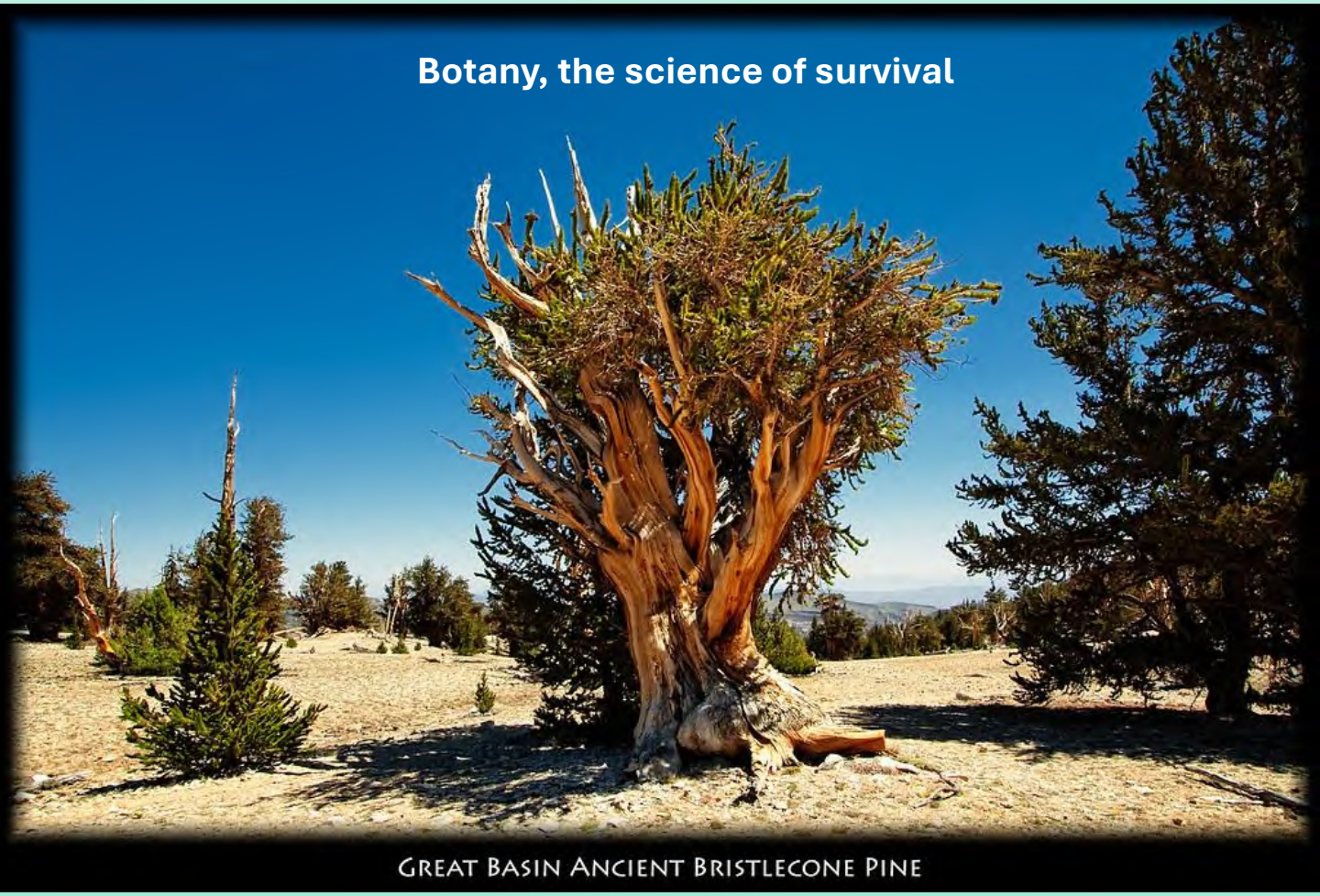
SACRED HEART COLLEGE (AUTONOMOUS), THEVARA

KOCHI, KERALA, 682013

Curriculum and Syllabi

Botany

For Undergraduate (Honours) Degree Programmes



GREAT BASIN ANCIENT BRISTLECONE PINE

2024-25

SACRED HEART COLLEGE (AUTONOMOUS), THEVARA

KOCHI, KERALA, 682013

Curriculum and Syllabi

Under the discipline

Botany

For Undergraduate (Honours) Degree Programmes

Introduced from 2024-25 admissions onwards

Prepared by

Board of Studies in Botany

Sacred Heart College (Autonomous, Thevara, Kochi.

BOARD OF STUDIES IN BOTANY
SACRED HEART COLLEGE (AUTONOMOUS), THEVARA, KOCHI, KERALA

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Preface

In alignment with the aspirational goals of the 21st century and addressing the many growing developmental imperatives of our country, the National Education Policy 2020 (NEP 2020) marks a significant milestone as India's first education policy of this century. This policy envisions a comprehensive revision and revamping of the entire education structure, including its regulation and governance, to create a new system that builds upon India's rich traditions and value systems while also aligning with Sustainable Development Goal 4 (SDG4).

NEP 2020 places a strong emphasis on the development of the creative potential of each individual. It underscores the necessity of nurturing cognitive capacities—both foundational capacities of literacy and numeracy and higher-order cognitive capacities, such as critical thinking and problem-solving—as well as social, ethical, and emotional capacities and dispositions. Following the guidelines suggested in NEP 2020, the University Grants Commission has introduced the Curriculum and Credit Framework for Undergraduate Programmes 2023 (CCFUP). This framework is designed to provide a flexible, choice-based credit system, promote a multidisciplinary approach, and offer multiple entry and exit options.

Considering the global education scenario and NEP 2020, the Kerala Higher Education Reforms Commission recommended comprehensive reforms in the undergraduate curriculum for the 2023-24 academic year. These reforms include the adoption of four-year undergraduate programs to elevate Kerala's undergraduate education to the standards of globally acclaimed universities. Consequently, the Kerala State Curriculum Committee for Higher Education was constituted, which proposed a model Kerala State Higher Education Curriculum Framework (KSHECF) for Undergraduate Education.

Based on this state curriculum framework, Mahatma Gandhi University has published the Rules and Regulations known as The Mahatma Gandhi University Undergraduate Programmes (Honours) Regulations, 2024. In alignment with these university regulations, Sacred Heart College (Autonomous) has developed its own set of

regulations, which have been approved by the governing body. These are known as The Sacred Heart College (Autonomous) Undergraduate Programmes (Honours) Regulations, 2024 {SHC-UGP (Honours)}, under the New Curriculum and Credit Framework, 2024.

The Board of Studies (BoS) in Botany, adhering to these college and university regulations, has meticulously developed this curriculum for the four-year undergraduate program in botany. This curriculum is designed to ignite and sustain students' interest in plant sciences through a balanced blend of theoretical knowledge and practical skills.

The BoS of the Department of Botany initiated the revision of the B.Sc. curriculum in December 2023. A comprehensive list of courses was prepared, with each course assigned to respective faculty members. These course teachers presented their proposed syllabus changes during BoS meetings. After several brainstorming sessions and discussions, the current form of the revised curriculum was finalized.

We are confident that this curriculum will provide a robust and engaging educational foundation, fostering the intellectual growth and professional development of our students. We welcome you to embark on this enriching academic journey at Sacred Heart College.

BoS Chairman

CONTENTS

1. INTRODUCTION

The National Education Policy (NEP) 2020 envisages the revision of the Choice Based Credit System (CBCS) for instilling innovation and flexibility. It emphasizes on promoting interdisciplinary studies, introducing new subjects, and providing flexibility in courses and fresh opportunities for students. It also envisages setting up of facilitative norms for issues, such as credit transfer, equivalence etc., and a criterion-based grading system that assesses student achievement based on the learning goals for each programme.

The NEP document suggests several transformative initiatives in higher education. These include:

- Introduction of holistic and multidisciplinary undergraduate education that would help develop all capacities of human beings - intellectual, aesthetic, social, physical, emotional, ethical and moral - in an integrated manner; soft skills, such as complex problem solving, critical thinking, creative thinking, communication skills; and rigorous specialization in a chosen field (s) of learning.
- Adoption of flexible curricular structures in order to enable creative combinations of disciplinary areas for study in multidisciplinary contexts in addition to rigorous specialization in a subject.
- Undergraduate degree programmes of either 3 or 4-year duration.
- The students are getting a chance to determine his/her own semester-wise academic load and will be allowed to learn at his/her pace, to the extent possible.
- Increase in the number of choices of courses available to students and the students are getting an opportunity to choose the courses of their interest from all disciplines.
- Multidisciplinary and holistic education with emphasizes on research, skill development and higher order thinking,
- Promotion of innovation and employability of the student.
- Flexibility for the students to move from one institution to another as per their choice.

- Flexibility to switch to alternative modes of learning (offline, ODL, and online learning, and hybrid modes of learning).

Outcome Based Education (OBE)

Undergraduate courses in Botany follow the Outcome-based Education (OBE) framework. OBE is a system where all the parts and aspects of education are focused on the outcomes of the course. The students take up courses with a certain goal of developing skills or gaining knowledge and they have to complete the goal by end of the course. Outcome-based education affirms teachers as facilitators, rather than lecturers. In this model, teachers guide the students and encourage them to develop their knowledge and skills. The undergraduate courses at the Department of Botany, Sacred Heart College (Autonomous), Thevara provides a learning approach in which students develop analytical ability and critical thinking and research acumen over different situations.

Programme Outcomes:

The SHC - Undergraduate Programme (SHC-UGP) Outcomes (POs) are as follows:

PO 1: Critical thinking and Analytical reasoning

- Critical thinking guides the assessment and judgment of information, while analytical reasoning involves specific methods for analysis and conclusion drawing. It includes the ability to assess evidence, identify assumptions, formulate coherent arguments, understand complex relationships, and evaluate practices and theories critically. Additionally, critical sensibility involves self-awareness and reflection on personal and societal experiences.

PO 2: Scientific reasoning and Problem solving

- Capacity to interpret and draw conclusions from data, critically evaluate ideas and evidence with an open-minded perspective; ability to apply learned competencies to solve unfamiliar problems and apply knowledge to real-life situations, avoiding mere replication of curriculum content.

PO 3: Effective communication and leadership skill

- Proficiency in expressing thoughts verbally and non-verbally, utilizing appropriate communication media. Confidently sharing ideas, active listening,

analytical reading and writing and presenting complex information clearly to diverse groups. Effective teamwork and leadership skills, including setting direction, inspiring vision, building and motivating teams, and guiding them efficiently towards common goals.

PO 4: Social consciousness and responsible citizenship

- Social consciousness involves an empathetic and informed perspective, extending beyond personal concerns to embrace a responsibility for the collective good in nation-building. It includes reflecting on the impact of research on conventional practices and a clear understanding of societal needs for inclusive and sustainable development. Responsible citizens contribute positively through civic engagement, environmental stewardship, and a commitment to social justice, abiding by laws and working for the advancement of society.

PO 5: Equity, Inclusiveness and Sustainability

- Promoting equity, inclusiveness, sustainability, and diversity appreciation. Developing ethical and moral reasoning with values of unity, secularism, and national integration for dignified citizenship. Understanding and appreciating diversity, managing differences, and using an inclusive approach. Emphasizing creating environments where diverse individuals feel valued, addressing present needs without compromising future generations' ability to meet their own needs, considering environmental, economic, and social factors.

PO 6: Moral and Ethical Reasoning

- Possessing the capacity to embody moral and ethical values in personal conduct, articulating positions and arguments on ethical matters from diverse perspectives, and consistently applying ethical practices in all endeavours. Proficient in recognizing and addressing ethical issues pertinent to one's work, steadfastly steering clear of any unethical behaviour.

PO 7: Networking and Collaboration

- Cultivating networking skills in education entails establishing meaningful professional connections and relationships among educators, administrators, and stakeholders. It also involves fostering cooperative efforts among

individuals, institutions, and research organizations within the educational realm. These practices are indispensable for nurturing a supportive, innovative, and dynamic learning environment.

PO 8: Lifelong Learning

- Cultivating the ability to continually acquire knowledge and skills, including the art of "learning how to learn," becomes paramount for lifelong learning. This self-paced and self-directed approach serves personal development, aligns with economic, social, and cultural objectives, and facilitates adaptation to evolving workplace demands through skill development and reskilling. It equips individuals with competencies and insights, allowing them to adeptly respond to society's changing landscape and enhance their overall quality of life. Lifelong learning extends beyond formal education, embracing diverse informal and non-traditional learning experiences.

2. REGULATIONS FOR UNDERGRADUATE (HONOURS) DEGREE PROGRAMMES

PREAMBLE

Sacred Heart College (Autonomous), Thevara, Kochi is a grant-in-aid private college affiliated to Mahatma Gandhi University, Kottayam, Kerala. The College was established in 1944 as a higher educational institute for men on the basis of the minority rights. It started admitting girls in 1975 and currently serves all sections of the society without any discrimination of caste or creed.

The College was granted Autonomous Status by the University Grants Commission (UGC) in 2014.

Vision and Mission of the Institution

The vision of the College aims at the formation of holistic individuals who would champion the cause of justice, love, truth and peace. To this effect, Sacred Heart College envisions the **"Fashioning of an enlightened society founded on a relentless pursuit of excellence, a secular outlook on life, a thirst for moral values as well as an unflinching faith in God."** It seeks the creation of a world, guided by divine wisdom, governed by moral principles, inclusive by secular outlook and united by the principle of equity.

The Mission of the Institution is to provide an environment that

- **facilitates the holistic development of the individual**
- **enables the students to play a vital role in the nation-building process and contribute to the progress of humanity**
- **disseminates knowledge even beyond the academia**
- **instils in the students a feel for the frontier disciplines, and**
- **cultivates a concern for the environment**

by setting lofty standards in the ever-evolving teacher-learner interface.

Framing of the Regulations

As part of the implementation of the National Education Policy 2020 (NEP 2020), the University Grants Commission (UGC) has issued the Curriculum and Credit Framework for Undergraduate Programmes 2023 (CCFUP) which would provide a flexible choice-based credit system, multidisciplinary approach, multiple entry and exit options, and establish three Broad Pathways, (a) 3-year UG Degree, (b) 4-year UG Degree (Honours), and (c) 4-year UG Degree (Honours with Research).

The Kerala Higher Education Reforms Commission has recommended a comprehensive reform in the undergraduate curriculum for the 2023-24 academic year, adopting 4-year undergraduate programs to bring Kerala's undergraduate education at par with well acclaimed universities across the globe.

The Kerala State Curriculum Committee for Higher Education has been constituted, and have proposed a model Kerala State Higher Education Curriculum Framework (KSHECF) for Undergraduate Education.

Further, an Academic Committee and various sub committees were constituted for the implementation of the Regulations. The Academic Committee submitted the draft regulations on 15-03-2024, namely**: THE SACRED HEART COLLEGE (AUTONOMOUS) UNDERGRADUATE PROGRAMMES (HONOURS) REGULATIONS, 2024 {SHC-UGP (Honours)}** under the New Curriculum and Credit Framework, 2024.

REGULATIONS

Short Title and Commencement

i. These Regulations may be called THE SACRED HEART COLLEGE (AUTONOMOUS) UNDERGRADUATE PROGRAMMES (HONOURS) REGULATIONS, 2024 {SHC-UGP (Honours)} under the New Curriculum and Credit Framework 2024.

ii. These Regulations will come into effect from the academic year 2024-2025 and will have prospective effect.

Scope and Application

i. These Regulations shall apply to all Undergraduate programmes under various Faculties conducted by THE SACRED HEART COLLEGE (AUTONOMOUS) for the admissions commencing in the academic year 2024-2025.

ii. Every programme conducted under the SHC-UGP shall be monitored by an SHC-UGP Academic Committee comprising members nominated by the principal.

