

**List of Papers addressing different cross cutting issues relevant to Gender, Human Values, Professional Ethics, Environment and Sustainability into the Curriculum**

S.No	Programme	Course Name	Course Code	Title of the Course	Issue addressed
1	BSc	Botany	BOT-RC-1016	Biodiversity (Microbes, Algae, Fungi and Archegoniate)	Environment
2	BSc	Botany	BOT-RC-2016	Plant Ecology and Taxonomy	Environment
3	BSc	Botany	BOT-RC-3016	Physiology and Metabolism	Environment
4	BSc	Botany	BOT-RC-4016	Plant Anatomy and Embryology	Environment
5	BSc	Botany	BOT-RC-5026	Economic Botany and Biotechnology	Environment
6	BSc	Zoology	ZOO-RC-1016	Animal Diversity	Environment
7	BSc	Zoology	ZOO-RE-5026	Applied Zoology	Environment
8	BSc	Zoology	ZOO-RE-6016	Aquatic Biology	Environment
9	BSc	Zoology	ZOO-SE-3014	Ornamental Fish & Fisheries	Environment
10		Zoology	ZOO-SE-4014	Apiculture	Environment
11		Zoology	ZOO-SE-5014	Non-Mulberry Sericulture	Environment
12	BSc	Physics	PHY-RC/HG-3016	Thermal Physics and Statistical Mechanics	Environment
13	BSc	Physics	PHY-RE-5056	Nuclear and Particle Physics	Environment
14	BSc				
15	Bsc	Botany	BOT-SE-3014	Bio fertilizers	Environment
16	Bsc	Botany	BOT-SE-4016	Nursery and Gardening	Environment
17	BA	Education	EDU-HC-3036	Value and Peace Education	Professional Ethics
18	BA	Education	EDU-HC-4036	Emerging Issues in Education	Gender
19	BA	Education	EDU-DSE-5016	Continuing Education	Professional Ethics
20	BA	Education	EDU-DSE-5046	Teacher Education in India	Professional Ethics
21	BA	Philosophy	PHI-RC-3016	Ethics	Professional Ethics
22	BA	Economics	ECO-HC-5016	Indian Economy-I	Gender and Sustainability
23	BA	Economics	ECO-HC-6026	Development Economics	Gender & Environment
24	BA	Political Science	POL-HE-6036	Women, Power and Politics	Gender
25	BA	Political Science	POL-HG-2026	Feminism: Theory and Practice	Gender
26	BA	Assamese	ASM-HC-4016	Comparative Indian Literature	Gender



*A. J. J. J.*  
Principal /c & Secretary  
BARBHAG COLLEGE

EDU-HC-3036

513 **VALUE AND PEACE EDUCATION**

**Total Marks: 100 (External: 80 and Internal: 20)**

**Credit-6**

**Course Objectives:**

After completion of this course the learner will be able to:

- Understand the concept and meaning of value.
- Become aware about the role of educational institutions in building a value based society.
- Understand the meaning and concept of peace and its importance in human life.
- Understand the meaning and importance of peace education and its relevance at national and international level.
- Identify the different issues/ challenges in imparting peace education.
- Identify the strategies and skills in promoting peace education at institutional level.

**Course contents**

Unit	Contents
Unit-1	<b>Value</b> <ul style="list-style-type: none"> <li>• Concept and characteristics of value.</li> <li>• Sources of values</li> <li>• Impact of globalization on culture and values.</li> <li>• Importance of values in human life</li> </ul>
Unit-2	<b>Types of values, their characteristics, functions and educational significance</b> <ul style="list-style-type: none"> <li>• Core values.</li> <li>• Social values</li> <li>• Moral values</li> <li>• Religious and spiritual values.</li> <li>• Aesthetic values.</li> <li>• Personal values</li> </ul>
Unit-3	<b>Value education</b> <ul style="list-style-type: none"> <li>• Concept, characteristics, Objectives and Importance of value education.</li> <li>• Value education at different stages – <ul style="list-style-type: none"> <li>- Primary</li> <li>- Secondary</li> <li>- Higher education.</li> </ul> </li> <li>• Role of teacher and family in imparting value education.</li> </ul>
Unit-4	<b>Peace education</b> <ul style="list-style-type: none"> <li>• Meaning, definition and characteristics of peace.</li> <li>• Importance of peace in human life.</li> </ul>

**EDU-HC-4036**  
**EMERGING ISSUES IN EDUCATION**  
 Total Marks: 100 (External=80 and Internal=20)  
 Credit-6

**Objectives:**

After completion of this unit, students will able to-

- Make the students acquaint with major emerging issues national, state, and local
- Acquaint the students with the various issues in education that are emerging in the recent years in the higher education system
- Address the various problem and challenges of education in India at all levels.

**Course contents**

Units	Contents
<b>Unit-1</b>	<b>Social Inequality in Education and Constitutional Safeguards</b> <ul style="list-style-type: none"> <li>• Concept of Social Inequality</li> <li>• Constitutional Provision for Ensuring Equality in Education</li> <li>• Education of Socially Disadvantaged Section: SCs, STs and Minorities , Education of people of Char area of Assam</li> <li>• Education for Back ward Children, Child Labour, Street Children and Slum Dwellers</li> <li>• Gender Disparity and Rural-Urban Disparity in Education</li> </ul>
<b>Unit-2</b>	<b>Liberalization, Privatization and Globalization of Education</b> <ul style="list-style-type: none"> <li>• Liberalization: Concept and its impact on education</li> <li>• Privatization: Concept and its impact on education</li> <li>• Globalization: Concept and its impact on education</li> <li>• Public-private Partnership</li> <li>• Education as investment</li> </ul>
<b>Unit-3</b>	<b>Issues related to Students</b> <ul style="list-style-type: none"> <li>• Youth Unrest: Concept, Causes and Remedies</li> <li>• Campus Disturbance : Concept, Causes and Remedies</li> <li>• Examination Anxiety: Concept, Causes and Remedies</li> <li>• Issues related to Educated Unemployment.</li> </ul>
<b>Unit-4</b>	<b>Environmental Education and Population Education</b> <ul style="list-style-type: none"> <li>• Main Environmental Issues: Global Warming, Ozone Depletion and Environmental Pollution</li> <li>• Role of Environmental Education for Sustainable Development</li> <li>• Role of Different Stakeholders (Government and Non-Government Organisations, Women, Media) in Environmental Protection</li> <li>• Population Explosion: Its Causes and Consequences</li> <li>• Population Education or Population Control</li> </ul>



### Unit-5

### Multi-Cultural Education and Alternative Education

- Concept, Objectives and Need of Multi-Cultural Education
- Curriculum and Instruction of Multi-Cultural Education
- Issues related to Multi-Cultural Education
- Concept of Alternative Education and its related Issues
- Role of NIOS and Sakshar Bharat Mission in Alternative Education
- Role of IGNOU and KKHSOU in Alternative Higher Education
- MOOC and its related Issues.

