



Board of Studies

(Including Proceeding, Course Structure, Course Curriculum and Evaluation Scheme)

For

B.Sc. (ZBC)

(Effective from the Session: 2026–27)

Faculty of Science

FUTURE UNIVERSITY, BAREILLY

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Dean
Faculty of Sciences
Future University
Bareilly





Date:- 27-07-2026

To

The Hon'ble Vice-Chancellor,
Future University, Bareilly
Through: Dean, Faculty of Science

Subject: Request for Permission to Conduct the Board of Studies (BoS) Meeting for B.Sc. (ZBC)

Respected Sir,

With due respect, this is to seek your kind permission to convene a meeting of the Board of Studies (BoS) for the B.Sc. (ZBC) programme under the Faculty of Science.

The purpose of the meeting is to review and approve the proposed course structure, syllabus, and academic regulations for the programme in accordance with UGC guidelines and the National Education Policy (NEP) 2020.

It is proposed to conduct the BoS meeting on 28-07-2026 in the Board Room, Future University, Bareilly.

Kind approval is requested to proceed with the necessary arrangements and to issue the formal notification for the same.

Thanking you for your kind consideration.

Yours sincerely,


Prof. (Dr.) Yogendra Kumar Singh
Dean, Faculty of Science
Future University, Bareilly


Dean
Faculty of Sciences
Future University
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Agenda

Faculty of Science

Meeting Agenda of Board of Studies

Programme: B.Sc. (ZBC)

Dated: 28-07-2026

1. To review and recommend the course structure and curriculum of B.Sc. (ZBC) for the session 2026–27, taking into consideration NEP 2020 guidelines.
2. To discuss the total credits to be taken for the programme, based on the decision taken in the meeting of all the Deans.
3. To assess the comprehensive and continuous evaluation and assessment scheme for the students.
4. To finalise the Vocational and Co-curricular papers across the semesters, as detailed in the proposed course structure.
5. Any other item with the permission of the Chair.


Prof. (Dr.) Yogendra Kumar Singh
Dean, Faculty of Science
Future University, Bareilly

Dean
Faculty of Sciences
Future University
Bareilly







Date:- 27-07-2026

To,

Dr. Vikas Verma Patel

Department of Botany

VRABL Rajkiya mahila mahavidyalay, Bareilly

Sub: Invitation as an Expert in the Board of Studies (BoS) of B.Sc. (ZBC).

Sir,

The Vice-Chancellor, Future University, Bareilly, has approved a recommendation that you be appointed as an External Expert Member for the Board of Studies meeting of the B.Sc. (ZBC) programme, Faculty of Science, Future University, Bareilly. The proposed date of the BoS meeting is 28-07-2026 from 10:00 AM onwards at the University Campus (Board Room). You are requested to kindly accept the invitation as an External Expert for the said meeting. The schedule of the meeting is as follows:

Date: 28-07-2026

Time: 10:00 AM

Venue: Board Room, Future University, Bareilly.

A line of acknowledgement of acceptance will be highly appreciated.

Thanks and Best Regards,

Prof. (Dr.) Yogendra Kumar Singh
Dean, Faculty of Science
Future University, Bareilly

**Dean
Faculty of Sciences
Future University
Bareilly**



Date:- 27-07-2026

To,

Dr. Chitrendu Ji Tripathi

Department of Chemistry

Bareilly College, Bareilly

Sub: Invitation as an Expert in the Board of Studies (BoS) of B.Sc. (ZBC).

Sir,

The Vice-Chancellor, Future University, Bareilly, has approved a recommendation that you be appointed as an External Expert Member for the Board of Studies meeting of the B.Sc. (ZBC) programme, Faculty of Science, Future University, Bareilly. The proposed date of the BoS meeting is 28-07-2026 from 10:00 AM onwards at the University Campus (Board Room). You are requested to kindly accept the invitation as an External Expert for the said meeting. The schedule of the meeting is as follows:

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Thanks and Best Regards,


Prof. (Dr.) Yogendra Kumar Singh
Dean, Faculty of Science
Future University, Bareilly




Dean
Faculty of Sciences
Future University
Bareilly

4. Board of Studies

B.Sc. (ZBC)

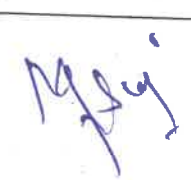
S.N.	Position	Designation	Proposed Member, Designation, Affiliation
1	Senior Faculty	Chairperson	Prof. (Dr.) Yogendra Kumar Singh, Dean, Faculty of Science, Future University, Bareilly.
2	Senior Faculty	Senior Member	Prof. (Dr.) Manish Kumar Singh, Professor, Faculty of Science, Future university, Bareilly
3	Senior Faculty	Member Secretary	Prof. (Dr.) Shalabh Saxena, Professor, Faculty of Science, Future university, Bareilly
8	Academic Expert (Member)	Member	Dr. Vikas Verma Patel, Associate Professor, Department of Botany, VRABL rajkiya mahila mahavidyalaya, Bareilly
9	Academic Expert (Member)	Member	Dr. Chitrendu Ji Tripathi, Associate Professor, Department of Chemistry, Bareilly College, Bareilly

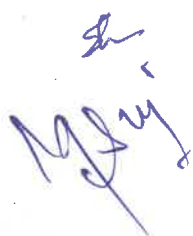
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 Dean
 Faculty of Sciences
 Future University
 Bareilly

5. Attendance List of BoS Members

B.Sc. (ZBC)

S.N.	Name of Member	Designation / Affiliation	Signature
1	Prof. (Dr.) Yogendra Kumar Singh	Dean, Faculty of Science, Future University, Bareilly.	
2	Prof. (Dr.) Manish Kumar Singh	Professor, Faculty of Science, Future University, Bareilly.	
3	Prof. (Dr.) Shalabh Saxena	Professor, Faculty of Science, Future University, Bareilly.	
4	Dr. Vikas Verma Patel	Associate Professor, Department of Botany, VRABL rajkiya mahila mahavidyalaya, Bareilly	joined online
5	Dr. Chitrendu Ji Tripathi	Associate Professor, Department of Chemistry, Bareilly College, Bareilly.	joined online.



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6. Budget of Board of Studies

B.Sc. (ZBC)

S. No.	Particulars	Amount	Pack	Total
1	Remuneration to External Experts (including TA for local experts, otherwise 5,000 + TA)	5,000	02	10,000
2	Refreshment / Working Lunch	1,000	01	1,000
3	Stationery and Printing	500	01	500
			Grand Total	11,500

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7. Point of Discussion

S. No.	Point of Discussion	Sub Point
1	Review and Approval of Scheme and Syllabus of B.Sc. (ZBC) (Batch 2026 onwards)	Subject code & syllabus will be defined for the programme and will be adopted as per UGC guidelines and the NEP 2020 credit framework.

M/S

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8. Minutes of Meeting

B.Sc. (ZBC)

Particulars	Details
Date	28-07-2026
Time	10:00 AM
Venue	Board Room, Future University, Bareilly
Chairperson	Dean, Faculty of Science

Panel of BoS Attendees:

As per the Attendance List of BoS Members (Section 5).

The following are the details of the discussions held:

1. As this is the first meeting of the Board of Studies for this programme, there were no previous minutes to be confirmed.
2. The proposed course structure and syllabus for B.Sc. (ZBC), for the session 2026–27 and for all semesters, was discussed threadbare. Suggestions given by the external experts were incorporated at various places, including greater emphasis on practical/laboratory components.
3. The total credits for the programme were discussed and finalised in line with the decision taken in the meeting of all the Deans and NEP 2020 guidelines.
4. After discussion, it was agreed that evaluation for each theory paper will be out of 100 marks, comprising 30 marks for internal continuous evaluation and 70 marks for end-semester examination; practical papers will be evaluated out of 50 marks (15 internal, 35 end-semester).
5. The Vocational and Co-curricular/Elective papers across semesters, as proposed in the course structure, were reviewed and approved.

Any other item with the permission of the Chair:

- Course work and practicals will carry codes as per UGC suggestions for Academic Bank of Credits (ABC) purposes.
- It was suggested that the University should follow the NCrf (National Credit Framework) structure across all programmes offered.


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- Practical credit shall be assigned as per UGC norms.
- The Board appreciated the efforts of the Faculty members in formulating the syllabus for the 2026–27 academic batch. The Member Secretary informed the Board that the detailed syllabi for the remaining semesters shall be presented for approval in subsequent BoS meetings, in consultation with subject experts, and placed before the Academic Council thereafter.

The meeting ended with a vote of thanks to the external members who spared their valuable time and offered valuable suggestions.


Prof. (Dr.) Yogendra Kumar Singh
Dean, Faculty of Science
Future University, Bareilly

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9. Course Structure / Scheme B.Sc. (ZBC)

Year	SEM	Course Code	Paper Title	Theory/ practical	L	T	P	Credit
First Year	First	BZO1103	Systematic and Animal Diversity@ animal form and Function	Theory	3	1	0	4
		BZO1173	Lab Work Based on course	Practical	0	0	2	2
	Second	BZO1201	Cell Biology and Biochemistry	Theory	3	1	0	4
		BZO1270	Lab based on course	Practical	0	0	2	2
Second Year	Third	BZO2303	Molecular Biology Bioinstrumentation and Biotechnology	Theory	3	1	0	4
		BZO2371	Bioinstrumentation and Molecular Biology lab	Practical	0	0	2	2
	Fourth	BZO2403	Gene Technology , Immunology and Computational Biology	Theory	3	1	0	4
		BZO2473	Lab Work Based on Paper	Practical	0	0	2	2
	Fifth	BZO3502	Diversity of Chordates and Comparative Anatomy	Theory	3	1	0	4
		BZO3505	Diversity of Non Chordates and Economic Zoology	Theory	3	1	0	4
Third Year	Fifth	BZO3571	Dissection , Economic Zoology and Parasitological	Practical	0	0	2	2
		Sixth	BZO3602	Evolutionary and Development Biology	Theory	3	1	0
	BZO3605		Ecology Ethalogy, Environmental Science and Wild Life	Theory	3	1	0	4
	BZO3670		Lab on Ecology, Environmental and Wild life	Practical	0	0	2	2

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Year	SEM	Course Code	Paper Title	Theory/ practical	L	T	P	Credit
First Year	First	BBT1102	Cryptogam and Plant Architecture	Theory	3	1	0	4
		BBT1171	Lab work based on course	Practical	0	0	2	2
	Second	BBT1202	Microbiology, Plant pathology, Cytology and Genetics	Theory	3	1	0	4
		BBT1271	Lab work based on course	Practical	0	0	2	2
Second Year	Third	BBT2302	Diversity of angiosperm: Systematic Development and Reproduction	Theory	3	1	0	4
		BBT2372	Plant Identification technology	Practical	0	0	2	2
	Fourth	BBT2402	Economic Botany, Ethanomedicine and Phytochemistry	Theory	3	1	0	4
		BBT2472	Commercial Botany and Phytochemical analysis	Practical	0	0	2	2
Third Year	Fifth	BBT3503	Plant resource utilization, Biostatistics & Molecular Biology	Theory	3	1	0	4
		BBT3504	Bioinformatics and Biochemistry	Theory	3	1	0	4
		BBT3570	Experiment in Physiology, Biochemistry	Practical	0	0	2	2
	Sixth	BBT3603	Plant Breeding and Nano Technology	Theory	3	1	0	4
		BBT3604	Ecology and Environmental Biology	Theory	3	1	0	4
		BBT3672	Lab on Cytogenetic and Environment	Practical	0	0	2	2
		BBT3673	Project in Botany	Project	0	0	0	




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Year	SEM	Course Code	Paper Title	Theory/ practical	L	T	P	Credit
First Year	First	BCHE1101	Structure and Bonding Organic Chemistry I	Theory	3	1	0	4
		BCHE1172	Qualitative analysis (Physical and Volumetric) Qualitative Analysis (Inorganic and Organic)	Practical	0	0	2	2
	Second	BCHE1203	Inorganic Chemistry –I Physical Chemistry -I	Theory	3	1	0	4
		BCHE1273	Chemistry Practical –II Qualitative analysis (Physical and Volumetric) Qualitative Analysis (Inorganic and Organic)	Practical	0	0	2	2
Second Year	Third	BCHE2301	Chemistry Dynamics and Coordination Chemistry	Theory	3	1	0	4
		BCH2370	Lab Work Based on Course Chemistry	Practical	0	0	2	2
	Fourth	BCH2401	Quantum Mechanics Spectroscopy and Analytic Techniques	Theory	3	1	0	4
		BCH2471	Lab Work Based on (Quantum mechanics spectroscopy and analytic techniques)	Practical	0	0	2	2
Third Year	Fifth	BCH3501	Organic Synthesis A	Theory	3	1	0	4
		BCH3506	Rearrangement and chemistry of Group Element	Theory	3	1	0	4
		BCH3572	Qualitative analysis	Practical	0	0	2	2
	Sixth	BCH3601	Organic Synthesis B	Theory	3	1	0	4
		BCH3606	Chemical Energetics and radiochemistry	Theory	3	1	0	4
		BCH3671	Lab Work Based on Course	Practical	0	0	2	2





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Evaluation Scheme

B. Sc. (PCM and ZBC)

S. N.	Subject	Internal	External	Total
1	Physics	30	70	100
2	Chemistry	30	70	100
3	Mathematics	30	70	100
4	Zoology	30	70	100
5	Botany	30	70	100
6	Vocational	100	--	100
7	Co-curricular	40	60	100



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10. Syllabus



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PROPOSED STRUCTURE OF SYLLABUS

ZOOLOGY

(FACULTY OF SCIENCE)

FUTURE UNIVERSITY, BAREILLY

18th Milestone, Bareilly-Lucknow Highway NH-24

Near Faridpur, Bareilly, Uttar Pradesh 243503

Website: www.futureuniversity.in




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Programme Objectives (POs)

1. The programme has been designed in such a way so that the students get the flavour of both classical and modern aspects of Zoology/Animal Sciences. It aims to enable the students to study animal diversity in Indian subcontinent, environmental science and behavioural ecology.
2. The modern areas including cell biology and genetics, molecular biology, biochemistry, physiology followed by biostatistics, Evolutionary biology, bioinformatics and genetic engineering have been included to make the study of animals more interesting and relevant to human studies which is the requirement in recent times.
3. The lab courses have been designed in such a way that students will be trained to join public or private labs.

Programme Specific Outcomes (PSOs)

PSO 1: This course introduces System Biology and various functional components of an organism. Emphasis will be on physiological understanding abnormalities and anomalies associated with white blood cells and red blood cells. The course emphasizes cell identification, cell differentiation and cell morphology evaluation procedures. This will enhance hematology analytical skills along with skill of using many

PSO 2: The students will have hands-on training in the techniques like microscopy, centrifugation and chromatography, and various biochemical techniques, preparation of slides which will help them in getting employment in pathology labs and contribute to health care system.

PSO 3: The students will be able to understand and apply the principles and techniques of molecular biology which prepares students for further career in molecular biology. Independently execute a laboratory experiment using the standard methods and techniques.



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PSO 4: The basic tools of bioinformatics will enable students to analyze large amount of genomic data and its application to evolutionary biology. Apply knowledge and awareness of the basic principles and concepts of biology, computer science and mathematics existing software effectively to extract information from large databases and to use this information in computer modeling.

PSO 5: This programme aims to introduce students to animal diversity of invertebrates and vertebrates. The students will be taught about invertebrates and vertebrates using observational strategies, museum specimens and field reports.

PSO 6: Inclusion of ecology and environmental sciences will enrich students with our world which is crucial for human well being and prosperity. This section will provide new knowledge of the interdependence between people and nature that is vital for food production, maintaining clean air and water, and sustaining biodiversity in a changing climate.

PSO 7: At the end of the course the students will be capable enough to comprehend the reason behind such a huge diversity of animals and reason out why two animals are grouped together or remain separate due to similarities and differences which exist at many levels along with ecological, environmental and cellular inputs.



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B.Sc., Year I, Semester I ZOOLOGY

Course Code:	BZOO1102	L	T	P	Credits
	Systematic and Animal Diversity & Animal Form and Function	3	1	0	4

CO1: Identify and classify different animal groups.

CO2: Explain the relationships between animals and their environments.

CO3: Apply knowledge of ecology, ethology, and wildlife conservation.

CO4: Understand animal structure, function, development, evolution, and diversity.

Unit I

Definition of taxonomy and relationship with systematics- Zoological nomenclature- Binominal and trinomial. Kinds of taxonomic characters- Morphological, Embryological, Cytogenetically, Biochemical, Numerical. Kinds of Zoological classification- Components of classification, Linnaean hierarchy - Concepts of species- Typological, Nominalist, Biological, Evolutionary.

Unit II

Animal Diversity: Criteria for classification of multicellular animals - Symmetry. Early development: spiral and radial cleavage, Protostomes and Deuterostomes, Body cavities: acoelomates, pseudo coelomates, coelomates (schizo- and enterocoelomates), Homology and analogy. Non-Chordates: General characters and classification of the following up-to classes with examples showing distinctive/adaptive features- Protozoans, Poriferans,

Cnidarians, Ctenophorans, Platyhelminths, Nematodes, Annelids, Arthropods, Molluscs, Echinoderms. Hemichordates: General characters and classification up to sub-classes Chordates: General characters and classification of the following up to sub-classes with examples-Protochordates: Urochordates, Cephalochordates, Cyclostomes, Fishes, Amphibians, Reptiles, Birds, Mammals.

Unit III

Nutrition & Digestion: Intracellular and extracellular digestion: food vacuole and gastrovascular cavity. Feeding mechanisms: suspension, deposit, cropping & sucking (herbivorous) and raptorial (carnivorous). Gas exchange and internal transport: Structure and function of gills, Structure and function of trachea, book lungs and vertebrate lungs, Respiratory pigments and transport of gases, Types of circulatory systems, Pattern of circulation in non-chordates and chordates. Types of excretory organs in non-chordates and chordates. Open tubular: metanephridia, Closed saccular: protonephridia, Malpighian tubules and kidney.

Unit IV

Nervous system - Patterns of nervous system in non-chordates, Organization of nervous system in vertebrates: central and autonomous system, Receptors and Sense organs, Phonoreception in fish and mammals, Photoreception in insects and mammals.

Unit V

Reproduction: Types of asexual reproduction: fission, regeneration and parthenogenesis. Sexual reproduction: primary and accessory sex organs. Parental care in amphibians. Types of excretory organs in non-chordates and chordates. Open tubular: metanephridia.

Text Books:

Books Recommended

1. Dalela & Sharma: Animal Taxonomy and Museology (1976, Jai Prakash Nath).
2. Kapoor: Theory and Practicals of Animal Taxonomy (1988, Oxford & IBH).
3. Simpson: Principles of Animal Taxonomy (1962, Oxford).
4. Roymahoney: Laboratory Techniques in Zoology (1966, Butterworths).
5. Mayer & Ashlock: Principles of Systematic Zoology (1991, McGraw Hill).
6. Boolotian & Stiles: College Zoology (10th ed 1981, Macmillan)
7. Campbell & Reece: Biology (7th ed 2005, Pearson)
8. Dorit, Walker & Barnes: Zoology (1991, Saunders)
9. Taylor, Green & Stout: Biological Sciences (3rd ed. 2005, Cambridge)
10. Mader: Biology (9th ed. 2007, W.C. Brown)
11. Marshall & Williams: Textbook of Zoology, Vol. I (Parker & Haswell, 7th ed. 1972, Macmillan)
12. Miller & Harley: Zoology (6th ed. 2005, W.C. Brown)
13. Nigam: Biology of Non-chordates (1997, S Chand)
14. Nigam: Biology of Chordates (1997, S Chand)
15. Parker & Haswell: Text Book of Zoology, Vol. II (2005, Macmillan)
16. Purves et al: Life-the Science of Biology (7th ed. 2004, Sinauer)
17. Starr: Biology, Concepts and Applications (1991, Wadsworth)
18. Tortora and Anagnostakos: Principles of Anatomy and Physiology (6th ed. 1986, Harper & Row).
19. Villee, Walker & Baranes: General Zoology (5th ed 1979, Saunders)
20. Wolfe: Biology – the Foundations (1987, Wadsworth)
21. Schmidt Nielson: Animal Physiology (5th ed. 2005, Cambridge)
22. Hoar: General and Comparative physiology (7th ed. 2005), Indian reprint.

23. Arms and Camp: Biology (4th ed. 1995)

B.Sc., Year I, Semester I ZOOLOGY

Course Code:	BZOO1102	L	P	Credits
	Lab Work based on Animal Diversity	3	0	3

CO1: Identify and classify different animal groups.

CO2: Explain the relationships between animals and their environments.

CO3: Apply knowledge of ecology, ethology, and wildlife conservation.

CO4: Understand animal structure, function, development, evolution, and diversity.

Systematics and Animal Diversity

[Signature]
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1. Identification of certain locally available fishes on the basis of their morphological characters.
2. Identification of the following species of *Drosophila* on the basis of their sex-combs.: *D. melanogaster*, *D. ananassae*, *D. bipectinata* and *D. malerkotliana*.
3. Zoological names of some common animals.
4. Cold anesthesia in fish.
5. Narcotization of leech/earthworm and pond snail.
6. Preservation of insects.
7. Fixation of fresh water protozoans.
8. Study of transverse sections/chart of the following:
9. Sycon (as an example of Parazoa to show its structure, spicules and canal system), Hydra (as an example of diploblastic animal), Fasciola (as an example of triploblastic acoelomate animal), Ascaris (as an example of triploblastic pseudocoelomate animal), Hirudinaria (as an example of triploblastic schizocoelomate animal), Frog (as an example of triploblastic enterocoelomate animal) – by charts.
10. Study of salient features and classification up to classes of the following non-chordates with special emphasis on their adaptive characters:
11. Amoeba, Euglena, Plasmodium, Paramecium, Euplectella, Physalia, Corallium, Sea-Anemone, Hormiphora, Taenia, Ascaris (male and female), Nereis (including heteronereid stage), Hirudinaria, Bonellia, Chiton, Mytilus, Octopus, Peripatus, Limulus, Eupagurus, Sacculina, Asterias, Echinus, Holothuria, Ophiothrix, Antedon.
12. Salient features and classification up to Orders of the following with special emphasis on their adaptive characters:
13. Balanoglossus, Herdmania, Amphioxus, Lamprey, Trygon, Chimaera, Lung Fish, Uraeotyphlus, Ambystoma, Alytes, Hyla, Chameleon, Tortoise, poisonous and non-poisonous snakes, Duck, Kiwi, Duck-billed Platypus.