Definitions

Unless used in a context otherwise specified,

i. College means THE SACRED HEART COLLEGE (Autonomous), a grant-in-aid private college affiliated to Mahatma Gandhi University, Kottayam, Kerala.

ii. 'University' means the MAHATMA GANDHI University which is the affiliating University of Sacred Heart College (Autonomous).

iii. FYUGP means Four Year Undergraduate Programme.

iv. Academic Year: Two consecutive (one odd and one even) semesters followed by a vacation in one academic year.

v. Academic Coordinator/Nodal Officer: Academic Coordinator/Nodal Officer is a faculty nominated by the college council to co-ordinate the effective conduct of the FYUGP including Continuous Comprehensive Assessment (CCA) undertaken by various departments within the college. She/ he/ they shall be the convenor for the College level Academic Committee.

vi. Academic Week: A unit of five working days in which the distribution of work is organized, with at least five contact hours of one-hour duration on each day.

vii. Academic Credit: A unit by which the course work is measured. It determines the number of hours of instructions required per week in a semester. It is defined both in terms of student efforts and teacher's

efforts. A course which includes one hour of lecture or tutorial or minimum 2 hours of lab work/ practical work/ field work per week is given one credit hour. Accordingly, one credit is equivalent to one hour of lecture or tutorial or two hours of lab work/ practical work/ field work/ practicum and learner engagement in terms of course related activities (such as seminars preparation, submitting assignments, group discussion, recognized club-related activities etc.) per week. Generally, a one credit course in a semester should be designed for 15 hours Lecture/ tutorials or 30 hours of practical/ field work/ practicum and 30 hours learner engagement.

viii. Academic Bank of Credits (ABC): An academic service mechanism as a digital/ virtual entity established and managed by Government of India to facilitate the learner to become its academic account holder and facilitating seamless learner mobility, between or within degree-granting Higher Education Institutions (HEIs) through a formal system of credit recognition, credit accumulation, credit transfers and credit redemption to promote distributed and flexible process of teaching and learning. This will facilitate the learner to choose their own learning path to attain a Degree/ Diploma/ Certificate, working on the principle of multiple entry and exit, keeping to the doctrine of anytime, anywhere, and any level of learning.

ix. Credit Accumulation: The facility created by ABC in the Academic Credit Bank Account (ABA) opened by the learner across the country in order to transfer and consolidate the credits earned by them by undergoing courses in any of the eligible HEIs.

x. Credit Recognition: The credits earned through eligible/ partnering HEIs and transferred directly to the ABC by the HEIs concerned.

xi. Credit Redemption: The process of commuting the accrued credits in the ABC of the learner for the purpose of fulfilling the credits requirements for the award of various degrees. Total credits necessary

to fulfil the criteria to get a degree shall be debited and deleted from the account concerned upon collecting a degree by the learner.

xii. Credit Transfer: The mechanism by which the eligible HEIs registered with ABC are able to receive or provide prescribed credits to individual's registered with ABA in adherence to the UGC credit norms for the course(s) registered by the learner in any HEIs within India.

xiii. Credit Cap: Maximum number of credits that a student can take per semester, which is restricted to 30.

xiv. Continuous Comprehensive Assessment (CCA): The mechanism of evaluating the learner by the course faculty at the institutional level.

xv. End Semester Evaluation (ESE): The mechanism of evaluating the learner at the end of each semester.

xvi. Audit Course: a course that the learner can register without earning credits, and is not mandatory for completing the SHC-UGP. The student has the option not to take part in the CCA and ESE of the Audit Course. If the student has 75% attendance in an Audit Course, he/she/they is eligible for a pass in that course, without any credit (zero-credit).

xvii. Courses: refer to the papers which are taught and evaluated within a programme, which include lectures, tutorials, laboratory work, studio activity, field work, project work, vocational training, viva, seminars, term papers, presentations, assignments, self-study, group discussion, internship, etc., or a combination of some of these elements.

xviii. Choice Based Credit System (CBCS) means the system wherein students have the option to select courses from the prescribed list of courses.

xix. College-level Academic Committee: Is a committee constituted for the FYUGP at the college level comprising the Principal as the Chairperson, the Academic Co-ordinator/ Nodal Officer as its convenor.

xx. Academic Co-ordinator/ Nodal Officer: A senior faculty member nominated by the college council.

xxi. Course Faculty: A faculty member nominated by the Head of the Department shall be in charge of offering a particular course in a particular semester of FYUGP.

xxii. Department means any teaching department in a college offering a course of study approved by the College as per the regulations of the college and it includes a Department, Centre, or School of Teaching and Research conducted directly by the College.

xxiii. Board of Studies (BoS) means the academic body duly constituted to frame the syllabus of each department.

xxiv. Senior Faculty Advisor (SFA) is a faculty nominated by a Department Council to co-ordinate all the necessary work related to FYUGP undertaken in that department, including the continuous comprehensive assessment.

xxv. Department Council means the body of all teachers of a department in a college.

xxvi. Faculty Adviser (FA) means a teacher from the parent department nominated by the Department Council to advise students in academic matters.

xxvii. Graduate Attributes means the qualities and characteristics to be obtained by the graduates of a programme of study at the College, which include the learning outcomes related to the disciplinary areas in the chosen field of learning and generic learning outcomes. The College will specify graduate attributes for its programmes.

xxviii. Programme means the entire duration of the educational process including the evaluation leading to the award of a degree.

xxix. Programme Pathway: Combination of courses that can be chosen by a student that give options to pursue interesting and unconventional combinations of courses drawn from different disciplinary areas, like the sciences and the social sciences/ humanities. The pathways could be in terms of major- minor options with different complementary/ allied disciplines.

xxx. Regulatory Body means University Grants Commission (UGC), All India Council for Technical Education (AICTE), National Assessment and Accreditation Council (NAAC) and National Board of Accreditation (NBA) etc.

xxxi. Signature Courses: Signature courses are the specialized Discipline Specific Elective courses or skill-based courses designed and offered by the regular/ ad hoc/ visiting/ emeritus/ adjunct faculty member of a particular college with the prior recommendation of the BoS and the approval of Academic Council of the College.

xxxii. Letter Grade or simply 'Grade' in a course is a letter symbol (O, A+, A, B+, B, C, P, F, and Ab). Grade shall mean the prescribed alphabetical grade awarded to a student based on their performance in various examinations. The Letter grade that corresponds to a range of CGPA.

xxxiii. Grade Point: Each letter grade is assigned a 'Grade point' (G) which is an integer indicating the numerical equivalent of the broad level of performance of a student in each course. Grade Point means point given to a letter grade on 10-point scale.

xxxiv. Semester Grade Point Average (SGPA) is the value obtained by dividing the sum of credit points obtained by a student in the various courses taken in a semester by the total number of credits in that semester. SGPA shall be rounded off to two decimal places. SGPA determines the overall performance of a student at the end of a semester.

xxxv. Credit Point (P) of a course is the value obtained by multiplying the grade point (G) by the credit (C) of the course: $P = G \times C$

xxxvi. Cumulative Grade Point Average (CGPA) is the value obtained by dividing the sum of credit points in all the semesters earned by the student for the entire programme by the total number of credits in the entire programme and shall be rounded off to two decimal places.

xxxvii. Grade Card means the printed record of students' performance, awarded to them.

xxxviii. Words and expressions used and not defined in this regulation, but defined in the Mahatma Gandhi University Act and Statutes, being the Act and Statues of Sacred Heart College (Autonomous)'s affiliating University shall have the meaning assigned to them in the Act and Statutes.

Features and Objectives of SHC-UGP

The features and objectives of the SHC-UGP shall be:

i. The features, meaning, and purpose of FYUGP shall be as stipulated by the UGC and as adapted by the Kerala State Higher Education Curriculum Framework (KSHECF) for undergraduate education.

ii. The practice of lateral entry of students to various semesters exists, but an exit with a Degree shall be awarded only upon successful completion of 133 credits as per the conditions stipulated in this regulation.

iii. FYUGP shall have three Broad Pathways, (a) 3-year UG Degree, (b) 4-year UG Degree (Honours), and (c) 4-year UG Degree (Honours with Research).

iv. Students who choose to exit after 3 years shall be awarded UG Degree in their respective Discipline/ Disciplines after the successful completion of the required minimum Courses with 133 credits.

v. A 4-year UG Degree (Honours) in the Discipline/ Disciplines shall be awarded to those who complete the FYUGP with a specific number of Courses with 177 credits including 8 credits from a graduate project/ dissertation in their major discipline.

vi. Students who acquire minimum 75% in their graduation (upto 6th semester) are eligible for Honours with Research Programme. However if necessary, College may conduct screening test for the honours with research programme in accordance with College Regulations from time to time.

vii. 4-year UG Degree (Honours with Research): Students who aspire to pursue research as a career may opt for 4-year UG Degree Honours with

Research stream under FYUGP with a specific number of Courses with 177 credits including 12 credits from a research project in their major discipline.

viii. The recognized research departments or departments with at least two faculty members having PhD shall offer the Honours with Research programme. Minimum 2 students (mentees) should be allotted to a faculty member (Mentor).

ix. Students who have chosen the honours with research stream shall do their entire fourth year under the mentorship of a mentor.

x. The mentor shall prescribe suitable advanced level/capstone level courses for a minimum of 20 credits to be taken within the institutions along with the courses on research methodology, research ethics, and research topic-specific courses for a minimum of 12 credits which may be obtained either within the institution or from other recognized institutions, including online and blended modes.

xi. Students who have opted for the honours with research should successfully complete a research project under the guidance of the mentor and should submit a research report for evaluation. They need to defend successfully the research project to obtain 12 credits under a faculty member of the College. The research shall be in the Major/ allied discipline.

xii. The research outcomes of their project work may be published in peer-reviewed journals or presented at conferences or seminars or patented.

xiii. The proposed FYUGP curriculum comprises Three Broad Parts: a) Foundation Components, b) Discipline Specific Pathway components (Major/ Minor), and c) Discipline Specific Capstone Components.

xiv. The Foundation component of the FYUGP shall consist of a Set of General Foundation Courses and a Set of Discipline Specific Foundation Courses.

xv. General Foundation Courses shall be grouped into 4 major baskets as Ability Enhancement Courses (AEC), Skill Enhancement Courses (SEC), Value Addition Courses (VAC), and Multi-Disciplinary Courses (MDC).

xvi. Ability Enhancement Courses shall be designed specifically to achieve competency in English, other languages as per the student's choice with special emphasis on language and communication skills.

xvii. English or other language courses shall be designed to enable the students to acquire and demonstrate the core linguistic skills, including critical reading, academic and expository writing skills as well as the cultural and intellectual heritage of the language chosen. Separate courses will be designed for Science, Humanities and Commerce streams.

xviii. Multi-Disciplinary Courses (MDC) shall be so designed as to enable the students to broaden their intellectual experience by understanding the conceptual foundations of Science, Social Sciences, Humanities, and Liberal Arts. Students shall not be eligible to take the MDC in the same discipline that they have studied during their +2. Third semester MDC can be Kerala specific content.

xix. Skill Enhancement Courses (SEC) shall be designed to enhance 21st century workplace skills such as creativity, critical thinking, communication, and collaboration.

xx. Discipline Specific Courses shall include Discipline Specific Pathway Courses, both Major and Minor streams, enabling students to gain basic knowledge in the chosen discipline.

xxi. Discipline Specific Foundation Courses shall focus on foundational theories, concepts, perspectives, principles, methods, and critical thinking essential for taking up advanced/ Capstone Courses. Practical courses shall be included in discipline specific foundation courses.

xxii. The curriculum of the SEC should be designed in a manner that at the end of year- 1, year-2, year-3, and year-4 students are able to meet the level descriptors for levels 5, 6, 7, and 8 of the UGC Guidelines on

National Skills Qualifications Framework (NSQF). The detailed descriptors of the NSQF levels are provided as **Appendix I** below.

xxiii. Value Addition Courses (VAC) shall be so designed as to empower the students with personality development, perspective building, and self-awareness.

xxiv. Discipline Specific Pathway Components (Major/ Minor) shall provide the students with an opportunity to pursue in-depth study of a particular subject or discipline and develop competency in that chosen area, which includes Discipline Specific Core (DSC) courses and Discipline Specific Elective (DSE) courses as Major and Minor courses.

xxv. Major components consist of three types: Discipline Specific Core or the Discipline Specific Elective Courses, and the research /laboratory/ fieldwork.

xxvi. Minor Courses can be selected from any discipline that may supplement or complement the Major Courses.

xxvii. Students who complete a sufficient number of Courses in a discipline or an interdisciplinary area of study other than their chosen Major shall qualify for a Minor in that discipline or in a chosen interdisciplinary area of study.

xxviii. Major Components shall be the main focus of study. By selecting a Major, the student shall be provided with an opportunity to pursue an in-depth study of a particular discipline.

xxix. Each Board of Studies (BoS) shall identify specific Courses or baskets of Courses towards Minor Course credits. Students shall have the option to choose Courses from disciplinary/ interdisciplinary minors and skill-based courses related to a chosen programme.

xxx. Students can opt for a change of Major at the end of the second semester to any Minor discipline studied among the foundation level courses. Students also can opt for a change of Major at the end of the second semester to any MDC.

xxxi. Students should opt their 5th and 6th semester VAC and SEC from their Major disciplines only.

xxxii. Course cum Credits Certificate: After the successful completion of a semester as proof for re-entry to another institution this certificate is essential. This will help the learner for preserving the credits in the Academic Bank of Credits.

xxxiii. The Advanced Level/ Capstone Level Courses shall be designed in such a manner as to enable students to demonstrate their cumulative knowledge in their main field of study, which shall include advanced thematic specialization or internships or community engagement or services, vocational or professional training, or other kinds of work experience.

xxxiv. Advanced/ Capstone level Major Specialization shall include Courses focused on a specific area of study attached to a specific Major, which could be an Elective Course. They shall include research methodology as well.

xxxv. The student has the option to register for and attend a course without taking part in the CCA and ESE of that course. Such a course is called the Audit Course. If the student has 75% attendance in an Audit Course, he/she/they is/are eligible for a pass in that course, without any credit (zero-credit). The Audit Course will be recorded in the final grade card of the student.

xxxvi. All students shall undergo Summer Internship or Apprenticeship in a Firm, Industry or Organization; or Training in labs with faculty and researchers or other Higher Education Institutions (HEIs) or Research Institutions. The College will adhere to the guidelines on internship published by the University.

xxxvii. Students will be provided the opportunities for internships with local industries, business organizations, agriculture, health and allied sectors, Local Government institutions (such as panchayats, municipalities), State Planning Board, State Councils/ Boards, Research

Institutions, Research Labs, Library, elected representatives to the parliament/ state assembly/ panchayat, media organizations, artists, crafts persons etc. These opportunities will enable the students to actively engage with the practical aspects of their learning and to improve their employability.

xxxviii. The College will provide opportunities for field-based learning/minor projects enabling them to understand the different socio-economic and development-related issues in rural and urban settings. The College will provide the students with opportunities for Community engagement and services, exposing them to socio-economic issues to facilitate theoretical learning in real-life contexts.

xxxix. Additional Credits will be awarded for those who actively participating in Social Activities, which may include participation in National Service Scheme (NSS), Sports and Games, Arts, participation in college union related activities (for respective elected/ nominated members), National Cadet Corps (NCC), adult education/ literacy initiatives, mentoring school students, and engaging in similar social service organizations that deemed appropriate to the College.

xl. Grace marks shall be awarded to a student for meritorious achievements in co-curricular activities (in Sports/ Arts/ NSS/ NCC etc.). Such a benefit is applicable in the same academic year spreading over two semesters, in which the said meritorious achievements are earned. The Academic Council will decide from time to time the eligibility and other rules of awarding the grace marks.

xli. Options will be made available for students to earn credit by completing quality- assured remote learning modes, including Online programmes offered on the Study Webs of Active-Learning for Young Aspiring Minds (SWAYAM) or other Online Educational Platforms approved by the competent body/university from time to time.

xlii. Students shall be entitled to gain credits from courses offered by other recognized institutions directly as well as through distance learning.

xliii. For the effective operation of the FYUGP, a system of flexible academic transaction timings shall be implemented for the students and teachers.

Eligibility for Admission and Reservation of Seats

i. The eligibility for admissions and reservation of seats for various FYUG Degree Programmes shall be in accordance with the norms/ rules made by the Government/ University from time to time.

ii. No student shall be eligible for admission to FYUG Degree Programmes in any of the disciplines unless he/she/they have successfully completed the examination conducted by a Board/University at the +2 level of schooling or its equivalent.

iii. Students shall be admitted and enrolled in the respective programmes solely based on the availability of the academic and physical facilities within the institution. The College shall provide all students with a brochure detailing the Courses offered by the various departments under the various Programmes and the number of seats sanctioned by the University for each Programme.

iv. During the time of admission each student may be provided with a unique higher education student ID which may be linked with the Aadhar number of the student so that this ID can be transferred if required to other higher education institutions as well.

v. The students at the end of second semester may be permitted to change their major programme of study to any course/ institution/ university across the state. Based on the availability of seats and other facilities, the students may be permitted to opt any discipline which he/she/they had studied during the first two semesters as Discipline Specific Foundation courses/ Multidisciplinary Foundation courses. If ranking is required it will be in the order of the highest-grade points secured in the discipline to which the switching of Major is sought.

vi. Students shall be allowed to change their major programmes, if required, to a maximum of 10% of the sanctioned strength of that

particular programmes depending upon the academic and infrastructural facilities available in the Institution.

vii. Depending upon the availability of academic and infrastructural facilities, the College may also admit a certain number of students who are registered for particular programmes in each semester by transfer method, if required, from other Institutions subject to conditions as may be issued by the University.

viii. A student who has already successfully completed a First-Degree Programme and is desirous of and academically capable of pursuing another First-Degree Programme may also be admitted with the prior approval of the University as per the conditions regarding programme requirements specified by the University.

ix. A Student can also be admitted for an additional major/ second major/ additional minor and on completion of the required credits he/she/they can be awarded a second major/ additional major/ minor. He/she/they may be exempted from minor pathway and general foundation course requirement.

x. The College can also enrol students in certain courses as per their choice depending upon the availability of infrastructure and other academic facilities from other recognized HEIs who are already registered for a particular programme there either through regular/ online/ distance mode irrespective of the nature of programme (Govt./ Aided/ Self- finance/ Autonomous). On successful completion of the course the credits may be transferred through the Academic Bank of Credit.

