Details of Generic Elective (GE) Courses

Generic Elective courses provide multidisciplinary or interdisciplinary education to students. Various GE courses will be offered which may be opted by students as listed below :

Details of Generic Elective (GE) Courses

GE COURSES (4 Credits each)		
COURSE CODE	**NAME OF THE COURSE**	**CREDITS T=Theory Credits P=Practical Credits**
POOL FOR ODD SEMESTER		
ALS BOT GE 01	Agricultural Botany and Weed Science	T=2 P=2
ALS BOT GE 02	Plant Quarantine and Seed Health Technology	T=2 P=2
ALS BOT GE 03	Plant Cell and Tissue Culture Techniques*	T=2 P=2
ALS BOT GE 04	Recombinant DNA Technology and Proteomics*	T=2 P=2
ALS CHEM GE 01	Bioinorganic Chemistry	T=2 P=2
ALS CHEM GE 02	Chemistry of Carbohydrates, Nucleic Acids and Lipids	T=2 P=2
ALS ZOO GE 01	Agricultural Pests of Crops**	T=2 P=2
ALS ZOO GE 02	Insect Vectors and Diseases	T=2 P=2
ALS ZOO GE 03	Techniques for Insect Collection, Rearing and Preservation	T=2 P=2
POOL FOR EVEN SEMESTER		
ALS BOT GE 05	Hydroponics and Organic Farming	T=2 P=2
ALS BOT GE 06	Informatics and Statistics for Biology and Allied Sciences*	T=2 P=2
ALS BOT GE 07	Genetically Modified Plants*	T=2 P=2
ALS CHEM GE 03	Chemistry of Amino acids, Proteins and Enzymes	T=2 P=2
ALS CHEM GE 04	Conductance and Chemical Kinetics	T=2 P=2
ALS ZOO GE 04	Animal Cell Culture Techniques	T=2 P=2
ALS ZOO GE 05	Locust and its management	T=2 P=2
ALS ZOO GE 06	Beneficial Insects and their Products**	T=2 P=2
ALS ZOO GE 07	Insect Ecology	T=2 P=2

***: Cannot be offered to students with some combinations of DSC/DSE/GE/SEC papers; **: Only for General Pool; Not offered for ALS-ACPM students.** In addition to the courses highlighted above, the selection of GE/SEC courses would be governed by the other combinations of DSC and DSE courses studied by the student to ensure that a student does not select courses with significant overlap in course contents.

SYLLABUS FOR UNDERGRADUATE PROGRAMME IN APPLIED LIFE SCIENCES WITH AGROCHEMICALS AND PEST MANAGEMENT

(BOTANY)

DISCIPLINE SPECIFIC CORE COURSE – 2

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Economic Botany ALS BOT DSC 02	**4**	**2**	**nil**	**2**	Class XII pass with Biology and Chemistry	NA

Learning Objectives:

The Learning Objectives of this course are as follows:

- To understand the economic importance of diverse plant species, identifying plants of economic importance through field visit, live plant specimens, herbarium specimens and digital resources.
- To understand the importance of various plant parts and their products used as food, fibres, medicines, oils and economically important products.
- To learn the processing of various economically important plant resources, identification and analysis of nutrients using simple microchemical tests.

Learning Outcomes:

By studying this course, students will be able to:

- acquire knowledge about the economic importance of plants, their products and their role in our daily lives.
- perform micro-chemical tests to study the presence of various biochemical constituents.
- explore the regional diversity of economically important plants.

SYLLABUS OF DSC-2

UNIT – I (1 Week)

Introduction and Origin of Cultivated Plants: Importance of Plant Resources; Vavilov's concept for the Origin of cultivated plants; Centers of Origin (Primary and Secondary); Centers of diversity, Harlan's concept of gene pools.

UNIT – II (2 Weeks)

Cereals: Wheat (Origin, Evolution of Wheat; (tetra&hexaploid), Morphology, Production, Cultivation and Economic importance of hexaploid wheat); Rice (Origin-Monophyletic and Polyphyletic, Production, Morphology, Cultivation, Comparison between *indica* and *japonica* Rice, Parboiling, Economic Importance); Millets, man-made cereal (*Triticale*) and Pseudocereals, Green revolution (briefly).

UNIT – III (1.5 Weeks)

Legumes: General account (Nutritive Value of Pulses, Protein Malnutrition, Lathyrism, Favism, Ecological Importance); Chick pea, and Groundnut (Production, Morphology and Economic Importance). Fodder legumes and green manure crops.

UNIT – IV (1.5 Weeks)

Sugars and Starches: Sugar-Different sources of sugar, Sugarcane (Morphology, Ratooning, Nobilization, Uses of products and by- products); Starch- sources, types of starch grain, Potato (Morphology, Tuber Anatomy, Seed Tubers vs True Potato Seeds and Economic uses).

UNIT – V (1.5 Weeks)

Spices, Condiments & Flavorings: General Account (Spices, Condiments, Culinary Herbs and Essences, with examples), Importance of Spices, Clove (Morphology, Anatomy of part used and Economic importance) and Black Pepper (Morphology, Anatomy of part used and Economic importance).

UNIT – VI (1 Week)

Beverages: Types of Beverages (Alcoholic and Non-Alcoholic) with examples, Tea and Coffee (Morphology, Varieties, Chemistry and Economic Importance).

UNIT – VII (1.5 Weeks)

Fibres and Fibre-yielding plants: Classification of Fibres based upon their Origin (surface fibres, bast fibres, and leaf fibres, with examples); Jute (morphology, extraction and economic importance), Cotton (*Gossypium* species, morphology and economic importance).

UNIT – VIII (1.5 Weeks)

Oil-Yielding Plants: Fatty Oils and Essential Oils, Comparison between Fatty Oils and Essential Oils; Fatty Oils (Classification with examples, Keeping quality), Coconut and Mustard (Morphology and Economic Importance); Essential Oils (General characteristics, and Economic Importance, with examples).

UNIT – IX (1 Week)

Medicinal and Drug-Yielding Plants: Brief Account of Therapeutic Drugs with Examples; Morphology, Chemical Constituents, Economic Importance of *Cinchona,Rauwolfia, Digitalis.*

UNIT – X(1 Week)

Fumigatory& Masticatory: Tobacco **(**Morphology, species - *Nicotiana tabacum* &*N. rustica*), Products, Economic Importance and Health Hazards).

UNIT – XI(0.5 Week)

Rubber: Para Rubber - *Hevea brasiliensis* (Morphology, Tapping of latex, Products and Economic Importance).

UNIT – XII(1 Week)

Vegetables and Fruits: General account with common examples.