B.Sc., Year I, Semester II ZOOLOGY

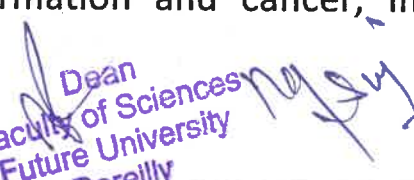
Course Code:	BZOO1202	L	P	Credits
	Cell Biology and Biochemistry	3	0	3

Unit I

The Cell: Introduction to cell theory, Comparison of a generalized pro- and eukaryotic cell. Methods in Cell Biology: Elementary idea of microscopy and cell fractionation. Organization of cell: Extranuclear - Elementary knowledge of structure and function of plasma membrane. Introduction to endomembrane system (endoplasmic reticulum, Golgi complex, lysosome), peroxisome. Introduction to cytoskeleton. Structure and functions of mitochondria. Nuclear envelope, nucleolus and biogenesis of ribosome. Interphase chromatin and its compaction into metaphase chromosome. Introduction to polytene and lampbrush chromosomes

Unit II

Cell reproduction: Basic features of cell cycle, Mitosis, mitotic spindle and chromosome movement, Process and phases of meiosis and its significance, Elementary idea of cell transformation and cancer, Introduction to the cellular basis of immunity



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Unit III

General: Chemistry of living system: its scope and importance, chemical bonds and energy, Biomolecules: configuration and conformation, Properties of water as biological solvent, Introduction to metabolism. Amino acids- Structure and classification, Properties of peptide bond. Proteins- Functions and diversity, Structural organisation and conformation

Unit IV

- Enzymes-General properties, Major classes of enzymes, Mechanism of enzyme action (binding to substrate, lowering of energy of activation, K_m and V_{max}), Carbohydrates-Classification and nomenclature. Structure and conformation of monosaccharides. Reducing and non-reducing sugars. Oligosaccharides (disaccharides) and polysaccharides, Lipids- Biological significance and classification, Fatty acids, Formation of lipid bi-layer

Unit V

- Nucleic acids- DNA structure: DNA double helix (Watson and Crick model). DNA and RNA as genetic material, DNA replication, Semi-conservative replication, Basic mechanism of replication (Prokaryotes), Types of RNA, Transcriptional unit and basic concept of transcription (Prokaryotes), Genetic code and basic mechanism of translation (Prokaryotes), Introduction to recombinant DNA techniques and their application




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B.Sc., Year I, Semester II ZOOLOGY

Course Code:	BZOO1272	L	P	Credits
	Cell Biology and Biochemistry (Practical)	3	0	3

Section A: Cell Biology

Unit	Topic	Proposed Lecture
I	Drawing of ultrastructure of cell and different organelles (from photographs provided), Familiarization with the student's light microscope and stereo binocular microscope, Application of centrifuge – separation of sperm from other testicular cells by low speed centrifugation, Diversity of eukaryotic cells – methylene blue staining of buccal epithelium, sperm, neurons, striated muscle cells; Leishman staining of mammalian blood cells, Permeability of plasma membrane – effect of isotonic, hypotonic and hypertonic solutions on mammalian RBC, Staining of nucleolus (RNA) and chromatin (DNA) with methyl green-pyronin. Staining of mitochondria with Janus green in buccal epithelium, Mitosis in onion root tip, Meiosis in grasshopper testis, Demonstration of preparation of polytene chromosomes from salivary glands of <i>Drosophila melanogaster</i> larva	20

Part B: Biochemistry

Unit	Topic	Proposed Lecture
II	Preparation of models of amino acids and dipeptides, Ninhydrin test for α -amino acids, To demonstrate catalase activity and its inactivation by heat,	12

	Benedict's test for reducing sugars, Iodine test for starch, Determination of acid value of oil, Preparation of models of nitrogenous bases, nucleosides and nucleotides	
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B.Sc., Year II, Semester III ZOOLOGY

Course Code:	BZO2303	L	P	Credits
	Molecular Biology, Bioinstrumentation and Biotechnology	3	0	3

UNIT-I

Process of Transcription

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- Fine structure of gene
- RNA polymerases
- Transcription factors and machinery
- Formation of initiation complex
- Initiation, elongation and termination of transcription in prokaryotes and eukaryotes

Process of Translation

- The Genetic code
- Ribosome
- Factors involved in translation
- Aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase
- Initiation, elongation and termination of translation in prokaryotes and eukaryotes

UNIT-II

Regulation of Gene Expression I

- Regulation of gene expression in prokaryotes: lac and trp operons in E. coli
- Regulation of gene expression in eukaryotes: Role of chromatin in gene expression
- Regulation at transcriptional level, Post-transcriptional modifications: Capping, Splicing, Polyadenylation
- RNA editing

Regulation of Gene Expression II

- Regulation of gene expression in eukaryotes: Regulation at translational level, Post-translational modifications: protein folding etc.
- Intracellular protein degradation
- Gene silencing, RNA interference (RNAi)

UNIT-III

Principle and Types of Microscopes

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- Principle of Microscopy and Applications
- Types of Microscopes: light microscopy, dark field microscopy, phase-contrast microscopy, Fluorescence microscopy, confocal microscopy, electron microscopy

UNIT-IV

Spectrophotometry and Biochemical Techniques

- Biochemical techniques: Measurement of pH, Preparation of buffers and solutions
- Principle of Colorimetry/Spectrophotometry: Beer-Lambert law
- Measurement, applications and safety measures of radio-tracer techniques

UNIT-V

Molecular Techniques

- Detection of nucleic acid by gel electrophoresis
- DNA sequencing, DNA fingerprinting, RFLP
- Polymerase Chain Reaction (PCR)
- Detection of proteins, PAGE, ELISA, Western blotting

Suggested Readings:

- Lodish et al: Molecular Cell Biology: Freeman & Co, USA (2004).
- Alberts et al: Molecular Biology of the Cell: Garland (2002).
- Cooper: Cell: A Molecular Approach: ASM Press (2000).
- Karp: Cell and Molecular Biology: Wiley (2002).
- Watson et al. Molecular Biology of the Gene. Pearson (2004).
- Lewin. Genes VIII. Pearson (2004).
- Pierce B. Genetics. Freeman (2004).
- Sambrook et al. Molecular Cloning Vols I, II, III. CSHL (2001).
- Primrose. Molecular Biotechnology. Panima (2001).

- Clark & Switzer. Experimental Biochemistry. Freeman (2000)

Course Books published in Hindi may be prescribed by the Universities and Colleges

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Semester III, Zoology (Practical):
Course Title: Bioinstrumentation and Molecular Biology Lab

Course Code: BZO2373

UNIT-I

- To study the working principle and Simple, Compound and Binocular microscopes.
- To study the working principle of various lab equipments such as pH Meter, Electronic balance, use of glass and micropipettes, Laminar flow, Incubator, Waterbath, Centrifuge, Chromatography apparatus, etc.

UNIT-II

- To prepare solutions and buffers.
- To measure absorbance in Colorimeter or Spectrophotometer.
- Demonstration of differential centrifugation to fractionate different components in a mixture.

UNIT-III

- To prepare dilutions of Riboflavin and verify the principle of spectrophotometry.
- To identify different amino acids in a mixture using paper chromatography.

UNIT-IV

- Demonstration of DNA extraction from blood or tissue samples.
- To estimate amount of DNA using spectrophotometer.

Suggested Readings:

- Sambrook et al. Molecular Cloning Vols I, II, III. CSHL (2001).
- Primrose. Molecular Biotechnology. Panima (2001).
- Clark & Switzer. Experimental Biochemistry. Freeman (2000)

Suggested Continuous Evaluation Methods:

- Viva voce (10 marks)

- Mock test (10 marks)
- Overall performance (05 marks)

Course prerequisites: To study this course, a student must have Opted Sem-III, Theory Paper.

  
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B.Sc., Year II, Semester IV ZOOLOGY

Course Code:	BZO2403	L	P	Credits
	Gene Technology, Immunology and Computational Biology	3	0	3

Course Outcome

CO1	Understand the principles of genetic engineering, how genes can be cloned in bacteria and the various technologies involved in it.
CO2	Know the applications of biotechnology in various fields like agriculture, industry and human health.
CO3	To have an in-depth understanding about Immune System & its mechanisms.
CO4	Get introduced to DNA testing and utility of genetic engineering in forensic sciences.
CO5	Get introduced to computers and use of bioinformatics tools.

UNIT – I

Principles of Gene Manipulation: Recombinant DNA Technology, Selection and identification of recombinant cells, Restriction Enzymes, DNA modifying enzymes, Cloning Vectors, Ligation, Gene transfer techniques, Gene therapy

UNIT – II

Applications of Genetic Engineering & DNA Diagnostics: Single cell proteins. Biosensors, Biochips, Crop and livestock improvement, development of transgenics, Development of DNA drugs and vaccines, Genetic analysis of human diseases, detection of known and unknown mutations, Concept of pharmacogenomics and pharmacogenetics

UNIT – III

Immune System and its Components: Historical perspective of Immunology, Innate and Adaptive Immunity, clonal selection, complement system
Structure and functions of different classes of immunoglobulins,

  
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Hypersensitivity, Humoral immunity and cell mediated immunity HLA complex: organization, class I and II HLA molecules

UNIT – IV: Biostatistics

- Calculations of mean, median, mode, variance, standard deviation
- Concepts of coefficient of variation, skewness, kurtosis
- Elementary idea of probability and application
- Data summarizing: frequency distribution, graphical presentation (pie diagram, histogram)
- Tests of significance: one and two sample tests, t-test and Chi-square test

UNIT – V: Bioinformatics

- Basics (CPU, I/O units) and operating systems
- Concept of homepages and websites, World Wide Web, URLs, using search engines
- Databases: nucleic acids, genomes, protein sequences and structures, bibliography
- Sequence analysis (homology): pairwise and multiple sequence alignments – BLAST, CLUSTALW
- Phylogenetic analysis

Suggested Readings:

- Primrose & Twyman. Principles of Genome Analysis and Genomics. Blackwell (2003)
- Hartl & Jones. Genetics: Principles & Analysis of Genes & Genomes. Jones & Bartlett (1998)
- Sambrook et al. Molecular Cloning Vols I, II, III. CSHL (2001)
- Primrose. Molecular Biotechnology. Panima (2001)
- Clark & Switzer. Experimental Biochemistry. Freeman (2000)
- Sudbery. Human Molecular Genetics. Prentice-Hall (2002)
- Wilson. Clinical Genetics: A Short Course. Wiley (2000)

- Pasternak. An Introduction to Molecular Human Genetics. Fitzgerald (2000)
- Jerrold H. Zar. Biostatistical Analysis (Fourth Edition). Pearson
- Snedecor & Cochran. Statistical Methods (Eighth Edition). Wiley Blackwell
- Daniel & Cross. Biostatistics (Tenth Edition). Wiley
- Havel et al. Introductory Biological Statistics (Fourth Edition)
- Westhead et al. Bioinformatics: Instant Notes. Viva Books (2003)

B.Sc., Year III, Semester V ZOOLOGY — Paper-I

Course Code:	Z030502T	L	P	Credits
BZO3505	Diversity of Chordates and Comparative Anatomy	3	0	3

Course Objectives

CO1	To demonstrate theoretical knowledge of fundamentals of Zoology in understanding Chordates and Hemichordates, Cephalochordata, Urochordata
CO2	To gain an understanding of the Vertebrates.
CO3	To understand the Digestive and Respiratory systems.
CO4	To understand the concepts of Circulatory and Urinogenital systems.
CO5	To familiarize the concepts of Nervous system and sense organs.

UNIT - I

Origin of Chordates & Hemichordata

Origin of Chordates. Classification of Phylum Chordata upto the class Hemichordata: General characteristics, classification and detailed study of Balanoglossus (Habit and Habitat, Morphology, Anatomy, Physiology and Development).

Cephalochordata: General characteristics, classification and detailed study of Branchiostoma (Amphioxus) (Habit and Habitat, Morphology, Anatomy, Physiology).

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Urochordata: General characteristics, classification and detailed study of Herdmania (Habit and Habitat, Morphology, Anatomy, Physiology and Post Embryonic Development).

UNIT II

Classification and General Characteristics of Vertebrates

General characters and Classification of different classes of vertebrates (Pisces, Amphibia, Reptilia, Aves, Mammalia) upto the order with examples.

Poisonous and Non Poisonous Snakes and biting mechanism, Neoteny and Paedogenesis, Migration in birds, Dentition in Mammals.

Comparative Anatomy and Physiology of Vertebrates

Integumentary System, Structure, functions and derivatives of integument, Skeletal System, Overview of axial and appendicular skeleton, Jaw suspensorium, Visceral arches.

UNIT – III

Digestive System: Alimentary canal and associated glands, dentition.

 Respiratory System: Skin, gills, lungs and air sacs; Accessory respiratory organs.

UNIT IV

Circulatory System: General plan of circulation, evolution of heart and aortic arches.

Urinogenital System: Succession of kidney, Evolution of urinogenital ducts, Types of mammalian uteri.

UNIT V

Nervous System: Comparative account of brain, Autonomic nervous system, Spinal cord, Cranial nerves in mammals

Sense Organs: Classification of receptors, Brief account of visual and auditory receptors in man

Suggested Readings:

- Harvey et al: The Vertebrate Life (2006)
- Colbert et al: Colbert's Evolution of the Vertebrates: A history of the backboned animals through time (5th ed 2002, Wiley - Liss)
- Hildebrand: Analysis of Vertebrate Structure (4th ed 1995, John Wiley)
- Kenneth V. Kardong (2015) Vertebrates: Comparative Anatomy, Function, Evolution McGraw Hill
- McFarland et al: Vertebrate Life (1979, Macmillan Publishing)
- Parker and Haswell: TextBook of Zoology, Vol. II (1978, ELBS)
- Romer and Parsons: The Vertebrate Body (6th ed 1986, CBS Publishing Japan)
- Young: The Life of vertebrates (3rd ed 2006, ELBS/Oxford)
- Weichert C.K and William Presch (1970). Elements of Chordate Anatomy, Tata McGraw Hills

COURSE OUTCOMES

CO1	Course Outcomes: Upon successful completion of this course students should be able to describe Chordates and Non-Chordates.
CO2	Students will be able to explore new areas of research in explaining the functioning of Vertebrates.
CO3	Students will be skilled in explain structural and functional characteristics of Digestive and Respiratory systems.
CO4	Students can describe Circulatory and Urinogenital systems.
CO5	Students will be able to describe Nervous system and have knowledge of Sense Organs.


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B.Sc., Year III, Semester V, Zoology — Paper-II

Course Code:	BZO3506	L	P	Credits
	Diversity Of Non-Chordates and Economic Zoology	3	0	3

UNIT-I

Protozoa to Coelenterate

- General Characteristics
- Protozoa – Paramecium (Morphology and Reproduction)
- Porifera – Sycon (Canal System)
- Coelenterata – Obelia (Morphology and Reproduction)

Ctenophora to Nemathelminthes

- General Characteristics
- Ctenophora - Salient features
- Platyhelminthes - Taenia (Tape worm) (Morphology and Reproduction)
- Nemathelminthes – Ascaris lumbricoides (Morphology and Reproduction)

UNIT-II

Annelida

- General Characteristics
- Annelida – Nereis (Morphology and Reproduction)

Arthropoda

- General Characteristics
- Arthropoda – Palaemon (Prawn) (Morphology, Appendages, Nervous System and Reproduction)

UNIT-III

Mollusca to Hemichordata

- General Characteristics

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- Mollusca – Pila (Morphology, Shell, Respiration, Nervous System and Reproduction)
- Echinodermata – Pentaceros (Morphology and Water Vascular System)

Vectors and pests

Life cycle and their control of following pests: Gundhi bug, Sugarcane leafhopper, Rodents, Termites and Mosquitoes and their control

UNIT-IV

Economic Zoology-1

Animal breeding and culture: Pisciculture

UNIT-V

Economic Zoology-2

Sericulture, Apiculture, Lac-culture, Vermiculture

Suggested Readings:

- Barnes et al (2009). The Invertebrates: A synthesis. Wiley Backwell 17
- Hunter: Life of Invertebrates (1979, Collier Macmillan)
- Marshall: Parker & Haswell Text Book of Zoology, Vol. I (7th ed 1972, Macmillan)
- Moore: An Introduction to the Invertebrates (2001, Cambridge University Press)
- Brusca and Brusca (2016) Invertebrates. Sinauer
- Jan Pechenik (2014) Biology of the invertebrates. McGraw Hill
- Neilsen (2012). Animal Evolution: Interrelationships amongst living Phyla. Oxford
- Parasitology - Chatterjee
- Parasitology - Chakraborty

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- Thomos C. Chung. General Parasitology. Hardcourt Brace and Co. Ltd. Asia, New Delhi.
- Gerard D. Schmidt and Larry S Roberts. Foundations of Parasitology. McGraw Hill.
- Bisht. D.S., Apiculture, ICAR Publication.
- Singh S., Beekeeping in India, Indian council of Agricultural Research, New Delhi.
- Jhingran. V.G. Fish and fisheries in India.
- Khanna. S.S, An introduction to fishes
- Boyd. C.E. & Tucker. C.S, Pond aquaculture water quality management,
- Biswas. K.P, Fish and prawn diseases,
- Pedigo, L.P. (2002). Entomology and Pest Management, Prentice Hall.
- Lee, Earthworm Ecology
- Stevenson, Biology of Earthworms
- Destructive and Useful Insects by C. L. Metcalf
- Sericulture for Rural Development: Hanumappa (1978), Himalaya Publication
- Sriculture in India Sarkar, D.C. (1988), CSB, Bangalore.

Course Outcomes:

The student at the completion of the course will be able to:

- demonstrate comprehensive identification abilities of non-chordate diversity
- explain structural and functional diversity of non-chordate
- explain evolutionary relationship amongst non-chordate groups
- Get employment in different applied sectors
- Students can start their own business i.e. self employments.
- Enable students to take up research in Biological Science

Course Books published in Hindi may be prescribed by the Universities and Colleges

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This course can be opted as an elective by the students of following subjects:
The eligibility for this paper is 10+2 with Biology as one of the subject



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Year III, Semester-V, Zoology (Practical):
Course Title: Dissection, Economic Zoology and Parasitology

Course Code: BZO3575

UNIT I

Study of animal specimens of various animal phyla.

- To prepare permanent stained slide of septal nephridia of earthworm.
- To take out the nerve ring of earthworm.
- To take out statocyst from Palaemon.

UNIT II

- Study on use and ethical handling of model organisms (Mice, rats, rabbit and pig).
- To prepare stained/unstained slide of placoid scales.
- Comparative study of bones of different vertebrates.
- Comparative study of histological slides of different tissues of vertebrates.

UNIT III

- Permanent Preparation of: Euglena, Paramecium
- Study of prepared slides/specimens of Entamoeba, Giardia, Leishmania, Trypanosoma, Plasmodium, Fasciola, Cotugnia, Taenia, Rallietina, Polystoma, Schistosoma, Echinococcus, Enterobius, Ascaris and Ancylostoma
- Permanent Preparation of Cimex (bed bug)/ Pediculus (Louse), Haematopinus (cattle louse), fresh water annelids, arthropods; and soil arthropods.
- Larval stages of helminths and arthropods.
- Permanent mount of wings, mouth parts and developmental stages of mosquito and house fly. Permanent preparation of ticks/mites, abdominal gills of aquatic insects viz. Chironomus larva, dragonfly and mayfly nymphs, preparation of antenna of housefly.

- Identification of pests.
- Life history of silkworm, honeybee and lac insect.
- Different types of important edible fishes of India.

UNIT IV

- Study of an aquatic ecosystem, its biotic components and food chain.
- Project Report/model chart making.
- Dissections: through multimedia / models
- Cockroach: Central nervous system
- Wallago: Afferent and efferent branchial vessels, Cranial nerves, Weberian ossicles.

Suggested Continuous Evaluation Methods:

- Viva voce (10 marks)
- Mock test (10 marks)
- Overall performance (05 marks)

Course prerequisites: To study this course, a student must have Opted Sem-III, Theory Paper-I

Suggested Readings:

Virtual Labs (Suggestive sites)

- <https://www.vlab.co.in>
- <https://zoologysan.blogspot.com>
- www.vlab.iitb.ac.in/vlab
- www.onlinelabs.in
- www.powershow.com
- <https://vlab.amrita.edu>
- <https://sites.dartmouth.edu>

Suggested Readings:

- Harvey et al: The Vertebrate Life (2006)
- Colbert et al: Colbert's Evolution of the Vertebrates: A history of the backboned animals through time (5th ed 2002, Wiley - Liss)
- Hildebrand: Analysis of Vertebrate Structure (4th ed 1995, John Wiley)
- Kenneth V. Kardong (2015) Vertebrates: Comparative Anatomy, Function, Evolution McGraw Hill
- McFarland et al: Vertebrate Life (1979, Macmillan Publishing)
- Parker and Haswell: TextBook of Zoology, Vol. II (1978, ELBS)
- Romer and Parsons: The Vertebrate Body (6th ed 1986, CBS Publishing Japan)
- Young: The Life of vertebrates (3rd ed 2006, ELBS/Oxford)
- Barnes et al (2009). The Invertebrates: A synthesis. Wiley Backwell 17
- Marshall: Parker & Haswell Text Book of Zoology, Vol. I (7th ed 1972, Macmillan)
- Moore: An Introduction to the Invertebrates (2001, Cambridge University Press)
- Brusca and Brusca (2016) Invertebrates. Sinauer
- Jan Pechenik (2014) Biology of the invertebrates. McGraw Hill
- Boradale, L.A. and Potts, E.A. (1961). Invertebrates: A Manual for the use of Students. Asia Publishing Home
- Robert Leo Smith Ecology and field biology Harper and Row publisher
- Handbook of Practical Sericulture: Ullal, S.R. and Narasimhanna, M.N. (1987), Central Silk Board Publication, Bangalore.
- Prost, P. J. (1962). Apiculture. Oxford and IBH, New Delhi.
- Bisht. D.S., Apiculture, ICAR Publication.
- Singh S., Beekeeping in India, Indian council of Agricultural Research, New Delhi.
- Ullal S.R. and Narasimhanna, M.N. Handbook of Practical Sericulture: CSB, Bangalore


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- Jolly. M. S. Appropriate Sericultural Techniques; Ed., Director, CSR & TI, Mysore.
- Handbook of Silkworm Rearing: Agriculture and Technical Manual-1, Fuzi Pub. Co.
- Santanam, B. et al, A manual of freshwater aquaculture
- Boyd. C.E. & Tucker. C.S, Pond aquaculture water quality management
- Pedigo, L.P. (2002). Entomology and Pest Management, Prentice Hall.
- Ranganathan L.S, Vermi composting technology - soil health to human health

Course Outcomes:

The student at the completion of the course will be able to:

- Demonstrate comprehensive identification abilities of chordate and non-chordates diversity
- Explain structural and functional diversity of chordates and non-chordates
- Explain evolutionary relationship amongst chordates and non-chordates
- Generate self employment
- Enable students to take up research in biological sciences.




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B.Sc., Year III, Semester VI ZOOLOGY — Paper-I

Course Code:	BZO3605	L	P	Credits
	Evolutionary And Developmental Biology	3	0	3

Course Objectives

CO1	To demonstrate theoretical knowledge of fundamentals of Evolution.
CO2	To gain an understanding of the Genetics.
CO3	To understand the Species Extinction.
CO4	To understand the concepts of Developmental Genes.
CO5	To familiarize the concepts of Early and Late Development Processes.

UNIT - I

Theories of Evolution

Origin of Life, Historical review of evolutionary concept: Lamarckism, Darwinism (Natural, Sexual and Artificial selection)

Modern synthetic theory of evolution, Patterns of evolution (Divergence, Convergence, Parallel, Coevolution)

UNIT-II

Population Genetics

Microevolution and Macroevolution: allele frequencies, genotype frequencies, Hardy-Weinberg equilibrium and conditions for its maintenance

Forces of evolution: mutation, selection, genetic drift.

UNIT-III

Direct Evidences of Evolution

Types of fossils, Incompleteness of fossil record, Dating of fossils, Phylogeny of horse

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Species Concept and Extinction

Biological species concept (Advantages and Limitations); Modes of speciation (Allopatric, Sympatric) and cell adhesion.

UNIT-IV

Developmental Genes: Genes and development, Molecular basis of development, Differential gene expression, Early Vertebrate Development, Early development of vertebrates (birds and mammals) Regeneration and stem cells, Extra embryonic membrane and placentation in mammals, Environmental regulation of development.

UNIT-V

Late Developmental Processes: The dynamics of organ development, Development of eye and brain, in chick, Metamorphosis: the hormonal reactivation of development in amphibians, insect Regeneration: salamander limbs, mammalian liver, Hydras: Aging: the biology of senescence.

Suggested Readings:

- Ridley, M. (2004). Evolution. III Edition. Blackwell Publishing
- Barton, N. H., Briggs, D. E. G., Eisen, J. A., Goldstein, D. B. and Patel, N. H. (2007). Evolution. Cold Spring, Harbour Laboratory Press.
- Hall, B. K. and Hallgrimsson, B. (2008). Evolution. IV Edition. Jones and Bartlett Publishers
- Campbell, N. A. and Reece J. B. (2011). Biology. IX Edition, Pearson, Benjamin, Cummings.
- Douglas, J. Futuyma (1997). Evolutionary Biology. Sinauer Associates.
- Developmental Biology: T. Subramaniam, (Reprint), Narosa Publishing House Pvt. Ltd., New Delhi (2013).
- Essential Developmental Biology: Jonathan M. W. Slack, (3rd ed.), Wiley-Blackwell. (2012).
- Developmental Biology: From a Cell to an Organism (Genetics & Evolution) eBook: Russ Hodge, Infobase Publishing. (2009).




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- Current Topics in Developmental Biology: Roger A. Pedersen, Gerald P. Schatten, Elsevier. (1998).
- Developmental biology: Werner A. Müller, Springer Science & Business Media. (2012).
- Human Embryology and Developmental Biology E-Book: Bruce M. Carlson, Elsevier Health Sciences. (2018).
- Developmental Biology: Michael J. F. Barresi, Scott F. Gilbert, Oxford University Press. (2019).