Academic Monitoring and Student Support

The academic monitoring and student support shall be in the following manner, namely

i. The College shall appoint a Senior Faculty member as Academic Co-ordinator/ Nodal officer for the smooth conduct of FYUGP.

ii. Advisory System: There shall be one Senior Faculty Advisor (SFA) for each department and one Faculty Advisor (FA) for 20 to 30 students of the class to provide advice in all relevant matters. The Head of the Department, in consultation with the SFA, shall assign FA for each student.

iii. The documents regarding all academic activities of students in a class shall be kept under the custody of the FA/ SFA.

iv. All requests/ applications from a student or parent to higher offices are to be forwarded/ recommended by FA/ SFA.

v. Students shall first approach their FA/ SFA for all kinds of advice, clarifications, and permissions on academic matters.

vi. It is the official responsibility of the institution to provide the required guidance, clarifications, and advice to the students and parents strictly based on the prevailing academic regulations.

vii. The SFA shall arrange separate or combined meetings with FA, faculty members, parents, and students as and when required and discuss the academic progress of students.

viii. The FA/ SFA shall also offer guidance and help to solve the issues on academic and non-academic matters, including personal issues of the students.

ix. Regular advisory meetings shall be convened immediately after the commencement of the semester and immediately after announcing the marks of the Continuous Comprehensive Assessment (CCA).

x. The CCA related results shall be displayed on the department notice board/ other official digital platforms of the college at least for two working days.

    a. Any concern raised by the students regarding CCA shall be looked into in the combined meetings of advisors, HOD, course faculty, and the students concerned.

    b. If the concerns are not resolved at the advisor's level, the same can be referred to the properly constituted college-level

grievance redressal committees as per the existing UGC/ University/ Government norms.

c. The Principal/ HOD shall ensure the proper redressal of the concerns raised by the students regarding CCA.

d. If the students raise further concerns about the issue, the principal shall refer the issue to the appropriate authorities with proper documents and minutes of all the committees.

xi. The FA/ SFA shall be the custodian of the minutes and action taken reports of the advisory meetings. The SFA shall get the minutes and action taken reports of advisory meetings approved by the Head of Department and the Principal.

xii. The principal shall inform/forward all regulations, guidelines, communications, announcements, etc. regarding student academic and other matters to the HODs/ SFA for information and timely action.

xiii. It shall be the official responsibility of the principal to extend the required administrative and financial support to the HODs, SFAs and FAs to arrange necessary orientation programmes for students regarding student counselling, the prevailing norms, regulations, guidelines and procedures on all academic and other related matters.

xiv. An integrated educational planning and administration software will be made available by the College to manage the academic information of all students including student admissions and registration, managing students' personal and academic information, course registrations, attendance management, all process related to assessments including regular & online examinations, grading, publishing of results, supplementary examinations, LMS, stakeholders' feedback, etc.

xv. Faculty, staff, students, and parents shall be allowed to access this software system over a highly secure authenticated mechanism from within the campus.

Course Registration

i. Each department shall publish well in advance the relevant details of courses offered, such as the name, academic level, expected outcomes, time slot, and course faculty members.

ii. Students shall be allowed to visit and interact with respective faculty members during the first week of each semester, to gather more information about the courses and the availability of seats.

iii. Based on consultations and advice from the faculty adviser, each student shall complete course registration within one week from the commencement of each semester.

iv. The number of credits that a student can take in a semester is governed by the provisions in these Regulations, subject to a minimum of 16 and a maximum of 30 Credits.

v. A student can opt out of a Course or Courses registered, subject to the minimum Credit/ Course requirement, if he/she/they feels that he/she/they has registered for more Courses than he/she/they can handle, within 30 days from the commencement of the semester.

vi. The college shall publish a list of the students registered for each course including audit course, if any, along with the chosen Programmes, repeat/ reappearance courses, if any.

vii. The higher education institutions shall admit candidates not only for programmes, but also for courses.

Re-admission and Scheme Migration

i. Students who opt out before the completion of the third year shall be provided with a 'Course cum Credits Certificate' after the successful completion of a semester as proof for re-entry to another institution.

ii. Students who have successfully completed a particular programme pathway may be permitted to take an additional minor or second major.

iii. Those students who are opting for a second major are eligible for getting certain credit transfer/ credit exemption from their previous minor

programs of study, subject to the prior recommendation of the BoS that, those credits are relevant for the present major programme of study.

Duration of Programme, Credits, Requirements and Options

i. Students will be offered the opportunity to take breaks during the programme and resume after the break, but the total duration for completing the FYUG programme shall not exceed 7 years.

ii. Students who wish to complete the undergraduate programmes faster may do so by completing different courses equivalent to the required number of credits and fulfilling all other requirements in N-1 semesters, where N is the number of semesters in the FYUGP.

iii. Provided further that the students may complete the undergraduate programme in slower pace, they may pursue the three years or six semester programmes in 4 to 5 years (8 to 10 semesters), and four years, or eight semester programmes in 5 to 6 years (10 to 12 semesters) without obtaining readmission.

iv. For students who crossed 6 semesters at a slower space, the requirement of 16 credits per semester from the institutions where they enrolled may be relaxed.

Credit Structure

The proposed number of credits per course and the credit distribution of them for the FYUG Programmes are given below:

i. An academic year shall consist of 200 working days; one semester consists of 90 working days; and an academic year consists of two semesters.

ii. Ten working days in a semester shall be used for extracurricular activities. One semester consists of 18 weeks with 5 working days per week. In each semester, 15 days (3 weeks) should be kept aside for End Semester Evaluation (ESE) and CCA.

iii. The maximum number of available weeks for curriculum transactions should be fixed at 15 in each semester. A minimum of 5 teaching or tutorial hours could be made available for a day in a 5-day week.

iv. A course that includes one hour of lecture/ tutorial or two hours of lab work/ practical work/ field work/ practicum per week is given one credit hour.

v. One credit in a semester should be designed for 15 hours of lectures/ tutorials or 30 hours of lab work/ practical work/ field work/ practicum and 30 hours of learner engagement in terms of course-related activities such as seminar preparation, submitting assignments, etc.

vi. A one-credit seminar or internship or studio activities or field work/ projects or community engagement and service will have two-hour engagements per week (30 hours of engagement per semester).

vii. A course can have a combination of lecture credits, tutorial credits, and practicum credits.

viii. Minimum credit for one Course should be 2 (Two), and the maximum credit should be 4 (Four).

ix. All Discipline Specific Major/ Minor Courses shall be of 4 (Four) credits.

x. For all Discipline Specific Major/ Minor Courses, there may be practical/ practicum of two or four hours per week.

xi. All Courses under the Multi-Disciplinary, Ability Enhancement, Value Addition and Skill Enhancement categories are of 3 credits.

xii. Summer Internship, Apprenticeship, Community outreach activities, etc. may require sixty hours (or as appropriate) of engagement for acquiring one credit.

xiii. A student shall be able to opt for a certain number of extra credits over and above the requirements for the award of a degree.

xiv. Maximum number of credits that a student can earn per semester shall be restricted to 30. Hence, a student shall have the option of acquiring credits to a maximum of 180 credits for a 6-semester UG programmes and 240 credits for a 4-year (8-semester) programmes.

xv. Each faculty member shall offer a maximum of 16 credits per semester. However, those who are offering both practical and theory courses shall offer a maximum of 12-16 credits per semester.

xvi. For a four-credit theory course, 60 hours of lecture/ tutorial class shall be assured as a mandatory requirement for the completion of that course.

Course Structure of the SHC-UGP Programme

The SHC-UGP consists of the following categories of courses and the minimum credit requirements for pathway option-one shall be as follows;

Sl. No.	Categorization of Courses for all Programme	Minimum Number of Credit Required	
1.	Major	68	88
2.	Minor	24	24+12*
3.	Multi-Disciplinary Courses (MDC)	9	9
4.	Skill Enhancement Courses (SEC)	9	9
5.	Ability Enhancement Courses (AEC)	12	12
6.	Value Addition Courses (VAC)	9	9
7.	Summer Internship, field-based learning etc.	2	2
8.	Research Project / Dissertation		12/8**

* The students can acquire advanced/capstone level courses with 12 credits from their DSC/ DSE/ Minor courses depending up on their pathway choice. The Minor courses can be of level 300 or above.

** The students pursuing the 4-year honours with research have to complete a project with 12 credits and for the 4-year honours degree students have to complete a project with 8 credits and DSC/ DSE capstone/ advanced level course in the 8th semester.

i. 20% syllabus of each course will be prepared by the teacher as 'Teacher Specific Content' and will be evaluated under CCA.

ii. In case of MDC, SEC, VAC courses coming under 3rd & 4th semester, college should make necessary arrangements to give adequate preference to courses designed by language departments. MDC in the 3rd semester can be Kerala Specific Content.

Academic Levels of Pathway Courses

Semester	Difficulty level	Nature of Course
1 & 2	100-199	Foundation-level or introductory courses
3 & 4	200-299	Intermediate level courses
5 & 6	300-399	Higher level courses
7 & 8	400-499	Advanced/Capstone level courses

Signature Courses

i. With a prior recommendation of BoS and the approval of academic council, each faculty member can design and offer at least one signature course in every semester, which may be offered as DSE /SEC/ VAC.

ii. The College will publish a list of signature courses in DSE/ SEC/ VAC offered by the faculty members with a prior recommendation of BoS and the approval of academic council.

iii. The College may empanel distinguished individuals who have excelled in their field of specialization like science and technology, industry, commerce, social research, media, literature, fine arts, civil services etc. as adjunct faculty as per the UGC guidelines with the approval of the College. With a prior recommendation of BoS and the approval of academic council, the adjunct faculty can offer SEC/VAC as signature course.

iv. Ad hoc/ Guest faculty/ Visiting faculty/ Visiting Scholars can also offer DSE/ SEC/ VAC as signature courses with a prior recommendation of BoS and the approval of academic council.

v. The faculty concerned may design the particular course and it should be forwarded to the concerned BoS after the approval of the Academic Committees formed as part of this regulations.

vi. The examinations and evaluation of the signature courses designed by the faculty shall be conducted by the faculty themselves and an external expert faculty chosen by the college from a panel of experts submitted by the faculty and recommend by the BoS concerned.

Programme Pathways and Curriculum Structure

Students who have joined for any programme under these regulations shall have the option to choose the following pathways for their UG degree and Honours programme.

i. **Degree with single Major**: A student pursuing the FYUG programme in a specific discipline shall be awarded a Major degree if he secures at least 50% of the total credits in the specific discipline required for the award of the Degree in that Discipline. Example: Physics Major/ Economics Major/ Commerce Major

ii. **Degree Major with Minor**: If a student pursuing the FYUG Programme is awarded a Major Degree in a particular discipline, he/she/they are eligible to be awarded a Minor in another discipline of his choice, if he earns a minimum of 32 credits (approximately 25% of credit required for the three-year programme) from 8 pathway courses in that discipline. Example: Physics Major with Chemistry Minor/ Chemistry Major with English Minor/ Commerce Major with Economics Minor/ English Major with Functional English Minor/ Hindi Major with Malayalam Minor etc.

iii. **Major with Multiple Disciplines** of Study: This pathway is recommended for students who wish to develop core competencies in multiple disciplines of study. In this case, the credits for the minor pathway shall be distributed among the constituent disciplines/ subjects. If a student pursuing FYUG Degree Programme is awarded a major Degree in a particular discipline, he/she/they are eligible to get mentioned his core competencies in other disciplines of his choice if he has earned 12 credits from the pathway courses of that discipline. Example: Physics Major with

Minors in Chemistry and Mathematics, Economics Major with Minors in History and English, Commerce Major with Minors in Economics and Statistics.

iv. **Interdisciplinary Major**: For these programme pathways, the credits for the major and minor pathways shall be distributed among the constituent disciplines/subjects to attain core competence in the interdisciplinary programme. Example: Econometrics Major, Global Studies Major, Biostatistics Major.

v. **Multi-Disciplinary Major**: For multidisciplinary major pathways, the credits for the major and minor pathways will be distributed among the broad disciplines such as Life Sciences, Physical Sciences, Mathematical and Computer Sciences, Data Analysis, Social Sciences, Humanities, etc. Example: Life Science, Data Science, Nano Science.

vi. **Degree with Double Major**: A student who secures a minimum of 50% credits from the first major will be awarded a second major in another discipline if he could secure 40% of credit from that discipline for the 3-year/ 4-year UG degree to be awarded a double major degree. Example: Physics and Chemistry Major, Economics and History Major, Economics and History Major, Commerce and Management Major.

Pathway Option 1 - Degree Major or Major with Multiple Disciplines of Study

Course Components	No. of Courses											
	Semester 1	Semester 2	Semester 3	Semester 4		Semester 5#	Semester 6#	Total	Remarks	Semester 7	Semester 8	Total
DSC A (4 Credit /Course)	1(P)	1(P)	3 (2P)	3 (2P)		5	4	17	7 Out of 17 can be opted as DSE	3	2	22
DSC B & C (4 Credit /Course)	2(P)	2(P)	1(P) (B or C)	1(P) (C or B)				6		3 (DSE/ any minor 300 level courses)		9
Multidisciplinary Courses (MDC) (3 Credit /Course)	1(P)	1(P)	1*					3	*Recommended that the course offered be related to Indian Knowledge Systems or allied areas.			3
Ability Enhancement Courses (AEC) (3 Credit /Course)	1 (English) 1 (OL)	1 (English) 1 (OL)						4				4
Skill Enhancement Courses (SEC) (3 Credit /Course)				1*		1**	1**	3	*Recommended that the course may be offered by the English Department **From DSC A only			3
Value Addition Courses(VAC) (3 Credit /Course)			1*	1*			1**	3	*Recommended that one VAC be offered by the English Department and one by Other Languages Department ** From DSC Aonly			3
Project/ Dissertation 12 credits for Honours with Research & 8 for Honours											**12/8 (1 DSC / DSE for Honours**	
Total Courses	**6**	**6**	**6**	**6**		**6**	**6**	**36**		**6**	**2+1**	
Total Credits	**21**	**21**	**22**	**22**	**2**	**23**	**22**		**Total Credits**	**24**	**20**	**Total Credits 177**

Internship of 2 Credits

									133			
Total Hours per Week	**25**	**25**	**25**	**25**		**25**	**25**		**Exit option available**	**25**	**25**	

BoS can include 2 practical courses in 5th semester and 3 practical courses in 6th semester in any of the 6 courses distributed in each semester.

Pathway Option 2 - Major with Minor

Course Components	**No. of Courses**											
	Semester 1	**Semester 2**	**Semester 3**	**Semester 4**		**Semester 5#**	**Semester 6#**	**Total**	**Remarks**	**Semester 7**	**Semester 8**	**Total**
DSC A (4 Credit /Course)	1(P)	1(P)	3 (2P)	3 (2P)		4	3	15	7 Out of 15 can be opted as DSE	3	2	20
DSC B (4 Credit /Course)	2(P)	2(P)	1(P)	1(P)		1	1	8	1 Out of 8 can be opted as DSE	3		11
Multidisciplinary Courses (MDC)/ (3 Credit /Course)	1(P)	1(P)	1*					3	*Recommended that the course offered be related to Indian Knowledge Systems or allied areas.			3
Ability Enhancement Courses (AEC) (3 Credit /Course)	1 (English) 1 (OL)	1 (English) 1 (OL)			**Internship of 2 Credits**			4				4
Skill Enhancement Courses (SEC) (3 Credit /Course)				1*		1**	1**	3	*Recommended that the course may be offered by the English			3

									Department ** From DSC A only			
Value Addition Courses(VAC) (3 Credit /Course)			1*	1*			1**	3	*Recommended that one VAC be offered by the English Department and one by Other Languages Department ** From DSC A only			3
Project/ Dissertation 12 credits for Honours with Research & 8 for Honours											**12/8 (1 DSC/ DSE for Honours**	
Total Courses	**6**	**6**	**6**	**6**		**6**	**6**	**36**		**6**	**2+1**	
Total Credits	**21**	**21**	**22**	**22**	**2**	**23**	**22**		**Total Credits 133**	**24**	**20**	**Total Credits177**
Total Hours per Week	**25**	**25**	**25**	**25**		**25**	**25**		**Exit option available**	**25**	**25**	

BoS can include 2 practical courses in 5th semester and 3 practical courses in 6th semester in any of the 6 courses distributed in each semester.

Pathway Option 3 - Double Major

Course Components	No. of Courses											
	Semester1	Semester2	Semester3	Semester4		Semester5#	Semester6#	Total	Remarks	Semester7	Semester8	Total
DSC A (4 Credit /Course)	1(P)	1 (P)	2(2P)	2(1P)		4	3	13	7 Out of 13 can beopted as DSE	3	2	18
DSC B (4 Credit /Course)	2(P)	2(P)	2(1P)	2(2P)		1	1	10	2 Out of 10 can be opted as DSE	3		13
Multidisciplinary Courses (MDC) (3 Credit /Course)	1(P)	1(P)	1*					3	*Recommended that the course offered be related to Indian Knowledge Systems or allied areas.			3
Ability Enhancement Courses (AEC) (3 Credit /Course)	1 (English)1 (OL)	1 (English)1 (OL)			**Internship of 2 Credits**			4				4
Skill Enhancement Courses (SEC) (3 Credit /Course)				1*		1	1	3	*Recommended that the course may be offered by the English Department			3
Value Addition Courses(VAC) (3 Credit /Course)			1*	1*			1	3	*Recommended that one VAC be offered by the English Department and one by Other Languages Department			3
Project/ Dissertation 12 credits for Honours withResearch & 8 for Honours											**12/8 (1 DSC/ DSE for Honours**	
Total Courses	**6**	**6**	**6**	**6**		**6**	**6**	**36**		**6**	**2+1**	
Total Credits	**21**	**21**	**22**	**22**	**2**	**23**	**22**		**Total Credits 133**	**24**	**20**	**Total Credits**

												177
Total Hours per Week	**25**	**25**	**25**	**25**		**25**	**25**		**Exit option available**	**25**	**25**	

BoS can include 2 practical courses in 5th semester and 3 practical courses in 6th semester in any of the 6 courses distributed in each semester.

Note: In all the above 3 tables "(P)" means courses with practical

Course Structure of Various Pathways based on Credit Requirements

The FYUG Programmes consist of the following categories of courses and the minimum credit requirements for each of them shall be as follows:

Table 1: FYUGP Course Structure – Major with Minors

Sl. No.	Categorization of courses for all Programmes	Minimum number of credits required	
		3-year UG	4-year UG
1	Major	68	88
2	Minor/ Minors	24	24+12*
3	Multi-disciplinary Courses (MDC)	9	9
4	Skill Enhancement Courses (SEC)	9	9
5	Ability Enhancement Course (AEC)	12	12
6	Value Addition Courses (VAC)	9	9
7	Summer Internship, field-based learning etc.	2	2
8	Project / Dissertation		12**
	Total Credits	133	177

* Students can acquire 12 credits from their DSC/ DSE- Minor courses (300-399 level) depending upon their pathway choice.