### Recommended Readings:

- Aggarwal J. C. (1997). *Development and Planning of Modern Education*. New Delhi: Vikas Publishing House Ltd.
- Chandel and Nand (2011). *Population Education*. Agra: Shri Vinod Pustak Mandir.
- Das, Dr. Phunu (Ed.) (2016). *Contemporary Issues of Indian Education*. Guwahati: Shanti Prakashan
- Krishnamacharyulu, V. (2005). *Environmental Education*. Hyderabad: Neelkamal Publications Pvt. Ltd.
- Mishra and Mohanty (2013). *Trends and Issues in Indian Education*. Meerut: R. Lall Book Depot.
- Taj, Haseen (2011). *Current Challenges in Education*. Hyderabad: Neelkamal Publications Pvt. Ltd.
- Tiwari, R.P. *Problems of Education in N.E. India*. Ludhiana: Tandon Publications.





EDU-RC-1016

Foundations of Education

Total Marks: 100 (External -80 and Internal -20)

Credit-6

**Objectives:**

- To acquaint the students with the principles of education
- To gain knowledge about different various Forms and Aims of Education
- To understand the concept and importance of Discipline and Freedom.
- To acquire knowledge about the concept of Emotional and National Integration and International Understanding.

Unit	Contents
1 SB	Concept of Education <ul style="list-style-type: none"><li>• Meaning ,Nature and Scope of education</li><li>• Forms of education- Formal education, Informal and Non formal education- Meaning and Nature. School as an agency of formal education</li><li>• Aims of education, Meaning and importance of Aims. Types of Aims- Social Vs Individual aim.</li><li>• Vocational and Liberal aim</li><li>• Democratic aim of education.</li></ul>
2✓ SC	Philosophy and Education <ul style="list-style-type: none"><li>• Philosophy: Meaning, Nature and Scope</li><li>• Philosophy of Education: Meaning and Scope</li><li>• Relationship between education and philosophy</li><li>• Impact of philosophy on education</li></ul>
3 ND	Psychology and Education: <ul style="list-style-type: none"><li>• Meaning and nature of Psychology</li><li>• Relation between education and psychology</li><li>• Educational Psychological-Nature, Scope, Method Observation, Experimentation, Case study method</li><li>• Importance of Educational Psychology in teaching –learning process</li></ul>
4 LP	Education for National Integration and International understanding <ul style="list-style-type: none"><li>• Meaning and Nature of National Integration and International understanding</li></ul>





## 5<sup>th</sup> SEMESTER (REGULAR)

EDU-DSE-5016

### CONTINUING EDUCATION

Total Marks: 100 (External: 80 and Internal: 20)

Credit-6

#### Course Objectives:

After completion of this course the learner will be able to:

- Know the concept, objectives, scope and significance of continuing education in the context of present scenario.
- Understand about different aspects and agencies of continuing education.
- Realize different methods and techniques as well as issues of continuing education.
- Know the meaning of open education and realise the importance of open school and open universities in continuing education.
- Understand the development of adult education in India, kinds of adult education and different problems of adult education.

#### Course Contents

Units	Contents
Unit-1	<b>Continuing Education</b> <ul style="list-style-type: none"> <li>• Continuing Education: Meaning, Nature and objectives</li> <li>• Functions and Scope of Continuing education</li> <li>• Significance of continuing education</li> <li>• Meaning and nature of different Aspects Continuing education: Fundamental education, Adult education, Social education &amp; Extension education</li> <li>• Agencies of continuing education</li> </ul>
Unit-2	<b>Methodologies and Issues of Continuing Education</b> <ul style="list-style-type: none"> <li>• Different methods of Continuing education</li> <li>• Strategies and devices of continuing education</li> <li>• Role of Mass-media in continuing education</li> <li>• Issues of continuing education in India</li> </ul>
Unit-3	<b>Open Education</b> <ul style="list-style-type: none"> <li>• Open Education: Meaning, Characteristics, Objectives and Types</li> <li>• Open School: Meaning and role of NIOS</li> <li>• Open University: Meaning, Characteristics, Objectives and</li> </ul>

	development • Role of Open university in Continuing education
<b>Unit-4</b>	<b>Adult Education</b> <ul style="list-style-type: none"> <li>• Meaning and Development of Adult education in India</li> <li>• Different kinds of adult education in India</li> <li>• Methods of Teaching adults</li> <li>• Planning adult education programmes in Assam for empowerment of rural women</li> <li>• Problems and Solution of Adult Education in India</li> </ul>
<b>Unit-5</b>	<b>Recent Literacy programmes in India</b> <ul style="list-style-type: none"> <li>• Changing concept of Literacy</li> <li>• National Literacy Mission 1988</li> <li>• Total Literacy Campaign and Post Literacy programme</li> <li>• Shakshar Bharat Mission</li> </ul>

#### Recommended Readings:

- Aggarwal, J. C. (2008). *Adult Education*. Delhi: Doaba House.
- Chandra, Dr. Soti Shivendra (2005). *Adult and Non-Formal Education*. Delhi: Surajeet Publications.
- Das, Dr. Lakshahira (1999). *Adult Continuing Education*. Guwahati: Amrita Prakashan.
- Goswami, Dulumoni (2009). *Literacy and Development*. Guwahati: DVS Publishers.
- Kalita, Utpal (2015). *Abirata Siksha Aaru Durattwa Siksha*. Guwahati: Shanti Prakashan.
- Kaur & Sood (2009). *Adult and Non-Formal Education*. Ludhiana: Tandon Publishers.
- Mohanty, S. (2012). *Lifelong and Adult Education*. New Delhi: APH Publishing House.
- Talukdar, B. K. (1993). *Adult Education: Concepts & Methods*. Guwahati: Bina Library.



3/3

EDU-DSE-5046

## TEACHER EDUCATION IN INDIA

Total Marks: 100 (External: 80 and Internal: 20)

Credit-6

### Course Objectives:

After completion of this course the learner will be able to:

- Explain the Concept, Scope, Aims & Objectives and Significance of teacher education
- Acquaint with the development of Teacher Education in India
- Acquaint with the different organising bodies of teacher education in India and their functions in preparation of teachers for different levels of education
- Acquaint with the innovative trends and recent issues in teacher education, and be able to critically analyse the status of teacher education in India
- Understand and conceive the qualities, responsibilities and professional ethics of teachers

### Course Contents

Units	Contents
Unit-1	<b>Conceptual Framework and Historical Perspectives of Teacher Education in India</b> <ul style="list-style-type: none"> <li>• Teacher Education-Concept, scope and aims and objectives</li> <li>• Need and Significance of Teacher Education in 21<sup>st</sup> Century</li> <li>• Types of Teacher Education-Pre-service and In-service</li> <li>• Development of Teacher Education in India</li> <li>• Shifting focus from Teacher Training to Teacher Education</li> </ul>
Unit-2	<b>Teacher Education For Different Levels of Education</b> <ul style="list-style-type: none"> <li>• Preparation of Teachers for Pre-Primary Level of education</li> <li>• Preparation of Teachers for Primary Level of education</li> <li>• Preparation of Teachers for Secondary Level of education</li> <li>• Preparation of Teachers for Higher Level of education</li> </ul>
Unit-3	<b>Structure and Organisations of Teacher Education in India</b> <ul style="list-style-type: none"> <li>• Basic Training Centre (BTC)</li> <li>• District Institute for Education and Training (DIET)</li> <li>• State Council for Educational Research and Training (SCERT)</li> <li>• National Council for Educational Research and Training (NCERT)</li> </ul>