COURSE OUTCOMES

CO1	Understand that by biological evolution we mean that many of the organisms that inhabit the earth today are different from those that inhabited it in the past. Understand that natural selection is one of several processes that can bring about evolution, although it can also promote stability rather than change.
CO2	Students will be able to explore how the single cell formed at fertilisation forms an embryo and then a full adult organism.
CO3	Students will integrate genetics, molecular biology, biochemistry, cell biology, anatomy and physiology during embryonic development.
CO4	Students will gain an understanding of a variety of interacting processes, which generate an organism's heterogeneous shapes, size, and structural features.
CO5	Understand how a cell behaves in response to an autonomous determinant or an external signal and the scientific reasoning exhibited in experimental life science.

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B.Sc., Year III, Semester VI ZOOLOGY — Paper II

Course Code:	BZO3606	L	P	Credits
	Ecology, Ethology, Environmental Science and Wildlife	3	0	3

Course Outcome

CO1	Complexities and interconnectedness of various environmental levels and their functioning
CO2	Global environmental issues, their causes, consequences and amelioration
CO3	To understand and identify behaviours in a variety of taxa.
CO4	The proximate and ultimate causes of various behaviours.
CO5	To interpret the cause and effect of lifestyle disorders contributing to public understanding of biological timing.

Unit I

Introduction to Ecology and Ecosystem: History of ecology, Autecology and synecology, Levels of organization, Laws of limiting factors, Study of physical factors, Population: Density, natality, mortality, life tables, fecundity tables, survivorship curves, age ratio, sex ratio, dispersal and dispersion, Exponential and logistic growth, Types of ecosystems with one example in detail, Food chain: Detritus and grazing food chains, Food web, Energy flow through the ecosystem, Ecological pyramids and Ecological efficiencies, Nutrient and biogeochemical cycle with one example of Carbon cycle

Unit II

Behavioural Ecology and Chronobiology: Origin and history of Ethology, Instinct vs. Learnt Behaviour, Associative learning, classical and operant conditioning, Habituation, Imprinting, Circadian rhythms; Tidal rhythms and Lunar rhythms, Chronomedicine

Unit III


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Effects of Climate Change: Effect of climate change on public health, Sources of waste, types and characteristics, Sewage disposal and its management, Solid waste disposal, Biomedical waste handling and disposal, Nuclear waste handling and disposal, Waste from thermal power plants, Case histories on Bhopal gas tragedy, Chernobyl disaster, Seveso disaster and Three Mile Island accident and their aftermath.

Unit IV

Introduction to Wild Life: Values of wild life - positive and negative; Conservation ethics; Importance of conservation; Causes of depletion; World conservation strategies. National parks & sanctuaries, Community reserve; important features of protected areas in India; Tiger conservation - Tiger reserves in India; Management challenges in Tiger reserve

Unit V

Environmental Hazards: Sources of Environmental hazards, Climate changes, Greenhouse gases and global warming, Acid rain, Ozone layer destruction

Suggested Readings:

- Ecology: Theories & Applications. Peter D. Stiling, 2001, Prentice Hall.
- Ecological Modeling. 2008. Grant, W.E. and Swannack, T.M., Blackwell.
- Ecology: The Experimental Analysis of Distribution and Abundance. Charles J. Krebs, 2016, Pearson Education Inc.
- Elements of Ecology. T.M. Smith and R.L. Smith, 2014, Pearson Education Inc.
- Environmental Chemistry. 2010. Stanley and Manahan, E. CRC, Taylor & Francis. London.
- Environment. Raven, Berg, Johnson, 1993, Saunders College Publishing.
- Essentials of Ecology. G.T. Miller, Jr. & Scott. E. Spoolman, 2014, Brooks/Cole, Cengage Learning.
- Freshwater Ecology: A Scientific Introduction. 2004. Closs, G., Downes, B. and Boulton, A. Wiley-Blackwell publisher, Oxford.
- Fundamental Processes in Ecology: An Earth system Approach. 2007. Wilkinson, D.M. Oxford

Year III, Semester VI, Zoology (Practical):
Course Title: Lab on Ecology, Environment and Wildlife.

Course Code: BZO3675

Course outcomes:

The student at the completion of the course will be able to:

- To understand the basic concepts, importance, status and interaction between organisms and environment.
- Get employment in forest services, sanctuaries, conservatories etc.
- Enable students to take up research in wildlife.

UNIT-I

- Study of life tables and plotting of survivorship curves of different types from the hypothetical/real data provided.
- Study of population dynamics through numerical problems.
- Study of circadian functions in humans (daily eating, sleep and temperature patterns).

UNIT-II

Report on a visit to National Park/Biodiversity Park/Wild life sanctuary.

UNIT-III

Demonstration of basic equipments needed in wildlife studies use, care and maintenance (Compass, Binoculars, Spotting scope, Range Finders, Global Positioning System, Various types of Cameras and lenses)

UNIT-IV

Familiarization and study of animal evidences in the field; Identification of animals through pug marks, hoof marks, scats, pellet groups, nest, antlers etc.

Demonstration of different field techniques for flora and fauna

Virtual Labs (Suggestive sites)


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- <https://www.vlab.co.in>
- <https://zoologysan.blogspot.com>
- www.vlab.iitb.ac.in/vlab

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National Education Policy-2020

PROPOSED STRUCTURE OF SYLLABUS

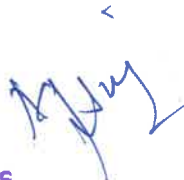
BOTANY

(FACULTY OF SCIENCE)

FUTURE UNIVERSITY, BAREILLY

18th Milestone, Bareilly-Lucknow Highway NH-24
Near Faridpur, Bareilly, Uttar Pradesh 243503
Website: www.futureuniversity.in




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Subject prerequisites:

1. To study Botany, a student must have had the subject Biology/Biotechnology learnt at 10+2 level.
2. Keen interest in plants and plant-related research, Potential in mathematics, biology and chemistry
3. Skills and aptitude for scientific study and research
4. Creativity and good comprehension while working on scientific procedures and research
5. Computer aptitude.

COURSE INTRODUCTION

The new curriculum of B.Sc. in Science (Botany) offers essential knowledge and technical skills to study plants in a holistic manner. Students would be trained in all areas of plant biology using a unique combination of core, elective and vocational papers with significant inter-disciplinary components. Students would be exposed to cutting-edge technologies that are currently used in the study of plant life forms, their evolution and interactions with other organisms within the ecosystem. Students would also become aware of the social and environmental significance of plants and their relevance to the national economy. B.Sc. Botany Programme covers academic activities within the classroom sessions along with practical concepts at laboratory sessions. Infield, outstation activities and projects are also required to be organized for real-life experience and learning. Candidates who have curiosity in plants kingdom, ecosystem, love exploring exotic places and wish to work as researchers or professions like Botanist, Conservationist, Ecologist, etc. can choose B.Sc. Botany course.

Programme outcomes (POs):

Transformed curriculum shall develop educated outcome-oriented candidature, fostered with discovery learning, equipped with practice & skills to deal practical problems and versed with recent pedagogical trends in education including e-learning, flipped class and hybrid learning to develop into responsible citizen for nation-building and transforming the country towards the future with their knowledge gained in the field of plant science.

PO 1	CBCS syllabus with a combination of general and specialized education shall introduce the concepts of breadth and depth in learning
PO 1	Shall produce competent plant biologists who can employ and implement their gained knowledge in basic and applied aspects that will profoundly influence the prevailing paradigm of agriculture, industry, healthcare and environment to provide sustainable development.
PO 1	Will increase the ability of critical thinking, development of scientific attitude, handling of problems and generating solutions, improve practical skills, enhance communication skill, social interaction, increase awareness in judicious use of plant resources by recognizing the ethical value system.
PO 1	The training provided to the students will make them competent enough for doing jobs in Govt. and private sectors of academia, research and industry along with graduate preparation for national as well as international competitive examinations, especially UGC-CSIR-NET, UPSC Civil Services Examination, IFS, NSC, FCI, BSI, FRI etc.
PO 1	Certificate and diploma courses are framed to generate self- entrepreneurship and selfemployability, if multi exit option is opted.

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PO 1	Lifelong learning be achieved by drawing attention to the vast world of knowledge of plants and their domestication.

Internal Assessment & External Assessment

Internal Assessment	Marks	External Assessment	Marks
Class Interaction	5	Viva Voce on Practicals	10
Quiz	7	Report of Botanical Excursion/ Lab Visits/Industrial training/ Survey/Collection/ Models	10
Seminar	8	Table work / Experiments	40
Assignments (Charts / Flora Botanical Excursion/ Lab Visits/Industrial training)	10	Practical Record File	10
TOTAL	30		70

Note: Botanical Excursion/ Lab Visits/Industrial training Is compulsory

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DETAIL SYLLABUS

FOR

B.Sc.-I Year



Course Code: BBT1102	B.Sc. Year I, Semester I BOTANY Cryptogams and Plant Architecture Paper – I (Theory)	L T P 3 1 0	Credits 4
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Max. Marks: 30+70

Total No of Lectures: 60

Course Outcome:

CO 1	Develop critical understanding on morphology, anatomy and reproduction of Bryophytes, Pteridophytes and Gymnosperms
CO 2	Understanding of plant evolution and their transition to land habitat.
CO 3	To understand the external morphology of various plants
CO 4	Develop understanding about the classification and diversity of different microbes including viruses, Algae, Fungi & Lichens & their economic importance
CO 5	Understand the structure and reproduction of certain selected bacteria algae, fungi and lichens

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Unit I

Phycology: Range of thallus organization in Algae, Pigments, Reserve food –Reproduction - Classification and life cycle of – Nostoc, Chlorella, Volvox, Hydrodictyon, Oedogonium, Chara; Sargassum, Ectocarpus, Polysiphonia. Economic importance of algae - Role of algae in soil fertility- biofertilizer – Nitrogen fixation- Symbiosis; Commercial products of algae –biofuel, Agar.

Unit II

Mycology: General characteristics, nutrition, life cycle, Economic importance of Fungi, Classification upto class. Distinguishing characters of Myxomycota: General characters of Mastigomycotina, Zygomycota: Rhizopus, Ascomycota: Saccharomyces, Penicillium, Peziza. Basidiomycotina: Ustilago, Puccinia, Agaricus; Deuteromycotina: Fusarium, Alternaria. Heterothallism, Physiological specialization, Heterokaryosis & Parasexuality.

Unit III

Introduction to Archegoniate & Bryophytes: Unique features of archegoniate, Bryophytes: General characteristics, adaptations to land habit, Range of thallus organization. Classification (up to family), morphology, anatomy and reproduction of Riccia, Marchantia, Anthoceros and Sphagnum. (Developmental details not to be included). Economic importance of bryophytes.

Unit IV

Pteridophytes: General characteristics, Early land plants (Rhynia). Classification (up to family) with examples, Heterospory and seed habit, stelar evolution, economic importance of Pteridophytes **Palaeobotany:** General account of Cycadofilicales, Bennettitales and Cordaitales; Geological time scale; Brief account of process of fossilization & types of fossils and study techniques; Contribution of Birbal Sahni

Unit V

Gymnosperms: Classification and distribution of gymnosperms; Salient features of Cycadales, Ginkgoales, Coniferales and Gnetales, their examples, structure and reproduction; economic importance. **Reproductive Botany:** Plant Embryology, Structure of microsporangium, microsporogenesis, Structure of megasporangium and its types, megasporogenesis, Structure and types of female gametophyte, types of pollination, Methods of pollination, Germination of pollen grain

Suggested Readings:

1. Gangulee H. S. and K. Kar 1992. College Botany Vol. I and II. (New Central Book Agency)
2. Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.


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3. Parihar, N.S. (1991). An introduction to Embryophyta. Vol. I. Bryophyta. Central Book Depot, Allahabad.
5. Sharma OP (1990) Textbook of Pteridophyta. MacMillan India Ltd. Delhi.
6. Vashishtha BR, Sinha AK and Kumar A (2010) Botany for Degree Students – Pteridophyta, S. Chand and Company,
7. Vashishtha BR, Sinha AK and Kumar A (2010) Botany for Degree Students – Gymnosperms, S. Chand and
10. Pandey BP (2010) College Botany Vol II S. Chand and Company, New Delhi
11. Maheswari, P. 1971. An Introduction to Embryology of Angiosperms. McGraw Hill Book Co., London
12. Bhattacharya et. al. 2007. A textbook of Palynology, Central, New Delhi.

Suggested Continuous Evaluation Methods: Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests. The marks shall be as follows:

Internal Assessment	Marks
Class Interaction	5
Quiz	7
Seminar	8
Assignments (Charts / Flora Botanical Excursion/ Lab Visits/Industrial training)	10
Total	30



Course Code: BBT1172	B.Sc. Year I, Semester I Land Plants Architecture (Paper –II Practical)	L T P 0 0 2	Credits 2
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Max. Marks: 30+70

Total No of Lectures: 60

Course Outcome:

CO 1	To gain an understanding of the history and concepts underlying various approaches to plant taxonomy and classification.
CO 2	To discover and use diverse taxonomic resources, reference materials, herbarium collections, publications.
CO 3	To understand the external morphology of various plants
CO 4	To understand the concept of Fertilization
CO 5	To familiarize the concept of anatomy in plants

Unit I

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Bryophytes: Marchantia- morphology of thallus, W.M. rhizoids and scales, V.S. thallus through Gemma cup, W.M. gemmae (all temporary slides), V.S. antheridiophore, archegoniophore, L.S. sporophyte (all permanent slides). Sphagnum- morphology, W.M. leaf, rhizoids, operculum, peristome, annulus, spores (temporary slides); permanent slides showing antheridial and archegonial heads, L.S. capsule and protonema.

Unit II

Pteridophytes: Lycopodium: Habit, stem T.S. strobilus V.S., Selaginella: Habit, rhizophore T.S, stem T.S, axis with strobilus, V.S. of strobilus, Megasporophyll and microsporophyll. Equisetum - Habit, rhizome and stem T.S. and V.S. of strobilus. Azolla – Habitat & its structure

Unit III

Gymnosperms: 1. Cycas – seedling, coralloid root and coralloid root T.S., T.S. of leaflet and Rachis, micro and megasporophyll, male cone V.S., microsporophyll T.S. entire and V.S. of ovule. Pinus - Branch of indefinite growth, spur shoot, T.S. of old stem and needle R.L.S. and T.L.S. of stem, male and female cone, V.S. of male and female cone. 2. Ephedra & Thuja: Habit, stem T.S. (young and mature), leaf T.S, male and female strobilus, V.S. of male and female cone, ovule V.S. and seed.

Unit IV

Palaeobotany & Palynology: 1. Morphology of Rhynia and fossils gymnosperms & other groups. 2. Visit Birbal Sahni Institute of Palaeosciences or virtual conference with their scientists to learn fossilization. 3. Mark and know about Indian geographical sites rich in plant fossils.

Unit V

Angiosperm Morphology: 1. To study diversity in leaf shape, size and other foliar features. 2. To study monopodial and sympodial branching. 3. Morphology of Fruits. 4. Inflorescence types- study from fresh/preserved specimens. 5. Flowers- study of different types from fresh/preserved specimens. 6. Fruits- study from different types from fresh/preserved specimens. 7. Study of ovules (permanent slides/specimens/photographs) 8. Modifications in Roots, stems, leaves and inflorescences

Suggested Readings:

1. Santra, SC and Chatterjee. 2005. College Botany Practical Vol. I. New Central Book Agency (P) Ltd.
2. Kumar, S and Kashyap. 2003. Manual of Practical Algae. Campus Books International, New Delhi
3. Bendre and Kumar A text book of Practical Botany. Vol I,II., Rastogi Pub. Meerut. Suresh Kumar ,
4. Amar Singh Kashyap Manual of Practical Algae.. Campus Books Internet , New Delhi
5. Santra, SC. 2005. College Botany Practical Vol. II. New Central Book Agency (P) Ltd

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Suggested Continuous Evaluation Methods: Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests. The marks shall be as follows:

Internal Assessment	Marks
Class Interaction	5
Field work /Virtual/E-learning /Participation in group discussions	10
Industrial or Central laboratory training of two weeks in summer/winter (Compulsory)	15
Total	30



Course Code: BBT1202	B.Sc. Year I, Semester II BOTANY Microbiology, Plant Pathology and Cytology Paper –I (Theory)	L T P 3 1 0	Credits 4
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Max. Marks: 30+70

Total No of Lectures: 60

Course Outcome:

CO 1	Develop conceptual skill about identifying microbes, pathogens, biofertilizers & lichens.
CO 2	Gain knowledge about developing commercial enterprise of microbial products.
CO 3	Learn host –pathogen relationship and disease management.
CO 4	Gain Knowledge about uses of microbes in various fields
CO 5	To familiarize the concept of Mushroom Cultivation

Unit I

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Microbial Techniques & instrumentation Microscopy – Light, phase contrast, electron, scanning and transmission electron microscopy, staining techniques for light microscopy, sample preparation for electron microscopy. Common equipment of microbiology lab and principle of their working – autoclave, oven, laminar air flow, centrifuge. Colorimetry and spectrophotometry, immobilization methods, fermentation and fermenters.

Unit II

Microbial world: History and scope of Microbiology, Position of microorganisms in the living world; morphological, metabolic and molecular criteria for the classification of bacteria (scheme not required), Structure of a bacterial cell: capsule and slime, flagella, cell wall, cell membrane, chromosome, plasmid and endospore, Structure of bacteriophages belonging to 'T' series, Lysogenic and lytic cycles, A brief account of genetic recombination in bacteria (transformation, conjugation and transduction)

Unit III

Plant Pathology: Disease concept, Symptoms, Etiology & causal complex, Primary and secondary inoculum, Infection, Pathogenicity and pathogenesis, Koch's Postulates. Mechanism of infection, Disease cycle. Defense mechanism with special reference to Phytoalexin, Resistance- Systemic acquired and Induced systemic fungicides, General symptoms of viral, bacterial and fungal diseases of plants. The study of the following plant diseases: Tobacco mosaic, citrus canker, late blight of potato, powdery mildew of pea, loose smut of wheat, covered smut of barley and wilt of pigeon pea.

Unit IV

Mushroom Cultivation, Lichenology & Mycorrhiza: Mushroom cultivation. General account of lichens, reproduction and significance; Mycorrhiza: ectomycorrhiza and endomycorrhiza and their significance.

Unit V

Cytology: Ultrastructure of plant cell: Nucleus, cytoskeleton, Cell cycle: Interphase nucleus: chromatin and heterochromatin, mitosis, meiosis; genetic significance of meiosis. Basic tenets of cytogenetics: Terminologies: Cytology, genetics, cytogenetics, cell and cell theory, germplasm theory, genotype-phenotype concept.

Suggested Readings:

Tortora, G.J., Funke, B.R., Case, C.L. (2010). Microbiology: An Introduction, Pearson Benjamin Cummings, U.S.A. 10th edition.

Aneja, K. R. 1993. Experiments in Microbiology, Pathology and Tissue Culture, Vishwa Prakashan, New Delhi.

Basu, A. N. 1993. Essentials of Plant Viruses, Vectors and Plant diseases, New Age International, New Delhi.

Dubey, R. C. and Maheshwari. D.K. 2012. Practical Microbiology, S. Chand & Company, Pvt. Ltd., New Delhi.

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Agrios, G.N. (1997). Plant Pathology, 4th edition. Cambridge, U.K.: Academic Press.
 .Sharma, P.D. (2011). Plant Pathology. Meerut, U.P.: Rastogi Publication.
 Pandey B.P. 2001. College Botany Volume 1, S Chand & Company Pvt.Ltd, New Delhi.
 Pandey. B.P. 2014 Modern Practical Botany, (Vol-I) S. Chand and Company Pvt. Ltd., New Delhi.
 Pelzar, 1963. Microbiology, Tata Mc Graw Hill, New Delhi
 Rangaswamy, G. 2009, Disease of Crop Plants in India, Prentice Hall of India, New Delhi.
 Sharma, P. D. 2012, Microbiology and Plant Pathology, Rastogi Publication Pvt Ltd., Meerut, India.
 Singh, R. P. 2007. Microbial Taxonomy and Culture Techniques, Kalyani Publication, New Delhi.
 Sundar Rajan. S. 2010. College Botany Volume I, Himalaya Publications, Mumbai.

Suggested Continuous Evaluation Methods: Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests. The marks shall be as follows:

Internal Assessment	Marks
Class Interaction	5
Quiz	7
Seminar	8
Assignments (Charts / Rural Service/ Technology Dissemination)	10
Total	30



Course Code: BBT1272	B.Sc. Year I, Semester II BOTANY Techniques in Microbiology & Plant Pathology Paper –II (Practical)	Credits 2
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Max. Marks: 30+70

Total No of Lectures: 60

Unit I

Instruments & Techniques:

1. Laboratory safety and good laboratory practices.
2. Principles and application of Laboratory instruments-microscope, incubator, autoclave, centrifuge, LAF, filtration unit, shaker, pH meter.
3. Buffer preparation & titration.
4. Preparation of media- Nutrient Agar and Broth.
5. Inoculation and culturing of bacteria in Nutrient agar and nutrient broth.

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Unit II

Bacterial Identification:

1. Isolation and Identification of bacteria.
3. Staining techniques: Gram's, Negative, Endospore, Capsule and Cell Wall.
5. Pure culture techniques (Types of streaking).
6. Biochemical characterization: IMViC, Carbohydrate fermentation test, Mannitol motility test, Gelatin liquefaction test, Urease test, Nitrate reduction test, Catalase test, Oxidase test, Starch hydrolysis, Casein hydrolysis

Unit III

Experimental Plant Pathology:

1. Preparation of fungal media (PDA) & Sterilization process.
2. Isolation of pathogen from diseased leaf. Identification: Pathological specimens of Brown spot of rice, Bacterial blight of rice, Loose smut of wheat, Stem rot of mustard, Late blight of potato; Slides of uredial, telial, pycnial & aecial stages of Puccinia, Few viral and bacterial plant diseases.

Unit IV

Practicals in Applied Microbiology-I:

1. Isolation of nitrogen fixing bacteria from root nodules of legumes.
2. Isolation of antagonistic Pseudomonas from soil.
3. Microscopic observations of root colonization by VAM fungi.
4. Isolation of Azospirillum sp. from the roots of grasses.

Unit V

Practicals in applied microbiology-II:

1. Wine production.
2. Isolation of lactic acid bacteria from curd.
3. Isolation of lipolytic organisms from butter or cheese.

Suggestive reading:

1. Aneja, K. R. 1993. Experiments in Microbiology, Pathology and Tissue Culture, Vishwa Prakashan, New Delhi.
2. Dubey, R. C. and Maheshwari. D.K. 2012. Practical Microbiology, S. Chand & Company, Pvt. Ltd., New Delhi.
3. Kodo, C.I. and Agarwal, H.O. 1972. Principles and techniques in Plant Virology, Van Nostrand, Reinhold Company, New York.
4. Madhavee Latha, P. 2012, A Textbook of Immunology, S. Chand & Company Pvt. Ltd., New Delhi.
5. Pandey. B.P. 2014 Modern Practical Botany, (Vol-I) S. Chand and Company Pvt. Ltd., New Delhi.
6. Sambamurty. A.V.S.S. 2006, A Textbook of Algae, I. K. International Publishing House, Pvt. Ltd.,
7. Singh, R. P. 2007. Microbial Taxonomy and Culture Techniques, Kalyani Publication, New Delhi.

Suggested Continuous Evaluation Methods: Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests. The marks shall be as follows:

Internal Assessment	Marks
Class Interaction	5
Field work /Virtual/E-learning /Participation in group discussions	10
Minor field work/excursion/lab visit/technology dissemination etc	15
Total	30

  
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DETAIL SYLLABUS

FOR

B.Sc.-II Year



Course Code: BBT2302	B.Sc. Year II, Semester III BOTANY Diversity of Angiosperm: Systematic, Development and Reproduction	Credits 4
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Max. Marks: 30+70

Total No of Lectures: 60

Course Outcome:

CO 1	To gain an understanding of the history and concepts underlying various approaches to plant taxonomy and classification.
CO 2	To discover and use diverse taxonomic resources, reference materials, herbarium collections, publications.
CO 3	To understand the external morphology of various plants
CO 4	To understand the concept of Fertilization
CO 5	To familiarize the concept of anatomy in plants

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Unit I

Systematic: Principles and rules of Botanical Nomenclature according to ICN (ranks and names; principle of priority, binomial system; type method, Artificial, natural and phylogenetic. Bentham and Hooker (upto series), Engler and Prantl (upto series) angiosperm phylogeny group (APG IV). Components of taxonomy (identification, nomenclature, classification) ; Taxonomic resources: Herbarium- functions & important herbaria, Botanical gardens,

Unit II

Taxonomic study of following families and their economic importance: Ranunculaceae, Malvaceae, Rutaceae, Fabaceae, Myrtaceae, Cucurbitaceae, Rubiaceae, Asteraceae, Apocynaceae, Acanthaceae, Asclepiadaceae, Solanaceae, Amaranthaceae, Euphorbiaceae, Papaveraceae, Apiaceae, Lamiaceae, Orchidaceae, Liliaceae, Musaceae, Poaceae, Cyperaceae, Areaceae.