** Students pursuing a four-year Honours degree are required to complete an 8-credit project as well as one capstone course from their chosen pathway, either DSC or DSE (400-499 level).

Table 2: FYUGP Course Structure – Double Major

Sl. No.	Categorization of courses for all Programmes	Minimum number of credits required	
		3-year UG	4-year UG
1	First Major	52	72
2	Second Major	40	52
3	Multi-disciplinary Courses (MDC)	9	9
4	Skill Enhancement Courses (SEC)	9	9
5	Ability Enhancement Course (AEC)	12	12
6	Value Addition Courses (VAC)	9	9

7	Summer Internship, field-based learning etc.	2	2
8	Project/(8 Credit project + 1 capstone course)		12
	Total Credits	**133**	**177**

Table 3: FYUGP Course Structure – Multidisciplinary

Sl. No.	Categorization of courses for all Programmes	Minimum number of credits required	
		3-year UG	4-year UG
1	Multidisciplinary Major	52	72
2	Multidisciplinary Minors	40	52
3	Multi-disciplinary Courses (MDC)	9	9
4	Skill Enhancement Courses (SEC)	9	9
5	Ability Enhancement Course (AEC)	12	12
6	Value Addition Courses (VAC)	9	9
7	Summer Internship, field-based learning etc.	2	2
8	Project / (8 Credit project + 1 capstone course)		12
	Total Credits	**133**	**177**

Guidelines for Acquiring Credit from Other Institutions/Online/Distance Mode

i. A student shall register to a minimum of 16 credit per semester from the college/ department where he/she/they officially admitted for a particular programme. However, students enrolled for a particular programme in one institution can simultaneously enroll for additional credits from other HEIs within the University or outside university subject to a maximum of 30 credits per semester including the 16 institutional credits.

ii. The College shall publish a list of courses that are open for admission for students from other institutions well in advance before the commencement of each semester.

iii. Each BoS shall prepare and publish a list of online courses at different levels before the commencement of each semester offered in various online educational platforms recognized by the Academic Council of the college, which can be opted by the students for acquiring additional credits.

iv. BoS shall prepare and publish a list of allied/ relevant pathway courses before the commencement of each semester offered by other Board of Studies that can be considered as pathway course for major/ minor for their disciplines at different levels.

v. At the end of each semester the college will include the credit acquired by the student through online courses in their semester grade card subject to a maximum of 30 credits.

Attendance

i. A student shall be permitted to register for the end-semester evaluation of a specific course to acquire the credits only if he has completed 75% of the prescribed classroom activities in physical, online, or blended modes, including any makeup activities as specified by the course faculty of that particular course.

ii. A student is eligible for attendance as per the existing university and government orders which includes participation in a meeting, or events organized by the college or the university, a regularly scheduled curricular or extracurricular activity prescribed by the college or the university. Due to unavoidable or other legitimate circumstances such as illness, injury, family emergency, care-related responsibilities, bad or severe weather conditions, academic or career-related interviews students are eligible for authorized absence. Apart from this, all other eligible leaves such as maternity leave, and menstrual leave shall also be treated as authorized absences.

iii. The condonation facility can be availed as per the university norms.

Workload

i. The workload of a faculty who offers only lecture courses during an academic year shall be 32 credits.

ii. The workload of a faculty offering both practical courses and theory courses may be between 24-32 credits per academic year.

iii. An academic year shall consist of two semesters.

iv. To protect the existing language workload, college should make necessary arrangements to give adequate preference to those courses designed by language departments coming under MDC, SEC and VAC of 3rd & 4th semester. It is recommended that the MDC offered in the third semester shall be based on Indian

Knowledge Systems or Nation-specific topics and may be offered by the Other Languages department or any other department as may be seen fit. Additionally, the SEC in the fourth semester may be offered by the English Department and of the VACs in the third and fourth semesters, one may be offered by the Other Languages Department and the other may be offered by the English Department. These recommendations may be modified as per the recommendations of the SHC-UGP Academic Monitoring Committee.

v. Programme wise workload calculation will be as per the FYUGP workload ordinance 2024.
vi. The teachers given the administrative responsibilities in the department and college level may give a relaxation in their work load as specified in the UGC regulations 2018.

Credit Transfer and Credit Accumulation

i. The college will establish a digital storage (DIGILOCKER) of academic credits for the credit accumulation and transfer in line with ABC.

ii. The validity of credits earned shall be for a maximum period of seven (7) years or as specified in the university/ UGC regulations. The students shall be required to earn at least 50% of the credits from the College.

iii. Students shall be required to earn the required number of credits as per any of the pathway structure specified in this regulation for the award of the degree.

Outcome Based Approach

The curriculum will be designed based on Outcome Based Education (OBE) practices. The Graduate Attributes (GA) and Programme Outcomes (PO) will be defined and specified in the syllabus of each programme.

Assessment and Evaluation

i. The assessment shall be a combination of Continuous Comprehensive Assessment (CCA) and an End Semester Evaluation (ESE).

ii. 30% weightage shall be given for CCA. The remaining 70% weight shall be for the ESE.

iii. Teacher Specific Content will be evaluated under CCA.

iv. CCA will have two subcomponents Formative Assessment (FA) and Summative Assessment (SA). Each of these components will have equal weightage and to be conducted by the course faculty/ course coordinator offering the course.

v. FA refers to a wide variety of methods that teachers use to conduct in-process evaluations of student comprehension, learning needs, and academic progress during a lesson, unit, module or course. FA is to encourage students to build on their strengths rather than fixate or dwell on their deficits. FA can help to clarify and calibrate learning expectations for both students. FA will help students become more aware of their learning needs, strengths, and interests so they can take greater responsibility over their own educational growth. FA will be prerogative of the course faculty/ course coordinator based on specific requirement of the student.

vi. Suggestive methods of FA are as follows: (anyone or in combinations as decided by the course faculty/ course coordinator)

a. Practical assignment
b. Observation of practical skills
c. Viva voce
d. Quiz
e. Interview
f. Oral presentations
g. Computerized adaptive testing
h. In-class discussions
i. Group tutorial work
j. Reflection writing assignments
k. Home assignments
l. Self and peer Assessments
m. Any other method as may be required for specific course/ student by the course faculty/ course coordinator.

vii. Summative Assessments (SA) are used to evaluate student learning, skill acquisition, and academic achievement at the conclusion of a defined instructional period- typically at the end of a project, unit, module, course or semester. SA may be a class tests, assignments, or project, used to determine whether students have learned what they were expected to learn. It will be based on evidence, collected using single or multiple ways of assessment. The systematically collected evidences should be kept in record by course faculty/ course coordinator and the marks should be displayed on the college notice board/ other official digital platforms of the college before the end semester examinations.

viii. The method of SA will be as follows: (any one as decided by the course faculty/ course coordinator)

a. Written test
b. Open book test
c. Laboratory report
d. Problem based assignments
e. Individual project report
f. Case study report
g. Team project report
h. Literature survey
i. Standardized test
j. Any other pedagogic approach specifically designed for a particular course by the course faculty/ course coordinator.

ix. A student may repeat SA only if for any compulsive reason due to which the student could not attend the assessment.

x. The prerogative of arranging a CCA lies with the course faculty/ course coordinator with the approval of SHC-UGP Academic Committee based on justified reasons.

xi. The course faculty/ course coordinator shall be responsible for evaluating all the components of CCA. However, the college may involve any other person (External or Internal) for evaluation of any or all the components as decided by

the Principal/Controller of Examinations from time to time in case any grievances are raised.

xii. Written tests shall be precisely designed using a variety of tools and processes (e.g., constructed responses, open-ended items, multiple-choice), and the students should be informed about the evaluation modalities before the commencement of the course.

xiii. The course faculty may provide options for students to improve their performance through continuous assessment mechanism.

xiv. There shall be theory and practical examinations at the end of each semester.

xv. Regarding evaluation, one credit may be evaluated for 25 marks in a semester; thus, a 4-credit course will be evaluated for 100 marks; 3-credit courses for 75 marks and 2-credit courses for 50 marks.

xvi. All examinations will be conducted by the College and will be evaluated at the College itself.

xvii. Individual Learning Plans (ILPs) and/ or specific assessment arrangements may be put in place for differently abled students. Suitable evaluation strategies including technology assisted examinations/ alternate examination strategies will be designed and implemented for differently abled students.

Mark Distribution for Assessment of SHC-UGP(Hons.) Courses

Mark Distribution for a <u>4-Credit Courses without Practical</u>	
a) Marks of End Semester Evaluation (ESE)	70
b) Marks of Continuous Comprehensive Assessment (CCA)	30
Total Marks	**100**
Mark Distribution for a <u>4-Credit Courses with Practical</u>	
Theory (3 Credits):	
a) Marks of End Semester Evaluation (ESE)	50
b) Marks of Continuous Comprehensive Assessment (CCA)	25
Practical (1 Credit):	
a) Marks of End Semester Evaluation (ESE)	20
b) Marks of Continuous Comprehensive Assessment (CCA)	05
Total Marks	**100**

Mark Distribution for a 3-Credit Courses without Practical	
a) Marks of End Semester Evaluation (ESE)	50
b) Marks of Continuous Comprehensive Assessment (CCA)	25
Total Marks	**75**
Mark Distribution for 3 Credit Courses with Practical	
Theory (2 Credits):	
a) Marks of End Semester Evaluation (ESE)	35
b) Marks of Continuous Comprehensive Assessment (CCA)	15
Practical (1 Credit):	
a) Marks of End Semester Evaluation (ESE)	20
b) Marks of Continuous Comprehensive Assessment (CCA)	05
Total Marks	**75**

Practical Examination

i. The end semester practical examination will be conducted and evaluated by the institution.

ii. There shall be a CCA for practical courses conducted by the course faculty/ course coordinator.

iii. The scheme of evaluation of practical courses will be as given below:

Components for the Evaluation of Practical Courses	**Weightage**
CCA of practical/practicum.	30%
ESE of practical/practicum.	70%

iv. Those who have completed the CCA alone will be permitted to appear for the ESE.

v. For grievance redressal purpose, the university shall have the right to call for all the records of CCA.

vi. Duration of Examination: Questions shall be set as per the defined Outcome. The duration of the examinations shall be as follows;

Mode	Time (in Hours)
Written Examination	2
Multiple Choice	1.5
Open Book	2
Any Other Mode	2

Evaluation of Project/Dissertation

The evaluation of project work shall be CCA with 30% and ESE 70%. The scheme of evaluation of the Project is given below:

Project type	Maximum Marks	CCA	ESE
Research Project of Honours with Research (12 credits)	200	60	140
Project of Honours (8 credits)	100	30	70

Evaluation of Internship

The evaluation of internship shall be done by a committee constituted by the Department Council. The scheme of CCA and ESE is given below:

Components of Evaluation ofInternship	Weightage	Marks for Internship 2 Credits/ 50 Marks
CCA	30%	15
ESE	70%	35

The department council may decide any mode for the completion of the Internship. If in case evaluation is not specified in any of the selected internship programme, institution can adopt a proper evaluation method as per the weightage specified in the table above.

Letter Grades and Grade Points

Mark system is followed for evaluating each question. For each course in the semester, letter grade and grade point are introduced in 10-point indirect grading system as per guidelines given below,

i. The Semester Grade Point Average (SGPA) is computed from the grades as a measure of the student's performance in a given semester. The SGPA is based on the grades of the current term, while the Cumulative Grade Point Average (CGPA) is based on the grades in all courses taken after joining the programme of study.

ii. Based on the marks obtained, the weighted grade point will be mentioned in the student's grade cards.

Letter Grade	**Grade Point**	**Percentage of Marks (Both Internal & External Marks put together)**	**Class**
O (Outstanding)	10	95% and above	First Class with Distinction
A+ (Excellent)	9	85% and above but below 95%	
A (Very good)	8	75% and above but below 85%	
B+ (Good)	7	65% and above but below 75%	First Class
B (Above average)	6	55% and above but below 65%	
C (Average)	5	45% and above but below 55%	Second Class
P (Pass)	4	35% and above below 45% Aggregate (external and internal put together) with a minimum of 30% in external	Third Class
F (Fail)	0	Below an aggregate of 35%or below 30% in external evaluation	Fail
Ab (Absent)	0		Fail

iii. When students take audit courses, they may be given pass (P) or fail (F) grade without any credits.

Computation of SGPA and CGPA

The following method is recommended to compute the Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA):

iv. The SGPA is the ratio of the sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student and the sum of the number of credits of all the courses undergone by a student in the semester, i.e.

$$\mathbf{SGPA}\ (Si) = \Sigma(Ci \times Gi) / \Sigma Ci$$

Where Si is the SGPA in the i^{th} semester, Ci is the number of credits of the i^{th} course and Gi is the grade point scored by the student in the i^{th} course.

$$\textbf{SGPA} = \frac{\text{Sum of the credit points of all courses in a semester}}{\text{Total Credits in that Semester}}$$

Illustration – Computation of SGPA

Semester	**Course**	**Credit**	**Letter Grade**	**Grade point**	**Credit Point** (Credit x Grade)
I	DSC A	4	A	8	4 x 8 = 32
I	DSC B	4	B+	7	4 x 7 = 28
I	DSC C	4	B	6	4 x 6 = 24
I	MDC	3	B	6	3 x 6 = 18
I	AEC 1	3	O	10	3 x 10 = 30
I	AEC 2	3	C	5	3 x 5 = 15
	Total	21			147
	SGPA				147/21 = 7

The CGPA is also calculated in the same manner considering all the courses undergone by a student over all the semesters of a programme, i.e.

$$\textbf{CGPA} = \frac{\text{Sum of the credit points of all courses in six or eight semesters}}{\text{Total Credits in Six (133) or Eight (177) semesters}}$$

v. The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.

Implementation and Monitoring of SHC-UGP

i. The implementation and monitoring of SHC-UGP will be carried out by duly appointed bodies/committees of the college such as the Academic Council, the various Boards of Studies and the Academic Monitoring Committee.

ii. Academic Council

Among its other functions, the Academic Council of the College shall:

i. Scrutinize and approve all the proposals submitted by the Board of Studies of each Department with regard to the SHC-UGP details such as, academic pathways, allowed syllabi enrichment/ updating, details of elective courses, Online courses, blended teaching, courses offering to the students of other HEIs, panel of examiners, summative and formative evaluation tools proposed by the course faculty concerned, new courses and syllabus proposed by the faculty members as signature courses etc.

ii. The Academic Council can differ on any proposal and it shall have the right to return the matter for reconsideration to the Board of Studies concerned or reject it, after giving sufficient reasons to do so.

iii. Undertake the scrutiny of all documents related to Teacher Specific Content.

iv. Recommend to the College Governing Council for starting innovative programmes using the flexibility and holistic nature of the SHC-UGP curriculum frame work.

iii. Board of Studies

Among its other functions, the Board of Studies of each Department shall:

i. Prepare teacher specific content of syllabi for various courses keeping in view the objectives of the SHC-UGP and submit the same for the approval of the Academic Council.

ii. Scrutinize the signature course content and its evaluation techniques.

iii. Suggest methodologies for innovative teaching and evaluation techniques.

iv. Suggest panel of examiners to the Office of the Controller of Examinations.

v. Coordinate research, teaching, extension and other academic activities in the department.

iv. SHC-UGP Academic Monitoring Committee

The SHC-UGP Academic Monitoring Committee shall be constituted under the Chairmanship of the Principal, with the Academic Coordinator as the Convenor, shall be entrusted to oversee the implementation and monitoring of the SHC-UG programme.

i. The Academic Monitoring Committee will collect and whet the proposals submitted by the Board of Studies of each Department regarding the SHC-UGP and duly forward them to the Academic Council.

ii. It will oversee and coordinate the activities undertaken for the successful implementation of SHC-UGP in the College and will function as an advisory body in such matters.

Power to Remove Difficulties

If any difficulty arises in giving effect to the provisions of these Regulations, the Principal may by order make such provisions which appears to him/her to be necessary or expedient for removing the difficulty. Every order made under this rule shall be subject to ratification by the appropriate authorities.

Modifications to the Regulations

Notwithstanding anything contained in these Regulations, any amendments or modifications issued or notified by the University Grants Commission or the State Government or the Mahatma Gandhi University from time to time, shall be incorporated into these Regulations by the appropriate regulatory bodies of the College and shall constitute an integral part thereof.

