100 (Int.: 30 + Ext.: 70)

Course Outline

Unit I: Aquaculture

- Introduction and scope of Economic Zoology; Edible species of fishes
- Fish culture: Sources of fish feeds and induced breeding, Cultivable fish species, Fish by-products.
- Edible species of prawn, lobsters and molluscs
- Shell fish farming: Prawn and pearl oyster

Unit II: Applied Entomology, Poultry and Animal Husbandry

- Brief account of Sericulture, Apiculture and Lac-culture
- Poultry industry and commercially important poultry breeds in India
- Breeds of cattle and buffaloes, Dairy farming in India, Milk production and pasteurization.
- Meat, leather and wool industries, their production and export potentials

Unit III: Microbiology

- Systematic position of microbes in biological world, classification of microorganisms
- A general account and economic importance of following microbial groups: Bacteria; Cynobacteria; ; Viruses; Fungi; Protists

Unit IV: Immunology

- A comparative account of innate and adaptive immunity
- Cells and organs of immune system
- Antigen vs Immunogen and antigenicity, immunogenicity, adjuvants and haptens, factors influencing immunogenicity, B and T-cell epitopes.
- Immunoglobulins: structure, classes and function, Antigenic determinants on immunoglobulins
- MHC and immune responsiveness, complement system and its activation
- Elementary idea of Hypersensitivity, Immune disorders and Vaccines

Suggested Reading:

1. Gangal, S., & Sontakke, S. (n.d.). Textbook of basic and clinical immunology. University Press.
2. Kindt, T. J., Goldsby, R. A., & Osborne, B. A. (n.d.). Kuby immunology. W. H. Freeman.
3. Pelczar, M. J. Jr., Chan, E. C. S., & Krieg, N. R. (n.d.). Microbiology. Tata McGraw-Hill.
4. Pillay, T. V. R. (n.d.). Aquaculture: Principles and practice. Wiley-Blackwell.
5. Santhanam, E., Sukumaran, N., & Natarajan, P. (n.d.). A manual of freshwater aquaculture. Oxford & IBH.
6. Shukla, G. S., & Upadhyay, V. B. (n.d.). Economic zoology. Rastogi Publications.
7. Sumbali, G., & Mehrotra, R. S. (n.d.). Principles of microbiology. Tata McGraw-Hill.
8. Tortora, G. J., Funke, B. R., & Case, C. L. (n.d.). Microbiology: An introduction. Pearson.

CYTOGENETICS, PLANT PATHOLOGY AND ENVIRONMENTAL BOTANY	
Course Code: BEB510	**Credit:** 04 (L-3, T-1, P-0)
Contact Hours: 60	**MM:** 100 (Int.: 30 + Ext.: 70)

Course Outline

Unit I: Cytogenetics: Chromatin Structure and Chromosome Organization

- Chromatin Structure and Chromosome Organization:
  - Classes of DNA
  - Chromosomal Proteins: Histones and Their Modifications
  - Non-Histone Proteins
  - Scaffold/Matrix Proteins
- Giant Chromosomes:
  - Models for Studies on Chromosome Organization and Gene Expression

Unit II: Cytogenetics: Chromosomal Aberrations and Variation in Chromosome Number

- Variation in Chromosome Structure (Chromosomal Aberrations):
  - Definition and Origin
  - Cytological and Genetic Effects of:
    - Deletions
    - Duplications
    - Inversions
    - Translocations
- Variation in Chromosome Number:
  - Origin and Production
  - Morphological and Cytological Features
  - Applications in Crop Improvement and Evolution of:
    - Aneuploids
    - Euploids (Monoploids, Autopolyploids, and Allopolyploids

Unit III: Plant Pathology

- History and scope of plant pathology, Modes of infection and physiology of parasitism, Mechanisms of host-pathogen interactions
- Transmission and spread of plant diseases, Methods of plant disease control
- Causal organism, symptoms, disease cycle and control measures of the following plant diseases:
  - Green ear disease of bajra
  - Downy mildew of crucifers
  - Powdery mildew of Sheesham,
  - Rusts of pea and linseed,
  - Smut of bajra,
  - Wilt of tomato
  - Mosaic of sugarcane
  - Little leaf of brinjal.

Unit IV: Environmental Botany

- Principles of phytogeography, endemism, hotspots
- Phyto-geogarphical divisions of India: vegetation of North India
- Mineral resources of Planet Earth, Conservation of Mineral Resources
- Forests: global forest wealth, importance of forests.

Suggested Reading:

1. Davis, P. H., & Heywood, V. H. (1963). Principles of angiosperms taxonomy. London: Oliver and Boyd.
2. Gifford, E. M., & Foster, A. S. (1988). Morphology and evolution of vascular plants. New York: W.H. Freeman & Company.
3. Heywood, V. H., & Moore, D. M. (Eds.). (1984). Current concepts in plant taxonomy. London: Academic Press.
4. Lea, P. J., & Leegood, R. C. (1999). Plant biochemistry and molecular biology. Chichester, England: John Wiley & Sons.
5. Old, R. W., & Primrose, S. B. (1989). Principles of gene manipulation. Oxford, UK: Blackwell Scientific Publications.

CHEMISTRY LAB V	
Course Code: BEB551	**Credit:** 01 (L-0, T-0, P-2)
Contact Hours: 30	**MM:** 25 (Int.: 10 + Ext.: 15)

LIST OF EXPERIMENTS

(i) To determine the Viscosity of given liquid at room temperature by using Ostwald's. viscometer.
(ii) Determine the strength of given solution of HCI with standard NaOH solution.
(iii) To determine the concentration of given CuSO4 solution calorimetrically.
(iv) To determine the heat of solution of given hydrated salt by solubility.
(v) To determine the ionization constant of a weak acid conductometrically.
(vi) Determination of water equivalent of a calorimeter.

Note: Experiments may be added/ deleted subject to availability of time and facilities

Suggested Reading:

1. An Advanced Course in Practical Chemistry by A. K. Nad, B. Mahapatra and A. Ghoshal, New Central Book Agency (P) Ltd.
2. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.
3. Practical Workbook Chemistry (Honours), UGBS, Chemistry, University of Calcutta, 2015.

PHYSICS LAB V	
Course Code: BEB552	**Credit:** 01 (L-0, T-0, P-2)
Contact Hours: 30	**MM:** 25 (Int.: 10 + Ext.: 15)

LIST OF EXPERIMENTS

List of experiments (Perform Any Eight)

1. Verification of Stefan's Law: Determine the value of Stefan's constant through experimental verification.
2. Characteristics of a Photodiode: Study the current-voltage characteristics of a photodiode and analyze its response to different light intensities.
3. Verification of Inverse Square Law for Light: Use a photocell as a photometer to verify the inverse square law of light intensity.
4. Ionization Potential of Gas: Determine the ionization potential of a given gas (Xenon) through experimental methods.
5. Comparison of Illuminating Powers: Compare the illuminating powers of two given bulbs using a photocell.
6. Absorption Coefficient of a Liquid: Determine the absorption coefficient of a given liquid (or solution) using a photocell.
7. Characteristic Curves of a Photoelectric Cell: Plot the characteristic curves of a photoelectric cell and determine the stopping potential.
8. PE Hysteresis Loop of Ferroelectric Crystal: Study the polarization-electric (PE) hysteresis loop of a ferroelectric crystal.
9. Measurement of Magnetic Susceptibility: Measure the magnetic susceptibility of solids and liquids using appropriate techniques.
10. Determination of Low Resistance by Carey Foster's Bridge: Measure low resistance using Carey Foster's bridge.
11. Determination of Low Resistance by Potentiometer: Measure low resistance using a potentiometer.

Note: Experiments may be added/deleted subject to availability of time and facilities

Suggested Reading:

1. Geeta Sanon. (2007). BSc practical physics (1st ed.). R. Chand & Co.
2. Indu Prakash, & Ramakrishna. A text book of practical physics (Vol. 1 & Vol. 2). Kitab Mahal.
3. Khandelwal, D. P. (n.d.). A laboratory manual of physics for undergraduate classes. Vani Publication House.
4. Worsnop, B. L., & Flint, H. T. Advanced practical physics. Asia Publishing House.