Unit III

External morphology of vegetative and floral parts; modifications – phyllodes, cladodes, and phylloclades. Meristems-kinds study of tissue system - epidermal, ground, and vascular. Anatomy of roots, stems, and leaves. Cambium - its function and anomalies in roots and stems.

Unit IV

Structure and development of male and female gametophytes – microsporogenesis, microgametogenesis, megasporogenesis, and megagametogenesis, embryo sac types. Double fertilization development of embryo, endosperm development and its morphological nature, apomixis and polyembryony.

Unit V

Tools & softwares in plant identification: (i) Patterns (ii) Features (iii) Quantities OP02.010H11YLIP - Free Phylogenetic Software, Digital Taxonomy (e-flora), Description Language for Taxonomy – DELTA Internet directory for botany.

Suggested Readings:

1. Dr. Amar Singh. पादपवर्गिकी- Plant Taxonomy (An Old and Rare Book) from the category Ayurveda in our Books collection. Uttar Pradesh Hindi Sansthan, Lucknow
2. Bole, P. V. and Vaghani, Y. (1986) Field guide to the common trees of India. Oxford University Press; Bombay.
3. Brandis, D. (1906) Indian Trees (London, 5th edition. 1971). International Book Distributors; Dehra Dun.
4. Dallwitz, M. J., Paine, T. A. and Zurcher, E. J. (2003). Principles of interactive keys. <http://delta-intkey.com>
5. <https://www.naace.co.uk/school-improvement/ict-mark/>
6. Singh, G. 1999. Plant Systematics: Theory and Practice. Oxford and IBH, New Delhi.

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7. 12.Dutta A.C. 2016. Botany for Degree Students. Oxford University Press.
8. 13.Davis, P. H. and V. H. Heywood. 1963. Principles of Angiosperm Taxonomy. Oliver and Boyd,London. 14.Heywood, V. H. and D. M. Moore (Eds). 1984. Current Concepts in Plant Taxonomy. Academic Press, London.
9. 15.Austin, R. 2002. Elements of planting design. New York: John Wiley & Sons

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests. The marks shall be as follows:

Internal Assessment	Marks
Class Interaction	5
Quiz	5
Seminar	5
Assignment	5
Unit Test	10
Total	30



Course Code: BBT2372	B.Sc. Year II, Semester III BOTANY Plant Identification technology (Practical)	Credits 4
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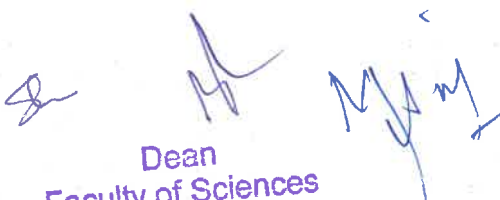
Max. Marks: 30+70

Total No of Lectures: 60

Course Outcome:

CO 1	To learn how plant specimens are collected, documented, and curated for a permanent record.
CO 2	To observe, record, and employ plant morphological variation and the accompanying descriptive terminology
CO 3	To gain experience with the various tools and means available to identify plants.
CO 4	To develop observational skills and field experience.
CO 5	To identify a taxonomically diverse array of native plants
	To recognize common and major plant families.

Unit I


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Herbarium: Plant collecting, Preservation and Documentation: Stepwise Practicing Herbarium techniques: a. FIELD EQUIPMENTS, Global Positioning System (GPS) instrument & Collection of any wild 25 plant specimens b. Learn to handle Herbarium making tools c. Pressing and Drying of collected plant specimens d. Special treatments for all varied groups of plants e. Mount on standard herbarium sheets f. Label them using Standard method g. Organize them and give Index Register Number

Unit II

Taxonomic Identification using plant structure : Classify 20 plants on the basis of Taxonomic description (Plant Morphology, Anatomy, Reproductive parts, Habit, adaptation anomalies) according to Bentham and Hooker natural system of classification in the following families: Malvaceae, Fabaceae (Papilionaceae), Solanaceae, Scrophulariaceae, Acanthaceae, Labiatae (Lamiaceae), Rubiaceae.

Unit III

Identification during excursions: a. Conducting Spot identification (Binomial, Family) of common wild plants from families included in the theoretical syllabus (list to be provided) and making FIELD NOTE BOOK and filling Sample of a page of field-book, used in Botanical Survey of India.

b. Describe/compare flowers in semi-technical language giving V.S. of flowers, T.S. of ovaries, floral diagrams and Floral Formulae. Identify and assign them to their respective families giving reasons

Unit IV

1. Create a Bonsai of any plant
2. Develop a miniature garden
3. Draw Layouts of various types of gardens
4. Plant Propagation methods practice

Unit V

Computer Application in taxonomy:

1. Use Taxonomic Softwares (Dichotomous Key)
2. Practicals on Phylogenetic analysis
3. Make line drawing of Plants for description
4. Using of plant identification apps on android phones

Suggested Readings:

1. Day, S.C. (2003) A Art of Miniature Plant Culture. - Agrobios. Jodhpur, India.
2. Practical Taxonomy of Angiosperms By : R K Sinha ISBN : 9789386768520 I.K International Publishing House Pvt. Ltd.
3. Day, S.C. (2003) Complete Home Gardening. (2003) Agrobios, Jodhpur, India.
4. Dhopte, A.M. (2003) Principles and Techniques for Plant Scientists. - Agrobios, Jodhpur, India.
5. Khan, M.R. (1995) Horticulture and Gardening. - Nirali Prakashan, Pune. India.
6. Pramila Mehra Gardening for everyone-. Hind pocket book private limited, New Dehli.
7. Kumarsen V. Horticulture, Saras Publication 6. Ramesh Bangia Learning Computer Fundamentals., Khanna Book Publishers
8. Jain, S.K. & R.R. Rao. 1977. A handbook of field and herbarium methods. Today & Tomorrow's Printers and Publishers, New Delhi.

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Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests. The marks shall be as follows:

Internal Assessment	Marks
Class Interaction	5
Botanical Excursion- compulsory	20
Assignment	5
Total	30



Course Code: BBT2402	B.Sc. Year II, Semester IV BOTANY Economic Botany, Ethanomedicine and Phytochemistry	Credits 4
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Max. Marks: 30+70

Total No of Lectures: 60

Course Outcome:

CO 1	To gain the theoretical knowledge of fundamentals of Economic Botany
CO 2	Understand about the uses of plants –will know one plant-one employment
CO 3	Understand phytochemical analysis related to medicinally important plants and economic products produced by the plants
CO 4	know about the importance of traditional medicines and herbs, and its relevance in modern times.
CO 5	To familiarize the importance of Medicinal Plant and its useful parts, economically important plants in our daily life

Unit I

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Origin and domestication of cultivated plants: Centers of diversity of plants, origin of crop plants. Domestication and introduction of crop plants. Concepts of sustainable development; cultivation; production and uses of Cereals, legumes, Spices & beverages. Botany of oils, Fibers, timber yielding plants & dyes, Study of the plants with Botanical names, Family, part used, and economic uses yielding Edible & essential oils; Sugar, Starch; Fibers; Paper, Fumitories & Masticatories, Rubber, Dyes, Timber, biofuel crops.

Unit II

Commercial production of Flowers, Vegetables, and fruits (To be Chosen area wise): Commercial greenhouse cultivation of rose, Gerbera, Gladiolus, Anthurium/lilium/lily, tomato, bell pepper, cucumber, strawberry & Exotic leafy vegetables using Hydroponics. **IPR & Traditional Knowledge:** IPR and WTO (TRIPS, WIPO), Patent Act 1970 and its amendments, TIFAC, NRDC, Rights, Procedure of obtaining patents, Working of patents, Infringement, Copyrights, Trademarks, Geographical Indications, Traditional Knowledge Digital Library, Protection of Traditional Knowledge & Protection of Plant Varieties and Biotech inventions.

Unit III

Ethnobotany: Methodologies of ethnobotanical research: Field work, Literature, Herbaria and Musea and other aspects of ethnobotany. Importance of ethnobotany in Indian systems of medicine (Siddha, Ayurveda and Unani), Role of AYUSH, NMPB, CI-MAP and CARI. Tribal knowledge towards disease diagnosis, treatment, medicinal plants, plant conservation and cultivation

Unit IV

Medicinal aspects: Study of common plants used by tribes (Aegle marmelos, Ficus religiosa, Cynodactylon, Eclipta alba, Oxalis, Ocimum sanctum and Trichopus zeylanicus) Ethnobotanical aspect of conservation and management of plant resources, Preservation of primeval forests in the form of sacred groves of individual species and Botanical uses depicted in our epics. Plants in primary health care: common medicinal plants: Tinospora, Acorus, Ocimum, Turmeric and Aloe. Indian Pharmacopoeia, Quality Evaluation of crude drugs & adulteration

Unit V

Herbal Preparations & Phytochemistry : Collection of wild herbs - Capsules - compresses - Elixirs - Glycerites - Hydrotherapy or Herbal bath - Herbal oils - Liquid extracts or Tincture - Poultices - Salves - Slippery elm slurry and gruel - Suppositories - Teas. Plant natural products, general detection, extraction and characterization procedures. Glycosides and Flavonoids and therapeutic applications. Anthocyanins and Coumarins and therapeutic applications, Lignans, Terpenes, Volatile oils and Saponins, Carotenoids and Alkaloids Carotenoids and pharmacological activities

Suggested Readings:

1. Kochhar, S.L. (2011). Economic Botany in the Tropics, MacMillan Publishers India Ltd., New Delhi. 4th edition.
2. Sambamurthy, AVSS & Subrahmanyam, NS (2000). Economic Botany of Crop Plants. Asiatech Publishers. New Delhi.
3. Singh, D.K and K.V. Peter. 2014. Protected cultivation of horticultural crops. New India Publishing Agency, India.

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4. Reddy P. Parvatha. 2016. Sustainable crop protection under protected cultivation. Springer, Singapore.
5. AmitDeogirakar. 2019. A Text Book on Protected Cultivation and Secondary Agriculture. RajlaxmiPrakashan, Aurangabad, India.
6. Singh, B., B. Singh, N. Sabir and M Hasan. 2014. Advances in protected cultivation. New India Publishing Agency, India.
7. Sharma, OP. 1996. Hill's Economic Botany (Late Dr. AF Hill, adopted by OP Sharma). Tata McGraw Hill Co. Ltd., New Delhi.
8. Joe J. Hanan. 1997. Greenhouses: Advanced Technology for protected horticulture. CRC Press.
9. Krishnamurthy, K.V. (2004). An Advanced Text rbook of Biodiversity - Principles and Practices. Oxford and IBH Publications Co. Pvt. Ltd. New Delhi
10. .N.K. Acharya: Textbook on intellectual property rights, Asia Law House (2001).

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests. The marks shall be as follows:

Internal Assessment	Marks
Class Interaction	5
Quiz	5
Seminar	5
Assignment	5
Unit Test	10
Total	30



Course Code: BBT2472	B.Sc. Year II, Semester IV BOTANY Commercial Botany & Phytochemical Analysis(Practical)	Credits 2
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Max. Marks: 30+70

Total No of Lectures: 60

Course Outcome:

CO 1	Know about the commercial products produced from plants
CO 2	Gain the knowledge about cultivation practices of some economic crops
CO 3	Understand about the ethnobotanical details of plants.
CO 4	Learn about the chemistry of plants &herbal preparations
CO 5	Can become a protected cultivator, aromatic oil producer, Pharmacologist or quality analyst in drug company

Unit I

Economic Botany & Microtechnique: Cereals: Wheat (habit sketch, L.S./T.S. of grain, starch grains, micro-chemical tests); rice (habit sketch, study of paddy and grain, starch grains, micro-


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chemical tests) Legume: Pea or ground nut (habit, fruit, seed structure, micro-chemical tests) Source of sugars and starches: Sugarcane (habit sketch; cane juice- micro-chemical tests); potato (habit sketch, tuber morphology, T.S. of tuber to show localization of starch grains, W.M. of starch) grains, micro-chemical tests. Tea- tea leaves, tests for tannin Mustard- plant specimen, seeds, tests for fat in crushed seeds Timbers: section of young stem. Jute- specimen, transverse section of stem, tests for lignin on T.S. of stem and study of fiber following maceration technique. Study of specimens of economic importance

Unit II

Commercial Cultivation: Field visit to Green houses for understanding Floriculture & vegetables production Development of hydroponics nutrient solutions & running models for cultivation of vegetables Development of hydroponics nutrient solutions & running models for cultivation of fodder

Unit III

Ethnobotany: Study of common plants used by tribes. Aegle marmelos, Ficus religiosa, Cynodactylon. Visit a tribal area and collect information on their traditional method of treatment using crude drugs. Familiarize with at least 5 folk medicines and study the cultivation, extraction and its medicinal application. Observe the plants of ethnobotanical importance in your area. Visit to an Ayurveda college or Ayurvedic Research Institute / Hospital

Unit IV

Instrumentation and herbal Preparations Develop Capsules of herbs/ Develop Herbal oils/ Develop Poultice/cream Analyse some active ingredients using chromatography /Spectrophotometry

Unit V

Documentation from: Traditional Knowledge Digital Library, Mark the Geographic Indications on Map, Understand –Nakshatra Vatika, Navagrahvatika and develop in your college To extract the names of the plants and Botanical uses depicted in our epics. Visit NISCAIR, New Delhi

Suggested Readings:

1. Wallis, T. E. 1946. Textbook of Pharmacognosy, J & A Churchill Ltd.
2. Roseline, A. 2011. Pharmacognosy. MJP Publishers, Chennai.
3. Jain S. K. 1989. Methods and approaches in Ethnobotany, Society of Ethnobotanists, Lucknow.
4. Pal, D.C. & Jain, S.K., 1998. Tribal Medicine. NayaPrakash Publishers, Calcutta.
5. Datta & Mukerji, 1952. Pharmacognosy of Indian roots of Rhizome drugs. Bulletin No.1 Ministry of Health, Govt. of India.
6. Young Ken, H.W., 1948. Text Book of Pharmacognosy. Blakiston C., Philadelphia.
7. Shukla, R.S., 2000. Forestry for tribal development. A.H. Wheeler & Co. Ltd., India.
8. Raychudhuri, S.P., 1991. (Ed.) Recent advances in Medicinal aromatic and spice crops. Vol.1, Today & Tomorrow's printers and publishers, New Delhi.

9. Khasim S.M Botanical Microtechniques: Principles and Practice
10. Sambamurthy, AVSS &Subrahmanyam, NS (2000). Economic Botany of Crop Plants. Asiatech Publishers. New Delhi.

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests. The marks shall be as follows:

Internal Assessment	Marks
Class Interaction	5
Report of Visit to NISCAIR/ Ayurvedic hospital	20
Assignment	5
Total	30


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DETAIL SYLLABUS

FOR

B.Sc.-III Year



Course Code: BBT3503	B.Sc. Year II, Semester V BOTANY Paper I Plant resource utilization, Biostatistics and Molecular Biology	L T P 3 1 0	Credits 4
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Max. Marks: 30+70

Total No of Lectures: 60

Course Outcome:

CO 1	Understand the role of Physiological and metabolic processes for plant growth and development.
CO 2	To gain an understanding of the plants of economic importance
CO 3	To understand the conservation of plant resources
CO 4	To understand the concept of Palyonology and Biostatistics
CO 5	To familiarize the concept of Molecular Biology


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Unit I

Plant water relation, Mineral Nutrition, Transpiration and translocation in phloem: Importance of water, water potential and its components; Transpiration and its significance; Factors affecting transpiration; Root pressure and guttation. Criteria of essentiality of elements; Role of essential elements; Symptoms of mineral deficiency in major crops, Transport of ions across cell membrane, active and passive transport, Composition of phloem sap, girdling experiment; Pressure flow model

Unit II

Conservation of plants resources: for agriculture and forestry. In situ conservation sanctuaries, national parks, biosphere reserves, wetlands, mangroves. Exsitu conservation; botanical gardens, field gene banks, seed banks, cryobanks

Unit III

An introductory knowledge to palynology: morphology, viability and germination of pollens. Classification of data, mean, median and mode. Standard deviation, standard error, variance, correlation, X² test and experimental designs

Unit IV

Nucleic acid as genetic material, nucleotides, structure of nucleic acids, properties of genetic code, codons assignments, chain initiation of codons mechanism of protein synthesis and its regulation. Structure and properties polysaccharides, aminoacids, proteins, vitamins and hormones; Enzymes: active sites, specificity, mechanisms, factors, general aspects of enzyme kinetics. Bioenergetics: Laws of thermodynamics, concept of Gibb's free energy, high energy compounds.

Unit V

Replication of DNA in prokaryotes and eukaryotes, gene expression and regulation. Hormonal control and second messengers Ca²⁺, Cyclic AMP, IP₃ etc. Introduction to biotechnology, recombinant DNA technology, plant tissue culture, methods of gene transfer, transgenic plants, biotechnology and healthcare, microbial and environmental biotechnology.

Suggested Readings:


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Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests. The marks shall be as follows:

Internal Assessment	Marks
Class Interaction	5
Quiz	5
Seminar	5
Assignment	5
Unit Test	10
Total	30



Course Code: BBT3504	B.Sc. Year II, Semester V BOTANY Paper II Bioinformatics and Biochemistry	L T P 3 1 0	Credits 4
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Max. Marks: 30+70

Total No of Lectures: 60

Course Outcome:

CO 1	Gain working knowledge of the practical and theoretical concepts of bioinformatics
CO 2	To gain an understanding of the Biomolecules
CO 3	To familiarize the concept of Biochemistry

Unit I

Bioinformatics & its applications Computer fundamentals - programming languages in bioinformatics, role of supercomputers in biology. Historical background. Scope of bioinformatics - Genomics, Transcriptomics, Proteomics, Metabolomics, Molecular Phylogeny,

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computer aided Drug Design (structure based and ligand based approaches), Systems Biology and Functional Biology. Applications and Limitations of bioinformatics.

Unit II

Biological databases : Introduction to biological databases - primary, secondary and composite databases, NCBI, nucleic acid databases (GenBank, EMBL, DDBJ, NDB), protein databases (PIR, SwissProt, TrEMBL, PDB), metabolic pathway database (KEGG, EcoCyc, and MetaCyc), small molecule databases (PubChem,)

Unit III

Data Generation and Data Retrieval Generation of data (Gene sequencing, Protein sequencing, Mass spectrometry, Microarray), Sequence submission tools (BankIt, Sequin, Webin); Sequence file format (flat file, FASTA, GCG, EMBL, Clustal, Phylip, Swiss-Prot); Sequence annotation; Data retrieval systems (SRS, Entrez)

Unit IV

Biomolecules: Carbohydrates: Nomenclature and classification; Role of monosaccharides (glucose, fructose, sugar alcohols – mannitol and sorbitol); Disaccharides (sucrose, maltose, lactose), Oligosaccharides and polysaccharides (structural-cellulose, hemicelluloses, pectin, chitin, mucilage; storage – starch, inulin). Lipids: Storage lipids: Fatty acids structure and functions, Structural lipids: Phosphoglycerides; Lipid functions: cell signals, cofactors, prostaglandins, Introduction of lipid micelles, monolayers, bilayers

Unit V

Proteins: Structure of amino acids; Peptide bonds; Levels of protein structure-primary, secondary, Ramchandranplot, tertiary and quaternary; Isoelectric point; Protein denaturation and biological roles of proteins **Nucleic acids:** Structure of nitrogenous bases; Structure and function of nucleic acids, Nucleic acid denaturation & Re-naturation , **MiRNA** **Enzymes:** Structure of enzyme: holoenzyme, apoenzyme, cofactors, coenzymes and prosthetic group; mechanism of action

Suggested Readings:

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Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests. The marks shall be as follows:

Internal Assessment	Marks
Class Interaction	5
Quiz	5
Seminar	5
Assignment	5
Unit Test	10
Total	30



Course Code: BBT3573	B.Sc. Year III, Semester V BOTANY Experiments in physiology, Biochemistry & molecular biology (Practical)	Credits 2
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Max. Marks: 30+70

Total No of Lectures: 60

Course Outcome:

CO 1	Know and authentic the physiological processes undergoing in plants along with their metabolism
CO 2	Identify Mineral deficiencies based on visual symptoms
CO 3	Understand and develop skill for conducting molecular experiments for genetic engineering

Unit I

Plant water relation, Mineral Nutrition and translocation in phloem

1. Determination of osmotic potential of plant cell sap by plasmolytic method

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2. Osmosis – by potato osmoscope experiment
3. Experiment to demonstrate the transpiration phenomenon with the bell jar method
4. Experiment for demonstration of Transpiration by Four-Leaf Experiment:
5. Structure of stomata (dicot & monocot)
6. Experiment to measure the rate of transpiration by using Ganong's potometer
7. Study of mineral deficiency symptoms using plant material/photographs

Unit II

Techniques for biochemical analysis

1. Weighing and Preparation of solutions -percentage, molar & normal solutions, dilution from stock solution etc.
2. Separation of amino acids by paper chromatography.
3. Qualitative Analysis of carbohydrates, Amino acids and Proteins

Unit III

Genetic material

1. Instruments and equipments used in molecular biology.
2. Preparation of LB medium and cultivating E.coli on it.
3. Isolation of DNA from plants
4. Examination of the purity of DNA by agarose gel electrophoresis.
5. Quantification of DNA by UV-spectrophotometer

Unit IV

Applications of Genetic engineering

1. ELISA Test,
2. Viability tests of cells
3. Study of steps of genetic engineering for production of Bt cotton, Golden rice, FlavrSavr tomato through photographs

Unit V

Nitrogen Metabolism, Photo Synthesis & Respiration

1. A basic idea of chromatography: Principle, paper chromatography and column chromatography; demonstration of column chromatography.
2. Estimation of total chlorophyll content from different chronologically aged leaves (young, mature and senescence) by Arnon method.
3. Measurement of oxygen uptake by respiring tissue (per g/hr.)
4. Determination of the RQ of germinating seeds.
5. Effect of light intensity on oxygen evolution in photosynthesis using Wilmott's bubble

Suggested Continuous Evaluation Methods:

  
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Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests. The marks shall be as follows:

Internal Assessment	Marks
Class Interaction	5
Botanical Excursion- compulsory	20
Assignment	5
Total	30



Course Code: BBT3603	B.Sc. Year III, Semester VI BOTANY Paper I Plant Breeding & Nanotechnology	L T P 3 1 0	Credits 4
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Max. Marks: 30+70

Total No of Lectures: 60

Course Outcome:

CO 1	Acquire knowledge on cell ultrastructure
CO 2	Understand the structure and chemical composition of chromatin and concept of cell division
CO 3	Interpret the Mendel's principles, acquire knowledge on cytoplasmic inheritance and sex-linked inheritance
CO 4	Understand the concept of 'one gene one enzyme hypothesis' along with the molecular mechanism of mutation.

Unit I

Plant breeding Plant introduction. Agencies of plant introduction in India, Procedure of introduction - Acclimatization – Achievements, Selection - mass selection, pure line selection and clonal selection. Genetic basis of selection methods, Hybridization: Procedure of

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hybridization, inter generic, inter specific, inter varietal hybridization with examples. Composite and synthetic varieties, Male sterility, Heterosis and its exploitation in plant breeding, Mutation, Molecular Breeding (use of DNA markers in plant breeding), achievements in India, Breeding for pest, pathogenic diseases and stress resistance

Unit II

Plant Tissue Culture: Principles, components and techniques of in vitro plant cultures, Callus cultures, Cell culture, cell suspension cultures, Embryogenesis and organogenesis, Protoplast isolation and culturing of protoplast- principle and application, regeneration of protoplasts, protoplast fusion and somatic hybridization- selection of hybrid cells, Somaclonal variation, Plant secondary metabolites production.