Practical component –

1. **Cereals**: Wheat (Habit Sketch, L.S/T.S. grain, W.M. starch grains, Micro-chemical tests), Rice (Habit Sketch, Study of paddy and grain, W.M. starch grains, Micro-chemical tests).Millets (anyone) and Pseudocereals (any one) (specimens/digital resources and grains).
2. **Legumes**:Chickpea, Groundnut (Habit, Fruit, Seed structure, Micro-chemical tests).
3. **Sugars and Starches**:Sugarcane (Habit Sketch, Products and By-products, Cane Juice-Micro - chemical tests); Potato (Habit Sketch, Tuber morphology, T.S. tuber to show localization of starchgrains, W.M. starch grains, Micro-chemical tests).
4. **Spices**: Clove and Black pepper (Habit and sections L.S./T.S.).
5. **Beverages**: Tea (Plant specimen, Tea leaves), Coffee (Plant specimen, Beans).
6. **Fibres**:Jute (Specimens/digital resources of Jute, T.S. stem, Test for cellulose and lignin on section of stem and fibre). Cotton (Specimen, W.M. seed to show lint and fuzz; W.M. fibre, Test forcellulose).
7. **Vegetable Oil-Yielding Plants**:Fatty Oils: Coconut; Habit (photograph), Fruit, T.S. nut, Mustard; (Habit- specimen, seeds).
8. **Essential Oils:** Extraction methods (Specimen/ digital resources), Habit Sketch of Rose, Jasmine, *Vetiver* sp., (specimens/photographs).
9. **Drug-Yielding plants:**Habit - Fever Bark Tree, Poppy, Foxglove (Specimens/ Photographs).
10. **Fumigatory Material:** *Nicotiana sp.* (specimens/photographs), Tobacco Products.

11. **Rubber:** Para Rubber - Habit, Tapping of latex (Specimen/photograph), Rubber Products.

Essential/recommended readings

1. Kochhar, S.L. (2012). *Economic Botany in Tropics.* MacMillan & Co.
2. Kochhar, S.L. (2016). *Economic Botany – A Comprehensive Study* (5th Ed.). Cambridge University Press.
3. Wickens, G.E. (2001). *Economic Botany: Principles & Practices*. The Netherlands:Kluwer Academic Publishers.

Suggestive readings

1. Chrispeels, & M.J., Sadava, D.E. (1994). *Plants. Genes and Agriculture*. Jones & Bartlett-Publishers.
2. Berg L, (2008). *Introductory Botany: Plants, People, And the Environment*. Thomson Brooks/Cole.
3. Cook F.E.M. (1995). *Economic Botany: Data Collection*. Standard Royal Botanic Garden, Kew, Richmond.

- **Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.**

GENERIC ELECTIVE (GE-5)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Hydroponics and Organic Farming ALS BOT GE 05	**4**	**2**	**nil**	**2**	Class XII pass with Biology and Chemistry	NA

Learning Objectives

The Learning Outcomes of this course are as follows:

- to provide knowledge and expertise of various aspects of hydroponics, aeroponics and organic farming to the students.
- to become economically self-reliant by growing and marketing organic herbs, vegetables, micro greens and fruits.
- with various acts and regulations related to seeds.

Learning outcomes

By studying this course, students will:

- develop a thorough understanding of the concept of Hydroponics, Aeroponics and Organic farming.
- be trained in establishing a hydroponic facility. Students will learn the development of various organic products such as biopesticides, biofertilizers and bio-growth promoters.
- be able to understand and explain various government policies in marketing of hydroponic and organic produce.
- Understand and apply Good Agricultural Practices associated with protected agriculture.

SYLLABUS OF GE-5

UNIT – I (1 Week)

Introduction to Protected Agriculture: Types of Protected Agriculture (hydroponics, aquaponics and organic farming), definition history, terminology, importance and advantages over traditional agriculture, limitations and challenges.

UNIT – II (2.5 Weeks)

Plant Growth Requirements and Media formulations: Physical parameters - light (quality and quantity) artificial light, light balancers; pH, conductivity, salinity (Dissolved Oxygen - DO, Total Dissolved Solid - TDS) and temperature; Chemical parameters - mineral nutrient requirements, deficiencies, toxicities, growth regulators (auxins, gibberellins, cytokinins and abscisic acids); Growth media - types, properties, uses, nutrient formulae, preparation of solutions, solid Media and nutrient film.

UNIT – III (3.5 Weeks)

Hydroponic growing systems: Basic concepts and designs (closed and open systems techniques Nutrient Film Technique (NFT), Deep Water Culture (DWC), Dutch Bucket and other small-scale systems), Systems layout, Strengths and weaknesses of various systems, site considerations, componentry, nutrient delivery, pumping, Principles of aeroponics.

UNIT – IV (2 Weeks)

Hydroponics associated pest and diseases: Hydroponics associated pests - mites, thrips, whiteflies, leaf miners; Identification and management of diseases-bacterial, fungal and viral diseases; safety practices (Good Agricultural Practices (GAP) and Integrated Pest Management (IPM).

UNIT – V (4 Weeks)

Organic farming and its management: Introduction to Organic farming and associated management practices (nutritional requirements, pest, diseases, weeds); use of biofertilizers, biopesticides, bioherbicides, biocontrol agents (plant growth promoting rhizobacteria (PGPR), pheromone trapping, *Trichoderma*, *Pseudomonas*, neem oil, garlic etc.) in management, Different concepts of organic farming – Natural farming, Biodynamic farming, Permaculture and Zero Budget Farming

UNIT – VI (2 Weeks)

Produce Marketing and Policies Marketing of the produce, Government institutes and policies related to protected farming (hydroponics and organic farming).

Practical component-

1. Study of various instruments used in hydroponics.
2. Preparation of growth media for hydroponics.
3. Estimation of NPK, DO, TDS, pH of growing media
4. Study of techniques used in hydroponics (Circulating methods such as Nutrient Film Technique (NFT), Deep Flow Technique (DFT), Dutch bucket; Non circulating methods such as Root dipping, Floating, Capillary action; Aeroponics such as root mist and fog feed techniques.
5. Demonstration of construction of a sustainable hydroponic unit.
6. Perform rapid tests for estimation of NPK in different soil samples (at least three).
7. Bulk density and porosity of soilless media e.g., coco-peat, perlite, vermiculite, expanded clay, rockwool (any two media).
8. Study of suitable conditions for Hydroponics - quality, light intensity, photoperiod and temperature.
9. Demonstration of growing a leafy vegetable/ fruity vegetable/ medicinal herb/aromatic plant in Hydroponics solution.
10. Study of traditional organic inputs and formulation of biofertilizer.
11. Preparation of biopesticides, plant health promoters like *Panchgavya, Beejamrut*etc.

12. Field visit to organic farm/hydroponic farm and submission of visit report.

Essential/recommended readings

1. Schwarz, M. (1995). *Soilless Culture Management*, *Advanced Series in AgriculturalSciences* (vol. 24). Springer, Berlin, Heidelberg.

2. Hasan, M., Sabir, N., Singh, A.K., Singh, M.C., Patel, N., Khanna, M., Rai, T., &Pragnya, P. (2018). *Hydroponics Technology for Horticultural Crops*. Tech. Bull.TB-ICN188/2018. Publ. by I.A.R.I.