	<ul style="list-style-type: none"> <li>• National Council for Teacher Education (NCTE)</li> <li>• National University of Educational Training and Administration (NUEPA)</li> <li>• Regional Colleges of Education</li> </ul>
Unit-4	<b>Status of Teacher Education in India: Trends, Issues and Challenges</b> <ul style="list-style-type: none"> <li>• Skill and Competency based Teacher Education, Flanders Interaction Analysis, Micro Teaching and Simulated Social Skill Teaching (SSST)</li> <li>• National Curriculum Framework for Teacher Education (NCFTE), 2009</li> <li>• NCTE Regulations, 2014</li> <li>• Present problems of Teacher Education in India and their solution</li> <li>• Quality Assurance in Teacher Education and its challenges</li> </ul>
Unit-5	<b>Quality, Responsibility and Professional Ethics of Teachers</b> <ul style="list-style-type: none"> <li>• Qualities and responsibilities of a teacher</li> <li>• Teacher as a Facilitator, Counsellor and Practitioner-Researcher</li> <li>• Role expectations of Teachers in twenty first century</li> <li>• Professional ethics and accountability of teachers</li> </ul>

#### Recommended Readings:

- Aggarwal, J. C. (2004). *Teacher and Education in a Developing Society*. New Delhi: Vikas Publishing House Pvt. Ltd.
- Bhargava, M. & Saikia, L. Rasul (2012). *Teacher in 21<sup>st</sup> Century- Challenges, Responsibilities, Creditability*. Agra: Rakhi Prakashan.
- Flanders, Ned, A. (1970). *Analysing Teacher Behaviour*. London: Wesly Publishing Company.
- Gurrey, P. (). *Education and the Training of Teachers*. London: Longmans, Green and Company.
- Kalita, Sahariah & Sarmah (2014). *Sikshar Siksha*. Guwahati: Shanti Prakashan.
- Mukherjee, S. N. (1968). *Education of Teachers in India, Vol.-I and II*. New Delhi: S. Chand and Company.
- Rajput, J. S. and Walia, K. (2002). *Teacher Education in India*. New Delhi: Sterling Publishers Pvt. Ltd.
- Sharma, Sashi Prabha (2004). *Teacher Education in India*. New Delhi: Vikash Publications Pvt. Ltd.



## Semester-I

1

**BOT-RC-1016**

### **Biodiversity (Microbes, Algae, Fungi and Archegoniate)**

Total Lectures : 60 Credits : 6 (Theory - 4, Practical - 2)

#### **1.1 Theory**

##### **Unit 1 : *Microbes***

**(10 Lectures)**

Viruses – Discovery, general structure, replication (general account), DNA virus (T-phage); Lytic and lysogenic cycle, RNA virus (TMV); Economic importance; Bacteria – Discovery, General characteristics and cell structure; Reproduction vegetative, asexual and recombination (conjugation, transformation and transduction); Economic importance.

##### **Unit 2 : *Algae***

**(12 Lectures)**

General characteristics; Ecology and distribution; Range of thallus organization and reproduction; Classification of algae; Morphology and life-cycles of the following: Nostoc, Chlamydomonas, Oedogonium, Vaucheria, Fucus, Polysiphonia. Economic importance of algae.

##### **Unit 3 : *Fungi***

**(12 Lectures)**

Introduction- General characteristics, ecology and significance, range of thallus organization, cell wall composition, nutrition, reproduction and classification; True Fungi- General characteristics, ecology and significance, life cycle of Rhizopus (Zygomycota) Penicillium, Alternaria (Ascomycota), Puccinia, Agaricus (Basidiomycota); Symbiotic Associations- Lichens;

General account, reproduction and significance; Mycorrhiza: ectomycorrhiza and

endomycorrhiza and their significance



#### Unit 4 : *Introduction to Archegoniate*

(2 Lectures)

Unifying features of archegoniates, Transition to land habit, Alternation of generations.

#### Unit 5 : *Bryophytes*

(10 Lectures)

General characteristics, adaptations to land habit, Classification, Range of thallus organization. Classification (up to family), morphology, anatomy and reproduction of *Marchantia* and *Funaria*. (Developmental details not to be included). Ecology and economic importance of bryophytes with special mention of *Sphagnum*.

#### Unit 6 : *Pteridophytes*

(8 Lectures)

General characteristics, classification, Early land plants (*Cooksonia* and *Rhynia*). Classification (up to family), morphology, anatomy and reproduction of *Selaginella*, *Equisetum* and *Pteris*. (Developmental details not to be included). Heterospory and seed habit, stelar evolution. Ecological and economical importance of Pteridophytes.

#### Unit 4 : *Gymnosperms*

(6 Lectures)

General characteristics, classification. Classification (up to family), morphology, anatomy and reproduction of *Cycas* and *Pinus*. (Developmental details not to be included). Ecological and economical importance.

## 1.2 Practical

1. EMs/Models of viruses - T-Phage and TMV, Line drawing/Photograph of Lytic and Lysogenic Cycle.
2. Types of Bacteria from temporary/permanent slides/photographs; Binary Fission; Conjugation; Structure of root nodule.
3. Gram staining
4. Study of vegetative and reproductive structures of Nostoc, Chlamydomonas (electron micrographs), Oedogonium, Vaucheria, Fucus\* and Polysiphonia through temporary preparations and permanent slides.
5. Rhizopus and Penicillium: Asexual stage from temporary mounts and sexual structures through permanent slides.



2

BOT-RC-2016

## Plant Ecology and Taxonomy

Total Lectures : 60 Credits : 6 (Theory - 4, Practical - 2)

### 2.1 Theory

#### Unit 1 : *Introduction*

(2 Lectures)

#### Unit 2 : *Ecological factors*

(10 Lectures)

Soil: Origin, formation, composition, soil profile. Water: States of water in the environment, precipitation types. Light and temperature: Variation Optimal and limiting factors; Shelford law of tolerance. Adaptation of hydrophytes and xerophytes.

#### Unit 3 : *Plant communities*

(6 Lectures)

Characters; Ecotone and edge effect; Succession; Processes and types.

#### Unit 4 : *Ecosystem*

(8 Lectures)

Structure; energy flow trophic organisation; Food chains and food webs, Ecological pyramids production and productivity; Biogeochemical cycling; Cycling of carbon, nitrogen and Phosphorous

#### Unit 5 : *Phytogeography*

(4 Lectures)

Principle biogeographical zones; Endemism



## **Unit 6 : *Introduction to plant taxonomy***

Identification, Classification, Nomenclature.



## **Unit 7 : *Identification***

**(4 Lectures)**

Functions of Herbarium, important herbaria and botanical gardens of the world and India; Documentation: Flora, Keys: single access and multi-access

## **Unit 8 : Taxonomic evidences from palynology, cytology, phytochemistry and molecular data.**

**(6 Lectures)**

## **Unit 9 : *Taxonomic hierarchy***

**(2 Lectures)**

Ranks, categories and taxonomic groups

## **Unit 10 : *Botanical nomenclature***

**(6 Lectures)**

Principles and rules (ICN); ranks and names; binominal system, typification, author citation, valid publication, rejection of names, principle of priority and its limitations.