LIFE SCIENCE LAB V	
Course Code: BEB553	**Credit:** 01 (L-0, T-0, P-2)
Contact Hours: 30	**MM:** 25 (Int.: 10 + Ext.: 15)

LIST OF PRACTICALS

Practicals (Zoology):

1. Study of Plasmodium vivax, Entanweba histolytica, Trypanosoma gambiense, Ancylostoma duodenale and Wuchereria bancrolli and their life stages through permanent slides/photomicrographs or specimens.
2. Different types of important edible fishes of India: Catla catla, Labeo rohita, Cirrhinus mrigala, Cyprinus carpio, Clarias bartachus, Puntius sarana, Wallago attu, Heteropneustes fossilis, Latescalcarifer, Anabas testudineus, Pampus argenteus, Polynemusparadiseus.
3. Life history of silkworm, honeybee and lac insect.
4. Study of identifying features of lymphoid organs through permanent slides/photographs

Practicals (Botany):

1. To demonstrate and measure the rate of transpiration. (By Bell jar/farmer's potometer).
2. To measure un-equal transpiration from two surfaces of a leaf.
3. To compare the rate of water absorbed and the water lost in transpiration.
4. To prove that CO2 is evolved in aerobic respiration.
5. Demonstration of the an-aerobic respiration.
6. To show the role of gibberellic acid in the germination of seeds.
7. To separate and examine chlorophyll pigments from five different plant species.
8. To study the effects of some pollutants on aquatic micro-organisms.

Suggested Reading:

1. A manual of Freshwater Aquaculture – E. Santhanam, N. Sukumaran & P. Natarajan (Oxford IBH)
2. Economic Zoology – G. S. Shukla & V. B. Upadhyay (Rastogi)
3. Practical Botany, Vol. I, II, III by H.N. Srivastava, Pradeep Publications, India.

PEDAGOGY OF PHYSICAL SCIENCE I	
Course Code: BED503	**Credit:** 02 (L-2, T-0, P-0)
Contact Hours: 30	**MM:** 50 (Int.: 15 + Ext.: 35)

Course Outline

Unit I: Nature, Scope and Historical Perspective of Physical Sciences

- Nature, scope, and importance of Physical Sciences.
- Historical perspective of Physical Sciences.
- Contributions of Indian (ancient and modern) and other scientists.
- Recommendations/suggestions of various committees, commissions, and policies in reference to Physical Sciences.

Unit II: Aims and Objectives of Physical Sciences

- Aims and objectives of teaching Physical Sciences.
- Learning outcomes and competencies of teaching Physical Sciences at secondary stage.
- Linkages of Physical Sciences with other school subjects and place of the Physical Sciences in school curriculum.
- Values of Physical Sciences: scientific attitude and appreciating other systems of knowledge / alternative knowledge systems.

Unit III: Pedagogical Aspects of Physical Sciences

- Implication of various approaches - inductive deductive, constructivist, experiential learning, art integrated learning, sports integrated learning, blended learning, interdisciplinary and multidisciplinary approaches in Physical Sciences.
- Analytical pedagogical concerns in teaching of Physical Sciences for higher order thinking skills such as critical, creative, communication, decision making, reflective.
- Methods of teaching learning Physical Sciences: learner-centric and group-centric, lecture cum demonstration, activity based, discussion, problem-solving, laboratory, stem and steam, project based, scientific inquiry, hands on activity, discovery, experimentation, concept-mapping, collaborative and cooperative learning.
- Non-Formal approaches: Assignment, tutorials, independent self-study, seminar/conferences, workshop, Science clubs, Science exhibitions, Science fair, Science museum, herbarium, vivarium and scientific hobbies and its advantages

Suggested Reading:

1. Aggarwal, J. C. (2008). Essentials of Educational Technology: Teaching Learning Innovations in Education (2nd ed.). Vikas Publishing House.
2. Anderson, L. W., & Krathwohl, D. R. (2001). A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives. Pearson.
3. Bloom, B. S. (1956). Taxonomy of Educational Objectives: The Classification of Educational Goals. David McKay.
4. Chauhan, S. S. (2008). Innovations in Teaching-Learning Process. Vikas Publishing House.
5. Das, R. C. (1992). Science Teaching in Schools. Sterling Publishers.

6. Gupta, S. K. (1985). Teaching of Science Education. Vikas Publishing House.
7. Mangal, S. K. (2014). Teaching of Physical Science. PHI Learning Pvt. Ltd.
8. Mohan, R. (2019). Innovative Science Teaching. PHI Learning Pvt. Ltd.
9. NCERT. (2005). National Curriculum Framework 2005. National Council of Educational Research and Training.
10. NCERT. (2008). Science Textbooks for Classes VI-XII. National Council of Educational Research and Training.
11. Sharma, R. C. (2006). Modern Science Teaching (6th ed.). Dhanpat Rai Publishing.
12. Siddiqui, N., & Siddiqui, M. N. (2008). Teaching of Science: Today and Tomorrow. Doaba House.
13. Singh, U. K., & Nayak, A. K. (2007). Science Education and Evaluation. Common Wealth Publishers.
14. Thorndike, R. M. (1997). Measurement and Evaluation in Psychology and Education (6th ed.). Prentice Hall.
15. Yadav, M. S. (2003). Teaching of Science. Anmol Publications Pvt. Ltd.

PEDAGOGY OF MATHEMATICS I	
Course Code: BED504	**Credit:** 02 (L-2, T-0, P-0)
Contact Hours: 30	**MM:** 50 (Int.: 15 + Ext.: 35)

Course Outline

Unit I: Nature, Scope and Historical Perspective of Mathematics

- Development of Mathematics from a historical perspective.
- Nature of Mathematical Knowledge – Axioms and Postulates, Conjectures, Proofs in Mathematics: inductive - deductive reasoning, theorems, mathematical modeling.
- Importance of Mathematics knowledge in everyday life.
- Recommendations of various committees, commissions and policies related to Mathematics education at Secondary stage (especially in National Education Policies and National Curriculum Frameworks).

Unit II: Aims and Objectives of Teaching Mathematics

- Aims and objectives of teaching Mathematics at secondary stage.
- Learning outcomes and competencies of teaching Mathematics at secondary stage.
- Linkages of Mathematics with other school subjects and place in school curriculum.
- Inculcation of values through teaching of Mathematics.

Unit III: Pedagogical Aspects of Mathematics

- Implication of various approaches of teaching Mathematics – inductive deductive, analytical synthetical, constructivist, blended learning, experiential learning, transdisciplinary, interdisciplinary, and multidisciplinary.
- Learner-centric and participative methods of teaching of Mathematics: lecture cum demonstration, problem-solving, laboratory, project based.
- Analytical pedagogical concerns in teaching of Mathematics for higher order thinking skills such as critical, creative, decision making, reflective, collaborative, and cooperative.
- Techniques of teaching learning Mathematics: oral, written, drill work, homework, self-study, group study, supervised study, concept-mapping, learning, art and sports integrated learning.

Suggested Reading:

1. Arora, S. (2010). Teaching of Mathematics. New Delhi: Rajat Publications.
2. Ball, D. L., & Bass, H. (2003). Making mathematics reasonable in school. New York: Teachers College Press.
3. Bhanot, R. (2015). Pedagogy of Mathematics: Teaching Mathematics effectively. New Delhi: Rajat Publications.
4. Chambers, P., & Timlin, R. (2019). Teaching Mathematics in the Secondary School. London: Sage Publications.
5. Kumar, S. (2014). Teaching of Mathematics: Modern Methods and Approaches. New Delhi: Anmol Publications.
6. NCERT. (2005). National Curriculum Framework 2005. New Delhi: National Council of Educational Research and Training.
7. NCERT. (2006). Position Paper: National Focus Group on Teaching of Mathematics. New Delhi: National Council of Educational Research and Training.

8. NCTE. (2009). National Curriculum Framework for Teacher Education. New Delhi: National Council for Teacher Education.
9. Polya, G. (1957). How to Solve It: A New Aspect of Mathematical Method. Princeton, NJ: Princeton University Press.
10. Shukla, R. P. (2013). Teaching of Mathematics. New Delhi: APH Publishing Corporation.
11. Sidhu, K. S. (2006). The Teaching of Mathematics. New Delhi: Sterling Publishers.
12. Van de Walle, J. A., Karp, K. S., & Bay-Williams, J. M. (2013). Elementary and Middle School Mathematics: Teaching Developmentally. Boston: Pearson.
13. Yadav, M. S. (2018). Teaching of Mathematics at Secondary Level. New Delhi: Anmol Publications.