3. SYLLABUS INDEX

BOTANY

SEM	Course Code	Course Title	Course Level	Credit	Hours per Week	
					Theory	*Practical*
DISCIPLINE SPECIFIC COURSES (DSC)						
I	24UBOTDSC101	Plant Science and Its Advancements	100-199	4	3	2
II	24UBOTDSC102	Plant Resource Management	100-199	4	3	2
III	24UBOTDSC201	Microbiology and Phycology	200-299	4	3	2
	24UBOTDSC202	Plant Anatomy and Reproductive Biology	200-299	4	3	2
IV	24UBOTDSC203	Bryology, Pteridology and Gymnosperms	200-299	4	3	2
	24UBOTDSC204	Mycology And Plant Pathogen Interaction	200-299	4	3	2
	24UBOTDSC205	Angiosperm Morphology and Economic Botany	200-299	4	4	0
V	24UBOTDSC301	Angiosperm Systematics	300-399	4	3	2
	24UBOTDSC302	Cell And Molecular Biology	300-399	4	3	2
VI	24UBOTDSC304	Plant Physiology	300-399	4	3	2
	24UBOTDSC305	Genetics and Evolution	300-399	4	3	2
VII	24UBOTDSC401	Advancements in Thallophytes	400-499	4	3	2
	24UBOTDSC402	Advancements in Archegoniates	400-499	4	4	0
	24UBOTDSC403	Modern Trends in Plant Systematics	400-499	4	4	0
VIII	24UBOTDSC404	Plant Physiology and Metabolism	400-499	4	3	2
	24UBOTDSC405	Plant Breeding and Propagation Techniques	400-499	4	3	2
DISCIPLINE SPECIFIC ELECTIVE COURSES (DSE)						
III	24UBOTDSE201	Ethnobotany	200-299	4	4	0
V	24UBOTDSE301	Biotechnology and Genetic Engineering	300-399	4	4	0
	24UBOTDSE302	Phytogeography and Forestry	300-399	4	4	0
	24UBOTDSE303	Green Technology and Sustainable Development	300-399	4	4	0
VI	24UBOTDSE304	Plant Chemical Ecology	300-399	4	4	0
	24UBOTDSE305	Plant Ecology, Conservation and Sustainable Development	300-399	4	4	0

SEM	Course Code	Course Title	Course Level	Credit	Hours per Week	
					Theory	*Practical*
	24UBOTDSE306	Science Perspectives and Methodology	300-399	4	4	0
	24UBOTDSE307	Plant Animal Interactions and Pollination Biology	300-399	4	4	0
VII	24UBOTDSE401	Scientific Research, An in-Depth Approach	400-499	4	4	0
	24UBOTDSE402	Phytochemistry And Pharmacognosy	400-499	4	4	0
	24UBOTDSE403	Modern Trends in Genomics	400-499	4	4	0
VIII	24UBOTDSE404	Data Management for Plant Science	400-499	4	4	0
	24UBOTDSE405	Field Botany	400-499	4	4	0
DISCIPLINE SPECIFIC COURSES (DSC) - *Minor Pathway*						
I	24UBOTDSC101	Plant Science and Its Advancements	100-199	4	3	2
II	24UBOTDSC102	Plant Resource Management	100-199	4	3	2
III/IV	24UBOTDSC207	Floriculture and Olericulture	200-299	4	3	2
MULTIDISCIPLINARY COURSES (MDC)						
I	24UBOTMDC101	Ecotourism and Its Novel Trends	100-199	3	3	0
II	24UBOTMDC102	Outdoor Garden Management	100-199	3	3	0
III	24UBOTMDC103	Agri-Based Microenterprises	200-299	3	3	0
SKILL ENHANCEMENT COURSES (SEC)						
IV	24UBOTSEC201	Flower Arrangement and Fruit Carving	200-299	3	3	0
V	24UBOTSEC301	Mushroom Cultivation and Value-Added Products	300-399	3	3	0
VI	24UBOT SEC302	Macro-Photography with An Emphasis on Plant Science	300-399	3	2	2
VI	24UBOTSEC303	Botany In Real World Scenario	300-399	3	2	2
VALUE ADDITION COURSES (VAC)						
IV	24UBOTVAC201	Conservation Biology	200-299	3	3	0
VI	24UBOTVAC301	Environmental Science and Human Rights	300-399	3	3	0

Discipline Specific Course (DSC) – 01

Discipline/Programme	BOTANY				
Semester	**I**				
Type of Course	DSC				
Course Code	24UBOTDSC101				
Course Title	**PLANT SCIENCE AND ITS ADVANCEMENTS**				
Course Level	100-199				
Course Summary	The course entitled 'Fascinating World of Plant Science and Technology' aims to impart an understanding on the significance of plants to the future generation. Students will be familiarized with eminent botanists and their contributions to plant science. They will be introduced to the major plant groups and their uniqueness in terms of size, shape, habitat and associations. Students are expected to develop a passion to explore the plant kingdom as well as to make serious attempts to conserve plants. Knowledge about traditional and modern approaches in plant sciences and major branches related to plant science will also be acquired.				
Lecture/Tutorial/Practical Hours	75				
Credits	4	Theory	3	Practical	1
Pre-requisite, if any	Should have basic knowledge of Botany and have a natural intelligence				

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO
1	Comprehend the relevance of plants in nature, important milestones in the history of botany, and human efforts to realize life on Earth.	U	1, 5, 3, 8
2	Illustrate the diversity and evolutionary trends throughout the plant world that lay a solid foundation for the branch of natural philosophy, botany.	An	1, 2, 3,6, 8
3	Develop basic skills on instruments and techniques used in Botanical studies.	A	2
4	Facilitate awareness on the areas of research and potentials in the field of plant science.	A	1, 2, 7
5	Design experiments and communicate ideas, which would translate into a lasting and practical basis for building a career based on botany	C	1, 2, 7, 8
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)			

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	**Exploring the Plant Kingdom (23 Hours)**			
	1.1	A Journey Through Botanical History: Contributions of eminent botanists/naturalist: (a) Theophrastus, (b) Carl Linnaeus (c) John Ray (d) Nicolai Ivanovich Vavilov (c) Itty Achudan (d) Janaki Ammal Brief overview of Botany, citing events that changed the course of world history: Rice, Potato, Sugarcane and *Penicillium notatum, Phytophthora infestans*	4	1
	1.2	Plants and the Planet: maintaining ecological balance **<u>Learning Activity</u>**: Group Discussion on ●Usefulness and benefits of plants ●Significance of Plants as problem solver of our planet.	3	1

	1.3	Distinguishing characters and evolutionary trends in the **morphology** of major groups of plants: Algae, Bryophytes, Pteridophytes, Gymnosperms and Angiosperms. **<u>Learning Activity:</u>** An explorative nature walks to understand biodiversity of a selected locality: Paddy Field / Wetland ecosystem / Sacred Groves / Any other locality which harbors biodiversity and represents most of the major plant groups.	10	2
	1.4	Wonders of the plant world: • Unusual foods: Fungi (Mushrooms), Lichen (*Parmelia*), *Chlorella* as food supplement in aerospace programmes. • Psychoactive plants and zoopharmacognosy: Marula plant (*Sclerocarya birrea*); Lemurs eating tamarind and fig leaves. Biomimicry: Nature as model: Lotus effect® technology in paint industry; *Citrus maxima* fruit wall inspired design of crash absorbing structures. • Special Adaptations: Insectivorous plants, Heliotropism in sunflowers, Pseudocopulation strategy in orchids. • Gigantic plants: e.g. *Sequoiadendron giganteum*. • Plants that live in extreme environments: volcanoes: Haleakala silversword, desert: Saguaro cactus, arctic: Arctic poppy	6	2
2	**Traditional and Modern Approaches in Plant Science (17 Hours)**			
	2.1	Traditional approach and methods: (A) Exploration: Field Visit. (B) Collection of plant material: significance & tools used. (C) Preservation: Killing Agent: (Formalin), Fixing Agent: (FAA). Wet Preservation: Museum jar preservation. dry preservation: herbarium. (D) Free-hand sectioning: Transverse section (TS), Longitudinal section (LS)	4	3
	2.2	(E) Description: Description of plants. (F) Classification: Artificial, Natural and Phylogenetic (Definition and One	2	3

		Example Each). (G) Documentation: Significance of scientific diagrams and field books.		
	2.3	Modern Approaches: (A)Sectioning: Microtomy (Definition and purpose of rotary microtome, sledge microtome and ultramicrotome). (B) visualization techniques: parts and applications of simple & compound microscope, applications of electron microscope (SEM & TEM). (C) Separation techniques (Principle and Application): (i) Chromatography: TLC and Paper chromatography. (ii) Centrifugation: tabletop centrifuge and ultracentrifuge. (iii) Electrophoresis: agarose gel electrophoresis (AGE).	6	3
	2.4	A few current approaches and applications: (A)Molecular techniques (General Account and Applications): PCR, DNA barcoding (B) Remote Sensing (Brief Account): Application of Remote sensing and GIS for mapping of natural resources. (C) Use of Internet of Things (IoT), Deep learning and artificial intelligence (AI): Detection of water stress and disease detection in smart/precision Farming. **<u>Learning Activity 3:</u>** Visit to a laboratory to familiarize with a few of the instruments mentioned above.	5	3, 5
3	**Major Branches and Scope of Plant Science (5 Hours)**			
	3.1	Brief account and research potential in: Plant systematics, Ecology, Plant anatomy, Plant physiology, Genetics, Ethnobotany, Crop improvement & Plant genetic engineering	5	4, 5
4	**Practical (30 hours)**			
	4.1	Field Activities (Mandatory) • Conduct a two days field trip and survey, to appreciate the diversity of plant kingdom and to identify plants belonging to all the major groups discussed in theory. Prepare a set of 12 geo-tagged photographs containing at least one representative from each Major group.	15	2

	4.2	Laboratory Activities (Conduct Any Three) • Prepare a report and presentation on Botanists who made significant contributions to science • Familiarize students with a compound microscope and dissecting / simple microscope. Assess the magnifications of the microscope you are examining. Compare the real image (Naked eye) with the magnified virtual image of an appropriate plant specimen and make illustrations of magnified specimens. • Prepare temporary, single stained hand sections (TS and LS; one each) of appropriate plant specimens for light microscopic studies. • Design a working model for detecting Moisture of Soil/ Temperature and Humidity of Air, utilizing Arduino microcontroller kit/ Raspberry pi or other microcontroller boards and appropriate sensors. Possibilities to utilize IoT, as part of the model may be explored, if needed. • Prepare an extract of leaves of appropriate plant material and perform centrifugation using a table top centrifuge, decant to separate the pigments (Supernatant) from the debris (Pellet).		
5	**Teacher specific course components**			

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Discipline Specific Course (DSC) – 02

Discipline/Programme	**BOTANY**				
Semester	II				
Type of Course	DSC				
Course Code	24UBOTDSC102				
Course Title	**PLANT RESOURCE MANAGEMENT**				
Course Level	100-199				
Course Summary	The course aims to impart knowledge on the importance of plants and plant-based products in everyday life. Several plant resources-based industries are successfully established in our society. Plethora of opportunities and innovations in plant science research are also discussed. Plant crafting and plant architect opportunities are explored. The course is designed to equip students with technical knowhow on business prospects and develop skills needed to successfully convert them into entrepreneurial ventures. On completion, learners will be able to develop ideas and enable them to be professionally competent so as to convert their ideas to successful business opportunities. This course aims at molding a successful entrepreneur through various avenues of Plant Science				
Lecture/Tutorial/Practical Hours	75				
Credits	4	Theory	3	Practical	1
Pre-requisite, if any	Should have basic knowledge on plants resources and its importance in everyday life				

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO
1	Identify and assess plant resources in various contexts.	U	1, 2, 3, 8
2	Understand the problems are approaches in agriculture, health and in environmental contexts critically	U	1, 2, 4, 7
3	Summarize the foundational knowledge about sustainable agriculture, horticultural activities, organic farming, nursery management and mushroom cultivation to human welfare.	U	2, 3, 5, 7, 8
4	Develop an understanding of entrepreneurial opportunities in plant science and fostering an entrepreneurial mindset	C	1, 2, 3, 4, 7
5	Reframe the significance of the plant world, gain insights into the potentials of personal prosperity and career opportunities in plant science.	E	1, 2, 6, 8
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)			

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	**Introduction to Plant Resources (15 Hours)**			
	1.1	Plants in everyday life: (General an outline with an example) ● Importance as food, ● Source of medicine, ● Cultural and aesthetic value. ● Role of plants in maintenance of air, water and soil quality, ● Plants as ecological indicators, ● Bio-control agents, ● Plant based bio manure, ● Plant-based bioplastics and ● Plant based biofuels.	2	1
	1.2	Plants as resource: (General account with special reference to the following): ● Drug yielding plants: Sarpagandha, *Vinca* - drug and its uses	10	1

		● Plant as staple food: Rice, Cassava - morphology of useful part and nutritional benefits ● Plant as source of fiber: Cotton and Coir - useful part and commercial aspects ● Rubber yielding plants: Pará rubber tree - commercial aspects ● Plants yielding essential oils: Eucalyptus and lemongrass – Industrial values ● Vegan Cosmetics: ● Cleanser: Cucumber, Rose ● Hair and Skin care products: Amla. Henna, Bhringaraj, Tulsi, Turmeric		
	1.3	Plant-based industries: (Basic outline only neede) ● Fruit production and processing: Dry Fruits and Canning. ● Fruit and Vegetable-based products: Squash, Syrup, Pulp, Paste, Ketchup, Soup, Vegetable Sauces, Jam and Jellies. ● Bamboo and Cane-based products. ● Production of Nutraceuticals.	3	1
2	**Exploring Plant Science Research (15 Hours)**			
	2.1	Introduction to plant science research: Significance in addressing global challenges like: Climate change, Food Security, Biodiversity conservation - brief account	2	2
	2.2	Innovation in plant Science: (Mention only) Crop improvement-Flood resistant rice, Green Revolution (Norman Borlaug- high Yielding Wheat), Genetic engineering - Bt-Cotton, gene editing for disease resistance, Synthetic biology – brief account	3	2
	2.3	Brief account on research institute in India, which identifies plant science / botany as a thrust area for investigation. Botanical Survey of India (BSI), National Bureau of Plant Genetic Resources (NBPGR), National Rice Research Institute (NRRI), Indian Institute of Sugarcane Research (IISR), Institute of Forest genetics and Tree Breeding	10	2

		(IFGTB), Jawaharlal Nehru Tropical Botanic Garden and Research Institute (JNTBGRI), Kerala Forest Research Institute (KFRI), Central Plantation Crops Research Institute (CPCRI), Central Tuber Crops Research Institute (CTCRI), Rubber Research Institute of India (RRII) and ICRISAT (International Corp Research Institute for Semi-Arid Tropics)		
3	**Insights into Botanical Entrepreneurship and Sustainable Future (15 Hours)**			
	3.1	Introduction to entrepreneurship: ● Definition and significance in the context of plant science. Basic traits and skills for entrepreneurs. ● Brief exploration of successful plant-based startups and their impact- Grow the Funguy, Vgrow, Jackfruit 360, Synthite, Coonfresh, Purple Pod, Paul & Mike etc.	3	4
	3.2	Identifying problems or opportunities within the plant science domain. ● Steps in the entrepreneurial journey: Overview of market assessment, enterprise selection, and resource mobilization. Schemes for Financial Assistance. Brief introduction to IPR, copyrights and GI tags.	4	4
	3.3	● Career paths in Botany: Few of the industries where a botanist can work: Research Lab/Institutions, Chemical Industry, Food Companies, Arboretum, Forest Services, Biotechnology Firms, Oil Industry, Land Management Agencies, Seed and Nursery Companies, Plant Health Inspection Services, National Parks, Biological Supply Houses, Plant Resources Laboratory and Educational Institutions ● Opportunities in Green World: General – (Scientific assistant, Plant geneticist, Computational biologist, Field botanist, Naturalist, Biotechnologist, Molecular Biologist, Nursery Manager, Plant Researcher,	8	5

		Teacher/Professor, Plant Pathologist, Ecologist, Plant Biochemist, Environmental Conservationist, Plant Microbiologist, Environment Consultant, Horticulturist, Plant explorer, Taxonomist, Cytologist, Biological Technician, Park Ranger, Nursery or Greenhouse manager, Farming consultant, Paleobotanist) ● Government opportunities (General discussion): Staff Selection Commission (SSC), Institute of Banking Personnel Selection (IBPS) and State bank of India (SBI), Kerala Public Service Commission (PSC), Union Public Service Commission (UPSC)/Civil services, CDS exam, Junior research fellowship (JRF), senior research fellowship (SRF), National Eligibility Test (NET) and Indian Forest Service exam (Discussion) **Activity 2:** Conduct a one-day workshop for students to confer awareness on academic progression, research, career and entrepreneurial prospects and opportunities in Botany.		
4	**Practical (30 hours)**			
	4.1	Field Activities (Mandatory) ❖ Conduct one day industrial visit: To plant-based industry in your near vicinity. ❖ Prepare a detailed report on functioning, products and marketing with the support of proper evidence and Geo-tagged photographs	10	2, 3, 4, 5, 7
	4.2	Laboratory Activities (Conduct any Two) ❖ Online course on Botanical entrepreneurships ❖ Industry visits and report preparation ❖ Group discussion on entrepreneurial ideas and report preparation ❖ Video preparation on botanical ideas	20	2, 3, 4, 5, 7
5	**Teacher specific course components**			

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Discipline Specific Course (DSC) – 03

Discipline/Programme	Botany				
Semester	III				
Type of Course	DSC				
Course Code	24UBOTDSC201				
Course Title	**MICROBIOLOGY AND PHYCOLOGY**				
Course Level	200-299				
Course Summary	The course will give an insight towards the diversity of microbes and algal flora. The study of microbiology provides a comprehensive understanding of microbes, its principles, and its applications in various fields, whereas phycology deals with the study of algae. Being the primary produces, both micro and macroalgae plays a significant role in aquatic ecosystems. Students learn its salient/ diagnostic features and its importance to ecosystems. It also focuses on the economic and ecological significance and its applications.				
Lecture/Tutorial/Practical Hours	75				
Credits	4	Theory	3	Practical	1
Pre-requisite, if any	Basic botanical learning and laboratory skills				

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO
1	Realize the world of microbes and its significance	U	PO 1, PO2, PO4, PO5, PO7, PO 8
2	Examine the range of thallus structure, pigment composition, photosynthetic end products and reproduction in various algal groups.	An	PO1, PO 2, PO3, PO6, PO 7

3	Demonstrate a comprehensive understanding of the economic importance of algae. Examining the ecological significance and research potential of algae	U	PO1, PO2, PO 3, PO 4, PO 5, PO 7, PO 8
4	Analyse the identifying features of microbes and algae	An	PO1, PO2, PO3, PO4, PO5, PO7, PO 8
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)			