## **Unit 11 : *Classification***

**(6 Lectures)**

Types of classification-artificial, natural and phylogenetic. Bentham and Hooker (upto series), Engler and Prantl (upto series).

## **Unit 12 : *Biometrics, numerical taxonomy and cladistics***

**(4 Lectures)**

Characters; variations; OTUs, character weighting and coding; cluster analysis; phenograms, cladograms (definitions and differences).

## **2.1 Practical**

1. Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, psychrometer/hygrometer, rain gauge and lux meter.
2. Study of morphological adaptations of hydrophytes and xerophytes (four each).



Semester IV

4

BOT-RC-4016

## Plant Physiology and Metabolism

Total Lectures : 60 Credits : 6 (Theory - 4, Practical - 2)

### 4.1 Theory

#### Unit 1 : *Plant-water relations*

(8 Lectures)

Importance of water, water potential and its components; Transpiration and its significance; Factors affecting transpiration: Root pressure and guttation.

#### Unit 2 : *Mineral nutrition*

(8 Lectures)

Essential elements, macro and micronutrients; Criteria of essentiality of elements; Role of essential elements; Transport of ions across cell membrane, active and passive transport, carriers, channels and pumps.

#### Unit 3 : *Translocation in phloem*

(6 Lectures)

Composition of phloem sap, girdling experiment; Pressure flow model; Phloem loading and unloading.

#### Unit 4 : *Photosynthesis*

(12 Lectures)

Photosynthetic Pigments (Chl a, b, xanthophylls, carotene); Photosystem I and II, reaction center, antenna molecules; Electron transport and mechanism of ATP synthesis; C3, C4 and CAM pathways of carbon fixation; Photorespiration.

3

4th Sem



BOT-RC4016

Plant Anatomy and Embryology

Total Lectures : 60 Credits : 6 (Theory - 4, Practical - 2)

### 3.1 Theory

**BD** Unit 1 : *Meristematic and permanent tissues* (8 Lectures)  
Root and shoot apical meristems; Simple and complex tissues.

Unit 2 : *Organs* (4 Lectures)

**BD** Structure of dicot and monocot root stem and leaf.

Unit 3 : *Secondary Growth* (8 Lectures)

**RA** Vascular cambium – structure and function, seasonal activity. Secondary growth in root and stem, Wood (heartwood and sapwood).

Unit 4 : *Adaptive and protective systems* (8 Lectures)

**DD** Epidermis, cuticle, stomata; General account of adaptations in xerophytes and hydrophytes.

Unit 5 : *Structural organization of flower* (8 Lectures)

**DD** Structure of anther and pollen; Structure and types of ovules; Types of embryo sacs, organization and ultrastructure of mature embryo sac.



### Unit 6 : *Pollination and fertilization*

DD Pollination mechanisms and adaptations; Double fertilization; Seed-structure and dispersal mechanisms.

### Unit 7 : *Embryo and endosperm*

(8 Lectures)

BD Endosperm types, structure and functions; Dicot and monocot embryo; Embryo- endosperm relationship.

### Unit 8 : *Apomixis and polyembryony*

(8 Lectures)

RA Definition, types and practical applications.

## 3.2 Practical

1. Study of meristems through permanent slides and photographs.
2. Tissues (parenchyma, collenchyma and sclerenchyma); Macerated xylary elements, Phloem (Permanent slides, photographs)
3. Stem: Monocot: Zea mays; Dicot: Helianthus; Secondary: Helianthus (only Permanent slides).
4. Root: Monocot: Zea mays; Dicot: Helianthus; Secondary: Helianthus (only Permanent slides).
5. Leaf: Dicot and Monocot leaf (only Permanent slides).
6. Adaptive anatomy: Xerophyte (Nerium leaf); Hydrophyte (Hydrilla stem).
7. Structure of anther (young and mature), tapetum (amoeboid and secretory) (Permanent slides).
8. Types of ovules: anatropous, orthotropous, circinotropous, amphitropous/ campylotropous (permanent slides)
9. Female gametophyte: Polygonum (monosporic) type of Embryo sac Development (Permanent slides/photographs).
10. Ultrastructure of mature egg apparatus cells through electron micrographs.
11. Pollination types and seed dispersal mechanisms (including appendages, aril, caruncle) (Photographs and specimens).
12. Dissection of embryo/endosperm from developing seeds.





2

BOT-RI:-5026

## Economic Botany and Biotechnology

Total Lectures : 60 Credits : 6 (Theory - 4, Practical - 2)

### 2.1 Theory

#### Unit 1 : *Origin of Cultivated Plants*

(4 Lectures)

Concept of centres of origin, their importance with reference to Vavilov's work

#### Unit 2 : *Cereals*

(4 Lectures)

Wheat -Origin, morphology, uses

#### Unit 3 : *Legumes*

(6 Lectures)

General account with special reference to Gram and soybean

#### Unit 4 : *Spices*

(6 Lectures)

General account with special reference to clove and black pepper (Botanical name, family, part used, morphology and uses)

#### Unit 5 : *Beverages*

(4 Lectures)

Tea (morphology, processing, uses)

#### Unit 6 : *Oils and Fats*

(4 Lectures)

General description with special reference to groundnut



#### Unit 7 : *Fibre Yielding Plants*

(4 Lectures)

General description with special reference to Cotton (Botanical name, family, part used, morphology and uses).

#### Unit 8 : *Introduction to biotechnology*

(2 lecture)

#### Unit 9 : *Plant tissue culture*

(8 Lectures)

Micropropagation ; haploid production through androgenesis and gynogenesis; brief account of embryo & endosperm culture with their applications

#### Unit 10 : *Recombinant DNA Techniques*

(18 Lectures)

Blotting techniques; Northern, Southern and Western Blotting, DNA Fingerprinting; Molecular DNA markers i.e. RAPD, RFLP, SNPs; DNA sequencing, PCR and Reverse Transcriptase-PCR, Hybridoma and monoclonal antibodies, ELISA and Immunodetection. Molecular diagnosis of human disease, Human gene Therapy.

## 2.2 Practical

1. Study of economically important plants : Rice, Wheat, Gram, Soybean, Black pepper, Clove Tea, Cotton, Groundnut, Curcuma, through specimens, sections and microchemical tests
2. Familiarization with basic equipments in tissue culture.
3. Study through photographs: Anther culture, somatic embryogenesis, endosperm and embryo culture; micropropagation.
4. Study of molecular techniques: PCR, Blotting techniques, AGE and PAGE.

## Suggested Readings

1. Kochhar, S.L. (2011). *Economic Botany in the Tropics*, MacMillan Publishers India Ltd., New Delhi. 4th edition.
2. Bhojwani, S.S. and Razdan, M.K., (1996). *Plant Tissue Culture: Theory and Practice*. Elsevier Science Amsterdam. The Netherlands.
3. Glick, B.R., Pasternak, J.J. (2003). *Molecular Biotechnology- Principles and Applications of recombinant DNA*. ASM Press, Washington.