3. Misra S., Misra S., &Misra R.L. (2017). *Soilless Crop production*. Daya PublishingHouse, Astral International (P) Ltd.

4. Palaniappan S. P., & Annadurai K. (2018). *Organic Farming: Theory & Practice*.Scientific Publisher.

5. Goddek, S., Joyce, A., Kotzen, B., & Burnell, G.M. (2019). *Aquaponics FoodProduction Systems*. Springer, Cham.

Suggestive readings

1. Jones, J. B. (2014). *Complete Guide for Growing Plants Hydroponically*. CRC Press.
2. Vayas, S.C, Vayas, S., Modi, H.A. (1998). *Bio-fertilizers and organic Farming*. AktaPrakashan.
3. Jones, J. Benton (2005). *Hydroponics: A Practical Guide for the Soilless Grower* (4thEdition). CRC Press.
4. Roberto, K. (2003). *How to Hydroponics* (4th Ed.). The Future Garden press.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

GENERIC ELECTIVE (GE-6)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Informatics and Statistics for Biology and Allied Sciences ALS BOT GE 06	**4**	**2**	**nil**	**2**	Class XII pass with Biology and Chemistry	NA

Learning Objectives

The Learning Outcomes of this course are as follows:

- to build an understanding *insilico*/computational approaches in various aspects of understanding biology and biological research.
- to build analytical skills and integrate the principles of statistical analyses for robust interpretation of biological observations.

Learning outcomes

By studying this course, students will be able to:

- learn the basics of bioinformatics and develop awareness of the interdisciplinary nature of this field.
- learn about biological databases, and perform sequence retrieval, alignment, and phylogenetic analysis using various tools.
- Understand and apply the basic concepts of sampling methods, data classification, presentation and statistical analysis.

SYLLABUS OF GE-6

UNIT – I (1.5 Weeks)

Introduction to Bioinformatics: Historical background, Aims and scope, bioinformatics in Genomics, Transcriptomics, Proteomics, Metabolomics, Systems biology and drug discovery, Applications and Limitations in bioinformatics.

UNIT – II (2 Weeks)

Biological databases: Introduction to biological databases - Primary, secondary and composite databases. Study of following databases: NCBI (GenBank, PubChem, PubMed and its tools (BLAST)), introduction to EMBL, DDBJ, UniProt, PDB and KEGG.

UNIT – III (2 Weeks)

Basic concepts of Sequence alignment: Similarity, identity and homology. Concepts of alignment (gaps and penalty); Alignment – pairwise and multiple sequence alignments.

UNIT – IV (2 Weeks)

Molecular Phylogeny: Introduction to Molecular Phylogeny, methods of construction of phylogenetic trees: maximum parsimony (MP), maximum likelihood (ML) and distance (Neighbour-joining) methods.

UNIT – V (1 Week)

Biostatistics: Biostatistics – definition, Basics of descriptive and inferential statistics; Limitations and applications of biostatistics.

UNIT – VI (1.5 Weeks)

Data types and presentation: Primary and secondary data; Sampling methods (in brief); tabulation and presentation of data.

UNIT – VII (2 Weeks)

Descriptive Statistics: Measures of central tendency - mean, median, and mode; Measures of dispersion - range, standard deviation, and standard error.

UNIT – VIII (1.5 Weeks)

Correlation and Regression Types and methods of correlation, Introduction to simple regression equation; similarities and dissimilarities between correlation and regression.

UNIT – IX (1.5 Weeks)

Statistical inference: Hypothesis – (simple hypothesis), student's t test, chi-square test.

(Note: Numerical based questions of unit 7, 8 and 9 should be covered only in practical)

Practical component-

1. Biological databases (NCBI, EMBL, UniProt, PDB)
2. Literature retrieval from PubMed
3. Sequence retrieval (protein and gene) from NCBI (formats - FASTA, GenBank and GenPept formats)
4. Protein Structure retrieval from PDB (in pdb format) and visualization by viewing tools (Ras Mol/ J mol/Mol*/Swiss 3D Viewer/Pymol)
5. Multiple sequence alignment (MEGA/Clustal omega)
6. Construction of phylogenetic tree (PHYLIP/ MEGA/ Clustal omega).
7. Making of Bar diagrams, Pie chart, Histogram, Frequency polygon, Cumulative frequency curve (any four) in the given data set using Microsoft Excel
8. Calculation of mean, mode, median, standard deviation and standard error (through manual calculation and using Microsoft Excel) (use only ungrouped data)
9. Calculation of correlation coefficient values by Karl Pearson's /Spearman Rank methods (through manual calculation and using Microsoft Excel)
10. Student's t-test (using Microsoft Excel only), chi square test (Manual and using Microsoft Excel).

Essential/recommended readings

1. Ghosh, Z., & Mallick, B. (2008). *Bioinformatics – Principles and Applications* (1st ed.). Oxford University Press.
2. Baxevanis, A.D., Ouellette, B.F., John (2005). *Bioinformatics: A Practical Guide to theAnalysis of Genes and Proteins* (3rd ed.). Wiley & Sons, Inc.

3. Roy, D. (2009). *B* (1st ed.). Narosa Publishing House.
4. Andreas, D. Baxevanis& B.F. Francis Ouellette. (2004). *Bioinformatics: A practicalguide to the analysis of genes and proteins* (3rd ed.). John Wiley and Sons.
5. Khan, I.A., & Khanum, A. (2004). Fundamentals of Biostatistics (5th ed.). Ukaazpublications.
6. Campbell, R.C. (1998). *Statistics for Biologists*. Cambridge University Press.

Suggestive readings

1. Pevsner, J. (2009). *Bioinformatics and Functional Genomics* (2nd ed.). Wiley Blackwell.
2. Xiong, J. (2006). *Essential Bioinformatics* (1st ed.). Cambridge University Press.
3. Mount, D.W. (2004). *Bioinformatics: Sequence and Genome analysis* (2nd ed.). ColdSpring Harbor Laboratory Press, USA.
4. Zar, J.H. (2012). *Biostatistical Analysis* (4th ed.). Pearson Publication.
5. Pandey, M. (2015). *Biostatistics Basic and Advanced*. M V Learning.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

GENERIC ELECTIVE (GE-7)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		

Genetically Modified Plants ALS BOT GE 07	**4**	**2**	**nil**	**2**	Class XII pass with Biology and Chemistry	NA

Learning Objectives

The Learning Outcomes of this course are as follows:

- to illustrate the use of modern techniques for genome analysis and manipulation
- to understand the strategies involved and the need for developing transgenic crops
- to gain knowledge about biosafety and ethical concerns associated with Genetically Modified DNA.
- to train in strategizing research topics employing genetic engineering techniques.

Learning outcomes

By studying this course, students will be able to:

- know about the commercial application of Genetically Modified Plants in research, agriculture and human health.
- learn about modern techniques involved in the manipulation of nucleic acids and creation of genetically modified organisms (GMOs).
- explain the applications of PCR, hybridization techniques and sequencing.
- understand about the biosafety and ethical issues associated with Genetic engineering.
- design and conduct experiments involving genetic manipulation of plants.