PEDAGOGY OF BIOLOGICAL SCIENCE I	
Course Code: BED505	**Credit:** 02 (L-2, T-0, P-0)
Contact Hours: 30	**MM:** 50 (Int.: 15 + Ext.: 35)

Course Outline

Unit I: Nature, Scope and Historical Perspective of Biological Sciences

- Nature, scope, and importance of Biological Sciences.
- Historical perspective of Biological Sciences.
- Contributions of Indian (ancient and modern) and other scientists.
- Recommendations/suggestions of various committees, commissions, and policies in reference to Biological Sciences.

Unit II: Aims and Objectives of Biological Sciences

- Aims and objectives of teaching biological science as a component of multidisciplinary science.
- Learning outcomes and competencies of teaching Biological Sciences at secondary stage.
- Linkages of Biological Sciences with other school subjects and place of the Biological Sciences in school curriculum.
- Values of Biological Sciences; ethical, environmental and sustainability concerns.

Unit III: Pedagogical Aspects of Biological Sciences

- Implication of various approaches – inductive deductive, constructivist, experiential, art-integrated, blended learning, interdisciplinary and multidisciplinary approaches, stimulating the spirit of investigation and enquiry.
- Analytical pedagogical concerns in teaching of physical sciences for higher order thinking skills such as critical, creative, communication, decision making, reflective.
- Methods of teaching learning Biological Sciences: learner-centric and group-centric, lecture cum demonstration, activity based, discussion, problem-solving, laboratory and hands on activity based, sports- integrated, project based, inquiry, discovery, experimentation, concept-mapping, collaborative and cooperative learning; stem and steam concept.
- Non-Formal approaches: Assignment, tutorials, independent self-study, seminar/conferences, workshop, Science clubs, Science exhibitions, Science fair, Science museum, herbarium, vivarium and scientific hobbies and its advantages

Suggested Reading:

1. Agarwal, D. D. (2004). Modern methods of teaching biology. New Delhi: Sarup & Sons.
2. Anderson, R. D., & Krathwohl, D. R. (2001). A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives. New York: Longman.
3. Bhaskarachary, B. (2018). Biology education in India: Pedagogical and content issues. New Delhi: Orient BlackSwan.
4. Chauhan, S. S. (2008). Innovation in teaching-learning process. New Delhi: Vikas Publishing House.

5. Das, R. C. (2006). Science teaching in schools. New Delhi: Sterling Publishers.
6. Kaur, B., & Rani, M. (2017). Pedagogy of biological science. New Delhi: Lakshmi Publishers.
7. Mangal, S. K., & Mangal, U. (2009). Teaching of biological sciences. New Delhi: PHI Learning Private Limited.
8. NCERT. (2005). National curriculum framework 2005. New Delhi: National Council of Educational Research and Training.
9. Sharma, R. C., & Shukla, M. (2012). Teaching of life sciences. New Delhi: Dhanpat Rai Publishing Company.
10. Singh, U. N., & Singh, Y. K. (2007). Science education. New Delhi: APH Publishing Corporation.
11. Tewari, S. D., & Tewari, B. (2010). Teaching of biological science. New Delhi: Ashish Publishing House.
12. Yadav, M. S. (2004). Teaching of biology. New Delhi: Anmol Publications.

GENERAL HINDI	
Course Code: BED506	**Credit:** 02 (L-2, T-0, P-0)
Contact Hours: 30	**MM:** 50 (Int.: 15 + Ext.: 35)

पाठ्यचर्या की अंतर्वस्तु

इकाई I: भाषा की आधारभूत संरचना एवं उच्चारण तथा ध्वनि -व्यवस्था

- हिन्दी भाषा की समस्त ध्वनियाँ, संयुक्ताक्षरों, संयुक्त व्यंजनों, अनुस्वार एवं चन्द्रबिन्दु में अंतर।
- विलोम शब्द।
- पर्यायवाची शब्द।
- समास, समास विग्रह एवं समास के भेद।

इकाई II: भाषा शिक्षण

- भाषा अध्यापन के सिद्धांत।
- भाषा के कार्य तथा उपकरण के रूप में इसका उपयोग।
- व्याकरण और मौखिक क्षमता संबंधी वाले गद्यांश (तार्किक या साहित्यिक या कथा या वैज्ञानिक)।

इकाई III: भाषा कौशल एवं भाषा शिक्षण सहायक सामग्री

- भाषा की समझ और दक्षता का मूल्यांकन: श्रवण, भाषण, वाचन और लेखन।
- शिक्षण-अधिगम सामग्री: पाठ्यपुस्तक, बहु-मीडिया सामग्री, कक्षा के बहुभाषी संसाधन।
- उपचारात्मक शिक्षण।

पाठ्य हेतु सुझाव:

- वर्मा, ओंकार नाथ. (2020). सामान्य हिन्दी, अरिहन्त पब्लिकेशन लिमिटेड. इंडिया.
- तिवारी, डॉ. भोलानाथ (2011). हिन्दी भाषा की संरचना, वाणी प्रकाशन.
- श्रीवास्तव, रविंद्रनाथ (2015). हिन्दी भाषा का समाजशास्त्र. राधाकृष्ण प्रकाशन.
- प्रकाश, आर., शर्मा, एस., एवं सरलता (2022) हिन्दी भाषा संरचना और भाषा विज्ञान, अन्नुग्या बुक्स.

MICRO TEACHING	
Course Code: BED551	**Credit:** 02 (L-0, T-0, P-2)
Contact Hours: 30	**MM:** 50 (Int.: 15 + Ext.: 35)

Course Outline

Module 1: Introduction to Micro Teaching

- Definition and importance of micro teaching in teacher training.
- Objectives and components of micro teaching.
- Overview of the micro teaching cycle: planning, teaching, observing, and reflecting.

Module 2: Teaching Skills and Techniques

- Identification and explanation of essential teaching skills (Set Induction, Explanation, Illustration, Questioning, Probing, Black Board Writing and Reinforcement).
- Demonstrating specific skills through role-play and peer teaching.
- Skill practice: students will practice selected skills in pairs or small groups.

Module 3: Planning and Conducting Micro Teaching Sessions

- Designing micro teaching lessons: selecting content, objectives, and appropriate teaching aids.
- Conducting micro teaching sessions (individual presentations of 10-15 minutes).
- Observing peers and providing constructive feedback based on set criteria.

Module 4: Reflection and Improvement

- Analyzing feedback received from peers and instructors.
- Reflective practice: developing an action plan for improvement based on feedback.
- Final presentation: demonstrating improved teaching skills in a second micro teaching session.

Assessment

- **Micro Teaching Sessions (50%)**: Evaluation of two micro teaching sessions, including planning and delivery.
- **Peer Feedback (20%)**: Participation in peer observations and feedback sessions.
- **Reflection Report (30%)**: A reflective report on the micro teaching experience, including feedback analysis and personal growth.
- **Internal Assessment:** Preparation of Micro Lesson Plans and Reflection Report of all internal components.
- **External Assessment:** Appearing in external viva and demonstration of a skill along with all Micro Lesson Plans and Reflection Reports.

DRAMA AND ARTS IN EDUCATION	
Course Code: BED552	**Credit:** 02 (L-0, T-0, P-2)
Contact Hours: 30	**MM:** 50 (Int.: 15 + Ext.: 35)

Course Outline

Module 1: Introduction to Drama and Arts in Education

- Definition and significance of drama and arts in education.
- Historical perspectives and contemporary practices in arts education.

Module 2: Techniques and Approaches in Drama

- Overview of drama techniques: improvisation, role-play, tableau, and story dramatization.
- Planning and facilitating drama-based activities in the classroom.
- Using drama to develop communication skills, teamwork, and emotional intelligence.

Module 3: Integrating Arts in the Curriculum

- Exploring various art forms: visual arts, music, dance, and creative writing.
- Designing interdisciplinary lessons that incorporate drama and arts.
- Creating learning experiences that foster creativity, critical thinking, and cultural awareness.

Module 4: Practical Applications and Reflections

- Conducting arts-based workshops and drama sessions with peers.
- Reflective practice: evaluating the impact of drama and arts on student learning.
- Preparing a portfolio of lesson plans, activities, and reflections on teaching practices.