1

## BOT-SE-3014

### Biofertilizers

Total Lectures : 60 Credits : 4

**Unit 1:** General account about the microbes used as biofertilizer – *Rhizobium* – isolation, identification, mass multiplication, carrier based inoculants, Actinorrhizal symbiosis.

(8 Lectures)

**Unit 2:** *Azospirillum*: isolation and mass multiplication carrier based inoculant, associative effect of different microorganisms. *Azotobacter*: classification, characteristics – crop response to *Azotobacter* inoculum, maintenance and mass multiplication.

(16 Lectures)

**Unit 3:** Cyanobacteria (blue green algae), *Azolla* and *Anabaena azollae* association, nitrogen fixation, factors affecting growth, blue green algae and *Azolla* in rice cultivation.

(8 Lectures)

**Unit 4:** Mycorrhizal association, types of mycorrhizal association, taxonomy, occurrence and distribution, phosphorus nutrition, growth and yield – colonization of VAM – isolation and inoculum production of VAM, and its influence on growth and yield of crop plants.

(16 Lectures)

**Unit 5:** Organic farming Green manuring and organic fertilizers, Recycling of degradable municipal, agricultural and industrial wastes – biocompost making methods and method of vermicomposting field Application.

(12 Lectures)



### Suggested Readings

1. Dubey, R.C., 2005 A Text book of Biotechnology S.Chand & Co, New Delhi.
2. Kumaresan, V. 2005, Biotechnology, Saras Publications, New Delhi.
3. John Jothi Prakash, E. 2004. Outlines of Plant Biotechnology. Emkay Publication, New Delhi.
4. Sathe, T.V. 2004 Vermiculture and Organic Farming. Daya publishers.
5. Subha Rao, N.S. 2000, Soil Microbiology, Oxford & IBH Publishers, New Delhi.
6. Vayas, S.C., Vayas, S. and Modi, H.A. 1998 Bio-fertilizers and organic Farming Akta Prakashan, Nadiad





3

## BOT-SE-4014

### Nursery and Gardening

Total Lectures : 60 Credits : 4

**Unit 1:** Nursery: definition, objectives and scope and building up of infrastructure for nursery, planning and seasonal activities - Planting - direct seeding and transplants.

(8 Lectures)

**Unit 2:** Seed: Structure and types - Seed dormancy; causes and methods of breaking dormancy - Seed storage; Seed banks, factors affecting seed viability, genetic erosion - Seed production technology - seed testing and certification.

(12 Lectures)

**Unit 3:** Vegetative propagation: air-layering, cutting, selection of cutting, collecting season, treatment of cutting, rooting medium and planting of cuttings - Hardening of plants - green house - mist chamber, shed root, shade house and glass house.

(12 Lectures)

**Unit 4:** Gardening: definition, objectives and scope - different types of gardening - landscape and home gardening - parks and its components - plant materials and design - computer applications in landscaping - Gardening operations: soil laying, manuring, watering, management of pests and diseases and harvesting.

(16 Lectures)

RA  
**Unit 5:** Sowing/raising of seeds and seedlings - Transplanting of seedlings - Study of cultivation of different vegetables: cabbage, brinjal, lady's finger, onion, garlic, tomatoes, and carrots - Storage and marketing procedures.

(12 Lectures)

### Suggested Readings

1. Bose T.K. & Mukherjee, D., 1972, Gardening in India, Oxford & IBH Publishing Co., New Delhi.
2. Sandhu, M.K., 1989, Plant Propagation, Wile Eastern Ltd., Bangalore, Madras.
3. Kumar, N., 1997, Introduction to Horticulture, Rajalakshmi Publications, Nagercoil.
4. Edmond Musser & Andres, Fundamentals of Horticulture, McGraw Hill Book Co., New Delhi.
5. Agrawal, P.K. 1993, Hand Book of Seed Technology, Dept. of Agriculture and Cooperation, National Seed Corporation Ltd., New Delhi.
6. Janick Jules. 1979. Horticultural Science. (3rd Ed.), W.H. Freeman and Co., San Francisco, USA.





Semester III  
PHI-RC-3016  
Ethics



**Unit I**

Nature, Scope and Utility of study of Ethics  
Moral Consciousness, Object of Moral Judgement, Moral Obligation  
Postulates of Morality

**Unit II**

Virtue Ethics: Aristotle  
Deontological Ethics: Kant  
Utilitarianism: Bentham, Mill

**Unit III**

Theories of Punishment, Capital Punishment  
Professional Ethics  
Environmental Ethics

**Unit IV**

Law of Karma, Varna and Asrama Dharma, Purusarthas  
Buddhist Pancasila; Brahmvihara; Bodhisattva Bhūmis  
Jaina Triratna, Anuvrata and Mahavratas

**Books Recommended:**

Chakravarty, D.K.	<i>Problems of Analytical Ethics</i>
Dasgupta, S.N.	<i>A History of Indian Philosophy</i>
Frankena, W.	<i>Ethics</i>
Hiriyana, M.	<i>Outlines of Indian Philosophy</i>
Hudson, W.D.	<i>Modern Moral Philosophy</i>
Lillie, William.	<i>An Introduction to Ethics</i>
Mackenzie, J.N.	<i>Manual of Ethics</i>
Moore, G.E.	<i>Ethics</i>
Radhakrishnan, S.	<i>Indian Philosophy</i>
Singer, Peter.	<i>Applied Ethics</i>
Singer, Peter.	<i>Practical Ethics</i>
Tiwari, Kedar Nath.	<i>Classical Indian Ethical Thought: A Philosophical Study of Hindu, Jaina and Buddhist Morals</i>





**Unit I**

Nature, Scope and Utility of study of Ethics  
Moral Consciousness, Object of Moral Judgement, Moral Obligation  
Postulates of Morality

**Unit II**

Virtue Ethics: Aristotle  
Deontological Ethics: Kant  
Utilitarianism: Bentham, Mill

**Unit III**

Theories of Punishment, Capital Punishment  
Professional Ethics  
Environmental Ethics

**Unit IV**

Law of Karma, Varna and Asrama Dharma, Purusarthas  
Buddhist Pancasila; Brahmovihara; Bodhisattva Bhūmis  
Jaina Triratna, Anuvrata and Mahavratas

**Books Recommended:**

Chakravarty, D.K.  
Dasgupta, S.N.  
Frankenna, W.  
Hiriyana, M.  
Hudson, W.D.  
Lillie, William.  
Mackenzie, J.N.  
Moore, G.E.  
Radhakrishnan, S.  
Singer, Peter.  
Singer, Peter.  
Tiwari, Kedar Nath.

*Problems of Analytical Ethics*  
*A History of Indian Philosophy*  
*Ethics*  
*Outlines of Indian Philosophy*  
*Modern Moral Philosophy*  
*An Introduction to Ethics*  
*Manual of Ethics*  
*Ethics*  
*Indian Philosophy*  
*Applied Ethics*  
*Practical Ethics*  
*Classical Indian Ethical Thought: A Philosophical Study of Hindu, Jaina and Buddhist Morals*





oxidation states and e.m.f. (Latimer & Frost diagrams). Difference between the first, second and third transition series.