SYLLABUS OF GE-7

UNIT – I (1 Week)

Introduction to Transgenics: First and Second-generation transgenic crops. Terminology: Transgenics, Transgene, Genetic transformation, recombinant DNA,

Putative Transgenic, Stable gene integration. Gene Construct. Introduction to selectable marker (*npt II, hpt, spt*) and reporter (*GUS, GFP* and Luciferase) genes.

UNIT – II (5 Weeks)

Gene Isolation and Genetic Transformation: Methods for gene isolation - Direct selection, construction and screening of genomic and cDNA libraries (Replica plating, Complementation screening, heterologous gene probe-based hybridizations); Gene transfer methods - Direct (*Agrobacterium* mediated transformation, molecular basis of T-DNA transfer); Indirect methods (Electroporation, Microinjection and Particle Bombardment). Screening for putative transgenics through PCR and Southern blotting. Gene expression analyses at transcriptional level (Northern blotting, DNA microarrays) and translational level (Western blotting, ELISA). Generation of marker-free transgenics. Chloroplast transformation.

UNIT – III (4.5 Weeks)

Transgenics for Resistance to Biotic and Abiotic Stress Biotic stress - Strategies for developing Insect resistant plants (Bt toxin, protease inhibitor, *α-amylase* inhibitor and other protein genes), Virus resistant plants (Coat protein mediated protection, Pokeweed antiviral protein, *RNaseIII*, micro-RNA and other viral genes), Fungal and Bacterial disease resistant plants (Genes for PR proteins like *Chitanase*, β-1,3 *Glucanase*, Thaumatin like, Osmotin; Antimicrobial proteins like Ribosome Inactivating Proteins, Lectins, Lysozyme; Phytoalexins etc.); Abiotic Stress - Strategies for overcoming Oxidative, Salt & Drought, Chilling stress through transgenics approach. Herbicide Resistance- Strategies, Roundup Ready Soybean.

UNIT – IV (1.5 Weeks)

Transgenics for Improved Quality and Other Traits: Engineering for shelf-life (Antisense *Polygalacturanase* gene, *SAM hydrolase*) and nutritional quality (β-

carotene production). Transgenics as bioreactor - plantibodies and edible vaccines. Biodegradable Plastics.

UNIT – V (3 Weeks)

Safety and Ethical Issues: Field testing and commercialization, Rules and Regulations for handling rDNA/ GMOs, Terminator technology, Ethics: Impact and safety, moral, social, regulatory & ethical issues.

Practical component-

1. Isolation of plasmid DNA from bacteria
2. Isolation of genomic DNA from plant (Cauliflower head/ *Brassica* seedlings)
3. Preparation of competent cells in *E. coli*.
4. Transformation of *E. coli* cell by $CaCl_2$ method and calculation of transformation efficiency.
5. Restricting Mapping of linear and circular DNA.
7. Study of direct and indirect gene transfer methods by photographs: Electroporation, Microinjection and Particle Bombardment, Ti-plasmid mediated gene transfer
8. Study of techniques using digital resources/ demonstration: PCR, Southern, Northern and Western blotting, ELISA, DNA Microarray.
9. Study of Sequencing techniques (Whole Genome Shot Gun Approach, Clone by Clone Sequencing, Sanger's Dideoxy Sequencing) through digital resources.
10. Study of Genetically Modified Plants using digital resources: Bt-Cotton, Golden rice, Flavr Savr tomato, Round-up Ready Soybean
11. Visit to a research laboratory/field.

Essential/recommended readings

1. Brown, T. A. (2016) *Gene Cloning and Analysis: An Introduction.* Wiley-BlackwellPublishing.

2. Chrispeels M.J., &Sadava D. E. (1994). *Plants, Genes and Agriculture.* Jones andBartlett Publishers.
3. Glick B.R., & Patten C.L. (2022). *Molecular Biotechnology: Principles & Applications of Recombinant DNA* (6th Ed.). ASM Press.
4. Green, M.R., & Sambrook, J. (2012). *Molecular Cloning: A Laboratory Manual*(4th Ed.). ColdSpring Harbor.
5. Wink, M. (2011). *An Introduction to Molecular Biotechnology: MolecularFundamentals, Methodsand Applications in Modern Biotechnology* (2nd Ed.).Wiley.
6. Primrose, S. B., & Twyman, R. (2009). *Principles of gene manipulation and genomics.*Wiley.
7. Howe, C. J. (2007). *Gene cloning and manipulation.* Cambridge University Press.

Suggestive readings

1. Primrose, S. B., & Twyman, R. (2006) *Principles of Gene Manipulation and Genomics* (7th ed.). Wiley-Blackwell.
2. Dale J. W., Schantz M. V. and Plant N. (2011) *From Genes to Genomes: Concepts and Applications of DNA Technology.* John Wiley & Sons.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

SYLLABUS FOR UNDERGRADUATE PROGRAMME IN APPLIED LIFE SCIENCES WITH AGROCHEMICALS AND PEST MANAGEMENT

(CHEMISTRY)

DISCIPLINE SPECIFIC CORE COURSE – 2:

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Soil Fertility, Fertilizers and Micronutrients; ALS CHEM DSC-2	**4**	**2**	**nil**	**2**	Class XII pass with Biology and Chemistry	NA

Learning Objectives:

The Learning Objectives of this course are as follows:

- To make students aware of different types of soils, soil composition and soil fertility.
- To provide an understanding of the role of different plant nutrients, as soil is the natural resource for many nutrients which are required during the growth and development of plants.
- To familiarize students to fertilizers and their use as supplementary nutrients, as they contribute to the healthy growth of the plants.

Learning Outcomes:

By studying this course, students will be able to:

- Understand and explain about the different types of soils, soil composition and important physical properties of soil.
- Know the importance and use of different fertilizers and apply this knowledge for agriculture to get better crop productivity.

SYLLABUS OF DSC-2

Unit- 1(3 Weeks)

Nature, origin, composition, and types of soil. Chemistry of weathering of soils and clay minerals. Soil acidity, salinity, and alkalinity. Liming of soil. Introduction to soil fertility and productivity. Factors affecting soil fertility and productivity. Organic matter (OM), Cation exchange capacity (CEC), Anion exchange capacity (AEC) of agricultural soils.

Unit- 2 (4 Weeks)

Plant nutrients- Definition, classification of nutrients as: Primary nutrients, Secondary nutrients, Macronutrients (N, P, K, Ca, Mg, S) and Micronutrients (Cl, Fe, B, Mn, Zn, Cu, Mo, Ni): Properties, uses and deficiency symptoms of nutrients. Definition and uses of beneficiary elements (Co, Na, Si, Se and V). Nitrogen cycle, Nitrification, denitrification, and ammonification.