Unit III

Nanotechnology Fundamentals of nanoscale self-assembly process involved in important functional biomolecules such as Nucleic acid (DNA and RNA), Proteins, Enzymes. Cell structure and organelles, nanoscale assembly of cellular components (cell membrane and liposomes). Nanoscale assembly of microorganisms (virus). Nano-particles synthesis, Biological synthesis of Nanoparticles, Advantages and applications of biologically synthesized nanomaterials. Introduction to biological nanomaterials. Biomineralization, Magnetosomes, nano-pesticides, nano-fertilizers, nano-sensors.

Unit IV

Artificial Intelligence in Plant Sciences Big Data Analytics, Blockchain Technology, 3-D Printing, Machine learning, Algorithms of Machine Learning, Expert systems and Fuzzy logic, Artificial Neural Networks and Genetic algorithms, Predictive Analytics, Agents and Robotics, IoT Sensors, Object Image capture & analysis; Applications of Artificial Neural Networks in Plant Science

Unit V

Introduction to use of Digital technologies – AI, IoT& ICT in Botany Educational software- INFLIBNET, NICNET, BRNET, internet as a knowledge repository google scholar, science direct. resource management, weather forecasting. IoT Database management, IoT platforms, IoT Graphical user interface • IoT application development for Android Mobile phones, ICT Applications for different crops and horticulture

Suggested Readings:

1. Cell Biology And Genetics (Hindi) 2/e PB...Gupta P K (Hindi) rastogi Publications
2. PLANT BIOTECHNOLOGY (HINDI) October 2019 Publisher: Kindle Direct
3. G.M. Cooper. (2015). The cell: A Molecular Approach. 7th Edition. Sinauer Associates.
4. Alberts, B., Johnson, A.D., Lewis, J., Morgan, D., Raff, M., Roberts, K., Walter, P. (2014). Molecular Biology of Cell. 6th Edition. WW. Norton & Co.

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5. Campbell, M.K. (2012) Biochemistry, 7th ed., Published by Cengage Learning.
6. Campbell, P.N. and Smith, A.D. (2011). Biochemistry Illustrated, 4th ed., Published by Churchill Livingstone
7. Tymoczko, J.L., Berg, J.M. and Stryer, L. (2012). Biochemistry: A short course, 2nd ed., W.H. Freeman.
8. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2011) Biochemistry, W.H. Freeman and Company
9. Nelson, D.L. and Cox, M.M. (2008). Lehninger Principles of Biochemistry, 5th Ed., W.H. Freeman and Company.
10. Karp, G. (2010). Cell Biology, John Wiley & Sons, U.S.A. 6th edition.

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests. The marks shall be as follows:

Internal Assessment	Marks
Class Interaction	5
Quiz	5
Seminar	5
Assignment	5
Unit Test	10
Total	30



Course Code: BBT3604	B.Sc. Year III, Semester VI BOTANY Paper II Ecology & Environmental Botany	L T P 3 1 0	Credits 4
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Max. Marks: 30+70

Total No of Lectures: 60

Course Outcome:

CO 1	acquaint the students with complex interrelationship between organisms and environment
CO 2	Make them understand methods for studying vegetation, community patterns and processes, ecosystem functions, and principles of phytogeography.
CO 3	This knowledge is critical in evolving strategies for sustainable natural resource management and biodiversity conservation.

Unit I

Natural resources & Sustainable utilization: Land Utilization; Soil degradation and management strategies; Restoration of degraded lands. Soil: Origin, Formation, composition, Soil types, Soil Profile. Water, Wetlands; Threats and management strategies, Ramsar sites, Forests: Major and minor forest products; Depletion, Biological Invasion, Energy: Renewable and non-renewable sources of energy,


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Contemporary practices in resource management : EIA, GIS, Participatory Resource Appraisal, Ecological Footprint with emphasis on carbon footprint, Resource Accounting

Unit II

Ecology & Ecosystem Definition of Ecology, Ecological Factors, Positive and negative interactions. Ecosystem – Concept of an ecosystem-structure and function of an ecosystem. Abiotic and biotic components. Energy flow in an ecosystem Ecological Succession-Definition & types. Processes and types (autogenic, allogenic, autotrophic, heterotrophic, primary & secondary), Hydrosere and Xerosere. Food chains and food webs, Ecological pyramids, production and productivity; And components. Types of ecosystems: Forest Ecosystem, Grassland, Crop land, aquatic Ecosystems Ecological Adaptations – Hydrophytes, Xerophytes, Halophytes, Epiphytes and Parasites.

Unit III

Biodiversity and its conservation: Definition -genetic, species, and ecosystem diversity. Value of biodiversity: social, ethical, aesthetic and option values; hotspots of Biodiversity threats to biodiversity, Biotic communities and populations, their characteristics and dynamics. Endemic and endangered species of plants in India. Ecological niche, ecotypes, ecological indicators. Conservation of Biodiversity: Ex-situ and in-situ conservation, Red data book, botanical gardens, National park, Sanctuaries, hot & hottest spots and Bioserves. Role of Seed Bank and Gene Bank Valuing plant resources, ecotourism, Role of NBPGR, FAO, BSI

Unit IV

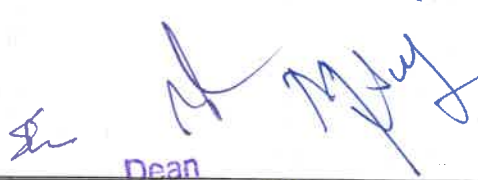
Pollution, Waste management & Circular Economy Environmental pollution, Environmental protection laws, Bioremediation, Activated Sludge Process (ASP) – Trickling Filters – oxidation ponds, fluidized bed reactors, membrane bioreactor, neutralization, ETP sludge management; digesters, up flow anaerobic sludge blanket reactor, fixed film reactors, sequencing batch reactors, hybrid reactors, bioscrubbers, biotrickling filters; regulatory framework for pollution monitoring and control; case study: Ganga Action Plan; Yamuna Action Plan; implementation of CNG ;Waste- Types , collection and disposal, Recycling of solid wastes (hazardous & non-hazardous) –

Unit V

Environmental audit & Sustainability Concept of environmental audit; Guidelines of environmental audit; Methodologies adopted along with some industrial case studies; Environmental standards: ISO 14000 series; Scheme of labelling of environment friendly products (Ecomark); Life cycle analysis; Concept of energy and green audit, Strategies and debates on sustainable development; Concept of Sustainable Agriculture; India's environment action programme: issues, approaches and initiatives towards Sustainability; Sustainable development in practice

Suggested Readings:

1. Environmental Studies (Hindi) ISBN 81-301-0004-5B. L. Chaudhary & Jitendra Pandey Edition: 2013 Pages: 340 + XII Apex Publishing House
2. Soil and Water Conservation ISBN #: 978-81-301-0071-5S. C. Mahnot & P. K. Singh Apex Publishing House
3. Odum, F.P. Fundamentals of Ecology, Latest Ed., Saunders
4. Sharma, P.D. Elements of Ecology, Latest Ed., Rastogi Publications


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5. Ambast, R.S. & Ambast, N.K. A Text Book of Plant Ecology, Latest Ed., CBS Publication & Distributors 9. Mani, M.S. Bio-Geography of India, Latest Ed., Springer-Verlag.
6. Mackenzie et al. Ecology, Latest Ed., Viva Books
7. Cain, Bowman, Hacker. Ecology. 2014, 3rd Ed. Sinauer Associates
8. Singh, J. S., Singh, S.P. and Gupta, S. (2006). Ecology, Environment and Resource Conservation. Anamaya Publications, New Delhi

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests. The marks shall be as follows:

Internal Assessment	Marks
Class Interaction	5
Quiz	5
Seminar	5
Assignment	5
Unit Test	10
Total	30



Course Code: BBT3673	B.Sc. Year III, Semester VI BOTANY Lab on Cytogenetics, Conservation & Environment management(Practical)	Credits 2
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Max. Marks: 30+70

Total No of Lectures: 60

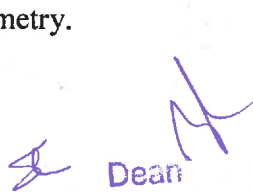
Course Outcome:

CO 1	To perform all experiments related to the semester-i.e. Plant tissue cultured plants, conducting breeding on field, conserving and depolluting the environment.
CO 2	Can be employed in environment impact assessment companies & start his own venture

Unit I

Cell biology

1. Study of plant cell structure with the help of epidermal peel mount of Onion/Rhoeo/Crinum
2. Measurement of cell size by the technique of micrometry.


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3. Determination of mitotic index and frequency of different mitotic stages in pre-fixed root tips of *Allium cepa*.

Unit II

Plant tissue culture

1. Familiarization of instruments and special equipments used in the plant tissue culture experiments
2. Preparation of plant tissue culture medium, and sterilization, Preparation of stock solutions of nutrients for MS Media.
3. Micropropagation of potato/tomato/ - Demonstration

Unit III

Ecology & Environment

1. Ecological Adaptations: Hydrophytes, Xerophytes, Halophytes, Epiphytes and Parasites
2. Study of morphological adaptations of hydrophytes and xerophytes (four each).
3. Observation and study of different ecosystems mentioned in the syllabus.
4. Field visit to familiarize students with ecology of different sites

Unit IV

Soil Formation, Properties & Conservation

1. Determination of pH of various soil and water samples (pH meter, universal indicator/Lovibond comparator and pH paper)
2. Analysis for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency from two soil samples by rapid field tests.
3. Determination of organic matter of different soil samples by Walkley & Black rapid titration method.

Unit V

Pollution & Waste management

1. Study of instruments Like: Soil thermometer, maximum and minimum thermometer, anemometer, psychrometer/hygrometer, rain gauge and lux meter
2. Estimation of chloride and dissolved oxygen content in water sample
3. Comparative anatomical studies of leaves from polluted and less polluted areas.
4. Measurement of dissolved O₂ by azide modification of Winkler's method.
5. Determination of dissolved oxygen of water samples from polluted and unpolluted sources.

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6. Microbiological assessment of drinking water using MPN technique- water from well, river, water supply department and packaged drinking water
7. Making kitchen waste from compost/vermicompost by Enzymes/Bio decomposer/ Whey with dung

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests. The marks shall be as follows:

Internal Assessment	Marks
Class Interaction	5
Report of Visit to NISCAIR/ Ayurvedic hospital	20
Assignment	5
Total	30



Course Code: BBTR002	B.Sc. Year III, Semester VI BOTANY	Project In Botany for Graduation
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Max. Marks:

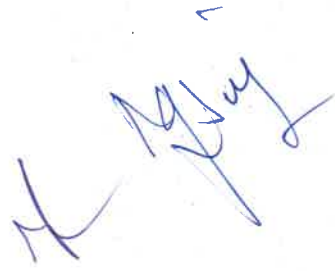
Course Outcome:

CO 1	Project work will supplement field experimental learning and deviations from classroom and laboratory transactions.
CO 2	project work will enhance the capability to apply gained knowledge and understanding for selecting, solving and decision-making processes
CO 3	They will learn to consult Scientists, libraries, laboratories and herbariums and learn importance of discussions, Botanical & field trips, print and electronic media, internet etc. along with data documentation, compilation, analysis & representation in form of dissertation writing

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SSUGGESTIVE LIST OF PROJECTS

1. Prepare beds for growing nursery for herbs, shrubs and trees.
2. Develop Green house facility in college and grow plants
3. Develop hydroponics facility in college and grow plants.
4. Develop botanical garden in the college with labelling
5. Vertical gardens, roof gardens.
6. Culture & art of making bonsai.
7. Computer Aided Designing (CAD) for outdoor and indoor scaping
8. Exposure to CAD (Computer Aided Designing)
9. Phytochemical Analysis of Medicinal plants
10. Bio composting and Vermicomposting.
11. Rural Areas: Flora of a city/ village, Biodiversity of Village
12. Industrial waste management
13. water pollution status of rural water & promotion of WASH in villages
14. Plant Disease identification in farms, nurseries and orchards.
15. Rare and endangered plants & their conservation & domestication
16. Air pollution tolerance index (APTI) : Screening of sensitive/tolerant plant species at various locations in particular area
17. Phytochemistry of medicinal plants & their antimicrobial, nutraceutical and antioxidant properties.



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National Education Policy-2020

PROPOSED STRUCTURE OF SYLLABUS

CHEMISTRY

(FACULTY OF SCIENCE)

FUTURE UNIVERSITY, BAREILLY

18th Milestone, Bareilly-Lucknow Highway NH-24

Near Faridpur, Bareilly, Uttar Pradesh 243503

Website: www.futureuniversity.in

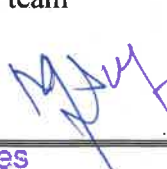

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Purpose of the Program: The purpose of the undergraduate chemistry program at the university and college level is to provide the key knowledge base and laboratory resources to prepare students for careers as professionals in various industries and research institutions.

Program's Outcomes:

1. Students will have a firm foundation in the fundamentals and application of current chemical and scientific theories including those in analytical, Inorganic, Organic and Physical Chemistries.
2. Students will be able to design and carry out scientific experiments as well as accurately record and analyze the results of such experiments.
3. Students will be skilled in problem solving, critical thinking and analytical reasoning as applied to scientific problems.
4. Students will be able to explore new areas of research in both chemistry and allied fields of science and technology.
5. Students will appreciate the central role of chemistry in our society and use this as a basis for ethical behavior in issues facing chemists including an understanding of safe handling of chemicals, environmental issues and key issues facing our society in energy, health and medicine.
6. Students will be able to explain why chemistry is an integral activity for addressing social, economic, and environmental problems.
7. Students will be able to function as a member of an interdisciplinary problem solving team




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Year I, Semester I, Paper-1 (Theory)

Course Code:	BCH1101	Credits 4
Course Title:	Organic Chemistry, Structure and Bonding	

Subject: Elective:

Max. Marks: 30+70

Total No. of Lectures: 60

UNIT I

Atomic Structure: Schrodinger wave equation; H atom; Radial and angular wave functions: quantum numbers and concept of orbitals; Slater orbitals. Shape of s,p,d orbital, Aufbau and Pauli principle. **Chemical Bonding:** VB and MO approach of H₂ molecule; MO treatment of homonuclear and heteronuclear (CO & NO) diatomic molecules; Concept of HOMO and LUMO. VSEPR theory; Structure of simple molecules and ions of main group elements.

UNIT II

Ionic Solids: Close packing, Radius ratio rule and crystal coordination number. Examples of MX and MX₂ type ionic solids (NaCl and TiO₂). **Metallic Bonding:** theories of bonding in metals; Free electron, VB and Band theories. **Weak Interactions:** Hydrogen bonding and van der Waal's interactions.

UNIT III

Concepts: Atomic orbitals, hybridization, orbital representation of methane, ethane, ethyne and benzene. **Polarity of bonds:** Inductive, resonance and steric effects hyperconjugation, and their influence on acidity and basicity of organic compounds. **Hydrocarbons:** Alkanes: Chlorination of methane, Alkenes: Addition reactions (Electrophilic and Free radical), Hydration, hydroxylation, hydroboration, epoxidation and ozonolysis. Alkynes: Reduction, Electrophilic addition, acidity and metal acetylides. **Conjugated and isolated Dienes:** 1,2- versus 1,4-addition. Diels - Alder reaction.

UNIT IV

Alkyl Halides: Nucleophilic substitution: SN₁, SN₂ mechanisms; Eliminations reactions: E₁ and E₂ mechanisms, Elimination versus substitution reactions; energy profile diagrams-transition states (general considerations). **Grignard reagents:** Preparation and synthetic applications. **Alcohols:** Comparative study of substitution, dehydration, oxidation, and esterification of primary, secondary and tertiary alcohols.


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UNIT V

Stereochemistry: Fischer, Saw-horse and Newman projection formulae, Chirality-optical activity, enantiomers and diastereoisomerism involving one and two chiral centres. Configuration; D/L, erythrose, threose and R/S nomenclatures. Geometrical isomerism and E/Z nomenclatures. Conformations of n-butane. Active methylene compounds: Preparation and synthetic applications of ethyl acetoacetate and diethyl malonate, Tautomerism




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Year I, Semester I, Paper-2 (Practical)

Course Code:	BCH1171	Credits
Course Title:	Quantitative Analysis	2

Subject: Elective:

Max. Marks: 30+70

Total No. of Lectures: 60

Unit I

Water Quality Analysis:

1. Estimation of Hardness of water by EDTA
2. Determination of Chemical Oxygen Demand
3. Determination of Biological Oxygen Demand

Unit II

4. Estimation of Ferrous and Ferric by dichromate method
5. Estimation of Copper using thiosulphate

Unit III

Detection of elements (X, N, S).

Detection of functional groups: PhOH, -COOH, C=O, -CHO, Ar-NH₂, Ar-NO₂, -CONH₂

Qualitative Inorganic Mixture Analysis: Anions and interfering anions.

Unit IV

Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture

Estimation of calcium content in chalk as calcium oxalate by permagnometry


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Year I, Semester II, Paper-1 (Theory)

Course Code:	BCH1201	Credits
Course Title:	Inorganic and Physical Chemistry	4

Subject: Elective:

Max. Marks: 30+70

Total No. of Lectures: 60

Course Objective

CO1	To demonstrate theoretical knowledge of fundamentals of Chemistry in understanding Chemical Kinetics.
CO2	To gain an understanding of the Spectroscopic techniques and their Applications.
CO3	To understand the Coordination complexes and their applicability.
CO4	To understand the concepts of liquid crystals and their applications.
CO5	To familiarize the concepts of Inorganic Spectroscopic techniques.

Unit 1

Periodic trends and properties: Size, Ionization Energy, Electron Affinity, Electronegativity, Lattice and Hydration Energies, Use of redox potential and reaction feasibility. Chemistry of s and p-block elements: Alkali and alkaline earth metals: Hydrides and Complexation tendencies. Structural features of hydrides, halides, oxides and oxyacids. Chemistry of d-block elements: Salient features, characteristic properties of 3d-elements with reference to oxidation states, colour, magnetic behaviour, and complex formation tendency.

Unit 1

Gaseous State: Kinetic theory of gases, ideal gas laws based on kinetic theory. Collision in a gas- mean free path, collision diameter, collision number. Behaviour of real gases - the van der Waal's equation. Critical phenomena - critical constants of a gas and their determination, the van der Waals equation and critical state, Principle of corresponding states. **Liquid State:** Surface tension of liquids - capillary action, experimental determination of surface tension, temperature effect on surface tension. Viscosity of liquids, experimental determination of viscosity coefficient, its variation with temperature.

Thermodynamics: First Law of thermodynamics and internal energy, state and state functions, sign convention for heat and work, nature of work, path dependence of heat and work. Enthalpy, heat changes at constant volume and constant pressure, heat capacities (C_v , C_p) and their relationship for

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ideal gases. Thermodynamic quantities (w , q , ΔU , ΔH) for isothermal and adiabatic reversible expansion of ideal gases and their comparison. Change in internal energy (ΔU) and enthalpy (ΔH) of chemical reactions, relation between ΔU and ΔH , variation of heat of reaction with temperature (Kirchhoff's equation).

Electrochemistry: Arrhenius theory of electrolytic dissociation, Hydrolysis of salts, hydrolysis constant, buffer solutions, indicators and theory of acid-base indicators. Migration of ions: transference number and its determination by Hittorf methods. Conductance of electrolyte solutions, molar conductance of electrolyte and its splitting into ionic molar conductance, Kohlrausch law of independent migration of ions, ionic mobility. Application of conductance measurements: determination of degree of dissociation and dissociation constant of weak electrolytes/acids, solubility of sparingly soluble salts, and Conductometric titrations.

Nuclear Chemistry: Nucleus and its classification, nuclear forces, nuclear binding energy, stability of nucleus. Radioactivity: Radioactive elements, general characteristics of radioactive decay, decay kinetics (decay constant, half life, mean life period), units of radioactivity.




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Year I, Semester II, Paper-2 (Practical)

Course Code:	BCH1271	Credits
Course Title:	Quantitative Analysis (Physical and Volumetric)	2

Subject: Elective:

Max. Marks: 30+70

Total No. of Lectures: 60

Course Objective

CO1	To demonstrate theoretical knowledge of fundamentals of Chemistry in understanding Chemical Kinetics.
CO2	To gain an understanding of the Spectroscopic techniques and their Applications.
CO3	To understand the Coordination complexes and their applicability.
CO4	To understand the concepts of liquid crystals and their applications.
CO5	To familiarize the concepts of Inorganic Spectroscopic techniques.

Determination of water equivalent of a calorimeter (cooling curve). Heat of neutralization (strong acid-strong base). Heat of dissociation of weak acid. Heat of solution (NH_4NO_3 , CaCl_2). Basicity of an acid by thermochemical method.

Qualitative Inorganic Mixture Analysis: Not containing more than 4 ions and one interfering anion

Separation of Mixture

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Year II, Semester III, Paper-1 (Theory)

Course Code:	BCH2301	Credits
Course Title:	Chemical Dynamics and Coordination Chemistry	4

Subject: Elective:

Max. Marks: 30+70

Total No. of Lectures: 60

Course Objective

CO1	To demonstrate theoretical knowledge of fundamentals of Chemistry in understanding Chemical Kinetics.
CO2	To gain an understanding of the Spectroscopic techniques and their Applications.
CO3	To understand the Coordination complexes and their applicability.
CO4	To understand the concepts of liquid crystals and their applications.
CO5	To familiarize the concepts of Inorganic Spectroscopic techniques.

UNIT - I

Chemical Kinetics: Rate of a reaction, molecularity and order of reaction, concentration dependence of rates, zero order, first order, second order, half-life and mean life. Determination of the order of reaction- method of integration and half-life method. **Theories of chemical kinetics:** Effect of temperature on rate of reaction, Arrhenius equation, concept of activation energy. Simple collision theory based on hard sphere model, transition state theory (equilibrium hypothesis).

UNIT – II

Chemical Equilibrium : Equilibrium constant and free energy, thermodynamic derivation of law of mass action. Le-Chatelier's principle. reaction isotherm and reaction isochore - ClapeyronClausius equation and its applications. **Liquid State:** Intermolecular forces, structure of liquids (a qualitative description). Structural differences between solids, liquids and gases. Liquid crystals: Difference between liquid crystal, solid and liquid. Classification, structure of nematic and cholesteric phases.

Liquids in solids (gels): Classification, preparation and properties, inhibition, general application.

UNIT – III

Coordination Chemistry: Werner's theory of coordination complexes, classification of ligands, ambidentate ligands, chelates, coordination numbers, IUPAC nomenclature of coordination complexes (up to two metal centers), Isomerism in coordination compounds, constitutional and stereo isomerism, geometrical and optical isomerism in square planar and octahedral complexes.

Theories of Coordination Chemistry: Metal-ligand bonding in transition metal complexes, limitations of valence bond theory, an elementary idea of crystal field theory, crystal field splitting in octahedral, tetrahedral and square planar complexes, Jahn Teller effect, factors affecting the crystal-field parameters.

Thermodynamic and kinetic aspects of metal complexes: A brief outline of thermodynamic stability of metal complexes and factors affecting the stability, stability constants of complexes and their determination, substitution reactions of square planar complexes.

UNIT – IV

Inorganic Spectroscopy and Magnetism

Electronic spectra of Transition Metal Complexes: Types of electronic transitions, selection rules for d-d transitions, spectroscopic ground states, spectrochemical series, Orgel-energy level diagram for d1 and d9 states, discussion of the electronic spectrum of $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$ complex ion.

Magnetic properties of transition metal complexes, types of magnetic behaviour, methods of determining magnetic susceptibility, spin-only formula, L-S coupling, correlation of μ_s and μ_{eff} values, orbital contribution to magnetic moments, application of magnetic moment data for 3d-metal complexes.

UNIT – V

Phase Equilibrium: Statement and meaning of the terms - phase, component and degree of freedom, derivation of Gibbs phase rule, phase equilibria of one component system - water, CO_2 and sulphur systems.

Phase equilibria of two component systems - Solid-liquid equilibria, simple eutectic - Bi-Cd, Pb-Ag systems.