Assessment

- **Practical Workshops (50%):** Evaluation based on participation in drama and arts workshops, including planning and execution.
- **Arts-Based Lesson Plans (30%):** Submission of two lesson plans incorporating drama and arts in various subjects.
- **Reflection Report (20%):** A reflective report on the experiences and learnings from the course, including feedback from peers and self-evaluation.
- **Internal Assessment:** Preparation of Art-Based Lesson Plans and Reflection Report of all internal components.
- **External Assessment:** Appearing in external viva along with portfolio of art-based Lesson Plans and Reflection Reports.

DEVELOPING LESSON PLANS	
Course Code: BED553	**Credit:** 02 (L-, T-0, P-2)
Contact Hours: 30	**MM:** 50 (Int.: 15 + Ext.: 35)

Course Outline

Module 1: Foundations of Lesson Planning

- Understanding the components of a lesson plan: objectives, materials, procedure, and assessment.
- Exploring lesson planning models (Herbart Approach, Blooms Approach, RCEM Approach, 5E Model).
- Setting SMART (Specific, Measurable, Achievable, Relevant, Time-bound) objectives.
- Aligning lesson plans with curriculum standards and learning outcomes.
    - **Activities:**
        - Developing sample objectives and aligning them with course standards.

Module 2: Designing Lesson Content and Instructional Strategies

- Selecting instructional strategies: lecture, discussion, group work, cooperative learning.
- Creating engaging content to cater to diverse learning styles (visual, auditory, kinesthetic).
- Planning learning activities to enhance student engagement and understanding.
    - **Activities:**
        - Drafting a lesson outline with a focus on diverse instructional strategies.
        - Preparation of Lesson Plans

Module 3: Implementation and Reflection

- Peer teaching sessions: Presenting developed lesson plans in small groups.
- Observing peer teaching and providing constructive feedback.
- Reflective practice: Analyzing the effectiveness of lesson plans and teaching strategies.

Module 4: Evaluation and Revision of Lesson Plans

- Revising lesson plans based on feedback and self-assessment.
- Developing a portfolio (pool) of lesson plans for future use.

Assessment

- **Lesson Plan Development (50%)**: Submission of a minimum of four lesson plans (two each of teaching subjects).
- **Peer Teaching Session (30%)**: Presentation of one lesson plan and peer feedback.
- **Reflection Report (20%)**: A reflective report on the lesson planning process and peer teaching experience.

Internal Assessment: Preparation of Lesson Plan Portfolio and Reflection Report of all internal components

External Assessment: Appearing in external viva along with all internal lesson plan portfolios and reflection reports.

INVERTIS
UNIVERSITY BAREILLY

SEMESTER - VI

BASICS OF PHYSICAL CHEMISTRY II	
Course Code: BEB606	**Credit:** 04 (L-3, T-1, P-0)
Contact Hours: 60	**MM:** 100 (Int.: 30 + Ext.: 70)

Course Outline

Unit I: Electrochemistry

- Arrhenius theory of electrolytic dissociation. Kohlrausch law of independent migration of ions.
- Applications of conductance measurement: (i) degree of dissociation of weak electrolytes, (ii) ionic product of water (iii) solubility and solubility product of sparingly soluble salts, (iv) conductometric titrations, and (v) hydrolysis constants of salts.
- Chemical cells, reversible and irreversible cells with examples.
- Electromotive force of a cell and its measurement, Nernst equation; Standard electrode (reduction) potential and its application to different kinds of half-cells.

Unit II: Solution and Colligative Properties

- Dilute solutions, Raoult's and Henry's Laws and their applications.
- Lowering of vapour pressure by a non-volatile solute, determination of molar masses from vapour pressure lowering,
- Osmosis and Osmotic pressure, the laws of osmotic pressure, isotonic solution, Van't Hoff equation for osmotic pressure of dilute ideal solution.
- Elevation of boiling point by a non-volatile solute and determination of Molar masses,
- Depression of freezing point by a non-volatile solute and determination of Molar masses.

Unit III: Chemical Kinetics

- 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,
- Temperature dependence of reaction rates; Arrhenius equation; activation energy.
- Collision theory of reaction rates, qualitative treatment of the theory of absolute reaction rates.

Unit IV: Colloids & Surface Phenomenon

- Classification: Lyophobic and lyophilic sols, electrical double layer, electrophoresis, origin of charge on colloidal particles, Zeta potential, protective colloids, gold number, applications.
- Heat of adsorption, Freundlich adsorption isotherm, physical adsorption and chemisorption, Langmuir's theory.

Suggested Reading:

1. Atkins, P. W., & de Paula, J. (2006). Atkins' Physical Chemistry (8th ed.). Oxford University Press.
2. Laidler, K. J., & Meiser, J. M. (1999). Physical Chemistry (3rd ed., International ed.). Houghton Mifflin.
3. Puri, B. R., Sharma, L. R., & Pathania, M. S. (1998). Principles of Physical Chemistry (37th ed.). Shoban Lal Nagin Chand & Co.
4. Rakshit, P. C. (1988). Physical Chemistry (5th ed., 4th reprint, 1997). Sarat Book House.

STATISTICS AND NUMERICAL ANALYSIS	
Course Code: BEB607	**Credit:** 04 (L-3, T-1, P-0)
Contact Hours: 60	**MM:** 100 (Int.: 30 + Ext.: 70)

Course Outline

Unit I: Descriptive Statistics

- Measures of Central Tendency: Mean, Median, and Mode
- Measures of Dispersion: Range, Quartile, Semi-Interquartile Deviation, Standard Deviation, Coefficient of Variance

Unit II: Probability and Inferential Statistics

- Correlation and Regression Analysis
- Analysis of Variance (ANOVA)
- Hypothesis Testing: f-test, t-test, z-test
- Discrete Distributions

Unit III: Fundamentals of Numerical Analysis

- Difference Operators: Shift, Forward, and Backward Difference Operators and Their Relationships
- Fundamental Theorem of Difference Calculus
- Interpolation Techniques: Newton-Gregory Forward and Backward Interpolation, Divided Differences
- Newton's Divided Difference and Lagrange's Interpolation Formulas

Unit IV: Numerical Methods for Calculus and Equations

- Numerical Differentiation and Integration: General Quadrature Formula, Trapezoidal and Simpson's Rules
- Numerical Solutions of First-Order Differential Equations: Euler's Method, Picard's Method, Runge-Kutta Method
- Solving Transcendental and Polynomial Equations: Iteration, Bisection, Regula-Falsi, and Newton-Raphson Methods

Suggested Reading:

1. Gupta, S. C., & Kapoor, V. K. (2021). Fundamentals of Mathematical Statistics. Sultan Chand & Sons.
2. Jain, M. K., Iyengar, S. R. K., & Jain, R. K. (2012). Numerical Methods for Scientific and Engineering Computation. New Age International Publishers.
3. Kapoor, J. N., & Saxena, H. C. (2010). Mathematical Statistics. S. Chand & Company.
4. Sastry, S. S. (2006). Introductory Methods of Numerical Analysis. Prentice Hall of India.
5. Sharma, J. N. (2004). Numerical Methods for Engineers and Scientists. Narosa Publishing House.
6. Singh, R. K., & Verma, A. (2018). Elements of Numerical Analysis. McGraw-Hill Education.