Unit- 3 (6 Weeks)

Functions and forms of Nitrogen, Phosphorous and Potassium in plants. Available nitrogen, phosphorous and potassium in fertilizers.

Nitrogen fertilizers: Urea, ammonium nitrate, calcium ammonium nitrate, sodium nitrate, ammonium chloride and their uses. Slow-release fertilizers. Neem coated urea (NCU) Sulphur coated urea (SCU) and polymer coated urea (PCU). Manufacturing of urea by Haber-Bosch process. Synthesis of ammonium nitrate, calcium ammonium nitrate, sodium nitrate and ammonium chloride.

Phosphorous fertilizers: Rock phosphate, Bone meal, basic slag, super phosphate of lime, single super phosphate, triple super phosphate, ammonium phosphates: manufacturing and uses.

Potassium fertilizers: Potassium nitrate, potassium chloride, potassium sulphate: synthesis and uses.

Unit-4 (2 Weeks)

Complex fertilizers and Mixed fertilizers. Advantages of NPK fertilizers. Introduction to Organic Manures and Biofertilizers, Residual effect of Fertilizers and impact on Environment.

Practical component(15 Weeks)

1. To determine soil texture by different size of sieves.
2. To determine moisture content in given soil sample.

3. To determine bulk density of given soil sample.
4. To determine water retention capacity of soil sample.
5. Estimation of organic matter in given soil sample volumetrically.
6. Qualitative estimation of nitrogen, phosphorous, potassium and calcium carbonate in given soil sample.
7. Determination of conductivity of given soil sample.
8. Determination of acidity of soil using pH meter.
9. To determine the phenolphthalein alkalinity and total alkalinity of given soil sample volumetrically.
10. To determine total phosphate in given fertilizer sample volumetrically.
11. Qualitative analysis for the type of fertilizer in a given sample.
12. To determine concentration of nitrate, ammonia and phosphate by spectrophotometer with the help of calibration curve.

Essential/recommended readings

1 Havlin, J. L., Tisdale, S. L., Nelson, W. L., & Beaton, J. D. (2016). *Soil fertility andfertilizers*. Pearson Education India.

2 Gupta A. K., & Varshney M. L. (2007). *Practical manual for Agriculture Chemistry*. Kalyani Publishers Pvt. Ltd., New Delhi.

3. Handbook of agriculture. Indian Council of Agricultural Research.

4. Yawalker, K.S., Agrawal, J.P., & Bokde, S. (1992). Manures and Fertilizers. Agri-Horticultural Publishing House, Nagpur (Maharashtra).

Suggestive readings

1. Tandon, H.L.S. (2008). *Fertilizers and Their Composition, Characteristics, Quality,Transformations and Applications*. Fertiliser DevelopmentConsultationOrganisation.
2. Langdon R., Elsworth, Paley, &W.O., Nova. (2008).*Fertilizers: Properties,Applications andEffects*. Science Pub.
3. Chopra, S. L., & Kanwar, J. S. (1976). *Analytical Agricultural Chemistry*. Kalyani Publishers.
4. Das, P. C., (2015). *Manures and fertilizers*. Kalyani Publishers Pvt. Ltd.
5. Nagornny, V. D., & Raghav, J. S. (2015). *Soil Fertility Management*. Kalyani Publishers Pvt.Ltd.

6. Snyder H. (2008). *The Chemistryof soils and Fertilizers*. Easton, Pa., The Chemical PublishingCo.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

GENERIC ELECTIVE – 3:

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Chemistry of Amino acids, Proteins and Enzymes; ALS CHEM GE - 3	**4**	**2**	**nil**	**2**	Class XII pass with Biology and Chemistry	NA

Learning Objectives:

The Learning Objectives of this course are as follows:

- To deliver information about biochemically significant features of the chemistry of peptides, proteins, enzymes by using suitable examples.
- To provide knowledge about classification, reaction chemistry and biological importance of these biomolecules.
- To extend the knowledge gained from synthetic organic chemistry to chemistry of biomolecules.
- To make students understand the structural principles that govern reactivity/physical /biological properties of biomolecules as opposed to learning structural detail.
- To build the concept of metabolism by the study of chemistry and energetics of biological system.

Learning Outcomes:

By studying this course, students will be able to:

- Understand and explain the structure of biomolecules (proteins, enzymes), their chemical properties, reactivity and biological uses.
- Gain an insight into mechanism of enzyme action and inhibition.

- Understand the basic principles of drug-receptor interaction and SAR.
- Understand the concept of metabolism and metabolic processes through specific examples.

SYLLABUS OF GE-3

Unit -1: Amino acids, Peptides & Proteins(6 Weeks)

Amino Acids and Peptides -Zwitterion, isoelectric point and electrophoresis. Preparation of amino acids: Strecker synthesis and using Gabriel's phthalimide synthesis. Reactions of amino acids: ester of –COOH group, acetylation of $–NH_2$ group, complexation with Cu^{2+} ions, ninhydrin test.

Determination of the primary structure of peptides by degradation Edman degradation (N-terminal) and C– terminal (thiohydantoin and with carboxypeptidase enzyme).

Synthesis of simple peptides (up to dipeptides) by N-protection (*t*-butyloxycarbonyl and phthaloyl) & C-activating groups and Merrifield solid-phase synthesis. An Overview of primary, secondary, tertiary and quaternary structure of proteins.

Unit-2: Enzymes(4 Weeks)

Classification of enzymes and their uses (mention ribozymes). Mechanism of enzyme action, factors affecting enzyme action, coenzymes and cofactors and their role in biological reactions, specificity of enzyme action (including stereo-specificity), enzyme inhibitors and their importance, and the phenomenon of inhibition (competitive and non-competitive inhibition including allosteric inhibition). Drug action-receptor theory. Structure – activity relationships of drug molecules, binding role of –OH group, $-NH_2$ group, double bond and aromatic ring.

Unit- 3: Concept of Energy in Biosystems (5 Weeks)

Cells obtain energy by the oxidation of foodstuff (organic molecules). Introduction to metabolism (catabolism, anabolism). ATP: The universal currency of cellular energy, ATP hydrolysis and free energy change. Agents for transfer of electrons in biological redox systems: NAD+, FAD. Conversion of food to energy: Outline of catabolic pathways of carbohydrate-glycolysis, fermentation, Krebs cycle. The caloric value of food, the standard caloric content of food types.

Practical component (15 Weeks)

1. Qualitative tests for amino acids and proteins.
2. Separation and identification of mixture of amino acids by paper chromatography.
3. Study the action of salivary amylase on starch under optimum conditions and determine the enzyme activity.
4. Study the effect of temperature and pH on the activity of salivary amylase.
5. Isolation of casein from milk.
6. Estimation of protein by Lowry's method.
7. To study the effect of concentration, temperature and pH on the activity of catalase.
8. Estimation of glycine by Sorensen's method.
9. To study the titration curve of glycine and determine the isoelectric point of glycine.