Chemistry of Ti, V, Cr Mn, Fe and Co (Chemistry of first -row transition elements) in various oxidation states as halides, oxides, hydroxides.

**Lanthanoids and Actinoids:**

(18 Lectures)

Electronic configuration, oxidation states, colour, spectral and magnetic properties, lanthanide contraction, separation of lanthanides (ion-exchange method only).

(6 Lectures)

**Bioinorganic Chemistry:**

Metal ions present in biological systems, classification of elements according to their action in biological system. Geochemical effect on the distribution of metals. Sodium / K-pump, carbonic anhydrase and carboxypeptidase. Excess and deficiency of some trace metals. Toxicity of metal ions (Hg, Pb, Cd and As), reasons for toxicity, Use of chelating agents in medicine.

Iron and its application in bio-systems, Haemoglobin; Storage and transfer of iron.

(10 Lectures)

**Recommended Books:**

1. Cotton, F.A., Wilkinson, G. and Gaus, P. L., Basic Inorganic Chemistry, 3<sup>rd</sup> Ed., Wiley, 2007.
2. Huheey, J. E., Keiter, E. A., Keiter, R. L., Medhi, O. K., Inorganic Chemistry: Principles of Structure and Reactivity, 4<sup>th</sup> Ed., Pearson Education India, 2006.
3. Lippard, S.J. & Berg, J.M. Principles of Bioinorganic Chemistry, Panima Publishing Company, 1994.
4. Cotton, F.A. & Wilkinson, G, Advanced Inorganic Chemistry. 6<sup>th</sup> Ed., Wiley-VCH, 2007.
5. Basolo, F, and Pearson, R.C., Mechanisms of Inorganic Chemistry, John Wiley & Sons, NY, 1967.
6. Greenwood, N.N. & Earnshaw, A., Chemistry of the Elements, 2<sup>nd</sup> Ed., Elsevier India, 2010.

---

CHE-HC-4012: LAB

**60 Lectures**

**Gravimetric Analysis:**

- i. Estimation of nickel(II) using dimethylglyoxime (DMG).
- ii. Estimation of copper as CuSCN
- iii. Estimation of iron as Fe<sub>2</sub>O<sub>3</sub> by precipitating iron as Fe(OH)<sub>3</sub>.
- iv. Estimation of Al (III) by precipitating with oxine and weighing as Al(oxine)<sub>3</sub> (aluminium oxinate).

**Inorganic Preparations:**

- i. Tetraamminecopper(II) sulphate, [Cu(NH<sub>3</sub>)<sub>4</sub>]SO<sub>4</sub>.H<sub>2</sub>O
- ii. *Cis* and *trans* K[Cr(C<sub>2</sub>O<sub>4</sub>)<sub>2</sub>.(H<sub>2</sub>O)<sub>2</sub>] Potassium dioxalatodiaquachromate (III)
- iii. Tetraamminecarbonatocobalt (III) ion
- iv. Potassium tris(oxalato)ferrate(III)

**Chromatography of metal ions**





8. Co-crystal controlled solid state synthesis ( $C_2S_3$ ) of N-organophthalimide using phthalic anhydride and 3-aminobenzoic acid.  
**Alternative sources of energy**
9. Solvent free, microwave assisted one pot synthesis of phthalocyanine complex of copper (II).
10. Photoreduction of benzophenone to benzopinacol in the presence of sunlight.

**Recommended Books:**

1. Anastas, P.T & Warner, J.C. *Green Chemistry: Theory and Practice*, Oxford University Press (1998).
2. Kirchoff, M. & Ryan, M.A. *Greener approaches to undergraduate chemistry experiment*. American Chemical Society, Washington DC (2002).
3. Ryan, M.A. *Introduction to Green Chemistry*, Tinnesand; (Ed), American Chemical Society, Washington DC (2002).
4. Sharma, R.K.; Sidhwani, I.T. & Chaudhari, M.K. *Green Chemistry Experiment: A monograph*, I.K International Publishing House Pvt Ltd. New Delhi. Bangalore CISBN 978-93-81141-55-7 (2013).
5. Cann, M.C. & Connelly, M. E. *Real world cases in Green Chemistry*, American Chemical Society (2008).
6. Cann, M. C. & Thomas, P. *Real world cases in Green Chemistry*, American Chemical Society (2008).
7. Pavia, D. L. Lampman, G. H. & Kriz, G.S. *W B Introduction to Organic Laboratory Techniques: A Microscale Approach*, 4<sup>th</sup> Ed., Brooks/Cole; 2007.

---

**CHE-HE-6024: INDUSTRIAL CHEMICALS AND ENVIRONMENT**

**(Credits: Theory-04, Practicals-02)**

**Theory: 60 Lectures**

**Course Objectives:** This course provides an introduction to the various industrial gases and inorganic chemicals, their manufacturing processes, applications, storage and the hazards of handling them. Contribution of these industrial chemicals towards air and water pollution and their effects on living organisms and the environment has also been covered. Students are also expected to learn about metallurgy, energy generation industry and the pollution threat they pose. This course also discusses about management of the different kinds of wastes, their safe disposal and the importance of practicing green chemistry in chemical industry.

**Learning Outcomes:** After successful completion of the course, students would have learnt about the manufacture, applications and safe ways of storage and handling gaseous and inorganic industrial chemicals. Students will get to know about industrial metallurgy and the energy generation industry. Students will also learn about environmental pollution by various gaseous, liquid wastes and nuclear wastes and their effects on living beings. Finally, the students will learn about industrial waste management, their safe disposal and the importance of environment friendly "green chemistry" in chemical industry.



## **Industrial Gases and Inorganic Chemicals**

*Industrial Gases:* Large scale production, uses, storage and hazards in handling of the following gases: oxygen, nitrogen, argon, neon, helium, hydrogen, acetylene, carbon monoxide, chlorine, fluorine, sulphur dioxide and phosgene.

*Inorganic Chemicals:* Manufacture, application, analysis and hazards in handling the following chemicals: hydrochloric acid, nitric acid, sulphuric acid, caustic soda, common salt, borax, bleaching powder, sodium thiosulphate, hydrogen peroxide, potash alum, chrome alum, potassium dichromate and potassium permanganate.

**(10 Lectures)**

## **Industrial Metallurgy**

Preparation of metals (ferrous and nonferrous) and ultrapure metals for semiconductor technology.

**(4 Lectures)**

## **Environment and its segments**

Ecosystems. Biogeochemical cycles of carbon, nitrogen and sulphur.

Air Pollution: Major regions of atmosphere. Chemical and photochemical reactions in atmosphere. Air pollutants: types, sources, particle size and chemical nature; Photochemical smog: its constituents and photochemistry. Environmental effects of ozone, Major sources of air pollution.

Pollution by  $\text{SO}_2$ ,  $\text{CO}_2$ ,  $\text{CO}$ ,  $\text{NO}_x$ ,  $\text{H}_2\text{S}$  and other foul smelling gases. Methods of estimation of  $\text{CO}$ ,  $\text{NO}_x$ ,  $\text{SO}_x$  and control procedures.

Effects of air pollution on living organisms and vegetation. Greenhouse effect and Global warming, Ozone depletion by oxides of nitrogen, chlorofluorocarbons and Halogens, removal of sulphur from coal. Control of particulates.