Suggested Readings:

- Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry Ed., Oxford University Press 13 (2006).
- Ball, D. W. Physical Chemistry Thomson Press, India (2007).
- Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).
- Cotton, F.A, Wilkinson, G and Gaus, P. L, Basic Inorganic Chemistry, 3rd Edition, Wiley 1995
- Lee, J.D, Concise Inorganic Chemistry 4th Edition ELBS, 1977
- Douglas, B, McDaniel, D and Alexander, J, Concepts of Models of Inorganic Chemistry, John Wiley & Sons; 3rd edition, 1994
- Shriver, D.E Atkins, P.W and Langford, C.H, Inorganic Chemistry, Oxford University Press, 1994.
- Porterfield, W.W, Inorganic Chemistry, Addison Wesley 1984.
- Sharpe, A.G, Inorganic Chemistry, ELBS, 3rd edition, 1993
- Miessler, G.L, Tarr, D.A, Inorganic Chemistry, 2nd edition, Prentice Hall, 2001

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Year II, Semester III, Paper-2 (Practical)

Course Code:	BCH2371	Credits
Course Title:	Physical Analysis	2

Subject: Elective:

Max. Marks: 30+70

Total No. of Lectures: 60

UNIT – I

Strengths of Solution

Calibration of fractional weights, pipettes and burettes. Preparation of standards solutions. Dilution – 0.1 M to 0.001 M solutions.

Mole Concept and Concentration Units: Mole Concept, molecular weight, formula weight, and equivalent weight.

Concentration units: Molarity, Formality, Normality, Molality, Mole fraction, Percent by weight, Percent by volume, Parts per thousand, Parts per million, Parts per billion, pH, pOH, milli equivalents, Milli moles.

UNIT II

Surface Tension and Viscosity

- Determination of surface tension of pure liquid or solution
- Determination of viscosity of liquid pure liquid or solution

UNIT III

Boiling point and Transition Temperature

- Boiling point of common organic liquid compounds [ANY FIVE] n-butylalcohol, cyclohexanol, ethyl methyl ketone, cyclohexanone, acetylacetone, isobutyl methyl ketone, isobutyl alcohol, acetonitrile, benzaldehyde and acetophenone. [Boiling points of the chosen organic compounds should preferably be within 180°C].
- Transition Temperature. Determination of the transition temperature of the given substance by thermometric/dilatometric method (e.g. $\text{MnCl}_2 \cdot 4\text{H}_2\text{O}$ / $\text{SrBr}_2 \cdot 2\text{H}_2\text{O}$).

UNIT IV

To study the effect of a solute (e.g. NaCl, succinic acid) on the critical solution temperature of two partially miscible liquids (e.g. phenol-water system) and to determine the concentration of that solute in the given phenol-water system

- To construct the phase diagram of two component (e.g. diphenylamine – benzophenone) system by cooling curve method.

Suggested Readings:

- Skoog, D.A., West, D.M and Holler, F.J., "Analytical Chemistry: An Introduction", 7th edition. Saunders college publishing, Philadelphia, (2010).
- Larry Hargis, G. "Analytical Chemistry: Principles and Techniques" Pearson© (1988)

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Year II, Semester IV, Paper-1 (Theory)

Course Code:	BCH2401	Credits
	Quantum Mechanics, Spectroscopy and Analytical Techniques	4

Subject: Elective

Max. Marks: 30+70

Total No. of Lectures: 60

Course Objectives

CO1	To demonstrate theoretical knowledge of fundamentals of Chemistry in understanding Of Quantum Mechanics.
CO2	To gain an understanding of the Spectroscopic techniques and their Applications.
CO3	To understand the Separation Techniques and their applicability.
CO4	To understand the concepts of Molecular Spectroscopy.
CO5	To familiarize the concepts of Vibrational Spectroscopy.

UNIT - I

Quantum Mechanics: Wave particle Duality, Schrodinger equation, atomic Structure, Chemical Bonding. Uncertainty Principle. of Black-body radiation, Planck's radiation law, photoelectric effect, heat capacity of solids, Bohr's model of hydrogen atom (no derivation) and its defects, Compton effect, de-Broglie hypothesis.

UNIT – II

Spectroscopic techniques and Applications: IR Spectroscopy: Fundamental and non-fundamental molecular vibrations; Hooke's law selection rule, IR absorption positions of various functional groups (C=O, OH, NH, COOH and nitrile) **NMR Spectroscopy:** introduction; nuclear spin; NMR active molecules; basic principles of Proton Magnetic Resonance; choice of solvent and internal standard; equivalent and non-equivalent protons; chemical shift and factors influencing it; ring current effect. Elementary idea and simple applications of Ultraviolet & Visible and NMR Spectroscopy.

UNIT – III

Separation Techniques: Solvent extraction: Classification, principle and efficiency of the technique. Mechanism of extraction: extraction by solvation and chelation. Technique of extraction: batch, continuous and counter current extractions. Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and non-aqueous media. **Chromatography:** Classification, principle and efficiency of the technique. Mechanism of separation: adsorption, partition & ion exchange. Development of chromatograms: frontal, elution and displacement methods.

UNIT – IV

Molecular Spectroscopy: Introduction: Electromagnetic radiation, regions of the spectrum, basic features of different spectrometers, statement of the Born-Oppenheimer approximation, degrees of freedom. **Rotational Spectrum:** Diatomic molecules. Energy levels of a rigid rotor (semi-classical principles), selection rules, spectral intensity, distribution using population distribution (Maxwell-Boltzmann distribution) determination of bond length, qualitative description of non-rigid rotor, isotope effect.

UNIT – V

Vibrational Spectrum: Infrared spectrum: Energy levels of simple harmonic oscillator, selection rules, pure vibrational spectrum, intensity, determination of force constant and qualitative relation of force constant and bond energies, effect of

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anharmonic motion and isotope on the spectrum, idea of vibrational frequencies. **Raman spectrum:** Concept of polarizability, pure rotational and pure vibrational, Raman spectra of diatomic molecules, selection rules. **Electronic Spectrum:** Concept of potential energy curves for bonding and antibonding molecular orbitals, qualitative description of selection rules.

Suggested Readings:

- Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry Ed., Oxford University Press 13 (2006).
- Ball, D. W. Physical Chemistry Thomson Press, India (2007).
- Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).
- Cotton, F.A, Wilkinson, G and Gaus, P. L, Basic Inorganic Chemistry, 3rd Edition, Wiley 1995
- Lee, J.D, Concise Inorganic Chemistry 4th Edition ELBS, 1977
- Douglas, B, McDaniel, D and Alexander, J, Concepts of Models of Inorganic Chemistry, John Wiley & Sons; 3rd edition, 1994
- Shriver, D.E Atkins, P.W and Langford, C.H, Inorganic Chemistry, Oxford University Press, 1994.
- Porterfield, W.W, Inorganic Chemistry, Addison Wesley 1984.
- Sharpe, A.G, Inorganic Chemistry, ELBS, 3rd edition, 1993
- Miessler, G.L, Tarr, D.A, Inorganic Chemistry, 2nd edition, Prentice Hall, 2001

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Year II, Semester IV, Paper-2 (Practical)

Course Code:	BCH32471	Credits
	Instrumental Analysis	2

Subject: Elective

Max. Marks: 30+70

Total No. of Lectures: 60

UNIT I

Molecular Weight Determination

- Determination of molecular weight of a non-volatile solute by Rast method/Beckmann freezing point method.
- Determination of the apparent degree of dissociation of an electrolyte (e.g., NaCl) in aqueous solution at different concentrations by Ebullioscopy.

UNIT II

Spectrophotometry

- To verify Beer–Lambert Law for $\text{KMnO}_4/\text{K}_2\text{Cr}_2\text{O}_7$ and determining the concentration of the given solution of the substance from absorption measurement
- Determination of pKa values of indicator using spectrophotometry.
- Determination of COD and BOD.

UNIT III

Chromatographic Separations

- Paper chromatographic separation of following metal ions: i. Ni(II) and Co(II) ii. Cu(II) and Cd(II)
- Separation of a mixture of o- and p-nitrophenol or o- and p-aminophenol by thin layer Chromatography (TLC).

UNIT-IV

Separation and identification of the amino acids present in the given mixture by paper chromatography. Reporting the Rf values

- TLC separation of a mixture of dyes (fluorescein and methylene blue)

Suggested Readings:

- Skoog, D.A., West, D.M and Holler, F.J., "Analytical Chemistry: An Introduction", 7th edition. Saunders college publishing, Philadelphia, (2010).
- Larry Hargis, G. "Analytical Chemistry: Principles and Techniques" Pearson© (1988)

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Year III, Semester V, Chemistry Paper-I

Course Code:	BCH3501	Credits
	Organic Synthesis -1	4

Subject: Elective

Max. Marks: 30+70

Total No. of Lectures: 60

Course Objectives

CO1	To demonstrate theoretical knowledge of alkanes and alkenes.
CO2	To gain an understanding of the alkynes and basic concepts of aromaticity.
CO3	To understand the basic principles of arenes, chemistry of aromatic reactions.
CO4	To understand the reactions of alcohols and phenols.
CO5	To understand the concepts and reactions of ethers and organic halides.

UNIT - I

Chemistry of Alkanes and Cycloalkanes

A) Alkanes: Classification of carbon atom in alkanes, General methods of preparation, physical and chemical properties of alkanes: Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halogenation - relative reactivity and selectivity

B) Cycloalkanes: Nomenclature, methods of formation, chemical reactions, Baeyer's strain theory and its limitations. Chair, Boat and Twist boat forms of cyclohexane with energy diagrams, ring strain in small rings, theory of strain less rings. The case of cyclopropane ring, banana bonds.

Chemistry of Alkenes

Methods of formation of alkenes, Addition to C=C: mechanism (with evidence wherever applicable), reactivity, regioselectivity (Markownikoff and anti-Markownikoff additions) and stereoselectivity; reactions: hydrogenation, halogenation, hydrohalogenation, hydration, ozonolysis, addition of singlet and triplet carbenes; Simmons-Smith cyclopropanation reaction; electrophilic addition to diene (conjugated dienes and allene); radical addition: HBr addition; mechanism of allylic and benzylic bromination in competition with brominations across C=C; use of NBS; interconversion of E- and Z- alkenes.

UNIT - II

Chemistry of Alkynes

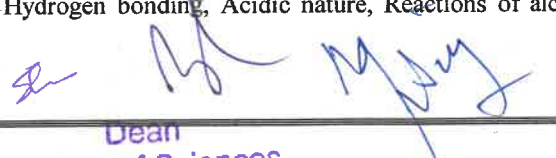
Methods of formation of alkynes, Addition to $C\equiv C$, mechanism, reactivity, regioselectivity and stereoselectivity; reactions: hydrogenation, halogenations, hydrohalogenation, hydration, oxymercuration demercuration, hydroboration-oxidation, dissolving metal reduction of alkynes (Birch); reactions of terminal alkynes by exploring its acidity; interconversion of terminal and non-terminal alkynes.

Aromaticity and Chemistry of Arenes

Nomenclature of benzene derivatives, MO picture of benzene, Aromaticity: Hückel's rule, aromatic character of arenes, cyclic carbocations/carbanions. Electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Craft's alkylation/acylation with their Mechanism. Directing effects of the groups. Birch reduction, Methods of formation and chemical reactions of alkylbenzenes, alkynylbenzenes and biphenyl, naphthalene and anthracene.

UNIT - III

Chemistry of Alcohols: Classification and nomenclature. Monohydric alcohols – nomenclature, methods of formation by reduction of Aldehydes, Ketones, Carboxylic acids and Esters, Hydrogen bonding, Acidic nature, Reactions of alcohols.


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Dihydric alcohols nomenclature, methods of formation, chemical reactions of vicinal glycols, oxidative cleavage [$\text{Pb}(\text{OAc})_4$ and HIO_4] and pinacol pinacolone rearrangement.

Trihydric alcohols - nomenclature, methods of formation, chemical reactions of glycerol.

UNIT – IV

Chemistry of Phenols: Nomenclature, structure and bonding, preparation of phenols, physical properties and acidic character, Comparative acidic strengths of alcohols and phenols, resonance stabilization of phenoxide ion. Reactions of phenols – electrophilic aromatic substitution, acylation and carboxylation. Mechanisms of Fries rearrangement, Claisen rearrangement, Gatterman synthesis, Hauben Hoesch reaction, Lederer-Manasse reaction and Reimer-Tiemann reaction.

UNIT – V

Chemistry of Ethers and Epoxides: Nomenclature of ethers and methods of their formation, physical properties, Chemical reactions – cleavage and autoxidation, Ziesel's method. Synthesis of epoxides, Acid and base-catalyzed ring opening of epoxides, orientation of epoxide ring opening, reactions of Grignard and organolithium reagents with epoxides.

Chemistry of Organic Halides

Nomenclature and classes of alkyl halides, methods of formation, chemical reactions, Mechanisms of nucleophilic substitution reactions of alkyl halides, $\text{S}_\text{N}2$ and $\text{S}_\text{N}1$ reactions with energy profile diagrams; Polyhalogen compounds: Chloroform, carbon tetrachloride; Methods of formation of aryl halides, nuclear and side chain reactions; The addition-elimination and the elimination-addition mechanisms of nucleophilic aromatic substitution reactions; Relative reactivities of alkyl halides vs allyl, vinyl and aryl halides, Synthesis and uses of DDT and BHC.

Suggested Readings:

- Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Sykes, P. A guidebook to Mechanism in Organic Chemistry, Pearson Education, 2003.
- Carey, F. A., Guiliano, R. M. Organic Chemistry, Eighth edition, McGraw Hill Education, 2012.
- Loudon, G. M. Organic Chemistry, Fourth edition, Oxford University Press, 2008.
- Clayden, J., Greeves, N. & Warren, S. Organic Chemistry, 2nd edition, Oxford University Press, 2012.
- Graham Solomons, T.W., Fryhle, C. B. Organic Chemistry, John Wiley & Sons, Inc.
- Smith, J. G. Organic Chemistry, Tata McGraw-Hill Publishing Company Limited.
- March, J. Advanced Organic Chemistry, Fourth edition, Wiley.
- Bariyar and Goyal, Organic Chemistry-II, Krishna Prakashan Media, Meerut, Third Edition, 2019

  
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Year III, Semester V, Chemistry Paper-2 (Theory)

Course Code:	BCH3502	Credits
	Rearrangements and Chemistry of Group Elements	4

Subject: Major Core Course

Max. Marks: 25+75

Total No. of Lectures: 60

Course Objectives

CO1	To demonstrate theoretical knowledge of Rearrangements.
CO2	To gain an understanding of the importance of Catalysis in Chemical reactions.
CO3	To understand the basic principles of s and p blocks.
CO4	To understand the basic concepts related to Lanthanides and Actinides.
CO5	To understand the concepts and reactions of Bioinorganic Chemistry.

UNIT I

Rearrangements: A detailed study of the following rearrangements: Pinacol-pinacolone, Demjanov, Benzil-Benzilic acid, Favorskii, Hofman, Curtius, Schmidt, Baeyer-Villiger and Fries rearrangement. **Catalysis:** General principles and properties of catalysts, homogenous catalysis (catalytic steps and examples) and heterogenous catalysis (catalytic steps and examples) and their industrial applications, Deactivation or regeneration of catalysts. Phase transfer catalysts, application of zeolites as catalysts. Enzyme catalysis; Michaelis-Menten equation, turn-over number.

UNIT-II

s-Block Elements: Comparative study, diagonal relationship, salient features of hydrides, solvation and complexation tendencies including their function in biosystems, an introduction to alkyls and aryls. **p-Block Elements:** Comparative study (including diagonal relationship) of groups 13-17 elements, compounds like hydrides, oxides, oxyacids and halides of group 13-16, hydrides of boron-diborane and higher boranes, borazine, borohydrides, fullerenes, carbides, fluorocarbons, silicates (structural principle), tetrasulphur tetra nitride, basic properties of halogens, interhalogens and polyhalides. **Chemistry of Noble Gases:** Chemical properties of the noble gases, chemistry of xenon, structure and bonding in xenon compounds.

UNIT-III

Chemistry of Transition Elements: Chemistry of Elements of First Transition Series - Characteristic properties of d-block elements. Binary compounds (hydrides, carbides and oxides) of the elements of the first transition series and complexes with respect to relative stability of their oxidation states, coordination number and geometry. **Chemistry of Elements of Second and Third Transition Series** - General characteristics, comparative treatment of Zr/Hf, Nb/Ta, Mo/W in respect of ionic radii, oxidation states, magnetic behavior, spectral properties and stereochemistry.

UNIT-IV

Chemistry of Lanthanides: Electronic structure, oxidation states and ionic radii and lanthanide contraction, occurrence and isolation, ceric ammonium sulphate and its analytical uses, complex formation. **Chemistry of Actinides:** Electronic configuration, oxidation states and magnetic properties, chemistry of separation of Np, Pu and Am from U.

UNIT-V

Metal Carbonyls: Metal carbonyls: 18-electron rule, preparation, structure and nature of bonding in the mononuclear and dinuclear carbonyls.: **Bioinorganic Chemistry** Essential and trace elements in biological processes, metalloporphyrins with

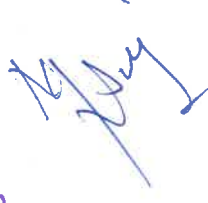
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special reference to hemoglobin and myoglobin. Biological role of alkali and alkaline earth metal ions with special reference to Ca^{2+} . Nitrogen fixation.

Suggested Readings:

- Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Sykes, P. A guidebook to Mechanism in Organic Chemistry, Pearson Education, 2003.
- Carey, F. A., Giuliano, R. M. Organic Chemistry, Eighth edition, McGraw Hill Education, 2012.
- Loudon, G. M. Organic Chemistry, Fourth edition, Oxford University Press, 2008.
- Clayden, J., Greeves, N. & Warren, S. Organic Chemistry, 2nd edition, Oxford University Press, 2012.
- Graham Solomons, T.W., Fryhle, C. B. Organic Chemistry, John Wiley & Sons, Inc.
- Smith, J. G. Organic Chemistry, Tata McGraw-Hill Publishing Company Limited.
- March, J. Advanced Organic Chemistry, Fourth edition, Wiley.
- Bariyar and Goyal, Organic Chemistry-II, Krishna Prakashan Media, Meerut, Third Edition, 2019




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Year III, Semester V, Chemistry Paper-3 (Practical)

Course Code:	BCH3571	Credits
	Qualitative Analysis	2

Subject: Major Core Course

Max. Marks: 30+70

Total No. of Lectures: 60

COURSE OBJECTIVES

CO1	To gain expertise in Inorganic qualitative analysis.
CO2	To gain knowledge in identifying organic compounds.
CO3	To develop skills in separating the organic mixture.
CO4	To develop basic skills required for analysis of the elements.
CO5	To gain practical knowledge in the identification of the functional groups.

UNIT I

Inorganic Qualitative Analysis

Semi micro Analysis – cation analysis, separation and identification of ions from Groups I, II, III, IV, V and VI, Anion analysis. Mixture containing 6 radicals - 2+4 or 4+ or 3+3

UNIT II

Identification of organic compounds

Identification of an organic compound through the functional group analysis, determination of melting point and preparation of suitable derivatives.

UNIT III

Separation of Organic Mixture

Analysis of an organic mixture containing two solid components using water, NaHCO_3

UNIT IV

Elemental analysis and identification of functional groups

Detection of extra elements (N, S and halogens) and functional groups (phenolic, carboxylic, carbonyl, esters, carbohydrates, amines, amides, nitro and anilide) in simple organic compounds.

Suggested Readings:

- Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.
- Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.
- Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.
- Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960.

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- Harris, D.C. Exploring Chemical Analysis, 9th Ed. New York, W.H. Freeman, 2016.
- Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age International Publisher, 2009.

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Year III, Semester VI Chemistry Paper I (Theory)

Course Code:	BCH3601	Credits
	Organic Synthesis B	4

Max. Marks: 30+70

Total No of Lectures: 60

Course Outcome

CO1	This paper provides detailed knowledge of synthesis of various class of organic compounds and functional groups inter conversion. Organic synthesis is the most important branch of organic chemistry which provides jobs in production & QC departments related to chemicals, drugs, medicines, FMCG etc. industries.
CO2	The study of natural products and heterocyclic compounds offers an excellent strategy toward identifying novel biological probes for a number of diseases. Historically, natural products have played an important role in the development of pharmaceutical drugs for a number of diseases including cancer and infection.

Unit I

Reagents in Organic Synthesis: A detailed study of the following reagents in organic transformations Oxidation with DDQ, CAN and SeO₂, mCPBA, Jones Oxidation, PCC, PDC, PFC, Collin's reagent and ruthenium tetroxide. Reduction with NaBH₄, LiAlH₄, Meerwein-Ponndorf-Verley (MPV) reduction, Wilkinson's catalyst, Birch reduction, DIBAL
Organometallic Compounds - Organomagnesium compounds: the Grignard reagents, formation, structure and chemical reactions. Organozinc compounds: formation and chemical reactions. Organolithium compounds: formation and chemical reactions.

Unit II

Chemistry of Aldehydes and ketones: Nomenclature and structure of the carbonyl groups, synthesis of aldehydes and ketones with particular reference to the synthesis of aldehydes from acid chlorides, synthesis of aldehydes and ketones uses 1,3-dithianes, synthesis of ketones from nitrites and from carboxylic acids, Physical properties. Mechanism of nucleophilic additions to carbonyl group with particular emphasis on benzoin, aldol, Perkin and Knoevenagel condensations, Condensation with ammonia and its derivatives. Wittig reaction, Mannich reaction. Oxidation of aldehydes, Cannizzaro reaction, MPV, Clemmensen, Wolff-Kishner, LiAlH₄ and NaBH₄ reductions. Halogenation of enolizable ketones An introduction to α , β unsaturated aldehydes and Ketones.

Unit III

Carboxylic acids and their Functional Derivatives: Nomenclature and classification of aliphatic and aromatic carboxylic acids. Preparation and reactions, Acidity (effect of substituents on acidity) and salt formation, Reactions: Mechanism of reduction, substitution in alkyl or aryl group. Preparation and properties of dicarboxylic acids such as oxalic, malonic, succinic, glutaric, adipic and phthalic acids and unsaturated carboxylic acids such as acrylic, crotonic and cinnamic acids, Reactions: Action of heat on hydroxy and amino acids, and saturated dicarboxylic acids, stereospecific addition to maleic and fumaric acids. Preparation and reactions of acid chlorides, acid anhydrides, amides and esters, acid and alkaline hydrolysis of esters, trans-esterification.

Unit IV

Heterocyclic Chemistry: Molecular orbital picture and aromatic characteristics of pyrrole, furan, thiophene and pyridine, Methods of synthesis and chemical reactions with particular emphasis on the mechanism of electrophilic substitution, Mechanism of nucleophilic substitution reaction in pyridine derivatives, Comparison of basicity of pyridine, piperidine and pyrrole. Introduction to condensed five and six membered heterocycles, Preparation and reactions of indole, quinoline and isoquinoline with special reference to Fisher indole synthesis, Skraup synthesis and Bischler-Nepieralski synthesis, Mechanism of electrophile substitution reactions of indole, quinoline and isoquinoline **Natural Products Alkaloids &**

Terpenes: Natural occurrence, General structural features, their physiological action, Hoffmann's exhaustive methylation, Emde's modification. Medicinal importance of Nicotine, Hygrine, Quinine, Morphine, Cocaine, and Reserpine. Natural Occurrence and classification of terpenes, isoprene rule.