MATHEMATICAL AND QUANTUM PHYSICS	
Course Code: BEB608	**Credit:** 04 (L-3, T-1, P-0)
Contact Hours: 60	**MM:** 100 (Int.: 30 + Ext.: 70)

Course Outline

Unit I: Vector Calculus

- Introduction to Vectors: Definition and significance
- Vector Operations: Addition, subtraction, and multiplication
- Applications of Vectors in Physics: Force, velocity, and acceleration
- Del Operator: Gradient, Divergence, and Curl
- Physical Significance of Del Operator
- Laplace and Poisson Equations: Formulation and applications

Unit II: Special Functions

- Legendre Equation:
  - Solution of Legendre's Equation
  - Rodrigue's Formulae
  - Generating Functions
  - Recurrence Relations
  - Orthogonality of Legendre Polynomials

Unit III: Fourier Series

- Introduction to Fourier Series: Concept and applications
- Evaluation of Fourier Coefficients
- Even and Odd Functions
- Sine and Cosine Series
- Applications: Square wave, saw-tooth wave, triangular wave

Unit IV: Quantum Mechanics

- Particles and Waves:
  - Wave Nature of Matter: de Broglie Hypothesis and Wave-Particle Duality
  - Davisson-Germer Experiment
  - Wave Description of Particles: Wave packets, Group and Phase Velocities
  - Wave Function: Definition and Physical Significance
- Heisenberg Uncertainty Principle:
  - Introduction and Derivation from Wave Packets
  - Applications: Non-existence of Electrons Inside the Nucleus, Bohr Radius
- Schrödinger Equation:
  - Properties of Wave Function
  - Derivation of Time-Independent and Time-Dependent Schrödinger Wave Equations
  - Applications:
    - Motion of Particle in a One-Dimensional Box
    - Potential Step Problem
    - Barrier Penetration Problem

Suggested Reading:

Textbooks

1. Courant, R., & Hilbert, D. (2008). Methods of Mathematical Physics: Partial Differential Equations. New Delhi: Wiley India.
2. Merzbacher, E. (1997). Quantum Mechanics (3rd ed.). New York: John Wiley & Sons.
3. Schiff, L. I. (1968). Quantum Mechanics (3rd ed.). New York: McGraw Hill.
4. Spiegel, M. R. (1974). Schaum's Outline of Theory and Problems of Fourier Analysis. New York: McGraw-Hill.

Reference Books

1. Crasemann, B., & Powell, J. L. (1965). Quantum Mechanics. Boston: Addison-Wesley.
2. Ghatak, A., & Lokanathan, S. (2004). Quantum Mechanics: Theory and Applications (5th ed.). New Delhi: Macmillan India.
3. Grewal, B. S. (2000). Higher Engineering Mathematics. New Delhi: Khanna Publishers.
4. Harper, C. (1995). Introduction to Mathematical Physics. New Delhi: Prentice Hall of India.
5. Kreyszig, E. (1985). Advanced Engineering Mathematics. New Delhi: Wiley Eastern Limited.
6. Prakash, S. (2000). Mathematical Physics. Meerut: Pragati Prakashan.

PHYSIOLOGY AND TOXICOLOGY, GENETICS AND BIOTECHNOLOGY	
Course Code: BEB609	**Credit:** 04 (L-3, T-1, P-0)
Contact Hours: 60	**MM:** 100 (Int.: 30 + Ext.: 70)

Course Outline

Unit I: Animal Physiology

- Digestive System - Mechanical and chemical digestion of food; Role of gastrointestinal hormones; Control and action of GI Tract secretions
- Respiration: Blood pigments: Role in oxygen transport, Oxygen dissociation curves and their physiological significances, Transport of CO2, Bohr and Haldane effect, Chloride shift
- Circulation: Cardiac cycle, Blood volume, cardiac out-put, Blood pressure and its regulation; Electrocardiogram, Autonomic control and chemical regulation of heart rate.
- Excretion: Structure of nephron, Physiology of Urine formation, Composition of normal urine
- Muscle: Types, Ultra structure of striated muscle, mechanism of muscle contraction
- Neuron and glia - Structure and function, Action potential, Origin and conduction of nerve impulse, Synapse and synaptic transmission.

Unit II: Toxicology

- Classification of toxicants, Dose-effect and dose response relationship; Biological and chemical factors that influence toxicity
- Toxic agents and their effects: Pesticides and Heavy Metals
- Determination of LC50 and LD50 Values
- Bioaccumulation and biomagnifications

Unit III: Genetics

- Mendel's experiments and Principles of Inheritance, Chromosome theory of inheritance,
- Incomplete dominance and co-dominance, Multiple alleles, Lethal alleles, Epistasis, Pleiotropy as exceptions of Mendel's laws.
- Linkage: complete and incomplete linkage
- Crossing over, significance of crossing over
- Sex linked inheritance

Unit IV: Biotechnology

- Introduction and scope of biotechnology
- Cloning vectors: Plasmids, Cosmids, Phagemids, Lambda Bacteriophage, M13, BAC, YAC, MAC and Expression vectors (characteristics only)
- Restriction enzymes: Nomenclature, detailed study of Type II restriction endonuclease
- Transformation techniques; Calcium chloride method and electroporation.
- Construction of genomic and cDNA libraries and screening by colony and plaque hybridization, Southern, Northern and Western blotting;
- DNA sequencing: Sanger method; Polymerase Chain Reaction, DNA Finger
- Printing and DNA micro array.

Suggested Reading:

1. Gardner, E. J. (2005). Genetics. New York, NY: John Wiley & Sons.
2. Gupta, P. K. (2016). Fundamentals of Toxicology. New Delhi: Narosa Publishing House.
3. Guyton, A. C. (1991). Textbook of Medical Physiology. Philadelphia, PA: Holt Saunders.
4. Kapoor, V. C. (2018). Toxicology. New Delhi: Narosa Publishing House.
5. Klug, W. S., & Cummings, M. K. (2019). Concepts of Genetics (12th ed.). Upper Saddle River, NJ: Pearson.
6. Meyers, R. A. (Ed.). (1995). Molecular Biology and Biotechnology. Weinheim, Germany: VCH Publishers.
7. Moyes, C. D., & Schulte, P. M. (2008). Principles of Animal Physiology (2nd ed.). San Francisco, CA: Pearson Benjamin Cummings.
8. Rastogi, V. B. (2008). Genetics. Meerut, India: Kedarnath Ramnath.
9. Rastogi, V. (2017). Textbook of Genetics. New Delhi: Kedar Nath Ram Nath.
10. Schmidt-Nielsen, K. (1997). Animal Physiology: Adaptation and Environment (5th ed.). Cambridge, UK: Cambridge University Press.
11. Snustad, D. P., & Simmons, M. J. (2015). Principles of Genetics (7th ed.). Hoboken, NJ: John Wiley & Sons.
12. Tortora, G. J., & Derrickson, B. H. (2014). Principles of Anatomy and Physiology (14th ed.). Hoboken, NJ: John Wiley & Sons.
13. Verma, P. S., & Agarwal, V. K. (2009). Genetic Engineering. New Delhi: S. Chand.

PLANT RESOURCE UTILIZATION, PALYNOLOGY AND BIOSTATISTICS	
Course Code: BEB610	**Credit:** 04 (L-3, T-1, P-0)
Contact Hours: 60	**MM:** 100 (Int.: 30 + Ext.: 70)

Course Outline

Unit I: Origin of Cultivated Plants

- Concept of centers of origin, their importance with reference to Vavilov's work
- Crop domestication and loss of genetic diversity;
- Evolution of new crops/varieties, importance of germplasm diversity.
- Role of dwarf varieties in green revolution

Unit II: Plant Resources

- Cereals; Wheat and Rice
- Brief account of millets and pseudocereals
- Legumes General account, importance to man and ecosystem, chief pulses grown in India.
- Fruits: Mango, Citrus
- Sugars and starches- Ratooning and mobilization of sugarcane-products and by-products of sugarcane industry
- Spices- saffron, clove, turmeric.
- Beverages-Tea, coffee and cocoa, their processing and some common adulterants
- Oils and Fats -General description with details of groundnut, coconut, linseed and Brassica spp
- Natural Rubber, Para Rubber, tapping and processing, Various substitutes of Para Rubber
- Drug Yielding Plants, Therapeutic and habit-forming drugs with special reference to Cinchona, Digitalis, Rauvolfia, Papaver and Cannabis
- Masticatories and Fumitories-Tobacco and Health hazards.

Unit III: Palynology

- An introductory Knowledge to Palynology, Morphology, Viability and Germination of Pollens.

Unit IV: Biostatistics

- Statistics, data, population, samples, parameters,
- Representation of Data: Tabular, Graphical
- Measures of central tendency: Arithmetic mean, mode, median
- Measures of dispersion: Range, mean deviation, variation, standard deviation
- Chi-square test for goodness of fit

Suggested Reading:

1. Davis, P. H., & Heywood, V. H. (1963). Principles of Angiosperm Taxonomy. London: Oliver and Boyd. New Delhi: New Age International Limited.
2. Gifford, E. M., & Foster, A. S. (1988). Morphology and Evolution of Vascular Plants. New York: W.H. Freeman & Company.
3. Kochhar, S. L. (2011). Economic Botany in the Tropics (4th ed.). New Delhi: Macmillan Publishers India Ltd.
4. Kumar, H. D. (2000). Molecular Biology (2nd ed.). New Delhi: Vikas Publishing House.
5. Old, R. W., & Primrose, S. B. (1989). Principles of Gene Manipulation. Oxford, UK: Blackwell Scientific Publications.
6. Zar, J. H. (2012). Biostatistical Analysis (4th ed.). U.S.A.: Pearson Publications.