*Water Pollution:* Hydrological cycle, water resources, aquatic ecosystems, Sources and nature of water pollutants, Techniques for measuring water pollution, Impacts of water pollution on hydrological and ecosystems.

Water purification methods. Effluent treatment plants (primary, secondary and tertiary treatment). Industrial effluents from the following industries and their treatment: electroplating, textile, tannery, dairy, petroleum and petrochemicals, agro, fertilizer, etc. Sludge disposal.

Industrial waste management, incineration of waste. Water treatment and purification (reverse osmosis, electro dialysis, ion exchange). Water quality parameters for waste water, industrial water and domestic water.

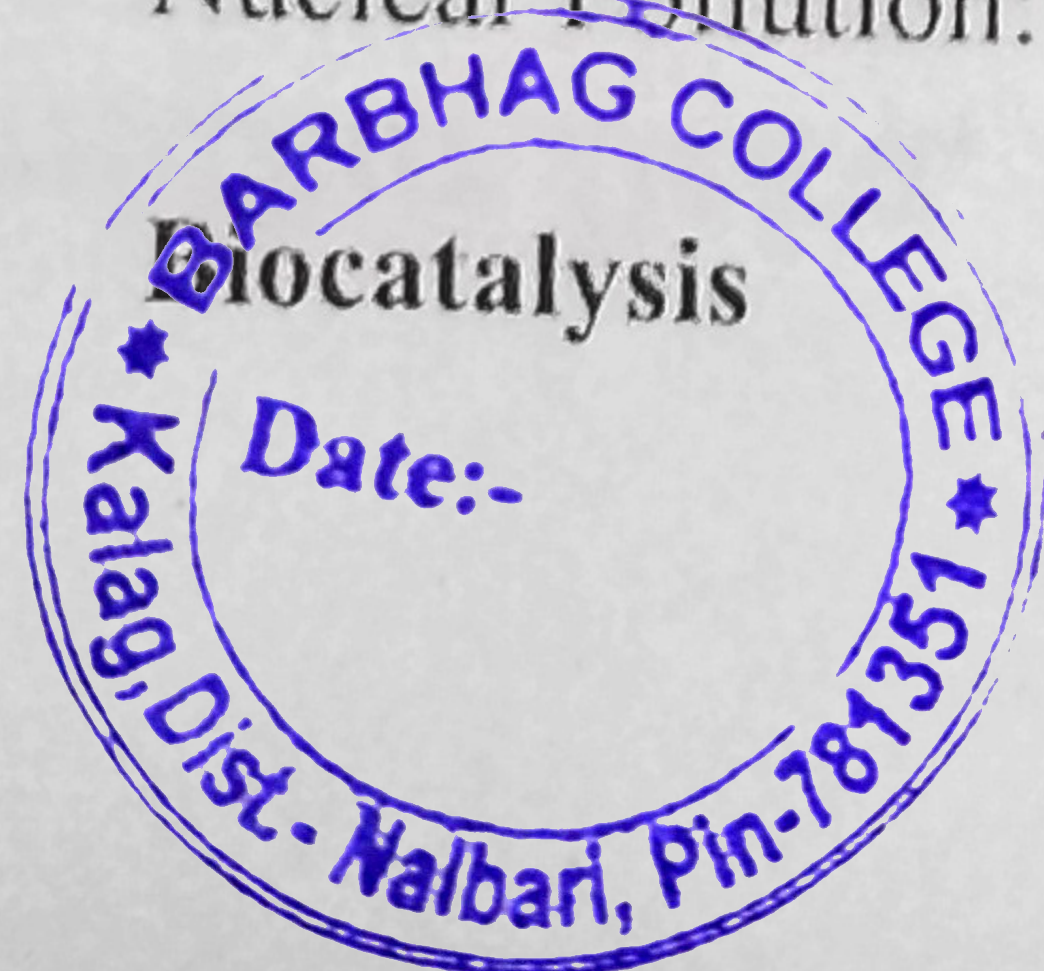
**(30 Lectures)**

## **Energy & Environment**

Sources of energy: Coal, petrol and natural gas. Nuclear Fusion / Fission, Solar energy, Hydrogen, geothermal, Tidal and Hydel, etc.

Nuclear Pollution: Disposal of nuclear waste, nuclear disaster and its management.

**(10 Lectures)**





CHE-SE-3034: BASIC ANALYTICAL CHEMISTRY

(Credits: 04)

60 Lectures

**Course Objective:** To familiarize students with different micro and semimicro analytical techniques and help develop the ability to use modern instrumental methods for chemical analysis of food, soil, air and water.

**Learning Outcome:** Upon completion of this course, students shall be able to explain the basic principles of chemical analysis, design/implement microscale and semimicro experiments, record, interpret and analyze data following scientific methodology.

**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.

**Analysis of soil:** Composition of soil, Concept of pH and pH measurement, Complexometric titrations, Chelation, Chelating agents, use of indicators

- Determination of pH of soil samples.
- Estimation of Calcium and Magnesium ions as Calcium carbonate by complexometric titration.

**Analysis of water:** Definition of pure water, sources responsible for contaminating 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.

**Analysis of food products:** Nutritional value of foods, idea about food processing and food preservations and adulteration.

- Identification of adulterants in some common food items like coffee powder, asafoetida, chilli powder, turmeric powder, coriander powder and pulses, etc.
- Analysis of preservatives and colouring matter.