Unit V

Organic Compounds of Nitrogen: Preparation of nitroalkanes and nitroarenes, Chemical reactions of nitroalkanes. Mechanisms of nucleophilic substitution in nitroarenes and their reductions in acidic, neutral and alkaline media, Picric acid. Halonitroarenes: reactivity, Structure and nomenclature of amines, physical properties, Stereochemistry of amines, Separation of a mixture of primary, secondary and tertiary amines. Structural features effecting basicity of amines. Amine salts as phase-transfer catalysts, Preparation of alkyl and aryl amines (reduction of nitro compounds, nitrites), reductive amination of aldehydic and ketonic compounds, Gabrielphthalimide reaction, Hofmann bromamide reaction. Reactions of amines, electrophilic aromatic substitution in aryl amines, reactions of amines with nitrous acid. Synthetic transformations of aryl diazonium salts, azo coupling

Suggested Readings:

- Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Sykes, P. A guidebook to Mechanism in Organic Chemistry, Pearson Education, 2003.
- Carey, F. A., Giuliano, R. M. Organic Chemistry, Eighth edition, McGraw Hill Education, 2012.
- Loudon, G. M. Organic Chemistry, Fourth edition, Oxford University Press, 2008.
- Clayden, J., Greeves, N. & Warren, S. Organic Chemistry, 2nd edition, Oxford University Press, 2012.
- Graham Solomons, T.W., Fryhle, C. B. Organic Chemistry, John Wiley & Sons, Inc.
- Smith, J. G. Organic Chemistry, Tata McGraw-Hill Publishing Company Limited.
- March, J. Advanced Organic Chemistry, Fourth edition, Wiley
- Acheson, R.M. Introduction to the Chemistry of Heterocyclic compounds, John Wiley & Sons (1976).
- Finar, I.L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Finar, I.L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)
- Singh, J., Ali, S.M. & Singh, J. Natural Product Chemistry, Pragati Prakashan (2010)
- Organic Chemistry III, Krishna Prakashan Media, Meerut, Third Edition, 2019

Year III, Semester VI Chemistry Paper-2 (Theory)

Course Code:	BCH3602	Credits
	Chemical Energetics and Radio Chemistry	4

Max. Marks: 30+70

Total No of Lectures: 60

Course Outcome

CO1	Upon successful completion of this course students should be able to describe laws of thermodynamics and its applications, phase equilibria of one and two component system, electrochemistry, ionic equilibrium applications of conductivity and potentiometric measurements
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UNIT – I

Thermodynamics-1: First Law of Thermodynamics: Statement, definition of internal energy and enthalpy. Heat capacity, heat capacities at constant volume and pressure and their relationship. Joule's law – Joule-Thomson coefficient and inversion temperature. Calculation of w , q , dU & dH for the expansion of ideal gases under isothermal and adiabatic conditions for reversible process. **Thermochemistry:** Standard state, standard enthalpy of formation – Hess's law of heat summation and its applications. Heat of reaction at constant pressure and at constant volume. Enthalpy of neutralization. Bond dissociation energy and its calculation from thermo-chemical data, temperature dependence of enthalpy. Kirchhoff's equation.

UNIT – II

Thermodynamics II: Second Law of Thermodynamics, Need for the law, different statements of the law, Carnot cycle and its efficiency. Carnot theorem. Thermodynamic scale of temperature. Concept of Entropy, Entropy as a state function, entropy as a function of V & T , entropy as a function of P & T , entropy change in physical change, Clausius inequality, entropy as a criteria of spontaneity and equilibrium. Entropy change in ideal gases and mixing of gases. Gibbs and Helmholtz Functions Gibbs function (G) and Helmholtz function (A) as thermodynamic quantities. A & G as criteria for thermodynamic equilibrium and spontaneity, their advantage over entropy change, Variation of G and A with P , V and T . Third Law of Thermodynamics; Nernst heat theorem, statement and concept of residual entropy. Nernst distribution law – Thermodynamic derivation, applications.

UNIT – III

Electrochemistry: Electrical transport: Conduction in metals and in electrolyte solutions, specific conductance, molar and equivalent conductance, measurement of equivalent conductance, variation of molar, equivalent and specific conductances with dilution. Migration of ions and Kohlrausch law, Arrhenius theory of electrolyte dissociation and its limitations. Weak and strong electrolytes. Ostwald's dilution law, its uses and limitations. Debye-Huckel-Onsager equation for strong electrolytes (elementary treatment only). Transport number, definition and determination by Hittorf method and moving boundary method.

UNIT – IV

Photo Chemistry: Interaction of radiation with matter, difference between thermal and photochemical processes. Laws of photochemistry: Grothus-Draper law, Stark-Einstein law, Jablonski diagram depicting various processes occurring in the excited state, qualitative description of fluorescence, phosphorescence, non-radiative processes (internal conversion, intersystem crossing), quantum yield, photosensitized reactions – energy transfer processes (simple examples), kinetics of photochemical reaction.

UNIT – V

Radiochemistry: Natural and induced radioactivity; radioactive decay - α -decay, β -decay, γ -decay; neutron emission, positron emission, electron capture; unit of radioactivity (Curie); half life period; Geiger-Nuttall rule, radioactive displacement law, radioactive series. Measurement of radioactivity: ionization chamber, Geiger counters, scintillation counters. Applications: energy tapping, dating of objects, neutron activation analysis, isotopic labelling studies, nuclear medicine - ^{99m}Tc radiopharmaceuticals

Suggested Readings:

- Foye, W.O., Lemke, T.L. & William, D.A.: Principles of Medicinal Chemistry, 4th ed., B.I. Waverly Pvt. Ltd. New Delhi.
- Peter Atkins & Julio De Paula, Physical Chemistry 9th Ed., Oxford University Press (2010).
- Metz, C.R. Physical Chemistry 2nd Ed., Tata McGraw-Hill (2009).
- Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry Ed., Oxford University Press 13 (2006).
- Ball, D. W. Physical Chemistry Thomson Press, India (2007).
- Castellan, G. W. Physical Chemistry 4th Edn. Narosa (2004).
- Allen Bard, J Larry, Faulkner R, Fundamentals of Electrochemical methods – fundamentals and applications, new York John, Wiley & sons, 2001
- H.J. Arnikar, Essentials of Nuclear Chemistry, 4th ed., New Age International, New Delhi, 1995.
- Bariyar and Goyal, Physical Chemistry-II, Krishna Prakashan Media, Meerut, Third Edition, 2019



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Year III, Semester VI Chemistry Paper-3 (Practical)

Course Code:	BCH3671	Credits
	Analytical Methods	2

Max. Marks: 30+70

Total No of Lectures: 60

Course Outcome

CO1	Upon successful completion of this course students should be able to describe laws of thermodynamics and its applications, phase equilibria of one and two component system, electrochemistry, ionic equilibrium applications of conductivity and potentiometric measurements
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UNIT-1

Gravimetric Analysis

1. Analysis of Cu as CuSCN,
2. Analysis of Ni as Ni (dimethylglyoxime)
3. Analysis of Ba as BaSO₄.

UNIT-1

Paper Chromatography

Ascending and Circular. Determination of R_f values and identification of organic compounds, Separation of a mixture

Unit-3

Thin Layer Chromatography

Determination of R_f values and identification of organic compounds: Separation of green leaf pigments (spinach leaves may be used)

Unit 4

Thermochemistry

1. To determine the solubility of benzoic acid at different temperatures and to determine ΔH of the dissolution process
2. To determine the enthalpy of neutralization of a weak acid/weak base versus strong base/strong acid and determine the enthalpy of ionization of the weak acid/weak base

Suggested Readings:

1. Skoog .D.A., West.D.M and Holler .F.J., "Analytical Chemistry: An Introduction", 7th edition, Saunders college publishing, Philadelphia,(2010).
2. Larry Hargis.G" Analytical Chemistry: Principles and Techniques" Pearson©(1988)
3. 4. <https://www.labster.com/chemistry-virtual-labs/> 5. <https://www.vlab.co.in/broad-area-chemical-sciences> 6. <http://chemcollective.org/vlabs>

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National Education Policy-2020
PROPOSED STRUCTURE OF SYLLABUS

Vocational Courses



(FACULTY OF SCIENCE)

FUTURE UNIVERSITY, BAREILLY

18th Milestone, Bareilly-Lucknow Highway NH-24
Near Faridpur, Bareilly, Uttar Pradesh 243503
Website: www.futureuniversity.in

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Vocational course: Semester-1
Course Title: Vyavharik Hindi

Programme/Class:	B.Sc.
Year:	First
Semester:	First
Vocational Course	
Course Code: VOC0001	Course Title: Vyavharik Hindi

Course outcomes:

- CO1 विद्यार्थी हिंदी भाषा एवं उसकी व्याकरणिक संरचना (वर्ण, शब्द, वाक्य) की मूल समझ विकसित कर सकेंगे।
- CO2 विद्यार्थी शुद्ध एवं प्रभावी हिंदी लेखन (वर्तनी, वाक्य रचना) कर सकेंगे।
- CO3 विद्यार्थी औपचारिक व अनौपचारिक पत्र, आवेदन पत्र तथा बायोडाटा का प्रारूप तैयार कर सकेंगे।
- CO4 विद्यार्थी प्रतिवेदन, सारांश एवं अनुवाद जैसे प्रारूपिक लेखन-कौशल में दक्षता प्राप्त कर सकेंगे।
- CO5 विद्यार्थी साक्षात्कार, प्रस्तुतिकरण व समूह चर्चा हेतु मौखिक संप्रेषण कौशल तथा व्यावसायिक हिंदी शब्दावली का उपयोग कर सकेंगे।

Credits: 2 Compulsory

Max. Marks: 100 Min. Passing Marks:

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 2-0-0

Unit	Topic	No. of Lectures
I	हिंदी भाषा एवं व्याकरण की मूल संरचना - हिंदी भाषा — उद्भव, विकास एवं स्वरूप - वर्ण विचार — स्वर एवं व्यंजन, उच्चारण स्थान - शब्द रचना — उपसर्ग, प्रत्यय - संधि एवं समास (परिभाषा, भेद, उदाहरण) - वर्तनी संबंधी सामान्य अशुद्धियाँ एवं शुद्धिकरण	
II	व्यावहारिक व्याकरण एवं शब्द भंडार (लिंग, वचन एवं कारक - मुहावरे एवं लोकोक्तियाँ - पर्यायवाची तथा विलोम शब्द - अनेकार्थी शब्द एवं शब्द-युग्म - वाक्य रचना के सिद्धांत एवं वाक्य शुद्धिकरण	


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Unit	Topic	No. of Lectures
III	पत्र लेखन एवं आवेदन-पत्र 1. औपचारिक एवं अनौपचारिक पत्र लेखन 2. कार्यालयीन पत्र — अवकाश हेतु आवेदन, शिकायत पत्र 3. नौकरी हेतु आवेदन-पत्र लेखन 4. बायोडाटा (Resume) तैयार करना 5. ई-मेल लेखन के व्यावहारिक नियम	
IV	संप्रेषण कौशल एवं व्यावसायिक हिंदी 1. मौखिक संप्रेषण — आत्म-परिचय एवं साक्षात्कार की तैयारी 2. प्रस्तुतिकरण (Presentation) कौशल 3. समूह चर्चा एवं वाद-विवाद कौशल 4. व्यावसायिक हिंदी शब्दावली — बैंकिंग, कार्यालय, तकनीकी क्षेत्र 5. दूरभाष/टेलीफोनिक संवाद के शिष्टाचार एवं भाषा प्रयोग	

Suggested Readings:

- Singh, Anita, "Food and Nutrition", Star Publication, Agra, India, 2018.
- 1000Days-Nutrition_Brief_Brain-Think_Babies_FINAL.pdf
- <https://pediatrics.aappublications.org/content/141/2/e20173716>
- <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5750909/>
- Sheel Sharma, Nutrition and Diet Therapy, Peepee Publishers Delhi, 2014, First Edition.

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Vocational course: Semester-2
Course Title: Computer Application

Vocational course

Programme/Class:	B.Sc.
Year:	First
Semester:	Second
Vocational Course	
Course Code: VOC0002	Course Title: Computer Application

Course outcomes:

- CO1 Understand the basic concepts of computer, its characteristics, and hardware/software components.
- CO2 Operate the Windows operating system and perform basic file and folder management operations.
- CO3 Create, edit and format documents using MS Word for personal and professional use.
- CO4 Prepare spreadsheets, apply formulas/functions and represent data using charts in MS Excel.
- CO5 Use the Internet and e-mail services effectively, and create basic presentations using MS PowerPoint.

Credits: Qualifying Compulsory

Max. Marks: 100 Min. Passing Marks:

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-0

Unit	Topic	No. of Lectures
I	Unit 1: Introduction to Computers - Computer — definition, characteristics and applications - Generations of computers - Classification of computers (based on size and purpose) - Hardware and Software — types of software (System, Application, Utility) - Input and Output devices - Memory — Primary memory (RAM, ROM) and Secondary memory (Hard Disk, Pen Drive, etc.) - Basics of number system (Binary, Decimal — introductory level)	
II	Unit 2: Operating System and Windows - Operating System — definition, functions and types - Introduction to Windows OS — Desktop, Icons, Taskbar, Start Menu - File and Folder management — creating, renaming, copying, moving, deleting - Introduction to Control Panel and system settings	

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Unit	Topic	No. of Lectures
	Introduction to Disk management (formatting, disk cleanup — basic level)	
III	Unit 3: MS Word (Word Processing) 1. Introduction to word processing software 2. Creating, saving and opening a document 3. Formatting text — font, size, style, alignment 4. Paragraph formatting, bullets and numbering 5. Working with Tables, Headers and Footers 6. Inserting images, page setup and printing 7. Introduction to Mail Merge	
IV	Unit 5: Internet and MS PowerPoint 1. Internet — introduction, uses and web browsers 2. Search engines and basics of web browsing 3. E-mail — creating an account, sending/receiving mails, attachments 4. Introduction to Presentation software (MS PowerPoint) 5. Creating slides, applying themes and templates 6. Inserting text, images and basic animations 7. Slide show and presentation delivery basics	

Suggested Readings:

1. Sinha, P.K. & Sinha, Priti. *Computer Fundamentals*. BPB Publications.
2. Rajaraman, V. *Fundamentals of Computers*. PHI Learning.
3. Peter Norton. *Introduction to Computers*. McGraw Hill Education.
4. Saxena, Sanjay. *MS Office 2016 (Word, Excel, PowerPoint) — A Practical Approach*. Vikas Publishing House.
5. ITL Education Solutions Limited. *Introduction to Information Technology*. Pearson Education.
6. Leon, Alexis & Leon, Mathews. *Fundamentals of Information Technology*. Vikas Publishing House.
7. Microsoft Official Documentation — Word, Excel, PowerPoint (support.microsoft.com)


 
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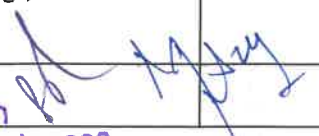


Vocational course: Semester-3
Course Title: Functional English

Syllabus: Functional English

Programme/Class: B.Sc.	Year: Second	Semester: Third
Vocational Course		
Course Code: VCC0003	Course Title: Functional English	
Course outcomes:		
• To develop an understanding of language functions in the students. • To employ Listening, Speaking, Reading, and Writing skills to the optimum in informal and formal settings. • To enhance speaking and writing skills and enable the students to develop power of communication through composition and conversational skills.		
Credits: 2		
Max. Marks: 100	Min. Passing Marks: 40	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 2-0-0		

Unit	Topics	No. of Lectures Total=30
I	Developing Conversational Ability a) Greetings and Introduction b) Participating in small talks- At the office, At the railway station, At the airport, At the travel agency, At the bank, At the doctor's clinic, At the hospital. c) Talking on the telephone. d) Socializing- Making requests, expressing thanks & responding to thanks; Expressing likes and dislikes, offering Apology & making Requests. Offering help, complimenting and congratulating, refusing.	
II	Listening Comprehension Basic skills of listening, Listening Models, Body Language, Avoiding the barriers to listening, Streamlining of soundshape	
III	Applied Reading Applied Reading Strategies: Skimming, scanning, making inferences, recognizing patterns. Identifying the main ideas & supporting Details of a reading passage and paraphrasing/summarizing them. • Active Reading Strategies: Using Text Structure • Transitions • Identifying Relationships Among Ideas • Critical Reading Strategies: Evaluating Fact or Opinion, feelings, Author's Point of View and Purpose	
IV	Developing Writing a) Profile writing.	


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	b) Writing Formal letters: inviting people, making enquiries, complaining, asking for permission, making requests. c) Writing Job Applications. d) Writing product description. e) Argumentative Essay	
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Suggested Readings:

- J.Charles Alderson. 2000. Assessing Reading. CUP.
- William Grabe.2009. Reading in a second language : moving from Theory and Practice. CUP.
- Enid Nolan Woods & David Foll. 1986. Penguin Advanced Reading skills. Penguin.
- Donne Byrne.1998. Teaching Writing Skills. Longman Handbook for English Teachers. Longman Publishing House.
- Sara Freeman.Written Communication in English. Ron White & Valerie Arndt. 1991.
- Zinkin Taya. 1988. Write Right. A guide to effective communication in English. Prentice Hall of India. New Delhi.
- Moon, R., (2000) The Power of Extraordinary Listening, Zanshin Press, California, USA.
- Bhasker, W.W.S. and Prabhu, N.S. (1975) English Through Reading, MacMillan India Ltd.
- Greg S. Baker. 2011. Fitly Spoken: Developing Effective Communication and Social Skills. Brighton Publishing LLC.
- Casey Malarcher. 2018. Developing Listening Skills. Compass Publishing.





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Vocational course: Semester-4
Course Title: Organic Farming

Syllabus: Organic Farming

Programme: B.Sc.	Year: Second	Semester: Forth
Co-Curricular Course		
Course Code: BVC0004	Course Title: Organic Farming	
Course outcomes:		
1. Explain the concepts and principles of organic farming		
2. Demonstrate on the preparation and use of organic inputs 3. describe the role of microbes through bio-fertilizer on plant growth promotion		
3.demonstrate hands on experience on preparation of biofertilizers, bio-control agents and other natural sources of plant nutrition		
4. Explain the post-harvest aspects of organic animal products.		
5. examine marketing and economic potential of organic products		
Credits: 2	Compulsory	
Max. Marks: 25+75	Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 2-0-0		

Unit	Topics	No. of Lectures Total=30
I	Organic farming, concept, principles and its scope in India and NE region; prospects and constraints of organic farming in India and NE region; Organic vs conventional farming; Traditional knowledge on organic management; Organic management of soil sources of plant nutrients, preparation and uses of different types of composts, FYM, vermicompost, green manures, oil cakes, bio-fertilizers etc	
II	- Organic management of pests, diseases and weeds: biological control of pests; biopesticides; cultural methods, crop rotation, mixed farming, trap cropping, companion cropping, smothering crops, bait traps, light traps, bird purchase etc.; - Trichoderma mass multiplication technique; soil solarization- types, methods and advantages; - Indigenous formulations for disease and pest management. Bio-pesticides. - Cultural and biological weed control methods. - Role of natural farming components on soil fertility and crop pest management.	
III	- Aspects of Organic milk, fish, eggs and meat production; Initiatives taken by the central Govt., state governments, NGOs and other organizations like APEDA for promotion of organic agriculture in India. - Post harvest management of organic products- Processing, labelling,	

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	storage and transport; Economic considerations and viability, marketing and export potential of organic products.; Operational structure of NPOP; Certification process and standards of organic farming	
IV	• Quality analysis of different bio-fertilizers. Methods of bio-fertilizer application. • Enrichment of FYM/compost/vermicompost. • Visit to the bio-fertilizer production plants. • Case studies of Indigenous Technical knowledge (ITK) for nutrient, insect, pest, disease and weed management. Economic analysis of organic production system.	

Suggested Readings:

1. Chandra S, Narayan S, Narayan R, Kumar A and Wani JA. 2023. Natural Farming a rising concept. Satish serial publishing house, New Delhi.
2. Organic Horticulture; Principles, Practices and Technologies, Westville, New Delhi.
3. Palaniappan SP and Annadurai K 2006. Organic Farming: Theory and Practices. Scientific Publishers, Jodhpur, India
4. Gehlot G. 2005. Organic farming; standards, accreditation certification and inspection. Agrobios, India.
5. 2. Lal CT. 2018. Marketing of organic food produce. Delve publishing, Canada. Organic Horticulture; Principles, Practices and Technologies, Westville, New Delhi.
6. 2. Palaniappan SP and Annadurai K 2006. Organic Farming: Theory and Practices. Scientific Publishers, Jodhpur, India.
7. 3. Panda SC 2011. Organic Farming for sustainable agriculture. Kalyani Publishers, Jalandhar.

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Co-curricular course: Semester-5
Course Title: Vermicomposting

Co-Curricular Course name: Vermicomposting

Programme/Class:	Bachelor of Science
Year:	Third
Semester:	Fifth
Subject: Co-Curricular Course	
Course Code: VOC0005	Course Title: Vermicomposting

Course outcomes (Analytic Ability):

- CO 1: Familiarize with analogy, number system, set theory and its applications, number system and puzzles.
- CO 2: To understand the basics of Syllogism, figure problems, critical and analytical reasoning.
- CO 3: Familiarize with word processing application and worksheet.
- CO 4: To understand the basics of web surfing and cyber security.

Credits: 2 Co-Curricular

Max. Marks: 100 Min. Passing Marks:

Total No. of Lectures-Tutorials-Practical (in hours per week): 2-0-0

Unit	Topic	No. of Lectures
I	Earthworms Introduction of earthworms, Classification of earthworms and their types. The behavior of earthworms as indicators of soil fertility, as plant growth promoters & soil health regulators. Role of Earthworms to protect Environment.	
II	Vermicomposting Vermiculture and Vermicomposting, Advantages of Vermicomposting, Chemical composition of vermicompost. Vermicomposting in everyday life earthworms and vermicomposting at commercial scale. Vermicomposting and Sustainable agriculture, restoration of degraded soil systems, vermicomposting and its effect on the greenhouse effect. Vermicomposting and its economic viability.	
III	Integrated Farming, including vermiculture Eco-friendly farming system technology. Criteria for ecological and appropriate technologies in agro-forestry, natural-management and planted forests (ranching, farmers' perception to organic Farming and case studies).	
IV	Vermiculture and Vermicomposting material Farm waste and its vermicomposting materials, types of vermicomposting (indoor and outdoor), requirements of vermicomposting bedding materials Selection of suitable and dominant earthworm species; Composting materials;	

Unit	Topic	No. of Lectures
	Production of vermicompost harvesting the compost and worm; vermicompost applications, predators, pathogens, and parasites of earthworms.	

Suggested Readings:

1. Biology and Ecology of Tropical Earthworms by Priya Shankar Chaudhari and S.M. Singh Discovery Publishing House Pvt. Ltd. New-Delhi.
2. Vermicomposting for Sustainable Agriculture by P.K. Gupta, Agrobios (India), Agro. House. Jodhpur. 342 or 2.
3. Earthworm Ecology by C.A. Edwards CRC Press U.S.A.
4. Soil Biodiversity Ecological Process and Landscaps Management by
5. P.S. Ramakrishnan. K.G. saxena, M.J. Sulift, K.S. Rao, R.K. Maikhuri, Oxford and IBH Publishing Co. RA Ltd. New Delhi.
6. Vermiculture Eco-technology: Bhawankar Earthworm Research Instiutute (BERI) Pune.
7. The Biological Management of Tropical soil Fertility- by P.L. Woomer and M. J Sulift Pub. John wiley & sons, New-York. Busbane Singapore.
8. Sultan Ahmed Ismail, 2005. The Earthworm Book, Second Revised Edition. Other India Press, Goa, India.
9. Bhatnagar & Patla, 2007. Earthworm vermiculture and vermin-composting, Kalyani Publishers, New Delhi.
10. Jordan & Verma, 2009. Invertebrate Zoology, Chand & Company Ltd.



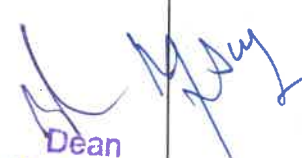
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Co-curricular course: Semester-6
Course Title: Web Designing Hardware and Networking

Programme: B.Sc.	Year: Third	Semester: Sixth
Co-Curricular Course		
Course Code: VOC0006	Course Title: Web Designing Hardware and Networking	
Course outcomes:		
• The course aims to provide exposure to problem-solving through programming. • It aims to train the student to the basic concepts of the C-programming language. • Students will learn to develop simple algorithms and flow charts to solve a problem. • Programming Proficiency: Develop basic programming skills and logical thinking through hands-on experience with a programming language. • Understanding Fundamental Concepts: Grasp the key principles of data structures and their importance in computer science. • Problem-Solving Skills: Enhance problem-solving skills by teaching students how to apply IT solutions to real-world problems.		
Credits: 2	Compulsory	
Max. Marks: 100	Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 2-0-0		

Unit	Topics	No. of Lectures Total=30
I	Introduction: Introduction to Programming, Program Concept, Characteristics of Programming, Stages in Program Development, Algorithms, Flowcharts, Types of Programming Methodologies, Introduction to C Programming Basic Program Structure in C, Variables and Assignments, Input and Output, Selection and Repetition Statements.	
II	Computer Hardware Fundamentals 1. Introduction to computer hardware and PC components 2. Motherboard — components and specifications 3. CPU, RAM and types of storage devices (HDD, SSD) 4. Power Supply Unit (SMPS) 5. Cabinets and form factors	


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	6. Ports and connectors (USB, HDMI, VGA, etc.) •	
III	Unit 3: Troubleshooting and Maintenance 1. Common hardware problems and their troubleshooting 2. Preventive maintenance of computer systems 3. Software troubleshooting — common OS issues 4. Backup and recovery — basic concepts • Antivirus and basic system security tools	
IV	Unit 4: Networking Fundamentals 1. Introduction to computer networks and their types (LAN, MAN, WAN) 2. Network topologies (Bus, Star, Ring, Mesh) 3. Networking devices — Hub, Switch, Router, Modem 4. OSI Model — introduction to seven layers 5. TCP/IP Model — introduction 6. Setting up a basic LAN 7. IP addressing basics (IPv4) 8. Wireless networking basics (Wi-Fi)	

Suggested Readings:

1. Meyers, Mike. *Mike Meyers' CompTIA A+ Guide to Managing and Troubleshooting PCs*. McGraw Hill Education.
2. Forouzan, Behrouz A. *Data Communications and Networking*. McGraw Hill Education.
3. Tanenbaum, Andrew S. & Wetherall, David J. *Computer Networks*. Pearson Education.
4. Dean, Tamara. *Network+ Guide to Networks*. Cengage Learning.
5. Sinha, P.K. & Sinha, Priti. *Computer Fundamentals*. BPB Publications.