CHEMISTRY LAB VI	
Course Code: BEB651	**Credit:** 01 (L-0, T-0, P-2)
Contact Hours: 30	**MM:** 25 (Int.: 10 + Ext.: 15)

LIST OF EXPERIMENTS

(i) Viscosity-composition curve for a binary liquid mixture.

(ii) Surface tension-composition curve for a binary liquid mixture.

(iii) Determination of indicator constant - colorimetry.

(iv) Determination of pH of a given solution using glass electrode.

(v) Beers Law - Determination of concentration of solution by colorimetry.

(vi) Order of reaction of I2 / Acetone / H+.

(vii) Equilibrium constant of methyl acetate hydrolysis reaction.

(viii) Dissociation constants of weak acid, base.

(ix) Conductometric titration: acid-base.

(x) Potentiometric titration: acid-base.

(xi) Kinetics of catalytic decomposition of H2O2.

(xii) Kinetics of acid-catalysed hydrolysis of sugar (chemical method).

Note: Experiments may be added/ deleted subject to availability of time and facilities

Suggested Reading:

1. An Advanced Course in Practical Chemistry by A. K. Nad, B. Mahapatra and A. Ghoshal, New Central Book Agency (P) Ltd.
2. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009

PHYSICS LAB VI	
Course Code: BEB652	**Credit:** 01 (L-0, T-0, P-2)
Contact Hours: 30	**MM:** 25 (Int.: 10 + Ext.: 15)

LIST OF EXPERIMENTS

List of experiments (Perform Any Eight)

1. Study The characteristics (FET)
2. Study The Characteristics Metal Oxide Semiconductor Field Effect Transistor (MOSFET)
3. To design an Inverting Amplifier of given gain using Op-amp 741 and to study its Frequency Response.
4. To design a Non-Inverting Amplifier of given gain using Op-amp 741 and to study its Frequency Response.
5. To design and study a precision Differential Amplifier of given I/O specification using Op-amp 741.
6. To design an A stable Multivibrator of given specifications using 555 Timer.
7. To determine the coefficient of thermal conductivity of a bad conductor by lee and charlton_s disc method.
8. To determine the value of e/m of an electron by helical (long solenoid) method.
9. To determine the value of Boltzmann Constant by studying Forward Characteristics of a Diode.
10. To study Hall effect and to calculate (i) Hall coefficient and (ii) Concentration of charge carrier
11. To determine the half-life period of given radioactive source using a G. M. counter.

Note: Experiments may be added/deleted subject to availability of time and facilities

Suggested Reading:

1. Geeta Sanon. (2007). BSc practical physics (1st ed.). R. Chand & Co.
2. Indu Prakash, & Ramakrishna. A text book of practical physics (Vol. 1 & Vol. 2). Kitab Mahal.
3. Khandelwal, D. P. (n.d.). A laboratory manual of physics for undergraduate classes. Vani Publication House.
4. Worsnop, B. L., & Flint, H. T. Advanced practical physics. Asia Publishing House.

LIFE SCIENCE LAB VI	
Course Code: BEB653	**Credit:** 01 (L-0, T-0, P-2)
Contact Hours: 30	**MM:** 25 (Int.: 10 + Ext.: 15)

LIST OF PRACTICALS

Practicals (Zoology):

1. Demonstration of counting of cells (blood and protozoan) by haemocytometer, haemoglobinometer.
2. Demonstration of pH meter, Colorimeter.
3. Experiments to be performed by candidates: Test for amylase.
4. Osmolarity of blood, Hemin crystals and test for sugar and acetone in urine.
5. Determination of haemoglobin percentage in blood sample (s).
6. Detection of amino acids in blood of an animal by paper chromatography.
7. Problems based on genetics- Pedigree analysis.
8. Preparation of buffers.
9. Blood group analysis.
10. Theoretical knowledge and demonstration of Blotting and Sequencing.

Practicals (Botany):

1. Study of cell division in slides. Study of cell organelles in slides.
2. To study the transpiration by four leaves method.
3. To study the root pressure.
4. To study the moisture content in the soil sample.
5. To study the germination of the gram.
6. Chlorophyll estimation by the method of the Dwedi and Randhawa.
7. Protein estimation by the method of the Lowery's method.
8. Instruments-minimum and Maximum thermo-meters.
9. Biostatics problems like mean, mode, and medium.
10. To test the hypothesis that is not possible for two similar species to occupy the same ecological niche in a given habitat.

Suggested Reading:

1. Ausubel, F. M., Brent, R., Kingston, R. E., Moore, D. D., Seidman, J. G., Smith, J. A., & Struhl, K. (1995). Short protocols in molecular biology (3rd ed.). John Wiley & Sons.
2. Guyton, A. C., & Hall, J. E. (2011). Textbook of medical physiology (12th ed.). Harcourt Asia Pvt. Ltd./W.B. Saunders Company.
3. Pasternak, J. J. (2003). Molecular biotechnology: Principles and applications of recombinant DNA. ASM Press.
4. Zar, J. H. (2012). Biostatistical analysis (4th ed.). Pearson.

PEDAGOGY OF PHYSICAL SCIENCE II	
Course Code: BED603	**Credit:** 02 (L-2, T-0, P-0)
Contact Hours: 30	**MM:** 50 (Int.: 15 + Ext.: 35)

Course Outline

Unit I: Teaching Learning Resources

- Teaching learning aids/materials: concept, definition, role and importance in classroom teaching.
- Types of teaching learning aids/ materials: print media such as textbook, teachers' manual/ handbook, laboratory manual and other print materials, non-print and digital media such as radio, TV, websites, animations, audios, videos, images, simulations, digital repository, Augmented Reality (AR), Virtual Reality (VR) and Artificial Intelligence (AI) based digital resources and Open Educational Resources (OERs) for offline/ online classroom teaching learning reflective journals, charts, 2-D and 3-D models, games, cards, worksheets, multimedia.
- Identification and use of learning resources in physical sciences from the local environment.
- Resource room/ laboratory/ library, virtual laboratories, teaching learning kits, physical sciences clubs, fairs, exhibitions, educational parks, excursions, community resources and pooling of resources.

Unit II: Content Analysis and Planning for Teaching Physical Sciences

- Pedagogical analysis of content taking examples from topics of physical sciences textbooks at secondary stage, identification of concepts, listing learning outcomes and competencies, planning, and evaluating learning experiences in an inclusive setup.
- Concept, types and importance of unit and lesson planning.
- Developing unit plans and lesson plans based on learning outcomes and experiential learning by selecting topics from textbooks of physical sciences at secondary stage.

Unit III: Assessment and Evaluation

- Assessment and evaluation: need for and importance of Physical Sciences.
- Assessment based on learning outcomes, strategies for continuous assessment, school-based assessment, qualitative assessment; formative and summative assessment, formal, informal and 360◦ assessment.
- Performance assessment: assessment of group activities, field observations, recording and reporting, creating platform and portfolio management, assessment of laboratory skills, assignments, projects, and presentations.
- Tools and techniques of assessment and evaluation - unit test based on Table of Specification (TOS) and its importance, basic steps of question paper setting, types of test items and preparing answer key and criteria for school, assessment, and feedback mechanism in teaching learning the content of Physical Sciences.