**Chromatography:** Definition, general introduction on principles of chromatography, paper chromatography, TLC etc.

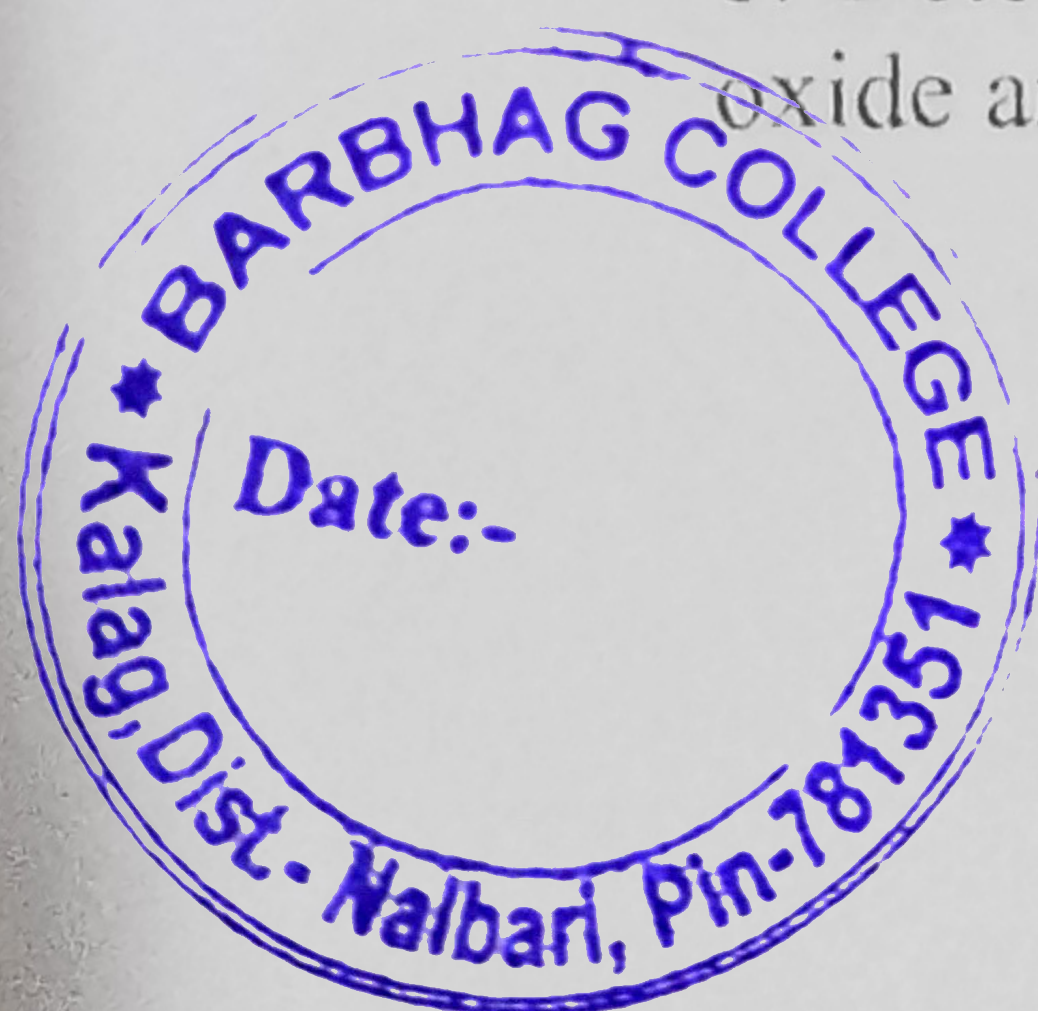
- Paper chromatographic separation of mixture of metal ion ( $\text{Fe}^{3+}$  and  $\text{Al}^{3+}$ ).
- To compare paint samples by TLC method.

**Ion-exchange:** Column, ion-exchange chromatography etc.

Determination of ion exchange capacity of anion / cation exchange resin (using batch procedure if use of column is not feasible).

**Analysis of cosmetics:** Major and minor constituents and their function

- Analysis of deodorants and antiperspirants, Al, Zn, boric acid, chloride, sulphate.
- Determination of constituents of talcum powder: Magnesium oxide, Calcium oxide, Zinc oxide and Calcium carbonate by complexometric titration.





**Suggested Applications (Any one):**

- To study the use of phenolphthalein in trap cases.
- To analyze arson accelerants.
- To carry out analysis of gasoline.

**Suggested Instrumental demonstrations:**

- Estimation of macro nutrients: Potassium, Calcium, Magnesium in soil samples by flame photometry.
- Spectrophotometric determination of Iron in Vitamin / Dietary Tablets.
- Spectrophotometric Identification and Determination of Caffeine and Benzoic Acid in Soft Drink.

**Recommended Books:**

- Willard, H. H. *Instrumental Methods of Analysis*, CBS Publishers.
  - Skoog & Lerry. *Instrumental Methods of Analysis*, Saunders College Publications, New York.
  - Skoog, D.A.; West, D.M. & Holler, F.J. *Fundamentals of Analytical Chemistry 6th Ed.*, Saunders College Publishing, Fort Worth (1992).
  - Harris, D. C. *Quantitative Chemical Analysis*, W. H. Freeman.
  - Dean, J. A. *Analytical Chemistry Notebook*, McGraw Hill.
  - Day, R. A. & Underwood, A. L. *Quantitative Analysis*, Prentice Hall of India.
  - Freifelder, D. *Physical Biochemistry 2nd Ed.*, W.H. Freeman and Co., N.Y. USA (1982).
  - Cooper, T.G. *The Tools of Biochemistry*, John Wiley and Sons, N.Y. USA. 16(1977).
  - Vogel, A. I. *Vogel's Qualitative Inorganic Analysis 7th Ed.*, Prentice Hall.
  - Vogel, A. I. *Vogel's Quantitative Chemical Analysis 6th Ed.*, Prentice Hall.
  - Robinson, J.W. *Undergraduate Instrumental Analysis 5th Ed.*, Marcel Dekker, Inc., New York (1995).
- 
- 

**CHE-SE-3044: CHEMICAL TECHNOLOGY & SOCIETY**

**(Credits: 04)**

**Theory: 60 Lectures**

**Course Objective:** The objective of the course is to enable students to have a firsthand understanding of different types of equipments needed in chemical technology and offer them concepts regarding some important parameters. The syllabus also emphasizes the dynamic nature of the relations between society on one hand and technological achievement from chemical industries on the other hand. In other words, it tries to explore societal and technological issues from a chemical perspective.

**Learning Outcome:** Students shall be familiarized with processes and terminologies in chemical industry, like mass balance, energy balance etc... Learners will be able to use chemical and scientific literacy as a means to better understand the topics related to the society.

**Chemical Technology**

Different types of equipments needed in chemical technology, including reactors, distillation columns, extruders, pumps, mills, emulgators. Scaling up operations in chemical industry. Introduction to clean technology.

Concept of relative humidity, molal humidity, dew point, partial saturation.





**Course Objective:** This is a brief and introductory course on pesticides, through which the students will be introduced to various classes of pesticides, their synthesis, applications and possible hazards of their uses.

**Learning Outcome:** Students will be able to explain or describe and critically examine different types of pesticides, their activity/toxicity and their applications and the need for the search of an alternative based on natural products.

Definition of pesticides, general introduction to pesticides (natural and synthetic), benefits and adverse effects of pesticides. Classification, mode of action, toxicity and methods of pesticides residue analysis. Synthesis and technical manufacture and uses of representative pesticides in the following classes: Organochlorines (DDT, Gammexene); organophosphate (Malathion, Parathion); Carbamates (Carbofuran and carbaryl); Quinones (Chloranil), Anilides (Alachlor and Butachlor)

**Practicals:**

1. To calculate acidity/alkalinity in given sample of pesticides formulations as per BIS specifications.
2. Preparation of simple organophosphates, phosphonates and thiophosphates.

**Recommended Book:**

1. R. Cremlyn: Pesticides, Preparation and Mode of Action, John Wiley & Sons, New York, 1978
2. RPBateman, Pesticide Applications, AAB Press, 2004
3. Principles of Pesticide chemistry: S K Handa, Ed. by Agrobios (India), 2008
4. Pesticide Science & Biotechnology: R Greenhalgh and T R Robers, IUPAC, Blackwell Scientific Publications, 1987
5. The Chemical Process Industries: D N Shreve
6. Pesticide Chemistry : G Matolesy, M. Nadasy, V. Andriska, Elsevier Sc. Publisher, USA, 1988

**CHE-SE-4064: FUEL CHEMISTRY**  
(Credits: 04)

60 Lectures

**Course Objectives:** This course discusses about the chemistry of various sources of energy. Students are expected to learn about the composition of coal and petroleum products, their extraction, purification methods and usage. A section also covers classification and applications of natural and synthetic lubricants. Students will also learn about the

