Institute of Botany

Faculty of Life Sciences

University of the Punjab, Lahore

Course Outline

Semester – VII

Programme	BS Botany	Course Code	Bot-400	Credit Hours	3
Course Title	Analytical Techniques in Botany (Theory)				

Course Introduction

This course intends to engage students into a high standard academic rigor and opportunities enabling students stay engaged in core aspects of botany at depth to create new knowledge. It will provide insights into the open source and proprietary, infrastructure-based and cloud-based advanced analytical tools, being used globally to understand the redefined prerequisites of learning botanical multidisciplined facets in the modern era such as, plants' distribution, classification, ecology, genetics, physiology, structure, and economic

Learning Outcomes

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

- Learn open-source advanced analytical tools involving machine learning and perspective analysis of data related to botany
- Become acquainted with the infrastructure-based and cloud-based tools of data analyses related to botany.
- Become capable of building multiple diverse ways to visualize data from simple data visuals to complex ones with drill-down capabilities.
- Provide capabilities that are scalable and built-in to support advanced analytics in multidisciplined facets of botany.

Course Contents

- **Application of AI-assisted techniques in plants:** application AI-assisted techniques in major branches of Botany, application of machine learning techniques in plant sciences.
- **Application of Robotics (UAVs, UGVs, and UUVs) in Botany:**
  UAVs (unmanned aerial vehicles) in Botany: application of UAVs for monitoring spatial and temporal variations of vegetation indices, UAVs for monitoring plant disease occurrence in the field, UAVs for monitoring plant productivity, UAVs for managing precise nutrition in plants, other applications of UAVs in Botany.
  UGVs (unmanned ground vehicles) in Botany: application of UGVs in reconnaissance studies in weed occurrence, application of UGVs in reconnaissance studies of macrofauna in forest floors.
  UUVs (unmanned underwater vehicles) in Botany: application of UUVs for monitoring quality of water in freshwater and oceanic water bodies, application of UUVs for monitoring freshwater algae and phytoplanktons, application of UUVs for monitoring oceanic algae and phytoplanktons.
- **Application of remote sensing and satellite imaging techniques in Botany:** application of remote sensing (RS) in Botany, RS techniques for monitoring terrestrial vegetation features, RS techniques for monitoring aquatic plants, RS techniques for studying plant ecology and ecosystems.
- **Biochemical characterization techniques in Botany:** techniques for isolation of proteins form plants, techniques for characterizing proteins in plants, techniques for determining nucleic acids in plants, techniques for characterizing nucleic acids in plants, mass spectrometric analysis of biochemical compounds in plants, x-ray diffraction analyses in plants, x-ray crystallographic analysis in plants.
- **Application of nanotechnological techniques in Botany:** techniques for synthesizing nanoparticles from plants, nanoparticle application and uses in plant science.
- **Biostatistical techniques in Botany:**
  Quantitative data techniques in Botany, techniques for quantitative data collection, techniques for quantitative data analyses.
  Qualitative data techniques in Botany: techniques for qualitative data collection in Botany, techniques for qualitative data analyses in Botany
  Techniques for data presentation in Botany
- **Cell fractionation techniques in Botany:** cell fractionation techniques in Botany, centrifugation techniques for

plants, cytochemical techniques for plants, histochemistry techniques for plants, autoradiography techniques in plants, fluorescent antibodies application in plants, single-cell analysis in plants, plant single cell analysis through genomics, plant single cell analysis through transcriptomics, plant single cell analysis through spatial resolution.