Suggested Reading:

1. Aggarwal, J. C. (2008). Essentials of Educational Technology: Teaching Learning Innovations in Education (2nd ed.). Vikas Publishing House.
2. Anderson, L. W., & Krathwohl, D. R. (2001). A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives. Pearson.
3. Bloom, B. S. (1956). Taxonomy of Educational Objectives: The Classification of Educational Goals. David McKay.
4. Chauhan, S. S. (2008). Innovations in Teaching-Learning Process. Vikas Publishing House.
5. Das, R. C. (1992). Science Teaching in Schools. Sterling Publishers.
6. Gupta, S. K. (1985). Teaching of Science Education. Vikas Publishing House.
7. Mangal, S. K. (2014). Teaching of Physical Science. PHI Learning Pvt. Ltd.
8. Mohan, R. (2019). Innovative Science Teaching. PHI Learning Pvt. Ltd.
9. National Council of Educational Research and Training. (2022). Mandate documents Guidelines for the development of National Curriculum Frameworks.
10. National Education Policy 2020, MoE, Government of India
11. National Curriculum Framework for School Education (2023).
12. NCERT. (2005). National Curriculum Framework 2005. National Council of Educational Research and Training.
13. NCERT. (2008). Science Textbooks for Classes VI-XII. National Council of Educational Research and Training.
14. Sharma, R. C. (2006). Modern Science Teaching (6th ed.). Dhanpat Rai Publishing.
15. Siddiqui, N., & Siddiqui, M. N. (2008). Teaching of Science: Today and Tomorrow. Doaba House.
16. Singh, U. K., & Nayak, A. K. (2007). Science Education and Evaluation. Common Wealth Publishers.
17. Thorndike, R. M. (1997). Measurement and Evaluation in Psychology and Education (6th ed.). Prentice Hall.
18. Yadav, M. S. (2003). Teaching of Science. Anmol Publications Pvt. Ltd.

PEDAGOGY OF MATHEMATICS II	
Course Code: BED604	**Credit:** 02 (L-2, T-0, P-0)
Contact Hours: 30	**MM:** 50 (Int.: 15 + Ext.: 35)

Course Outline

Unit I: Teaching Learning Resources

- Teaching learning materials: meaning and importance for secondary school Mathematics.
- Types of teaching learning resources: print media (Mathematics textbook, teachers' manual/ handbook, laboratory manual), non-print and digital media (charts, 2-D and 3-D models, games, web resources, interactive boards, animations, videos, images, simulations) for offline/ online classroom teaching and learning .
- Identification and use of learning resources in Mathematics from the local environment, community resources and pooling of resources.
- Mathematics resource room/ laboratory – equipment and management, concept of virtual laboratories.
- Organization of Mathematics club, fairs, exhibitions, learner community.

Unit II: Content Analysis and Planning for Teaching Mathematics

- Analysis for identification of axioms, concepts, rules, formulas, theorems, corollaries; pedagogical content knowledge of arithmetic, algebra, geometry, mensuration, and trigonometry of secondary stage.
- Planning and evaluating learning experiences in an inclusive setup based on learning outcomes and competencies, building a community of mathematicians in classrooms.
- Developing annual plan, unit plan, lesson plan – need, main consideration, and format.
- Strategies for method-based lesson plan for secondary classes - inductive-deductive, analytical- synthetical, lecture cum demonstration, problem-solving, laboratory, and project based.

Unit III: Assessment for Learning in Mathematics

- Meaning, need and organization of oral, written, and practical assessment in Mathematics.
- Construction of types of questions in Mathematics: objective, short answer, long answer, considerations for the marking different types of questions in Mathematics.
- Planning and developing teachers made tests in Mathematics - Table of Specification (TOS), question paper setting and preparing answer key.
- Tools to identify learning difficulties and provide corrective measures in Mathematics, concept of 360_o assessment, holistic progress card and assessment of mathematical aspects of students.

Suggested Reading:

1. Arora, S. (2010). Teaching of Mathematics. New Delhi: Rajat Publications.
2. Ball, D. L., & Bass, H. (2003). Making mathematics reasonable in school. New York: Teachers College Press.
3. Bhanot, R. (2015). Pedagogy of Mathematics: Teaching Mathematics effectively. New Delhi: Rajat Publications.
4. Chambers, P., & Timlin, R. (2019). Teaching Mathematics in the Secondary School. London: Sage Publications.
5. Kumar, S. (2014). Teaching of Mathematics: Modern Methods and Approaches. New Delhi: Anmol Publications.
6. NCERT. (2005). National Curriculum Framework 2005. New Delhi: National Council of Educational Research and Training.
7. NCERT. (2006). Position Paper: National Focus Group on Teaching of Mathematics. New Delhi: National Council of Educational Research and Training.
8. NCTE. (2009). National Curriculum Framework for Teacher Education. New Delhi: National Council for Teacher Education.
9. Polya, G. (1957). How to Solve It: A New Aspect of Mathematical Method. Princeton, NJ: Princeton University Press.
10. Shukla, R. P. (2013). Teaching of Mathematics. New Delhi: APH Publishing Corporation.
11. Sidhu, K. S. (2006). The Teaching of Mathematics. New Delhi: Sterling Publishers.
12. Van de Walle, J. A., Karp, K. S., & Bay-Williams, J. M. (2013). Elementary and Middle School Mathematics: Teaching Developmentally. Boston: Pearson.
13. Yadav, M. S. (2018). Teaching of Mathematics at Secondary Level. New Delhi: Anmol Publications.

PEDAGOGY OF BIOLOGICAL SCIENCE II	
Course Code: BED605	**Credit:** 02 (L-2, T-0, P-0)
Contact Hours: 30	**MM:** 50 (Int.: 15 + Ext.: 35)

Course Outline

Unit I: Teaching Learning Resources

- Teaching learning aids/materials: concept, definition, role, and importance in classroom teaching.
- Types of teaching learning aids/ materials: print media such as textbook, teachers' manual/ handbook, laboratory manual and other print materials, non-print and digital media such as museum, aquarium, terrarium, games, toys, radio, TV, websites, animations, audios, videos, images, simulations; Biological Sciences mobile apps, digital repository, Augmented Reality (AR), Virtual Reality (VR) and Artificial Intelligence (AI) based digital resources and Open Educational Resources (OERs) for offline/ online classroom teaching learning (reflective journals, charts, 2-d and 3-d models, games, cards, worksheets, multimedia etc.
- Identification and use of learning resources in Biological Sciences from the local environment - using nature as a laboratory; biology laboratory - designing, management and safe practices; virtual laboratories and museums.
- Resource room/ laboratory/ library, virtual laboratories, teaching learning kits, Biological Sciences clubs, fairs, exhibitions, science parks, zoo, botanical gardens, excursions community resources and pooling of resources.

Unit II: Content Analysis and Planning for Teaching Biological Sciences

- Pedagogical analysis of content taking examples from topics of Biological Sciences textbooks at secondary stage, identification of concepts, listing learning outcomes and competencies, planning, and evaluating learning experiences in an inclusive setup.
- Concept, types and importance of unit and lesson planning.
- Developing unit plans and lesson plans based on learning outcomes and experiential learning by selecting topics from textbooks of Biological Sciences at secondary stage.

Unit III: Assessment and Evaluation

- Assessment and evaluation: concept, need for and importance of teaching learning the Biological Sciences.
- Assessment based on learning outcomes, strategies for continuous assessment, school-based assessment, qualitative assessment; formative and summative assessment, formal, informal, and 360-degree assessment.
- Performance assessment: assessment of group activities, field observations, recording and reporting, creating platform and portfolio management, assessment of lab skills, assignments, projects, and presentations based on the concepts of Biological Sciences.
- Unit test based on Table of Specification (TOS) and its importance; basic steps of question paper setting of Biological Sciences, types of test items and preparing answer key and criteria for school, assessment, and feedback mechanism in teaching learning the concepts of physical science at secondary stage.

Suggested Reading:

1. Agarwal, D. D. (2004). Modern methods of teaching biology. New Delhi: Sarup & Sons.
2. Anderson, R. D., & Krathwohl, D. R. (2001). A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives. New York: Longman.
3. Bhaskarachary, B. (2018). Biology education in India: Pedagogical and content issues. New Delhi: Orient BlackSwan.
4. Chauhan, S. S. (2008). Innovation in teaching-learning process. New Delhi: Vikas Publishing House.
5. Das, R. C. (2006). Science teaching in schools. New Delhi: Sterling Publishers.
6. Kaur, B., & Rani, M. (2017). Pedagogy of biological science. New Delhi: Lakshmi Publishers.
7. Mangal, S. K., & Mangal, U. (2009). Teaching of biological sciences. New Delhi: PHI Learning Private Limited.
8. NCERT. (2005). National curriculum framework 2005. New Delhi: National Council of Educational Research and Training.
9. Sharma, R. C., & Shukla, M. (2012). Teaching of life sciences. New Delhi: Dhanpat Rai Publishing Company.
10. Singh, U. N., & Singh, Y. K. (2007). Science education. New Delhi: APH Publishing Corporation.
11. Tewari, S. D., & Tewari, B. (2010). Teaching of biological science. New Delhi: Ashish Publishing House.
12. Yadav, M. S. (2004). Teaching of biology. New Delhi: Anmol Publications.