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National Education Policy-2020

PROPOSED STRUCTURE OF SYLLABUS

Co-curricular Courses



(FACULTY OF SCIENCE)

FUTURE UNIVERSITY, BAREILLY

18th Milestone, Bareilly-Lucknow Highway NH-24

Near Faridpur, Bareilly, Uttar Pradesh 243503

Website: www.futureuniversity.in


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Co-curricular course: Semester-1
Course Title: Food, Nutrition and Hygiene

Programme/Class:	B.Sc.
Year:	First
Semester:	First
Co-Curricular Course	
Course Code: UCC0001	Course Title: Food, Nutrition and Hygiene

Course outcomes:

- To learn the basic concept of the Food and Nutrition
- To study the nutritive requirement during special conditions like pregnancy and lactation
- To learn meal planning
- To learn 100 days Nutrition Concept
- To study common health issues in the society
- To learn the special requirement of food during common illness

Credits: 2 Compulsory

Max. Marks: 40+60 Min. Passing Marks:

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 2-0-0

Unit	Topic	No. of Lectures
I	Concept of Food and Nutrition (a) Definition of Food, Nutrients, Nutrition, Health, balanced Diet (b) Types of Nutrition- Optimum Nutrition, under Nutrition, Over Nutrition (c) Meal planning- Concept and factors affecting Meal Planning (d) Food groups and functions of food	8
II	Nutrients: Macro and Micro RDA, Sources, Functions, Deficiency and excess of (a) Carbohydrate (b) Fats (c) Protein (d) Minerals Major: Calcium, Phosphorus, Sodium, Potassium Trace: Iron, Iodine, Fluorine, Zinc (e) Vitamins Water soluble vitamins: Vitamin B, C Fat soluble vitamins: Vitamin A, D, E, K (f) Water (g) Dietary Fibre	7
III	1000 days Nutrition (a) Concept, Requirement, Factors affecting growth of child (b) Prenatal Nutrition (0 - 280 days): Additional Nutrients' Requirement and risk factors during pregnancy (c) Breast / Formula Feeding (Birth – 6 months of age) Complementary and Early Diet (6 months – 2 years of age)	8
IV	Community Health Concept (a) Causes of common diseases prevalent in the society and Nutrition requirement in the following: Diabetes, Hypertension (High Blood Pressure), Obesity, Constipation, Diarrhea, Typhoid (b) National and International Program and Policies for improving Dietary Nutrition	7

Unit	Topic	No. of Lectures
	(c) Immunity Boosting Food	

Suggested Readings:

- Singh, Anita, "Food and Nutrition", Star Publication, Agra, India, 2018.
- 1000Days-Nutrition_Brief_Brain-Think_Babies_FINAL.pdf
- <https://pediatrics.aappublications.org/content/141/2/e20173716>
- <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5750909/>
- Sheel Sharma, Nutrition and Diet Therapy, Peepee Publishers Delhi, 2014, First Edition.




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Co-curricular course: Semester-2
Course Title: First Aid and Health

Co-curricular course

Programme/Class:	B.Sc.
Year:	First
Semester:	Second
Co-Curricular Course	
Course Code: UCC0002	Course Title: First Aid and First Aid and Health

Course outcomes:

- Learn the skill needed to assess the ill or injured person.
- Learn the skills to provide CPR to infants, children and adults.
- Learn the skills to handle emergency child birth
- Learn the Basic sex education help young people navigate thorny questions responsibly and with confidence.
- Learn the Basic sex education help youth to understand Sex is normal. It's a deep, powerful instinct at the core of our survival as a species. Sexual desire is a healthy drive.
- Help to understand natural changes of adolescence
- Learn the skill to identify Mental Health status and Psychological First Aid

Credits: Qualifying Compulsory
Max. Marks: 40+60 Min. Passing Marks: 35

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-0

Unit	Topic	No. of Lectures
I	A. Basic First Aid Aims of first aid & First aid and the law. Dealing with an emergency, Resuscitation (basic CPR). Recovery position, Initial top to toe assessment. Hand washing and Hygiene Types and Content of a First aid Kit B. First AID Technique Dressings and Bandages. Fast evacuation techniques (single rescuer). Transport techniques. C. First aid related with respiratory system Basics of Respiration. No breathing or difficult breathing, Drowning, Choking, Strangulation and hanging, Swelling within the throat, Suffocation by smoke or gases and Asthma. D. First aid related with Heart, Blood and Circulation Basics of The heart and the blood circulation. Chest discomfort, bleeding. D. First aid related with Wounds and Injuries Type of wounds, Small cuts and abrasions Head, Chest, Abdominal injuries Amputation, Crush injuries, Shock E. First aid related with Bones, Joints Muscle related injuries Basics of The skeleton, Joints and Muscles. Fractures (injuries to bones).	

Unit	Topic	No. of Lectures
II	F. First aid related with Nervous system and Unconsciousness Basics of the nervous system. Unconsciousness, Stroke, Fits – convulsions – seizures, Epilepsy. G. First aid related with Gastrointestinal Tract Basics of The gastrointestinal system. Diarrhea, Food poisoning. H. First aid related with Skin, Burns Basics of The skin. Burn wounds, Dry burns and scalds (burns from fire, heat and steam). Electrical and Chemical burns, Sun burns, heat exhaustion and heatstroke. Frost bites (cold burns), Prevention of burns, Fever and Hypothermia. I. First aid related with Poisoning Poisoning by swallowing, Gases, Injection, Skin J. First aid related with Bites and Stings Animal bites, Snake bites, Insect stings and bites K. First aid related with Sense organs Basic of Sense organ. Foreign objects in the eye, ear, nose or skin. Swallowed foreign objects. L. Specific emergency satiation and disaster management Emergencies at educational institutes and work Road and traffic accidents. Emergencies in rural areas. Disasters and multiple casualty accidents. Triage. M. Emergency Child birth	
III	Basic Sex Education Overview, ground rules, and a pre-test Basics of Urinary system and Reproductive system. Male puberty — physical and emotional changes Female puberty — physical and emotional changes Male-female similarities and differences Sexual intercourse, pregnancy, and childbirth Facts, attitudes, and myths about LGBTQ+ issues and identities Birth control and abortion Sex without love — harassment, sexual abuse, and rape Prevention of sexually transmitted diseases.	
IV	Mental Health and Psychological First Aid What is Mental Health First Aid? Mental Health Problems in the India The Mental Health First Aid Action Plan Understanding Depression and Anxiety Disorders Crisis First Aid for Suicidal Behavior & Depressive symptoms What is Non-Suicidal Self-Injury? Non-crisis First Aid for Depression and Anxiety Crisis First Aid for Panic Attacks, Traumatic events Understanding Disorders in Which Psychosis may Occur Crisis First Aid for Acute Psychosis Understanding Substance Use Disorder Crisis First Aid for Overdose, Withdrawal Using Mental Health First Aid	

Suggested Readings:

- Indian First Aid Mannual - <https://www.indianredcross.org/publications/FA-manual.pdf>
- Red Cross First Aid/CPR/AED Instructor Manual
- <https://mhfa.com.au/courses/public/types/youthedition4>
- Finkelhor, D. (2009). The prevention of childhood sexual abuse. Durham, NH: Crimes Against Children Research Center. www.unh.edu/ccrc/pdf/CV192.pdf
- Kantor L. & Levitz N. (2017). Parents' views on sex education in schools: How much do Democrats and Republicans agree? PLoS ONE, 12(7): e0180250.
- Orenstein, P. (2016). Girls and sex: Navigating the complicated new landscape. New York, NY: Harper.

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- Schwiegershausen, E. (2015, May 28). The Cut. www.thecut.com/2015/05/most-women-are-catcalled-before-they-turn-17.html
- Wiggins, G. & McTighe, J. (2008). Understanding by design. Alexandria, VA: ASCD.



Co-curricular course: Semester-3
Course Title: Human Values and Environment studies

Syllabus: Human Values and Environment studies

Programme/Class: B.Sc.	Year: Second	Semester: Third
Co-Curricular Course		
Course Code: UCC0003	Course Title: Human Values and Environment studies	
Course outcomes:		
The mission of the course on Human Values and Environmental Studies is to create morally articulate solutions to be helpful and just and to become responsible towards humanity. The course seeks to establish a continuous interest in the learners to improve their thought process with intent to develop a new generation of responsible citizens capable of addressing complex challenges faced by the society due to disruptions in human interactions effecting human values. This course works towards		
• Building fundamental knowledge of the interplay of markets, ethics, and law, • Look at various challenges faced by individual to counter unethical issues • Look at core concepts for business ethics • Look at core concepts of anti-corruption • Look at core concepts for a morally articulate solution evolver to management issues in general, • Issues of sustainable development for a better environment. • To know how environmental degradation has taken place. • Be aware of negotiations and international efforts to save environment. • How to develop sustainably? • Efforts taken up by UN in Sustainable Development. • Efforts taken by India in Sustainable Development.		
The course intends to create a sense of how to be more responsible towards the environment. Upon finishing of the course students will be able to come up with using ethical reasoning for decision making and frame ethical issues as well as operationalise ethical choices. The course integrates various facets of human values and environment.		
Credits: 2		
Max. Marks: 40+60	Min. Passing Marks: 40	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 2-0-0		
As the course requires two areas of Human Values and Environment Studies institutions can even opt for a parallel delivery		

Unit	Topics	No. of Lectures Total=30
I	Human Values- Introduction- Values, Characteristics, Types, Developing Value system in Indian Organisation, Values in Business Management, value based Organisation, Trans-cultural Human values in Management. Swami Vivekananda's philosophy of Character Building, Gandhi's concept of Seven Sins, APJ Abdul Kalam view on role of parents and Teachers. Human Values and Present Practices – Issues: Corruption and Bribe, Privacy Policy in Web and Social Media, Cyber threats, Online Shopping etc. Remedies UK Bribery Act, Introduction to sustainable policies and practices in Indian Economy. Principles of Ethics Secular and Spiritual Values in Management- Introduction- Secular and Spiritual values, features, Levels of value Implementation. Features of spiritual Values, Corporate Social Responsibility- Nature, Levels, Phases and Models of CSR, Corporate Governance. CSR and Modern Business Tycoons Ratan Tata, Azim Premji and Bill Gates.	


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II	Holistic Approach in Decision making- Decision making, the decision making process, The Bhagavad Gita: Techniques in Management, Dharma and Holistic Management. Discussion through Dilemmas – Dilemmas in Marketing and Pharma Organisations, moving from Public to Private – monopoly context, Dilemma of privatisation, Dilemma on liberalization, Dilemma on social media and cyber security, Dilemma on Organic food, Dilemma on standardization, Dilemma on Quality standards. Case Studies	
III	• Ecosystem: Concept, structure & functions of ecosystem: producer, consumer, decomposer, foodweb, food chain, energy flow, Ecological pyramids • Conservation of Biodiversity- In-situ & Ex-situ conservation of biodiversity • Role of individual in Pollution control • Human Population & Environment • Sustainable Development • India and UN Sustainable Development Goals • Concept of circular economy and entrepreneurship	
IV	• Environmental Laws? • International Advancements in Environmental Conservation • Role of National Green Tribunal • Air Quality Index • Importance of Indian Traditional knowledge on environment • Bio assessment of Environmental Quality • Environmental Management System • Environmental Impact Assessment and Environmental Audit	

Suggested Readings:

1. A foundation course in Human Values and Professional Ethics by RR. Gaur, R. Sangal et.al
2. JUSTICE: What's the Right Thing to Do? Michael J. Sandel.
3. Human Values by A. N. Tripathi New Age International
4. Environmental Management by N.K. Uberoi
5. <https://www.un.org/sustainabledevelopment/sustainable-development-goals/>
6. <https://www.india.gov.in/my-government/schemes>
7. <https://www.legislation.gov.uk/ukpga/2010/23/contents>
8. Daniel Kahneman, Thinking, Fast and Slow; Allen Lane Nov 2011 ISBN: 9780141918921


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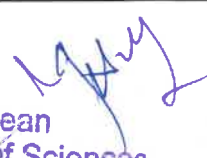


Co-curricular course: Semester-4
Course Title: Physical Education and Yoga

Syllabus: Physical Education and Yoga

Programme: B.Sc.	Year: First	Semester: Forth
Co-Curricular Course		
Course Code: UCC004	Course Title: Physical Education and Yoga	
Course outcomes: Students will learn the introduction of Physical Education, Concept of fitness and wellness, Weight management and lifestyle of an individual. The student will also learn about the relation of Yoga with mental health and value Education. In this course student will also learn about the aspects of the Traditional games of India.		
Credits: 2	Compulsory	
Max. Marks: 40+60	Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 2-0-0		

Unit	Topics	No. of Lectures Total=30
I	Physical Education: - Meaning, Definition, Aim and Objective. - Misconception About Physical Education. - Need, Importance and Scope of Physical Education in the Modern Society. - Physical Education Relationship with General Education. - Physical Education in India before Independence. - Physical Education in India after Independence.	
II	Concept of Fitness and Wellness: - Meaning, Definition and Importance of Fitness and Wellness. - Components of Fitness. - Factor Affecting Fitness and Wellness. Weight Management: - Meaning and Definition of Obesity. - Causes of Obesity. - Management of Obesity. - Health problems due to Obesity. Lifestyle: - Meaning, Definition, Importance of Lifestyle. - Factor affecting Lifestyle. - Role of Physical activity in the maintains of Healthy Lifestyle.	
III	Yoga and Meditation: - Historical aspect of yoga. - Definition, types scopes & importance of yoga. - Yoga relation with mental health and value education. - Yoga relation with Physical Education and sports. - Definition of Asana, differences between asana and physical exercise. - Definition and classification of pranayama. - Difference between pranayama and deep breathing. - Practical: Asana, Suraya-Namaskar, Bhujang Asana, Naukasana, Halasana, Vajrasana, Padmasana, Shavasana, Makrasana, Dhanurasana, Tad Asana. Pranayam: Anulom, Vilom.	
IV	Traditional Games of India: - Meaning. - Types of Traditional Games – Gilli-Danda, Kanche, Stapu, Gutte, etc. - Importance/ Benefits of Traditional Games. - How to Design Traditional Games. Recreation in Physical Education:	


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•	Meaning, Definition of Recreation.	
•	Scope and Importance of Recreation.	
•	General Principles of Recreation.	
•	Types of Recreational Activities.	
•	Aerobics and Zumba. (Fir India Movement)	

Suggested Readings:

- Singh, Ajmer, Physical Education and Olympic Abhiyan, "Kalayani Publishers", New Delhi, Revised Addition, 2006
- Patel, Shri Krishna, Physical Education, "Agrawal Publishers", Agra, 2014-15
- Panday, Preeti, Sharirik Shiksha Sankalan, "Khel Sanskriti Prakashan, Kanpur
- Kamlesh M.L., "Physical Education, Facts and foundations", Faridabad P.B. Publications.
- B.K.S. Yengar, "Light and Yog. Yoga Deepika", George Allen of Unwin Ltd., London, 1981.
- Braj Bilari Nigam, Yoga Power "The Kpath of Personal achievement" Domen and Publishers, New Delhi, 2001.
- Indira Devi, "Yoga for You", Gibbs, Smith Publishers, Salt Lake City, 2002 Domenand Publishers, New Delhi - 2001.
- Jack Peter, "Yoga Master the Yogic Powers", Abhishek Publications, Chandigarh, 2004.
- Janice Jerusalem, "A Guide To Yoga" Parragon Bath, Baiihe-2004.




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Co-curricular course: Semester-5
Course Title: Analytic Ability and Digital Awareness

Co-Curricular Course name: Analytic Ability and Digital Awareness

Programme/Class:	Bachelor of Science
Year:	Third
Semester:	Fifth
Subject: Co-Curricular Course	
Course Code: Z050501	Course Title: Analytic Ability and Digital Awareness

Course outcomes (Analytic Ability):

- CO 1: Familiarize with analogy, number system, set theory and its applications, number system and puzzles.
- CO 2: To understand the basics of Syllogism, figure problems, critical and analytical reasoning.
- CO 3: Familiarize with word processing application and worksheet.
- CO 4: To understand the basics of web surfing and cyber security.

Credits: 2 Co-Curricular

Max. Marks: 40+60 Min. Passing Marks:

Total No. of Lectures-Tutorials-Practical (in hours per week): 2-0-0

Unit	Topic	No. of Lectures
I	Alphabet test, Analogy, Arithmetic Reasoning, Blood relations, Coding and Decoding, Inequalities, Logical Venn diagram, Seating Arrangements, Puzzles and Missing numbers	
II	Syllogism, Pattern completion and figure series, Embedded Figure and counting of figures, Cube & Dice, Paper cutting and folding, Data sufficiency, Course of Action, Critical Reasoning, Analytical and decision making	
III	Computer Basics: Block diagram of Digital Computer, Classification of Computers, Memory System, Primary storage, Auxiliary memory, Cache memory, Computer Software (System/Application Software), MS Word Basics: The word screen, Getting to word documents, typing and Revising text, Finding and Replacing, Editing and Proofing tools, Formatting text characters, Formatting Paragraph, Document templates., Page set up, tables, Mail Merge, Macros, protecting documents, printing a document. MS-Excel Introduction, Worksheet basics, Creating worksheet, Heading information, Data & Text, Date & Time, Alphanumeric values, Saving & quitting worksheet, Opening and moving around in an existing worksheet, Toolbars and Menus, Excel shortcut and function keys, Working with single and multiple workbook, Working with formulae & cell referencing, Auto sum, coping formulae, Absolute & relative addressing, Worksheet with ranges, Formatting of worksheet, Previewing & Printing worksheet, Graphs and charts, Database, Creating and using macros, Multiple worksheets-concepts Introduction of Open Source Applications: LibreOffice, OpenOffice and Google Docs etc.	
IV	Web Surfing: An Overview: working of Internet, Browsing the Internet, E-Mail, Components of E-Mail, Address Book, Troubleshooting in E-Mail, Browsers: Netscape Navigator, Microsoft Internet Explorer, Google Chrome, Mozilla Firefox, Tor, Search Engines like Google, DuckDuckGo etc, Visiting web sites: Downloading. Cyber Security: Introduction to Information System, Type of information system, CIA model of Information Characteristics, Introduction to Information Security, Need of Information Security, Cyber Security, phishing, spamming, fake news, general issues related to cyber security, Business need, Ethical and Professional issues of security.	

Suggested Readings:



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- Sharma, A., "How to prepare for Data Interpretation and Logical Reasoning for the CAT" McGraw Hill Education Pvt. Ltd., New Delhi, India, 2011, Ed. 5, ISBN 978 2007 070 481
- Aggarwal, R.S., "A Modern Approach to Verbal and Non-verbal Reasoning" S. Chand Publishers New Delhi, India, 2010, ISBN 10: 8121905516
- Madan, Sushila, Introduction to Essential tools, Jain Book Agency, New Delhi/India, 2009, 5th ed.
- Goel, Anita, Computer Fundamentals, Pearson Education, India, 2012
- Michael E. Whitman and Herbert J. Mattord, "Principles of Information Security," Sixth Edition, Cengage Learning, 2017




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Co-curricular course: Semester-6
Course Title: Communication Skills and Personality Development

Co-curricular Certificate course 'Communication Skills and Personality Development'

Programme: B.Sc.	Year: Third	Semester: Sixth
Co-Curricular Course		
Course Code: Z060601	Course Title: Communication Skills and Personality Development	
Course outcomes:		
• To understand the concept of Personality. • To learn what personal grooming pertains. • To learn to make good resume and prepare effectively for interview. • To learn to perform effectively in group discussions. • To explore communication beyond language. • To learn to manage oneself while communicating. • To acquire good communication skills and develop confidence.		
Credits: 2	Compulsory	
Max. Marks: 40+60	Min. Passing Marks:	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 2-0-0		

Unit	Topics	No. of Lectures Total=30
I	PERSONALITY AND PERSONAL GROOMING Understanding Personality - Definition and Meaning of Personality - Types of Personality - Components of Personality - Determinants of Personality - Assessment of Personality Grooming Self - Dress for success - Make up & skin care - Hair care & styles for formal look - Art of accessorizing - Oral Hygiene	
II	INTERVIEW PREPARATION AND GROUP DISCUSSION - Meaning and Types of Interview [Face to Face, Telephonic, Video] - Interview procedure [Opening, Listening, Closure] - Preparation for Interview - Resume Writing - LinkedIn Etiquette - Meaning and methods of Group Discussion - Procedure of Group Discussion. - Group Discussion simulation - Group discussion common error	
III	BODY LANGUAGE AND BEHAVIOUR - Concept of human behavior - Individual and group behavior - Developing Self-Awareness - Behaviour and body language - Dimensions of body language: Proxemics, Haptics, Oculistics, Paralanguage, Kinesics, Sign Language, Chromatics, Chronemics, Olfactics - Cultural differences in Body Language - Business Etiquette & Body language	

	• Body Language in the Post Corona Era • Virtual Meeting Etiquette • Social Media Etiquette	
IV	ART OF GOOD COMMUNICATION • Communication Process • Verbal and Non-verbal communication • 7 C's of effective communication • Barriers to communication • Paralinguistics: Pitch, Tone, Volume, Vocabulary, Word stress, Pause • Types of communication: Assertive, Aggressive, Passive Aggressive • Listening Skills • Questioning Skills • Art of Small Talk • Email Writing	

Suggested Readings:

1. Cloninger, S.C., "Theories of Personality : Understanding Person", Pearson, New York, 2008, 5th edition.
2. Luthans F, "Organizational Behaviour", McGraw Hill, New York, 2005, 12th edition.
3. Barron, R.A. & Brian D, "Social Psychology", Prentice Hall of India, 1998, 8th edition.
4. Adler R.B., Rodman G. & Hutchinson C.C., "Understanding Human Communication", Oxford University Press: New York, 2011.
5. Suggestive digital platforms web links

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11. Ordinance

This section records the Ordinance governing the B.Sc. (ZBC) programme, as applicable under the First Statutes of Future University and the relevant UGC Regulations, including provisions relating to eligibility for admission, duration of the programme, scheme of examination, promotion criteria, attendance requirements, and award of the degree.

The detailed Ordinance document, once finalised and approved by the Academic Council and the Board of Management, shall be appended to this file as a controlled document and updated periodically to reflect regulatory changes.

- Eligibility for Admission: As per the University's admission policy notified for the relevant academic session.
- Duration of the Programme: Three years (six semesters), extendable as per the Credit Framework and University norms for slow-paced learners.
- Attendance Requirement: A minimum of 75% attendance in each course is required to be eligible to appear in the end-semester examination, subject to condonation as per University rules.
- Promotion Criteria and Award of Degree: As per the Scheme of Examination and Evaluation approved by the Academic Council.




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12. Annexure

The following documents are annexed / to be annexed to this Board of Studies file for record and reference:

- Annexure I: Detailed practical/laboratory manual for each paper.
- Annexure II: List of reference books and text books recommended for each paper.
- Annexure III: Mapping of Course Outcomes (COs) to Programme Outcomes (POs)/Programme Educational Objectives (PEOs).
- Annexure IV: CVs/brief profiles of the external experts who attended the meeting.

These annexures shall be compiled and appended by the Dean's office prior to final submission of this file to the Academic Council.



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