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	**Microbiology (15 hours)**			
	1.1	Three domains of life, General characters of Bacteria, Archaea and Eukarya. Bacteria: General characters, classification based on staining, morphology and flagellation. Ultra structure of bacteria. Reproduction - binary fission. Genetic recombination in bacteria - conjugation, transformation and transduction.	6	1
	1.2	Viruses: General characters of viruses, Structure of TMV and Bacteriophage (λ). Multiplication of λ phage – lytic and lysogenic cycle. Viroid and prions.	4	1
	1.3	Applications of microbes in industry, agriculture, food and medicine. Microbes in environmental conservation, waste management and as biocontrol agents.	5	1
2	**Introduction to Phycology (20 hours)**			
	2.1	Classification by Fritsch (1945) [up to class]; brief introduction to the modern classification by Lee (2016).	2	2
	2.2	Distribution, habitat diversity, range of thallus structure, pigment composition and photosynthetic end product in various groups of algae. Reproduction - vegetative,	4	2

		asexual and sexual reproduction. Major life cycle patterns found in algae (outline only).		
	2.3	Salient features and thallus structure of algae in the following groups with special reference to the type(s) mentioned: Cyanophyceae - *Nostoc*; Chlorophyceae - *Spirogyra, Chara* Bacillariophyceae - *Pinnularia*; Phaeophyceae– *Sargassum;* Rhodophyceae – *Polysiphonia*	14	2
3	**Economic importance of Algae, Ecology and Perspectives of Algal Research (10 hours)**			
	3.1	Useful aspects of algae: Food, SCP, Biofertilizers, Medicine Exploration of algae as source of valuable commercially important products-carrageenan, agar-agar, alginate, diatomite. Harmful effects of algae: Algal blooms, eutrophication, neurotoxins.	3	3
	3.2	Algae as primary producers and ecosystem engineers Algal associations and its significance (Parasitic algae, Symbiotic algae-association of algae with fungi, bryophytes, pteridophytes, gymnosperms, angiosperms, invertebrates) Algae based wastewater treatment for biodiesel production Role of algae as bioremediation agents. Role of algae in N2 fixation	5	3
	3.3	Role of algae in scientific research Brief overview on cultivation of macroalgae and microalgae.	2	3
4	**Practical (30 hours)**			
	Microbiology (10 hours)			
	4.1	Gram staining Isolation of microbes from soil through serial dilution	8	1,4
	4.2	Demonstrate the culture of bacteria.	1	1,4

	4.3	Microbes and type of fermentation - vine, vinegar, curd	1	1,4
	Phycology (20 hours)			
	4.4	Conduct a field visit to any one of the ecosystems rich in algae to experience algal diversity. Submit a report with photographs or Collect algae from diverse habitats, observe through microscope and click photographs and submit a report.	3	2,3,4
	4.5	Make micro preparations of thallus structures of the types mentioned in the syllabus.	16	2,3,4
	4.6	Familiarizing the technique of algal collection and preservation	1	2,3,4
5	**Teacher specific course components**			

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Discipline Specific Course (DSC) – 04

Discipline/Programme	**BOTANY**				
Semester	III				
Type of Course	DSC				
Course Code	24UBOTDSC202				
Course Title	**PLANT ANATOMY AND REPRODUCTIVE BIOLOGY**				
Course Level	200-299				
Course Summary	This course delves into the multifaceted realm of plant biology, exploring the intricate structures and functions of plant cell walls, essential for cell integrity and intercellular communication. It elucidates plant tissues' classification, structure, and pivotal roles in growth and adaptation. Through detailed study of plant anatomy, including primary and secondary structures of stems, roots, leaves, and wood, students grasp the nuances of dicotyledonous and monocotyledonous plants. The course culminates in a comprehensive analysis of the complex reproductive processes of flowering plants.				
Lecture/Tutorial/Practical Hours	75				
Credits	4	Theory	3	Practical	1
Pre-requisite, if any					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1.	Analyze the intricate structure and diverse composition of plant cell walls, and evaluate their significance in maintaining cell integrity, facilitating intercellular communication, and harnessing renewable resources for bioethanol production.	R, U	PO1, PO2, PO8
2	Understand the fundamental concepts of plant tissues, including their classification, structure, and functions, as	R, U	PO1, PO2, PO8

	well as their roles in plant growth, development, and adaptation.		
3	Recognize plant anatomy and growth processes, including primary and secondary structures of stems, roots, leaves, and wood in dicotyledonous and monocotyledonous plants.	R, U	PO1, PO2, PO8
4	Analyze and explain the intricate processes involved in the reproduction of flowering plants.	U, An	PO1, PO2, PO8
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	**Anatomical organization of plant body - Primary structure (15 hours)**			
	1.1	● Cell wall: Structure of plant cell wall – Primary wall, Secondary Wall and Middle lamella. ● Ultrastructure of Cell Wall - Cellulose chain, Microfibril, Macrofibril, and Cellulose Fiber. ● Pits – definition, types - simple and bordered pits; structure and function of Plasmodesmata. ● Cell wall materials – Cellulose, Hemicellulose, Pectin, Lignin, Suberin, Cutin, Enzymes ● Cellulose in bioethanol production (brief account)	5	1
	1.2	● Tissues – Definition, types – Meristematic tissue and Permanent tissue. ● Meristematic tissue – definition, characteristic features. ● Permanent tissues – Simple tissues, Complex tissues, and Secretory tissues. ● Simple tissues – Definition, Types - Parenchyma, Collenchyma and Sclerenchyma. ● Complex tissues - Definition, Types – Xylem and Phloem. ● Secretory tissues - Definition, Types – External and Internal secretory tissue systems	10	2

		• Tissue systems – Definition, Types - epidermal tissue system, Ground tissue system and Vascular tissue system		
2	**Anatomical organization of Plant body - Secondary structure (15 hours)**			
	2.1	a) Primary structure of stem – Dicot and monocot stem b) Primary structure of root – Dicot and monocot root c) Leaf anatomy – Dicot and monocot leaf	6	3
	2.2	a) Normal Secondary Growth - Secondary growth in dicot stem and root, Periderm formation, Bark and Lenticels. b) Anomalous secondary growth: *Bignonia* stem and *Dracaena* stem. c) Growth rings and Dendrochronology	6	3
	2.3	a) Wood – definition, basic structure of wood, tyloses formation b) Heart wood and Sap wood; Hard wood and Soft wood c) Reaction wood - Tension wood and compression wood.	3	3
	Reproductive Botany (15 hours)			
	3.1	Flower as a reproductive organ, floral components, and their roles.	1	4
	3.2	Microsporangium and male gametophyte, Microsporangium: structure and development of anther, microsporogenesis, Male gametophyte development, dehiscence of anther, structure of pollen.	3	4

3	3.3	Megasporangium and female gametophyte, Megasporangium: types of ovules – anatropous, orthotropous, amphitropous, campylotropous, circinotropous. Megasporogenesis – female gametophyte – structure of a typical embryo sac, types of embryo sacs - monosporic (Polygonum type).	6	4
	3.4	Fertilization: Mechanism of pollination, agents of pollination, Pollinators and global food security, Pollen pistil interaction, germination of pollen grains; double fertilization.	3	4
	3.5	Endosperm and Embryo development: Endosperm: types – cellular, nuclear and helobial. Embryogeny, structure of dicot and monocot embryo, seed formation. Polyembryony; Apospory	2	4
	Practical (30 hrs)			

4	4.1	Compound light microscope – parts and working**,** hand sectioning and slide preparation for microscopy, staining and fixing of specimens. Select and conduct any two of the following learning activities a/b/c//d (**Individual/Group):** a. Submission of an assignment on anatomical organization of the plant body based on the higher secondary level syllabus. b. Collect herbaceous members of dicot and monocot– prepare stained sections of root, stem, leaves, and flower bud. c. Prepare photographs of each and locate – Tissue types, epidermal, ground, and vascular tissue systems. d. Identify locally available plants with secretory tissues and prepare a report/ poster/audiovisual document. I. Micro preparation of root and stem after secondary thickening. II. Micro preparation of *Bignonia* stem after secondary thickening. III. Identification of commercial wood of Teak, Mahogany (*Swietenia* spp), *Dalbergia* (Indian rose wood)	20	1, 3, 4
	4.2	**I.** Dissect a flower and document (photograph/illustration) **II.** Identification of C.S of the anther. **III.** Identification and documentation of anther dehiscence pattern in five locally available plants. **IV.** Pollen viability tests – Acetocarmine test / Tetrazolium test **V.** Pollen germination test - Sugar solution test. **VI.** Dissection of dicot embryo.	10	6
5	**Teacher specific course components**			

References

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Discipline Specific Course (DSC) – 05

Discipline/Programme	**Botany**				
Semester	IV				
Type of Course	DSC				
Course Code	24UBOTDSC203				
Course Title	**BRYOLOGY, PTERIDOLOGY AND GYMNOSPERMS**				
Course Level	200-299				
Course Summary	The course provides a basic overview regarding the evolutionary significance, classification, morphology, and distinguishing characters of archegoniate. It also gives a basic outlook towards the ecological and economic significance of Archegoniates.				
Lecture/Tutorial/Practical Hours	75				
Credits	4	Theory	3	Practical	1
Pre-requisite, if any					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO
1	Explain the general characters of Archegoniates	U	PO4
2	Classify archegoniates to different plant groups	A	PO1, PO2
3	Compare the structure of gametophyte and sporophyte of Archegoniates	AN	PO1, PO2
4	Assess the economic and ecological significance of Archegoniates	E	PO7

5	Discuss the recent trends in archegoniate research	U	PO4, PO8
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)			

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	**Introduction to Archegoniates (5 hours)**			
	1.1	Unifying features of archegoniates; Transition to land habit; Alternation of generations.	2	1
	1.2	Evolution/ transition of the sporophyte and gametophytic phase of archegoniates	3	1
2	**Bryophytes and Pteridophytes (25 hours)**			
	2.1	● General characteristics of Bryophytes ● Classification of Bryophytes by Rothmaler 1951 (up to family)	2	1
	2.2	Type study: Morphology, anatomy, and reproduction of *Riccia, Anthoceros* and *Pogonatum* (Developmental details of sex organs not needed).	7	1, 2, 3
	2.3	Ecological and economic importance of bryophytes.	1	4
	2.4	General characteristics of Pteridophytes. Classification of Pteridophytes up to classes by Smith (2006) and PPG system (Pteridophyte Phylogeny Group) (Brief account only)	3	1, 2
	2.5	● **Lycophytes** Morphology, anatomy, and reproduction of *Selaginella* (Developmental details of sex organs and embryo not needed). ● **Ferns** Morphology, anatomy, and reproduction of *Psilotum,* and *Pteris* (Developmental details of sex organs and embryo not needed).	7	1, 3

	2.6	● Heterospory and seed habit ● Stelar evolution in pteridophytes	3	3
	2.7	● Ecological and economic importance of Pteridophytes. ● Ornamental pteridophytes	2	4
3	**Gymnosperms (15 hours)**			
	3.1	● General characteristics of Gymnosperms ● Classification Sporne (1965) (up to family), Brief account of classification by Christenhusz (2011)	4	1
	3.2	Morphology, anatomy, and reproduction of *Cycas* and *Pinus* (Developmental details of sex organs not needed)	8	1, 2, 3
	3.3	● Economic importance of Gymnosperms ● Ornamental Gymnosperms	3	4
4	**Practical (30 hours)**			
	4.1	Conduct a survey and submit a report with geo-tagged photos / images of gametophytes and/or sporophytes of archegoniates in your locality.	5	1, 2, 3, 4
	4.2	Discussion on three research publications (within five years) on archegoniates.	2	5
	4.3	Collect, identify the genus, and submit gametophytes and/or sporophytes of any five archegoniates.	5	1, 2, 3
	4.4	*Riccia* and *Anthoceros*– Morphology and anatomy of thallus. *Pogonatum*- Morphology of the sporophyte and gametophyte	6	1, 2, 3
	4.5	● *Psilotum*- Morphology of sporophyte and synangium ● *Selaginella*- Morphology of sporophyte, transverse section of the stem. ● *Pteris*- Morphology of sporophyte, transverse section of sporophyll.	8	1, 2, 3
	4.6	● *Cycas*- Morphology of coralloid roots and reproductive structures; TS of leaflet.	4	1, 2, 3

		Pinus- Morphology of male and female cones; TS of the needle		
5	**Teacher specific course components**			

References:

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Discipline Specific Course (DSC) - 06

Discipline/Programme	**BOTANY**				
Semester	IV				
Type of Course	DSC				
Course Code	24UBOTDSC204				
Course Title	**GENETICS AND EVOLUTION**				
Course Level	200-299				
Course Summary	This course delves into genetic principles, from Mendelian inheritance to modifications, enriching comprehension of inheritance patterns across organisms. Application of linkage, crossing over, and linkage mapping enhances problem-solving and map construction skills. Students explore mechanisms of sex determination, spanning chromosomal, environmental, and inheritance types, with applications in animals and plants. Population genetics concepts, including Hardy-Weinberg Equilibrium and epigenetics, are elucidated, offering insights into genetic diversity. Understanding evolutionary theories, evidences, and speciation patterns fosters a deeper appreciation of evolutionary biology's fundamental principles.				
Lecture/Tutorial/Practical Hours	60				
Credits	4	Theory	4	Practical	0
Pre-requisite, if any					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Describe the genetic terminologies, Mendelian principles, and modifications, enhancing comprehension of inheritance patterns in diverse organisms.	R, U	PO1, PO2, PO8
2	Apply the concepts of linkage, crossing over, linkage mapping, extra chromosomal inheritance, and quantitative inheritance, to genetic problem-solving and map construction.	A	PO1, PO2, PO8

3	Explain various mechanisms of sex determination, including chromosomal, environmental, X-linked, Y-linked, sex-limited, and sex-influenced inheritance, with applications in both animals and plants.	R, U	PO1, PO2, PO8
4	Understand population genetics concepts including allelic and genotypic frequencies, Hardy-Weinberg Equilibrium, and factors affecting it, alongside an introduction to epigenetics, encompassing DNA methylation and histone modifications.	U, A	PO1, PO2, PO8
5	Explain origin of life, evolution theories, evidences, character evolution, speciation concepts, and patterns, fostering understanding of evolutionary biology.	U	PO1, PO2, PO8
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	**Introduction to Genetics, Gene Interactions and Non-mendelian Inheritance (30 hours)**			
	1.1	a) Terms & Concepts – chromosome, gene, allele-dominant and recessive, locus, genotype & phenotype, chromosome theory of inheritance, cross-monohybrid & dihybrid, testcross, backcross b) Principles of Mendelian Inheritance-Dominance, Segregation, and Independent Assortment. c) Model genetic organisms- *Neurospora crassa*, *Saccharomyces cerevisisae*, *Arabidopsis thaliana*, *Zea mays* (mention only their importance in genetic study)	8	1

	1.2	Modifications of Mendelian ratios *a)* Incomplete dominance: Example - flower colour in *Mirabilis jalapa*. b) Co-dominance: Example - MN blood type in humans. c) Lethal genes: Example - pigmentation in Snapdragon. d) Epistasis: - Dominant epistasis: Example - fruit colour in summer squashes; Recessive epistasis – coat colour in mice e) Complementary gene interaction: Example - flower colour in *Lathyrus odoratus*. f) Multiple alleles: definition, example –Blood grouping in human ABO, Self-sterility in *Nicotiana tabaccum*.	10	1
	1.3	a) Linkage – chromosome theory of linkage; complete and incomplete linkage. b) Crossing Over –mechanism of crossing over; types of crossing over – single, double and multiple; recombinant & non-recombinant gametes c) Linkage mapping: -two-point testcross & calculation of distance between genes; recombination frequency & map units *d)* Extra chromosomal inheritance- cytoplasmic inheritance- Example: - leaf variegation in *Mirabilis jalapa* e) Quantitative inheritance: - polygenic; continuous traits. Example: ear size in maize; Quantitative trait Loci **Learning activity:** ● Workout Problems related to monohybrid cross, dihybrid cross, modified Mendelian ratios. ● Calculation of distance between genes by using two-point test crosses and linkage map construction.	12	2
	Sex Determination (10 hours)			

2	2.1	a) Chromosomal mechanism of sex-determination: XX- XY, XX-XO, ZZ-ZW, Haplo-Diplo system, genic balance system. b) Environmental Sex Determination: Sex determination in slipper limpet and reptiles c) X-linked inheritance - Haemophilia in man; Y-linked inheritance – SRY gene d) Sex-limited Inheritance – Example-feathering pattern in Fowl; Sex-influenced Inheritance - Example – Baldness in humans *e)* Mechanisms of sex determination in plants- *Melandrium*	10	3
3	**Population genetics & Epigenetics (10 hours)**			
	3.1	Concept of Population, Allelic frequency, genotypic frequency; Hardy- Weinberg Equilibrium and the factors affecting the equilibrium. **Learning activity:** Problems based on Hardy- Weinberg equation	7	4
	3.2	Epigenetics- Definition, Reasons - DNA methylation, Histone modifications	3	
4	**Evolution (10 hours)**			
	4.1	a.) Origin of life- biochemical origin of life (Miller's Experiment). Theories of evolution -Darwin's theory and modern synthetic theory. Evidences for evolution- (brief study) b.) Character evolution; Microevolution and macroevolution; Convergent, divergent, and parallel- evolution- (definition with examples) c.) Biological Species concept; speciation - genetic divergences and isolating mechanisms- geographical isolation & reproductive isolation (prezygotic and postzygotic- isolation mechanisms)- (brief study) d.) Patterns of speciation- allopatric, sympatric, quantum and parapatric speciation- (brief study)	10	5
5	**Teacher specific course components**			

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Discipline Specific Course (DSC) - 07