ARTIFICIAL INTELLIGENCE IN EDUCATION	
Course Code: BED606	**Credit:** 02 (L-2, T-0, P-0)
Contact Hours: 30	**MM:** 50 (Int.: 15 + Ext.: 35)

Course Outline

Unit I: Introduction to Artificial Intelligence and Education

- Definition, history, and scope of AI in general and in educational contexts.
- Key concepts: Machine Learning (ML), Natural Language Processing (NLP), and Data Analytics.
- Overview of AI's potential to transform teaching and learning processes.

Unit II: AI Applications in Teaching and Learning

- AI-driven educational tools: adaptive learning platforms, virtual assistants, and intelligent tutoring systems.
- Enhancing personalized learning experiences through AI: tailored content, learning paths, and feedback.
- AI for educational content creation, automated grading, and assessment tools.
- Automating administrative tasks: scheduling, grading, and managing resources.
- Role of AI in formative and summative assessments, including automated grading.

Unit III: Ethical and Practical Considerations of AI in Education

- Ethical challenges of AI in education: data privacy, bias, and accountability.
- Role of teachers in an AI-integrated classroom: balancing AI and human-centered learning.
- Limitations and challenges: dependency on technology and issue of digital divide
- Future perspectives on AI in education: potential, limitations, and evolving trends.

Suggested Reading:

1. Alhumaid, K. (2019). Artificial intelligence and machine learning in education: The prospects and concerns. Springer.
2. Bozkurt, A., & Sharma, R. C. (2020). Emergency remote teaching in a time of global crisis due to CoronaVirus pandemic. Asian Journal of Distance Education, 15(1), 1-6. https://doi.org/10.5281/zenodo.3778083
3. Holmes, W., Bialik, M., & Fadel, C. (2019). Artificial intelligence in education: Promises and implications for teaching and learning. Boston: Center for Curriculum Redesign.
4. Luckin, R. (2017). Enhancing learning and teaching with technology: What the research says. Institute of Education Press.
5. Luxton-Reilly, A., Denny, P., & Plimmer, B. (2020). Learning to program is easier with AI: Using AI to enhance student learning and teaching practices in computer science education. In Proceedings of the 2020 ACM Conference on International Computing Education Research (pp. 127-137). ACM. https://doi.org/10.1145/3372782.3406289
6. Russell, S., & Norvig, P. (2020). Artificial intelligence: A modern approach (4th ed.). Pearson.
7. Woolf, B. P. (2010). Building intelligent interactive tutors: Student-centered strategies for revolutionizing e-learning. Morgan Kaufmann.

DEVELOPING OPEN EDUCATIONAL RESOURCES	
Course Code: BED607	**Credit:** 02 (L-2, T-0, P-0)
Contact Hours: 30	**MM:** 50 (Int.: 15 + Ext.: 35)

Course Outline

Unit I: Introduction to Open Educational Resources (OER)

- Definition, history, and significance of OER.
- Types of OER: textbooks, videos, simulations, assessments, etc.
- Benefits and challenges of using OER in educational contexts.
- Major global and national OER initiatives.

Unit II: Platforms, Tools, and Resources for Creating OER

- Overview of popular OER platforms: OER Commons, MERLOT, OpenStax, and others.
- Tools for OER creation: multimedia creation tools, online repositories, and content editing software.
- Evaluating and selecting appropriate resources for specific teaching and learning objectives.

Unit III: Designing and Developing OER for Classroom Use

- Steps to develop OER: identifying needs, creating content, evaluating resources, and revising.
- Introduction to copyright, Creative Commons licenses, and open licensing for educational resources.
- Practical guidelines for adapting and remixing OER legally and ethically.
- Adapting existing OER for specific student needs, grade levels, and subjects.
- Practical exercise: developing a basic OER for a chosen subject area and level.

Suggested Reading:

1. Butcher, N., & Hoosen, S. (2012). Exploring the business case for open educational resources. Vancouver: Commonwealth of Learning.
2. Hilton, J. (2016). Open educational resources and college textbook choices: A review of research on efficacy and perceptions. Educational Technology Research and Development, 64(4), 573-590.
3. Wiley, D. (2014). The access hypothesis: Open educational resources and increased learning. Open Praxis, 6(2), 99-108.
4. UNESCO. (2019). Guidelines on the development and use of open educational resources in education. Paris: UNESCO.

SIMULATION TEACHING	
Course Code: BED651	**Credit:** 04 (L-0, T-0, P-4)
Contact Hours: 60	**MM:** 100 (Int.: 40 + Ext.: 60)

Course Outline

Practical Engagement

- Preparation and presentation of 10 Simulation teaching lesson plans (minimum 5 for each teaching subject).
- Simulation Teaching exercises with feedback from instructors and peers.
- Group reflection sessions to discuss experiences, challenges, and strategies for improvement.

Assessment

- **Participation and Engagement (30%):** Active participation in simulation sessions, role-playing, and group discussions.
- **Lesson Planning and Preparation (20%):** Developing and submitting lesson plans for simulation scenarios.
- **Practical Simulation Performance (30%):** Performance in simulated teaching sessions, evaluated on communication, classroom management, and engagement.
- **Reflection Report (20%):** Submission of a reflection report, analyzing personal strengths and areas for improvement based on simulation experience.
- **Internal Assessment:** Preparation of Simulation Lesson Plans and Reflection Report of all internal components.
- **External Assessment:** Appearing in external viva and demonstration of a Simulation Lesson Plan with portfolio of prepared Lesson Plans (during internal sessions) and Reflection Reports.

Note: For successful completion of the course participation in all activities of practicum is compulsory.

SCHOOL OBSERVATION II	
Course Code: BED671	**Credit:** 02 (L-0, T-0, P-0)
Contact Hours: Two Weeks	**MM:** 50 (Int.: 15 + Ext.: 35)

The course will enable the pupil-teachers to delve into the intricacies of school operations, teaching practices, and student dynamics through structured observation. It aims to enhance students' analytical and evaluative skills, enabling them to connect theoretical concepts with real-world educational settings. By engaging in advanced observation techniques, detailed classroom analysis, and administrative insights, students will develop a deeper understanding of effective teaching, school management, and professional growth.

Course Outline

- **Pre-Observation Preparation**
  - Orientation
    - Introduction to the course objectives and expectations
    - Overview of observation techniques and tools
    - Developing advanced techniques for systematic observation of classroom and school environments.

- **School Observation**
  - Classroom Observation
    - Observing different classes across various grades
    - Focus on teaching methods, classroom management, and student interactions
    - Analysis of teaching aids and instructional strategies.
  - Observation of Teacher Roles and Responsibilities
    - Observing teacher-student interactions
    - Understanding lesson planning and execution
    - Understanding diverse learning needs and adaptations made by teachers
    - Analyzing assessment and feedback methods
  - Observing School Culture and Environment
    - Observing and Participation in school routines and extracurricular activities
    - Understanding the role of administrative staff
    - Assessing the safety and inclusiveness of the school environment
    - Exploring the socio-cultural context of the school and its impact on teaching and learning
    - Understanding school policies, schedules, and administrative procedures

- **Post-Observation Analysis**
  - Reflection and Reporting
    - Preparing a comprehensive report that includes detailed observations, analysis, and professional insights.
    - Reflecting on key observations and learning outcomes
  - Discussions and Feedback Session
    - Discussing challenges and best practices observed
    - Presenting the report and engaging in discussions on how observations inform professional growth.
    - Identifying strategies for applying observational insights in future teaching and school leadership roles.

Assessment

- **Observation Reports**
  - Detailed reports on classroom and school observations (50%)
- **Reflection Essays**
  - Written reflections on key learnings and personal growth (30%)
- **Participation and Engagement**
  - Active participation in discussions and feedback sessions (20%)

Course Outline:

1. Participation in all activities of School Observation (Pre-observation Preparation, During Observation and Post-observation Analysis) as mentioned in course outline.
2. Recording of minimum 20 lessons (10 for each teaching subject).
3. Maintenance of record of school observation (Observation Reports and Reflective Essays) with brief report about school.
4. Viva-voce at the end of semester.

Note: For successful completion of the course, Participation in all activities of School Observation is compulsory.