Essential/recommended readings

1. Lubert Stryer, Jeremy Berg, John Tymoczko, & Gregory Gatto. (2019). *Biochemistry* (9thed.). W.H. Freeman.
2. Lehninger, A. L., & Nelson, D. L. (2009). *Principles of biochemistry*. W. H. Freeman.
3. Finar, I. L. (2007). *Organic chemistry* (Vol 1 & 2). Pearson education.
4. Mehta, B., & Mehta, M. (2015). *Organic Chemistry* (2nd ed.). PHI Learning Pvt. Ltd.
5. T. W. Graham Solomons, Craig B. Fryhle, & Scott A. Snyder. (2013). *Solomons's Organic Chemistry*(7th ed.). Pearson Education India.
6. Ghatak, K. L. (2014). *A textbook of organic chemistry and problem analysis*. PHI Learning.

Suggestive readings

1. Dean, J. R., Jones A.M, Holmes, D., & Reed, R. (2011). *Practical Skills in chemistry*. Prentice-Hall.
2. Wilson, K., & Walker, J. M. (2000). *Principles and techniques of practical biochemistry*. Cambridge University Press.
3. Varley, Harold., Gowenlock, A. H., McMurray, J. R., McLauchlan, D. M., & Varley, Harold. (1988). *Varley's practical clinical biochemistry*. CRC Press.
4. Mann, F. G., & Saunders, B. C. (2009). *Practical organic chemistry*. Pearson Education.

5. Pasricha, S., & Chaudhary, A. (2021). *Practical Organic Chemistry* (Volume II). IK International Publishing House Pvt. Ltd.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

GENERIC ELECTIVE– 4:

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Conductance and Chemical Kinetics; ALS CHEM GE-4	**4**	**2**	**nil**	**2**	Class XII pass with Biology and Chemistry	NA

Learning Objectives:

The Learning Objectives of this course are as follows:

- To impart the knowledge about electrochemical cells like electrolytic and galvanic cells.
- To provide a detailed understanding about the measurement of conductance, emf and their applications.
- To help the students to understand the kinetics of chemical reaction, activation energy and theories of reaction rates.

Learning Outcomes:

By studying this course, students will be able to:

- Explain the factors that affect conductance, migration of ions and application of conductance measurement.
- Understand different types of galvanic cells, their Nernst equations, measurement of emf, thermodynamic properties and other parameters from the emf measurements.
- Understand the concept of rate laws e.g., order, molecularity, half-life, and their determination.

SYLLABUS OF GE-4

Unit –1:Conductance (4 Weeks)

Conductivity, equivalent and molar conductivity, and their variation with dilution for weak and strong electrolytes, Kohlrausch Law of independent migration of ions, Transference number, Ionic mobility, applications of conductance measurements: determination of degree of ionization of weak electrolytes, solubility and solubility products of sparingly soluble salts, ionic product of water, hydrolysis constant of a salt. Conductometric titrations (only acid-base).

Unit–2: Electrochemistry(5 Weeks)

Reversible and irreversible cells, concept of EMF of a cell, measurement of EMF of a cell, Nernst equation and its importance, types of electrodes, Standard electrode potential, Electrochemical series. Thermodynamics of a reversible cell, calculation of thermodynamic properties: G, H and S from EMF data. Calculation of equilibrium constant from EMF data, Liquid junction potential and salt bridge, pH determination using hydrogen electrode and quinhydrone electrode.

Unit 3 : Chemical Kinetics(6 Weeks)

The concept of reaction rates, effect of temperature, pressure, catalyst and other factors on reaction rates. Order and molecularity of a reaction, derivation of integrated rate equations for zero, first and second order reactions (for equal concentrations of reactants), half–life of a reaction, general methods for determination of order of a reaction, Concept of activation energy and its calculation from Arrhenius equation.

Practical component (15 Weeks)

Conductance

1. Determination of cell constant.
2. Determination of equivalent conductance, degree of dissociation and dissociationconstant of a weak acid.
3. Perform Conductometric titrations:
   (a) Strong acid vs strong base
   (b) Weak acid vs strong base.

Potentiometry

1. Perform the potentiometric titrations of
   (a) Strong acid vs strong base and

(b) Weak acid vs strong base

Chemical Kinetics

1. Study the kinetics of the following reactions by integrated rate method:
   (a) Acid hydrolysis of methyl acetate with hydrochloric acid.
   (b) Compare the strength of HCl and H_2SO_4 by studying the kinetics of hydrolysis of methyl acetate.

Essential/recommended readings

1. Castellan, G. W. (2004). *Physical Chemistry*(Vol.). Narosa.
2. Kapoor, K. L. (2015). *A Textbook of Physical Chemistry* (6th ED., Vol. 1). McGraw Hill Education.
3. Kapoor, K. L. (2013). *A Textbook of Physical Chemistry*(3rd ed., Vol. 3). McGraw Hill Education.

Suggestive readings

1. Puri,B.R., Sharma,L.R., & M.S.Pathania. (2017). *Principles of Physical Chemistry*. Vishal Publishing Co.
2. Khosla, B. D., Garg, V. C., & Gulati A. (2015). *Senior Practical Physical Chemistry*. R. Chand & Co.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

SYLLABUS FOR UNDERGRADUATE PROGRAMME IN APPLIED LIFE SCIENCES WITH AGROCHEMICALS AND PEST MANAGEMENT

(ZOOLOGY)

DISCIPLINE SPECIFIC CORE COURSE – 2:

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Entomology ALS ZOO DSC 02	**4**	**2**	**nil**	**2**	Class XII pass with Biology and Chemistry	NA

Learning Objectives:

Learning objectives of this course are as follows:

- The course will give knowledge of the diversity of insects.
- It will impart knowledge about the morphology, anatomy and physiology of the insects.
- It will correlate the structural organization in different groups of insects with respect to the niche they occupy.

Learning Outcomes:

By studying this course, students will be able to:

- identify and classify insects up to orders.
- learn the methods of collection, preservation and rearing of insects.
- learn about the anatomy and physiology of various organ systems in insects.

- understand the concept of insect metamorphosis.

SYLLABUS OF DSC-2

Unit 1(3.5 Weeks)

Taxonomy: Salient features of insects, Basis of insect classification; Outline of insect classification upto orders, Characteristics of economically important orders.

Unit 2(6 Weeks)

Morphology of insects: Segmentation in insects; Head: typical structure of head, types of head, Antenna: typical structure, modification in antennae, types of mouth parts (Biting and chewing, sponging, piercing and sucking, siphoning and lapping), Compound eyes: structure of ommatidium, superposition and appositional images,Thoracic structures: Legs: typical structure of legs, modification in legs, modification in wings, veinations, coupling mechanisms.

Unit 3(3.5 Weeks)

Physiology of insects: Physiology of digestion, excretion, respiration, circulation, sense organs (mechano and chemoreceptors).