Discipline/Programme	**BOTANY**				
Semester	IV				
Type of Course	DSC				
Course Code	24UBOTDSC205				
Course Title	**ANGIOSPERM MORPHOLOGY AND ECONOMIC BOTANY**				
Course Level	200-299				
Course Summary	This course provides a comprehensive examination of angiosperm morphology, from leaves to gynoecium, through morphological analysis and functional evaluation. It delves into the diverse forms of inflorescence and fruits, offering insight into their classification. Exploring botanical characteristics and economic significance, students uncover plants' everyday utility. Special focus is placed on plants in tribal life, elucidating their cultural and practical importance. Practical sessions develop proficiency in plant part identification and understanding their functional roles, enriching students with practical skills for botanical study.				
Lecture/Tutorial/Practical Hours	75				
Credits	4	Theory	3	Practical	1
Pre-requisite, if any					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Analyze and classify floral structures, including leaves, flowers, perianth, androecium, and gynoecium, based on their morphological features and functions.	An	PO1, PO2, PO8
2	Evaluate the structural diversity of inflorescence and fruits and their classification.	A	PO1, PO2, PO8

3	Investigate and describe the botanical characteristics, economic importance, and morphological features of plants used for various purposes in day-to-day life.	A	PO1, PO2, PO8
4	Appraise the utility of plants in the daily life of tribal people.	U	PO1, PO2, PO8
5	Develop practical skills for identifying plant parts and organs, along with understanding their functional significance.	An	PO1, PO2, PO8
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	**Leaf and Floral Morphology (20 Hours)**			
	1.1	Leaves - leaf parts, leaf type, leaf attachment, leaf venation, leaf apex, leaf base, leaf shape, leaf margin	4	1
	1.2	Flowers- flower parts, flower sex and plant sex, flower attachment, flower symmetry, flower maturation	4	1
	1.3	Perianth- perianth arrangement, cycly, merosity, perianth fusion, perianth parts, perianth type, perianth aestivation	4	1
	1.4	Androecium- stamen type, stamen arrangement, cycly, position, and number, stamen attachment and insertion, stamen fusion, anther parts, type, and attachment, anther dehiscence	4	1

	1.5	Gynoecium- gynoecial fusion; carpel, locule number; ovary attachment and position, perianth/androecial position; placentation, ovule parts, type, and position, style position / structural type, stigma /stigmatic region types	4	1
2	**Inflorescence and Fruit Morphology (10 Hours)**			
	2.1	Inflorescence - racemose types - simple raceme, corymb, panicle, umbel, spike, spadix, head and capitulum; cymose types - simple cyme, monochasial-scorpoid and helicoid, dichasial, polychasial; special type- cyathium, hypanthodium, verticillaster, thyrsus, spikelet, fascicle inflorescence, cauliflorous inflorescence.	5	2
	2.2	Fruits: structure of fruit, simple, fleshy, dry-dehiscent, indehiscent, aggregate, multiple	5	2
3	**Economic Botany (15 Hours)**			
	3.1	Study of the following groups of plants based on their uses with special reference to the botanical name, family and morphology of the useful part ● Cereals- Rice, Wheat ● Millets- Ragi ● Pulses - Green gram, Bengal gram, Black gram ● Sugar yielding plants - Sugarcane ● Fruits - Apple, Pineapple, Orange, Mango and Banana ● Vegetables - Bitter Gourd, Ladies finger, Carrot and Cabbage. ● Timber yielding plants - Teak wood and Jack wood	10	3

		• Beverages- Tea, Coffee • Fibre yielding plants - Coir, Jute, Cotton • Oil yielding plants - Ground nut, Gingelly • Rubber yielding plants- Para rubber • Gums and Resins - White damer, Gum Arabic, Asafoetida • Spices - Cardamom, Pepper, Cloves, Ginger • Insecticide yielding Plants - Tobacco and Neem • Ornamental Plants – *Dendrobium*, *Aglaonema*, *Pothos*		
	3.2	Study of the following plants used in daily life by ethnic people and village folks for food, shelter and medicine. a) Food - *Artocarpus* spp.*, Dioscorea* spp.*,* b) Shelter - *Dendrocalamus , Ochlandra travancorica and Calamus thwaitesii* c) Medicine - *Curcuma longa, Trichopus zeylanicus and Alpinia galanga*	5	4
4	**Practicals (30 Hours)**			
		1. Study and prepare a report containing geotagged photo plates of leaf morphology mentioned in the syllabus 2. Study and prepare a report containing geotagged photo plates of floral morphology mentioned in the syllabus. 3. Study and prepare a report containing geotagged photo plates of different types of inflorescences mentioned in the syllabus. 4. Study and prepare a report containing geotagged photo plates of different types of fruits mentioned in the syllabus. 5. Conduct a one-day field visit to familiarize the morphological diversity in angiosperms and	30	5

		submit a report. 6. Study and submit the geotagged photos the useful parts of plants/finished products mentioned under economic botany and ethnobotany.		
5	Teacher Specific Content			

References

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12. Mayfield, E. (2021) Illustrated Plant Glossary. Australia: CSIRO Publishing.

Discipline Specific Course (DSC) - 08

Discipline/Programme	**BOTANY**				
Semester	V				
Type of Course	DSC				
Course Code	24UBOTDSC301				
Course Title	**ANGIOSPERM SYSTEMATICS**				
Course Level	300-399				
Course Summary	This course equips students with proficiency in botanical nomenclature, emphasizing principles, author citation conventions, and the Shenzhen Code. Understanding plant classification systems, including Bentham and Hooker's system and the APG System, enhances taxonomic knowledge. Practical skills in taxonomy tools, such as keys and herbarium techniques, are developed to effectively identify and classify plant species. Morphological analysis of plant families according to Bentham and Hooker's system deepens understanding. Through fieldwork and herbarium specimen preparation, students gain practical proficiency in plant taxonomy, enriching their botanical research skills and comprehension of plant diversity.				
Lecture/Tutorial/Practical Hours	75				
Credits	4	Theory	3	Practical	1
Pre-requisite, if any					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Demonstrate proficiency in botanical nomenclature, including principles, author citation conventions, typification, naming of infraspecific taxa, and publication of names according to the Shenzhen	U	PO1, PO2, PO8

	Code.		
2	Understand plant classification systems, including the Bentham and Hooker's system with its merits and demerits, as well as a brief overview of the APG System.	U	PO1, PO2, PO8
3	Proficiency in utilizing essential tools of taxonomy, including taxonomic keys, taxonomic literature, and herbarium techniques, enhancing their ability to identify, classify, and study plant species effectively.	A, S	PO1, PO2, PO8
4	Analyze and compare the morphological characteristics of plant families within the Polypetalae, Gamopetalae, Monochlamydeae, and Monocots, based on Bentham and Hooker's System of classification, enhancing their understanding of plant taxonomy and morphology.	A, S	PO1, PO2, PO8
5	Demonstrate practical proficiency in plant taxonomy through fieldwork, herbarium specimen preparation, construction of taxonomic keys, and plant identification up to family level, enhancing their botanical research skills and understanding of plant diversity.	A, S	PO1, PO2, PO8
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
	Botanical Nomenclature (10 hours)			
	1.1	● Binomial nomenclature and Brief history of ICN, Principles of ICN, Shenzhen Code	2	1
	1.2	● Author citation - Use of parentheses, square brackets, *et, et al, ex, in, emend*	1	1

1	1.3	● Typification – Holotype, Isotype, Syntype, Paratype, Lectotype, Neotype, Epitype, Topotype	2	1
	1.4	● Naming of infraspecific taxon	1	1
	1.5	● Principle of priority	1	1
	1.6	● Retention, rejection and changing of names - *Nomen nudum, Tautonym, Later homonym, Nomen superfluum, Nomen ambiguum, Later isonym, Nomen confusum, Nomen dubium*	2	1
	1.7	● Publication of names – Formulation -*sp. nov., comb. nov., comb. et stat. nov.* , *nom. nov.*	1	1
2	**Classification and Tools in Plant Taxonomy (10 hours)**			
	2.1	● Bentham and Hooker's system – classification, merits and demerits, APG System (brief account)	3	2
	2.2	● Herbarium technique – herbarium preparation steps, significance of herbarium, major herbaria - national and international, virtual herbarium	2	3
	2.3	● Taxonomic literatures: Floras, Revisions, Monographs, Manuals, Indices, Journals; Online Taxonomic Databases: International Plant Names Index (IPNI), Biodiversity Heritage Library (BHL), Plants Of the World Online (POWO),	2	3
	2.4	● Floral formula (updated version) and floral diagram	1	3
	2.5	● Taxonomic keys- Bracketed and Indented keys – features, preparation of keys	2	3
	Angiosperm Families (25 hours)			

3	3.1	Study the following families based on Bentham and Hooker's System of classification with special reference to their morphological characters. ● Polypetalae: Annonaceae, Malvaceae, Rutaceae, Leguminosae (Fabaceae, Caesalpiniaceae, Mimosaceae), Combretaceae, Myrtaceae, Cucurbitaceae, Apiaceae,	10	4
	3.2	● Gamopetalae: Rubiaceae, Asteraceae, Sapotaceae, Apocynaceae, Asclepiadaceae, Solanaceae, Convolvulaceae, Scrophulariaceae, Acanthaceae, Verbenaceae, Lamiaceae	11	4
	3.3	● Monochlamydeae: Euphorbiaceae	1	4
	3.4	● Monocots: Orchidaceae, Arecaceae, and Poaceae.	3	4
4	**Practicals (30 hours)**			
		1. Conduct field work for a period of not less than 5 days to familiarize plants under the guidance of the course faculty and submit a field report with geotagged photos. 2. Prepare five herbarium specimens (Simpson, 2019) and submit it for evaluation. 3. Preparation of indented and bracketed keys for at least 8 species from any two angiosperm families mentioned in the syllabus 4. Identification of plant specimens up to family level using the given family key. Prepare a geotagged photo album along with the drawings of flower L.S, floral diagram and write the floral formula.	30	5

		5. Visit a recognized herbarium and prepare report.		
5	**Teacher specific course components**			

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Discipline Specific Course (DSC) - 09

Discipline/Programme	Botany				
Semester	V				
Type of Course	DSC				
Course Code	24UBOTDSC302				
Course Title	**CELL AND MOLECULAR BIOLOGY**				
Course Level	300-399				
Course Summary	Cell and Molecular biology play a crucial role in shaping understanding of life. The course emphasizes the basic principles that buttress the processes unique to living organisms at the molecular and cellular levels. Students will acquire a basic understanding of architecture of plant cells, organization of genetic material, the storage, transfer, and regulation of genetic information etc. Students learn how genes and proteins organize cells for cellular activities thereby gaining an in-depth understanding of cellular function. On completion of this course, they are equipped to tackle fundamental scientific questions. The course envisages the application of modern molecular and cellular biology in Plant Sciences and provides a solid foundation for further studies in the areas of molecular life sciences, bioengineering, and biotechnology				
Lecture/Tutorial/Practical Hours	75				
Credits	4	Theory	3	Practical	1
Pre-requisite, if any	Basic understanding of cell structure in plants, process of cell division and knowledge of experiments that led to the discovery of genetic material.				

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO
1	Outline the historical developments in cell and molecular biology	U	PO3

2	Illustrate the structure and function of plant cell wall and cell organelles	A	PO2
3	Describe the function of the nucleus and chromosome condensation process and their role in heredity	U	PO1, PO2, PO6
4	Assess the gene regulatory network and inheritance in organisms	E	PO1, PO2
5	Examine how Cell division and programmed cell death occur within a plant cell	An	PO3, PO8
6	Investigate the role of enzymes in regulating cell activities	E	PO2
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)			

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	**Introduction, cellular architecture and cell organelles (20 hours)**			
	1.1	History and Scope of Cell and Molecular biology; Major developments in Cell and Molecular Biology.	1	1
	1.2	Cell Membrane and Chemical Composition of Cell Membrane.	3	2
	1.3	● Structure and Major Functions of the following cell organelles: Endoplasmic Reticulum, Lysosomes, Dictyosomes, Vacuole, ● Ribosomes (Brief Account) and Cytoskeleton; Functions of Microfilaments, Microtubules and Intermediate filaments. ● Endomembrane System: Protein production and transport (Brief Account).	6	2
	1.4	Ultra Structure of Nucleus, Nuclear Envelope, Nuclear Pore Complex (NPC). Structure and Function of Nuclear lamina and Nucleolus.	3	3
	1.5	● Morphology of a typical chromosome, Organization of genetic material in chromosomes.	6	3

		● Structural organization: Histones, Non-histone proteins, Nucleosomes, Chromatosomes. ● Higher level of chromosome organization; Zig Zag model. ● Special Chromosomes: Structure and Function of Polytene and Lamp brush chromosomes.		
	1.6	Types of Chromatins: Heterochromatin and Euchromatin Karyotype, Idiogram	1	3
2	**Genetic material, cell cycle and mutations (15 hours)**			
	2.1	Eukaryotic Cell cycle (G1, S, G2, M), Mitosis and Meiosis: Significance. **Activity:** Students may submit appropriate illustrations with short descriptions to explain how events of meiosis together with gametic fusion during sexual reproduction, brings about genetic variability in progenies of plants.	3	5
	2.2	Programmed Cell Death (Apoptosis) and Necrosis (Overview). **Activity:** Students may submit appropriate illustrations with short descriptions to explain how events of meiosis together with gametic fusion during sexual reproduction, brings about genetic variability in progenies of plants.	2	5
	2.3	Basic understanding of Genetic material 1. Types of DNA: A, B and Z DNA. 2. Types and functions of RNA: hnRNA, mRNA, tRNA, rRNA, snRNA and microRNA 3. Activity: Prepare a comparative account on the types of RNA and submit for evaluation	4	5
	2.4	DNA replication (prokaryotic): Role of enzymes - DNA Polymerases, Primases, Helicases, Ligases and DNA Topoisomerases.	3	6
	2.5	● Point Mutations: Definitions of Transition Mutations, Transversion Mutations, Silent mutations, Missense mutations, Nonsense Mutations. Molecular basis of point mutations. ● Definition and Significance of Frameshift mutations.	3	6

		• DNA repair mechanisms (An introduction). • Activity: Discuss how mutation in a single nucleotide leads to altered phenotype citing suitable examples.		
3	**Gene expression (10 hours)**			
	3.1	• Gene expression: Central dogma of molecular biology and its revisions. • Basic mechanism of Transcription in Prokaryotes. • Perspective of transcription in Eukaryotes: Split genes, Introns, Exons, Spliceosomes (Definitions and significance). • Post transcriptional modification of mRNA • Translation in Prokaryotes.	5	6
	3.2	Genetic code, Wobble hypothesis, Regulation of gene expression in prokaryotes by Operons: *Lac* and *Trp* operon.	4	5
	3.3	Endosymbiont hypothesis (Overview), Significance of chloroplast and nuclear DNA in the biosynthesis of RUBISCO.	1	6
4	**Practical (30 hours)**			
	4.1	Study of mitosis by squash preparation of *Allium* sp. root tip	30	2, 3, 5
	4.2	Calculate mitotic index of root tips prepared by squash preparation		
	4.3	Identification of various stages of meiosis I using appropriate illustrations/specimens.		
	4.4	Isolation of plant DNA from appropriate plant specimen		
	4.5	Demonstration (any one) of • Cell viability using tri-phenyl tetrazolium chloride (TTC). • Cell counting using haemocytometer • Observation of cyclosis and Chloroplast in leaf of *Hydrilla* or Staminal hairs of *Rheo discolor*		
	4.6	Separation of cells from cell suspension/ cell culture using centrifugation (yeast cells)		

5	**Teacher specific course components**

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14. Watson, J., Baker, T., Bell, S., Gann, A., Levine, M., Losick, R. (2013). Molecular Biology of the Gene, Pearson 7th edition ISBN-13 978-0321851499

Discipline Specific Course (DSC) - 10

Discipline/Programme	Botany				
Semester	VI				
Type of Course	DSC				
Course Code	24UBOTDSC304				
Course Title	**PLANT PHYSIOLOGY**				
Course Level	300-399				
Course Summary	The course aims at introducing the physiology of plant systems and indulges the student in finding out various processes that function within the plant body.				
Lecture/Tutorial/Practical Hours	75				
Credits	4	Theory	3	Practical	1
Pre-requisite, if any	Concept of a plant cell and cell components				

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO
1	Summarize the physiology of different plant life processes.	U	PO1
2	Categorize the factors affecting physiological processes	An	PO1
3	Investigate the role of biotic and abiotic components in plant stress	E	PO2
4	Design experiments in plant physiology	C	PO1
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)			

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	**Plant water relations (8 Hours)**			
	1.1	Plant water relations: Diffusion, imbibition, osmosis; Absorption of water - active and passive, apoplastic and symplastic pathways.	2	1
	1.2	Ascent of sap: Cohesion-tension theory, embolism; Transpiration - types, mechanism and significance; anti-transpirants. Guttation.	3	1, 2
	1.3	Major and minor elements in plant nutrition, mineral uptake - passive (ion exchange) and active (carrier concept).	3	1, 2
2	**Photosynthesis and respiration (22 Hours)**			
	2.1	**Photosynthesis:** ● The Light Reactions: PSI and PSII structure and composition, Mechanisms of Electron Transport, Proton Transport and ATP ● Synthesis in the Chloroplast. ● The Carbon Reactions: Rubisco-structure and function, The Calvin–Benson Cycle. ● The C2 Oxidative Photosynthetic Carbon Cycle and its role.	10	2,3
	2.2	**Translocation of solutes**: Phloem loading and unloading, polymer trapping (brief account); Mechanism - mass flow hypothesis.	2	2
	2.3	**Respiration:** ● Substrate level phosphorylation (Brief study) ● Plant Mitochondrial electron transport, and ATP synthesis – organization of electron transfer complexes (complex I to V). Inhibitors of oxidative phosphorylation. ● Cyanide-Resistant Respiration ● ATP synthase, Binding change mechanism of ATP synthesis (Oxidative phosphorylation).	10	2,4
3	**Plant hormones and stress physiology (15 Hours)**			