- **Chromatographic techniques in Botany:** application of paper chromatography in plants, application of column chromatography in plants, application of thin layer chromatography (TLC) in plants, application of gas-liquid chromatography (GLC) in plants, application of high-performance liquid chromatography (HPLC) in plants, application of ion exchange chromatography in plants, application of molecular sieve chromatography in plants, application of affinity chromatography in plants.
- **Imaging and related techniques in Botany:** use of light microscopic techniques in Botany, use of fluorescent microscopic techniques in Botany, use of confocal microscopic techniques in Botany, use of fluorochromes in Botany, use of flow cytometry (FACS) in plants, applications of fluorescence microscopy in plants, application of chromosome banding technique in plants, application of FISH in plant sciences, application of chromosome painting in plants, application of transmission electron microscopy (TEM) in plants, application of scanning electron microscopy (SEM) in plants.
- **Pollutant (inorganic) determination techniques in soil and plants:** techniques for determining mineral nutrient in plants, destructive techniques for determining nutrients in plant tissues, non-destructive techniques for determining nutrients in plants parts, techniques for determining mineral nutrients in soil samples, soil sample preparation techniques, mineral nutrient quantification techniques for soils, techniques for determining heavy metals in plants and soils, plant sample preparation techniques for determination of heavy metals, soil sample preparation techniques for determination of heavy metals, heavy metal quantification techniques for plants and soils.
- **Pollutant (organic) determination techniques in soil and plants like POPs, PFOS, PFAS, etc.:** soil and plant sample preparation techniques for determination of organic pollutants, techniques for identifying composition of the organic pollutants in plants and soil, quantification techniques for organic pollutants in plants and soil.
- **Radioisotopic techniques in Botany:** application of auto-radiographic techniques in plants, application of pulse chase experiment techniques in plants, application of other radioisotopic techniques in different branches of Botany.
- **Real-time 3D Imaging of plants roots through non-destructive approaches:** application of MRI for monitoring live tissues and organs of plants, application of distributed fibre optic sensing in plants, application of IR thermal imaging in plants.
- **Learning outcomes:** On the completion of the course, the students will understand how contemporary techniques being used in the study of plants. The course will provide knowledge about state-of-the-art and cutting-edge techniques being used in plant sciences. The students will be put into perspective of application of modern analytical techniques for improvement of plants.

Programme	**BS Botany**	**Course Code**	**Bot-314**	**Credit Hours**	1
Course Title	**Systematics of Angiosperms (Lab)**				

Lab Course Contents

- Hands on AI search algorithms and optimization
- Virtual interactive session about application of UAVs, UGVs, and UAAs for plant monitoring
- Interactive session on Google Earth Engine and its application in Botany
- Interactive session on ArcGIS and its application in Botany
- Acquaintance with chemical methods of DNA extraction from plants and microbes
- Acquaintance with physical methods of DNA extraction from plants and microbes
- Acquaintance with DNA structure characterization
- Cell fractionation and organelle isolation techniques

Textbooks and Reading Material

1. World Health Organization. (2023). International Code of Conduct on Pesticide Management. Guidance on use of pesticide regulation to prevent suicide. World Health Organization.
2. Fouda, H. Z. (2022). The latest technologies in agriculture and plant sciences: Improved techniques, methods, and yields. Delve Publishing, Arcler Education Inc., Burlington, Canada.

3. van Dusschoten, D., Metzner, R., Kochs, J., Postma, J. A., Pflugfelder, D., Bühler, J., ... & Jahnke, S. (2016). Quantitative 3D analysis of plant roots growing in soil using magnetic resonance imaging. Plant physiology, 170(3), 1176-1188.
4. Tei, M., Soma, F., Barbieri, E., Uga, Y., & Kawahito, Y. (2024). Non-destructive real-time monitoring of underground root development with distributed fiber optic sensing. Plant Methods, 20(1), 36.
5. Reddy, C. S. (2015). Applications of remote sensing in plant sciences: An overview. Plant Biology and Biotechnology: Volume I: Plant Diversity, Organization, Function and Improvement, 713-727.
6. Sun, Z., Wang, X., Wang, Z., Yang, L., Xie, Y., & Huang, Y. (2021). UAVs as remote sensing platforms in plant ecology: review of applications and challenges. Journal of Plant Ecology, 14(6), 1003-1023.
7. Watson, S., Duecker, D. A., & Groves, K. (2020). Localisation of unmanned underwater vehicles (UUVs) in complex and confined environments: A review. Sensors, 20(21), 6203.

Teaching Learning Strategies

- Lectures
- Group Discussion
- Laboratory work
- Seminar/ Workshop

Assignments: Types and Number with Calendar

- Lecture Based Examination (Objective and Subjective)
- Assignments
- Class discussion
- Quiz
- Tests

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