Unit 4(2 Weeks)

Reproduction and Development: Embryonic and post-embryonic development; Types of metamorphosis, Parthenogenesis

Practical component -

1. Collection, dry mounting, labelling and preservation of insects.
2. Study of mouth parts: biting and chewing, sponging, piercing and sucking, siphoning and lapping type through slides/ photographs.
3. Study of different types of wings, legs and antennae through slides/ photograph of insects.
4. Study of one insect from each economically important order (Thysanura, Odonata, Orthoptera, Dermaptera, Isoptera, Hemiptera, Thysanoptera, Lepidoptera, Diptera, Siphonaptera, Hymenoptera, Coleoptera and Strepsiptera) through specimens/ photographs.
5. Visit to Entomology Division IARI, Pusa, New Delhi.
6. Submission of project report on the basis of Field/Lab visit.

Essential/recommended readings

1. Imms, A. D. (1977) A General Text Book of Entomology. Chapman & Hall, UK.

2. Chapman, R. F. (1998) The insects: Structure and Function. Cambridge University Press, UK.
3. Atwal, A.S. (1993) Agricultural Pests of India and South East Asia. Kalyani Publishers, NewDelhi.
4. Dennis, S. Hill. (2005) Agricultural Insect Pests of the Tropics and Their Management, Cambridge University Press

Suggestive readings

1. David, B.V. and Ananthakrishnan, T.N. (2004) General and Applied Entomology. Tata-McGraw Hill, New Delhi.
2. Duntson, P.A. (2004) The insects: Structure, Function and Biodiversity. Kalyani Publishers, New Delhi.
3. Wigglesworth, V.B. (1984) Insect Physiology. VIII Edition, Chapman & Hall, NewYork.

E contents:

https://swayam.gov/appliedentomology.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

GENERIC ELECTIVE – 4:

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Animal Cell Culture techniques ALS ZOO GE 04	**4**	**2**	**nil**	**2**	Class XII pass with Biology and Chemistry	NA

Learning Objectives:

The learning objectives of this course are as follows:

- The aim of this course is to give knowledge about cell and tissue culture technology.
- The course will provide training to set up a tissue culture lab.

Learning Outcomes:

By studying this course, students will be able to:

- acquire the expertise to set up animal cell culture laboratory.
- They will learn about the maintenance and manipulation of animal cells *in vitro*.

SYLLABUS OF GE-04

Theory:

Unit 1(2Weeks)

Introduction to animal cell culture; Historical background, Biology of animal cell and cell-cell interactions, good laboratory practices, Sterilization methods and techniques.

Unit 2(4 Weeks)

Equipment: Laminar-Flow Hood, Autoclave, Inverted Microscope, Centrifuge, Haemocytometer, Humidified CO_2 incubator, Cryostorage Container.

Media and Buffers: Types of culture media, Physicochemical characteristics of medium - pH, O_2 CO_2 and Bicarbonate buffering, Osmolality, Temperature, Viscosity and Surface Tension. Importance of Serum and Serum-free media, Balanced salt solutions, Antibiotics and other supplements.

Unit 3 (5 Weeks)

Tissue Culture: Primary Cell Culture- Isolation of the tissue, Initiation of culture: Types of primary culture. Subculture and cell lines; culture of tumor cells, principles of cryopreservation of cell lines. *in vitro* transfection of animal cells-chemical method, lipid mediated gene transfer (lipofection), Electroporation. Microbial contaminants (Bacteria, Yeast, Fungi, Mycoplasma and Virus) in cell line.

Unit 4(4 Weeks)

Applications of Animal Cell Culture**:** Toxicology studies, Vaccine production, Gene therapy, Stem cell therapy, Production of recombinant proteins, Cancer Research.

Practical component -

1. Packing and sterilization of glassware and plastic ware for cell culture.
2. Study of different sterilization techniques used in cell culture laboratory.
3. Preparation and sterilization of culture medium, buffers and solutions.
4. Sub-culturing of cell lines.
5. Counting of cells in given cell line sample using hemocytometer.
6. To study about cytotoxicity and cell viability.
7. Demonstration of transfection in cell lines using Photographs/Videos.
8. Demonstration of working of the following instruments:
   i) Laminar Flow Hood ii) Autoclave iii) Humidified CO_2 Incubator iv) pH Meter.
9. Project report on visit to animal cell culture labs

Essential/recommended readings

1. Freshney, R. IAN. (2021). *Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications* (8th Ed.).
2. Masters, John. R. W. (2000). *Animal Cell Culture: A Practical Approach* (3rd Ed.).
3. Butler, M. (2003). *Animal Cell Culture and Technology.* (2nd Ed.).

Suggestive readings

4. Davis, John. M. (2011). *Animal Cell Culture: Essential Methods*.

5. Bhatt, Sheelendra. M. (2011). *Animal Cell Culture: Concept and Application.*

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

GENERIC ELECTIVE – 5:

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Locust and its management ALS ZOO GE 05	**4**	**2**	**nil**	**2**	Class XII pass with Biology and Chemistry	NA

Learning Objectives:

The learning objectives of this course are as follows:

- The course aims to apprise the students of locust as one of the most dangerous pests of agricultural crops.
- It focuses on identification of locust, reasons of their swarming and migratory nature which gives immense economic loss leading to national emergency of food and fodder.
- The course provides knowledge about the control, monitoring and management strategies of locust.

Learning Outcomes:

By studying this course, students will be able to:

- learn about the importance of locust as serious pest that cause damage to the agro-ecosystems affecting the economy.
- learn about the habit, habitat, behaviour, morphology and different phases of locust.
- learn about the biology of locust and and apply various methods of its control.

SYLLABUS OF GE-05

Theory:

Unit 1(3Weeks)

Introduction, historical background, locust plague and upsurges, Systematic position of locusts and grasshoppers; habitat, behaviour and morphology of locusts. Difference between locusts and grasshoppers.

Unit 2 (4.5 Weeks)

Locusts in India, distribution, life cycle: *Schistocerca gregaria, Patangasuccincta, Locusta migratoria;* damage caused by them.

Unit 3 (3.5 Weeks)

Breeding seasons and breeding areas, swarming.biological phases: solitary, transients and gregarious and changes in their behavior, color and structure. Biotic theory of periodicity.

Unit 4 (3 Weeks)

Locust management: National and international organizations - LWO, SALO, CALO, FAO, NLCC, IRLCO-CSA (International Red Locust Control Organization for Central and Southern Africa), swarm monitoring. Control methods- Mechanical and traditional, regulatory practices,Chemical methods: ULV Sprays, dusting, baits, IGRs; advantages and disadvantages of different chemical control methods, biological practices: biopesticides, predators, parasitoids; Integrated Pest Management; Plant quarantine.

Unit 5 (1 Week)

Socio-Economic importance: Impact on the health of fauna and humans; on agriculture.

Practical component -

1. Comparative study of different species of locusts through specimens /photographs.
2. Study of mouthparts, wings and legs of locust through specimens /photographs.

3. Study of sexual dimorphism in locust through specimens /photographs.
4. Study the life stages of the locust through specimens/slides/photographs.
5. Study of different tools used in the management of locust.
6. Study of different host plants of locust.
7. Visit to different institutes/stations/laboratories (submit a Report on visit/current status of locusts in India).

Essential/recommended readings

1. Ritchie, J. M., &Dobson, H. (1995).*Desert Locust, control operations and their environmental impact*. NRI bulletin 67, Hopps the printers Ltd.
2. Atwal, A. S.; & Dhaliwal, G. S. (2015). *Agricultural pest South Asia and their management* (8th Ed.). Kalyani publishers.
3. Pradhan, S. (2016). *Agricultural Entomology and Pest Control*. ICAR publication.
4. Pandey,& Kumari R. (2021) *Locust in Indian Agriculture*. Notion press India.

Suggestive readings

1. Rachadi, Tahar (2010).*Locust control handbook*. CTA publication, AJ Wagningen-The Netherlands.

2.Krall, S; Peveling, R & Diallo, D. Ba. (1997).*New strategies in Locust Control*. Pirahauser Basel springer.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

GENERIC ELECTIVE – 6:

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Beneficial Insects and their products ALS ZOO GE 06	**4**	**2**	**nil**	**2**	Class XII pass with Biology and Chemistry	NA

Learning Objectives:

The learning objectives of this course are as follows:

- The course will highlight the significance of beneficial insects.
- It will give knowledge about various products of insect origin and their uses.
- The course will help in developing entrepreneur skills required for self-employment.

Learning Outcomes:

By studying this course, students will be able to:

- attain knowledge of beneficial insects and their products.
- develop an understanding of the biology of beneficial insects, their interactions with each other and with the environment.

SYLLABUS OF GE-06

Theory:

Unit 1. Introduction (2.5 Weeks)

An introduction to the beneficial insects and their applications in agriculture - (Pollination and dispersal; decomposition - dung, carrion and plant materials), in medicine, in veterinary and in forensic entomology. Bioagents: Insectsas natural enemies of pests and as scavengers.

Unit 2. Honey and Wax(3.5 Weeks)

Introduction and history of bee-keeping; Honey bees: species type, morphology, biology, conservation, seasonal management, hives, diseases; Honey and wax production and their uses, Ripening of honey, Propolis.

Unit 3. Silk (3.5 Weeks)

History and development of silkworms in India, different species, voltinism and biology of silkworm, main and alternate host plants, method of harvesting and preservation of mulberry leaves, types of silk, silk production.

Unit 4. Lac (3 Weeks)

Species of lac insects, morphology, biology, host plants, Lac production and its uses, Types of lac; seed lac, button lac, shellac, and lac-products.

Unit 5. Dyes (2.5 Weeks)

Insect derived - Cochineal dye: *Dactylopius coccus*; Polish cochineal dye: *Porphyrophora polonica*; Carmine dye: *Kermes varmilo* and other insects.

Insect induced plant products: Tannic acid.

Other products: Honeydew.

Practical component -

1. Study of different species of honeybees(mouthparts, legs of worker, stinging apparatus) through specimens/photographs/slides.
2. Study of adult lac insect through photographs and slides.
3. Study of different species of silk moth (mouthparts and legs)
4. Study of biocontrol agents/natural enemies of insect pests through photographs/slides. .
6. To study the adulterations/purity of honey/shellac/silk.
7. Visit to research and training Institutions/Unit of Beekeeping, Sericulture, Lac culture.

Essential/recommended readings

1. David, V. Alford. (2019). *Beneficial insects*. CRC Press, taylor and francis, vocaraton, Florida.

2. Sathe, T. V., and Jadhav, A. (2002). *Sericulture and Pest Management.* Daya Publishing House.

Suggestive readings

1.Yonemura, M., and Rama Rao, N. (1951). *A Handbook of Sericulture. I. Rearing of silk-worms*. Government Branch Press, Mysore.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

GENERIC ELECTIVE –7:

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Insect Ecology ALS ZOOGE 07	**4**	**2**	**nil**	**2**	Class XII pass with Biology and Chemistry	NA

Learning Objectives:

The learning objectives of this course are as follows:

- The course aims to give knowledge about the basic ecology and role of different biotic and abiotic factors.
- The course introduces the concepts of ecosystem, energy flow, attributes of insect population and different factors affecting the distribution, abundance and prey- predator relationship of insects.

Learning Outcomes:

By studying this course, students will be able to:

- understand the key concepts of ecology and role of insects in ecosystem.
- learn about the community characteristics, ecosystem development and climax theories.

- gain knowledge about the types of ecosystems, energy models, and ecological efficiencies.

SYLLABUS OF GE-07

Theory

Unit 1(1.5 Weeks)

Fundamentals of Insect ecology, abiotic factors and biotic factors, Laws of limiting factors.

Unit 2(2.5 Weeks)

Ecosystem: Concept,types, role of insects in ecosystems. Food chain, Food web and energy flow through the ecosystem, Productivity, Ecological pyramids and ecological efficiencies, interactions of insects and their environment.

Unit 3 (6 Weeks)

Population: Attributes of Insect population: Density, Natality, Mortality, Life tables, Survivorship curves, Dispersal and Dispersion, Exponential *vs* Logistic growths, Carrying capacity. Population regulation, Basic concepts of Insect abundance: factors responsible for changes in the distribution and abundance of insects. Density dependent and independent factors.

Unit 4(2.5 Weeks)

Insect Population interactions: Basic factors governing the interspecific interactions, Classification of interspecific interactions, Understanding of Gause's principle with insects as examples, Prey-predator interactions, Lotka-Volterra Model. Functional and numerical response.

Unit 5(2.5 Weeks)

Community ecology: Characteristics, Abundance and diversity of insects, Species richness, Ecotone and edge effect. Food as a limiting factor for distribution. Insects as regulators of ecosystem processes. Ecological succession.

Practical component -

1. Study of Life tables and plotting of survivorship curves of different types from the hypothetical data provided/real data of insect population obtained from the field.
2. Determination of insect population density in a natural or hypothetical community by quadrate method and calculation of the Shannon Wiener Index.
3. Study of abiotic factors in aquatic ecosystems: Temperature, turbidity, pH, dissolved oxygen content (by Winkler's method) and light intensity.
4. Biochemical estimation of nitrates and phosphates from the pond water samples.

5. Estimation of water quality using insects/other organisms as bio-indicators.
6. Estimation of primary productivity by light and dark bottle method.
7. Field visits to understand different ecosystems and to study insect diversity.

Essential/recommended readings

1. Odum, E.P. (2008) Fundamentals of Ecology. Indian Edition. Brooks/Cole.
2. Smith, R. L. (2000) Ecology and field biology. Harper and Row publisher.
3. Krebs, C. J. (2001) Ecology. VI Edition. Benjamin Cummings.

Suggestive readings

1.Schowalter D. Timothy, (2006) Second edition, Insect Ecology an ecosystem approach, Academic Press.

2.Ricklefs, R.E. (2000) Ecology. V Edition. Chiron Press.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.