	3.1	**Plant hormones:** Physiological effect and practical applications - Auxins, Gibberellins, Cytokinins, ABA, and Ethylene. Other growth regulators - Jasmonic Acid, Brassinosteroids, Nitric Oxide.	6	2
	3.2	**Stress Physiology:** Abiotic (water and salt), Biotic (pathogens) stress, Role of phenolics and compatible solutes.	5	2, 3
	3.3	**Physiology of flowering:** Phytochromes, Photoperiodism, Vernalization	4	1, 2
4	**Practical (30 hours)**			
	4.1	Core Experiments (any 3): ● Separation of plant pigments by TLC/Paper/ Column chromatography. ● Estimation of plant pigments by colorimetry. ● Estimation of Proline in plant tissue under abiotic stress. ● Estimation of Phenol in plant tissues under biotic stress. ● Calculation of stomatal index in mesophytes and xerophytes ● Estimation of rate of photosynthesis Demonstration experiments: (ANY 4) ● Demonstration of plasmolysis. ● Demonstration of tissue tension. ● Demonstration of osmosis using osmoscope. ● Demonstration of Oxygen evolution during Photosynthesis. ● Measurement of transpiration rate using Ganong's potometer/Farmer's potometer ● Measurement of leaf conductance using leaf porometer.	20	
	4.2	**Activity** (Any one)	10	

		● Design and perform an experiment related to plant physiology. Prepare and submit a report with geotagged photos. ● Prepare and submit a report with your views and conclusions on the latest research in physiology based on journal publications on any topic mentioned in the syllabus (A copy of the original publication has to be submitted with the report. ● Design models representing physiological or biochemical processes taking place in plants and submit them for evaluation. ● Prepare a review article in a selected research area in Physiology and submit for evaluation. ● Retrieve 5 research articles on any selected topic in Physiology and submit them for evaluation.		
5	**Teacher specific course components**			

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Discipline Specific Course (DSC) - 11

Discipline/Programme	**BOTANY**				
Semester	IV				
Type of Course	DSC				
Course Code	24UBOTDSC304				
Course Title	**MYCOLOGY AND PLANT PATHOGEN INTERACTION**				
Course Level	300-399				
Course Summary	The course in Mycology and Plant Pathology provides a comprehensive exploration of the intricate worlds of fungi and plant diseases. Students delve into the morphology and ecological roles of fungi, gaining insights into their diverse functions as decomposers, symbionts, and pathogens. The curriculum also encompasses the study of plant diseases, investigating the interactions between plants and various pathogenic organisms, including fungi, bacteria, viruses, and nematodes. Through this course, students acquire the skills and knowledge necessary for disease diagnosis, prevention, and control, contributing to the sustainable management of plant populations in diverse settings.				
Lecture/Tutorial/Practical Hours	75				
Credits	4	Theory	3	Practical	1
Pre-requisite, if any	Basic botanical laboratory skills				

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO
1	Determine the diversity, reproductive behaviour and applications of fungi and Lichens	A	1, 2, 3, 5, 8
2	Identify ecological and economical significance of fungi and lichens	U	1, 2, 4, 5, 6, 8
3	Describe the basic aspects of plant pathogen interaction	U	1, 2, 7
4	Recognize the plant diseases and provide control measures	K	1, 2, 3, 4, 5, 7
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)			

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	**Introduction to Mycology (19 hours)**			
	1.1	Introduction and general characters of fungi. Classification based on Ainsworth (1973); Assembling the Fungal Tree of Life (AFTOL) - a brief account	2	1
	1.2	The thallus and reproductive structures of the genera mentioned in each group; ● Myxomycotina - General Characters ● Mastigomycotina – *Albugo* (Difference between Oomycete and true fungi) ● Zygomycotina – *Rhizopus*	4	1
	1.3	The thallus and reproductive structures of the genera mentioned in each group; Ascomycotina: ● Hemiascomycetes - *Saccharomyces* ● Plectomycetes - *Pencillium* ● Pyrenomycetes – *Xylaria* ● Discomycetes – *Peziza*	8	1
	1.4	The thallus and reproductive structures of the genera mentioned in each group;	4	1

		Basidiomycotina ● Teliomycetes – *Puccinia* ● Hymenomycetes - *Agaricus*		
	1.5	The thallus and reproductive structures of the genera mentioned in each group; ● Deuteromycotina - *Fusarium*	4	1
2	**Economic significance of Fungi and Lichenology (11 hours)**			
	2.1	Economic importance of Fungi – Beneficial (Food, antiviral, antibiotic) and detrimental aspects (Food spoilage and poisoning, Wood degradation).	2	2
	2.2	Fungi of Agricultural importance – mycoherbicides, myconematicides, mycoparasites, Mycorrhiza – diversity, function, and significance.	2	2
	2.3	Mushrooms- edible and poisonous types. Cultivation technique-Spawn production of Oyster mushroom, cultivation of Oyster mushroom (General Outline)	4	2
	2.4	**Lichenology**: General account, economic and ecological importance of lichen	1	1, 2
	2.5	Classification of lichens based on thallus and its significance	1	1
	2.6	Structure and life cycle of *Parmelia*.	1	1
3	**Plant Pathology (15 hours)**			
	3.1	History of plant pathology (Brief study)		3
	3.2	Classification of plant diseases based on causative organisms and symptoms	2	3
	3.3	Plant-Pathogen Interaction (general outline)	1	3
	3.4	Defense mechanisms in Plants	2	3
	3.5	Mechanism of infection, transmission, and dissemination of plant diseases.	1	3
	3.6	Prophylaxis - quarantine measures, seed certification; Therapeutic – physical therapy, chemotherapy.	2	4

	3.7	Biological control of plant diseases	1	4
	3.8	Study of following diseases with emphasis on symptoms, cause, and control: ● Bunchy top of Banana ● Bacterial blight of Paddy ● Root wilt of Coconut ● Abnormal leaf falls of Rubber ● Leaf mosaic disease of Tapioca ● Quick-wilt of pepper.	3	3, 4
4	**Practical (30 hours)**			
	4.1	Students are expected to identify the following types by making suitable micro preparations and make labelled sketches/clear geotagged images of *Albugo, Rhizopus, Saccharomyces, Penicillium, Xylaria, Peziza, Puccinia, Fusarium*	8	1
	4.2	Staining of endomycorrhiza or fungus using Trypan Blue.	2	1, 2
	4.3	Collection/identification of common macrofungi (5 types).	10	1, 2
	4.4	Identify the diseases mentioned in the syllabus with respect to causal organisms and symptoms	5	3
	4.5	Submit specimens/ herbarium preparations of any three of the diseases; Imaging can be done with geo tag and recorded	4	3
	4.6	Students should be trained to prepare the fungicides – Bordeaux mixture, Tobacco decoction.	1	3, 4
5	**Teacher specific course components**			

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Discipline Specific Course (DSC) - 12

Discipline/Programme	**Botany**				
Semester	VII				
Type of Course	DSC				
Course Code	24UBOTDSC401				
Course Title	**ADVANCEMENTS IN THALLOPHYTES**				
Course Level	400-499				
Course Summary	This course will enable the students to identify, and compare the characteristics of the major groups of thallophytes and to classify them within a phylogenetic framework. Students will be able to use the evidence of comparative biology to correlate the evolutionary trends to the diversity of plant life on earth. Knowledge about the interactions and associations of lower plants will provide better insights on the adaptive strategies of plants. Awareness in the thrust areas of research will generate interest in students to pursue the same.				
Lecture/Tutorial/Practical Hours	75				
Credits	4	Theory	3	Practical	1
Pre-requisite, if any	Basic knowledge about thallophytes				

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO
1	Explore the course of evolution of algae and land plants, Analyze the diversity of thallus forms in algae and its adaptive strategies to diverse environments.	An	PO1, PO 2, PO 4, PO 6, PO7
2	Review the affinities of fungi with other groups and differentiate morphological forms within the group.	U	PO1, PO 2, PO 3, PO 5, PO7

3	Analyse different fungal associations and its ecological impact	An	PO1, PO 2, PO 3, PO 4, PO 6, PO7
4	Evaluate the various applications of thallophytes in different fields	E	PO1, PO 2, PO 3, PO 5, PO8
5	Generate interest in recent research trends in Thallophyta.	C	PO1, PO 2, PO 3, PO 5, PO8
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)			

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	**Introduction to Algae and Evolution of Land Plants (15 hours)**			
	1.1	The range of thallus diversity and Evolution of thallus in algae Polyphyletic origin of algae and its evolution, with emphasis on endosymbiosis	3	1
	1.2	Algae and the fossil record; Gene sequencing and algal systematics.	2	1
	1.3	Algal pigments involved in photosynthesis Evolution and structural variations of Chloroplast in algae Algal responses to light- phototaxis, photophobia, and gliding.	4	1
	1.4	Adaptation strategies of algae to different environmental conditions-Resting spores, Allelopathy in algae.	2	1
	1.5	Nitrogen fixation by blue-green algae - Any one mechanism	4	1,4
2	**Introduction to Fungi and Fungal Associations (15 hours)**			
	2.1	Affinities of fungus with plants and animals; Modern trends in fungal classification; Molecular phylogeny of fungi with emphasis on ITS sequencing.	1	2

	2.2	Architecture of the fungal cell wall.	2	2
	2.3	Morphological diversity of fungi- an overview (Slime molds, Mycelial and non-mycelial fungi)	1	2,3
	2.4	Types of Fungal spores and its dispersal mechanisms (Ballistic dispersal, Dispersal by gravity, wind, water, insects and animals)	4	2
	2.5	Lichens– Ecological role, Nature of associations of algal and fungal partners with emphasis on its nutritional relation, Establishment of a lichen thallus-the process. Mycorrhiza- Phosphate solubilization, wood wide web.	4	2,3
	2.6	Fungus-insect mutualism- Fungal farming by ants Parasites Nematode trapping fungi, Lignolytic fungi	3	2,3
3	**Applied Aspects of Algae and Fungi (15 hours)**			
	3.1	Brief Account on the following applications of algae. Algal polysaccharides-its commercial utilization. pigments (Fucoxanthin, Phycoerythrin, Phycocyanin), fatty acids and pharmaceuticals, Production of biofuel, biogas and bioplastics from algae. Algae as pollution indicator, algae-based wastewater treatment for biodiesel production, phycoremediation and biodegradation of plastics. Algae in soil fertility: Soil algae and cyanobacteria	4	4,5
	3.2	Algal blooms: Beneficial, harmful and toxic bloom. Common cultivated algal species in India. Algal research stations in India Algal culture: scope and a brief account on isolation and culturing techniques (Axenic, Clonal, Unialgal, Enrichment, Maintenance, Batch, Continuous and Immobilized Culture) Molecular genetic techniques for algal bioengineering (Brief Account only), phylogenomic in algal research (Brief Account only) - current trends.	4	4,5
	3.3	Brief Account on the following applications of fungi. Fungi in the food industry-Flavour & texture, Fermentation, Baking.	4	4,5

		• Application of fungi in agriculture- Mycoherbicides, Mycoinsecticides, Myconematicides. • Fungi as a biofertilizer • Fungi as the source of Mycotoxins-Aflatoxins, Amatoxin, Ergot, Fusarin		
	3.4	Commercial production of Organic acids, Enzymes, Plant hormones, Mycoproteins, and alcohol from fungi. Antibiotics from fungi- penicillin, Volatile organic compounds production by fungi. Fungi as a model organism in genetic experiments- *Neurospora, Saccharomyces*. Recent research trends in fungi-Zombie ant fungi, Adaptive cognitive behavior and learning in slime molds.	3	4,5
4	**Practical (30 hours)**			
	4.1	Study of the thallus morphology of the following algal genera; • Cyanophyceae: *Lyngbya, Oscillatoria, Scytonema* • Chlorophyceae: *Chlorella, Zygnema, Mougeotia,Pithophora, Nitella*, *Caulerpa, Ulva, Halimeda* • Bacillariophyceae: *Navicula,* • Phaeophyceae: *Ectocarpus, Turbinaria, Padina, Dictyota* • Rhodophyceae: *Batrachospermum,Gracilaria, Gelidium* **Activity:** Conduct a field visit to familiarize algal habitats, especially seaweeds; and study algal diversity of a location and submit a report	15	1,4,5
	4.2	Morphological study of the following types by preparing suitable micro preparations of the following fungi; *Albugo, Rhizopus, Mucor, Aspergillus, Pilobolous, Xylaria, Peziza, Pleurotus, Auricularia, Lycoperdon, Fusarium*. Lichen-*Usnea*	15	2,4,5

		Isolation of fungi from rotten vegetables and culturing the same on PDA; Staining and observing AM fungi Fungal spore staining using lactophenol cotton blue. Conduct field visit to study on fungal diversity of a location. Lichen identification- morphological and chemical methods		
5	**Teacher specific course components**			

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- https://www.nature.com/articles/nature. 012.11811
- https://www.cell.com/current biology/pdf/S0960-9822(19)31164-9.pdf

Discipline Specific Course (DSC) - 13

Discipline/Programme	**Botany**				
Semester	VII				
Type of Course	DSC				
Course Code	24UBOTDSC402				
Course Title	**ADVANCEMENTS IN ARCHEGONIATES**				
Course Level	400-499				
Course Summary	The course is designed to make students aware of advances and applications in archegoniates. After completion of the course, the students will be able to ● Recognize the habitat variation, morphological diversity, and reproductive behavior of archegoniates. ● Describe the economic significance of archegoniates. ● Summarize the diversity and distributions of prehistoric archegoniate flora. ● Classify archegoniates based on morphological and evolutionary characters. ● Compare the evolutionary trends and ecological significance of archegoniates. ● Investigate the diversity of archegoniates. ● Construct artificial ecosystems for conservation of archegoniates.				
Lecture/Tutorial/Practical Hours	75				
Credits	4	Theory	3	Practical	1
Pre-requisite, if any	Nil				

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO
1	Recognize the habitat variation, morphological diversity, and reproductive behaviour of bryophytes, pteridophytes, and gymnosperms	U	PO1
2	Describe the economic significance of bryophytes, pteridophytes and gymnosperms	U	PO1
3	Summarize the diversity and distributions of prehistoric archegoniate flora	U	PO2
4	Classify archegoniates based on morphological and evolutionary characters	A	PO2 PO3
5	Compare the evolutionary trends and ecological significance of archegoniates	AN	PO3
6	Investigate the diversity of archegoniates	E	PO2 PO4
7	Construct artificial ecosystems for the conservation of archegoniates.	C	PO2 PO6
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)			

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	**Bryology (10 hours)**			
	1.1	Introduction- Salient features, classification by Goffinet *et al.*2008	2	4, 5
	1.2	Comparative account of gametophyte, sporophyte, their inter relationship and spore dispersal mechanisms of the following phylum Marchantiophyta (*Riccia, Marchantia, Porella*), Bryophyta (*Pogonatum)* and Anthocerotophyta (*Anthoceros*).	5	1, 6
	1.3	Origin and evolution of sporophyte and gametophyte in bryophytes.	2	5
	1.4	Progressive Sterilization of Sporogenous Tissue in Bryophytes.	1	2, 7

2	**Pteridology (20 hours)**			
	2.1	Introduction, general characters, Trends, and concepts in classification of pteridophytes with emphasis on PPG 1 (brief study)	5	4, 6
	2.2	• Stelar and soral evolution in pteridophytes. • Structural organization of sporophyte and gametophyte (development of sex organs not necessary) of the following type with special reference to stelar structure, heterospory and seed habit. **Lycophytes (Lycopodiopsida)** • *Palhinhaea cernua* (syn - *Lycopodiella cernua*) • *Isoetes* **Ferns (Polypodiopsida)** • *Equisetum* • *Ophioglossum* • *Osmunda* • *Marsilea*	10	1, 5
	2.3	Paleopteridology: • Study of the following types: *Rhynia*, *Hyenia*, *Calamites*	3	3
	2.4	• Endemic pteridophytes, and conservation.	2	1, 2, 7
3	**Gymnosperms (15 hours)**			
	3.1	• Introduction, general characters, evolutionary significance. • Origin of seed plants: -Evolution of pollen and seed -the key reproductive evolutionary mechanisms for Life on Land. • Relationships among gymnosperms - molecular phylogeny	2	4, 5
	3.2	• Study the Morphological and Applied Aspects of gymnosperms Cycadales - Ginkgoales clade (general account on morphology) • Coniferales clade -Pinaceae, Cupressaceae, Taxaceae, Podocarpaceae, Araucariaceae (general account on morphology)	8	1, 2, 5, 6, 7

		● Gnetales: *Gnetum* (general account on morphology). ● Brief study of habit, morphology and reproductive characters of *Welwitschia mirabilis* ● The ecological and economic importance of gymnosperms. Conservation of gymnosperms		
	3.3	Introduction, fossil types & technique of study. Indian contribution to paleobotany. **Fossil plants** Study of the following types; ● Fossil bryophytes: *Naiadita lanceolata* ● Fossil gymnosperms: *Williamsonia*	5	3
4	**Practical (30 hours)**			
	4.1	1. Detailed study of the structure of gametophytes and sporophytes of the following genera of bryophytes by suitable micropreparation: *Targionia, Cyathodium, Dumortiera, Reboulia, Pallavicinia, Porella, Anthoceros, Pogonatum*. 2. Conduct a field study and submit a report with geo-tagged photos related to diversity of bryophytes in your locality.	12	1, 6
	4.2	1. Study of morphology and anatomy of vegetative and reproductive organs using clear whole mounts/sections of the following genera: *Palhinhaea cernua, Selaginella, Equisetum, Angiopteris, Marsilea, Azolla, Lygodium, Acrostichum, Adiantum* 2. Study of two fossil pteridophytes with the help of specimens or permanent slides. 3. Conduct a survey and submit a report with geo-tagged photos of pteridophyte flora in your locality / Submit a survey report with geo-tagged photos of ornamental pteridophytes.	12	1, 2, 6
	4.3	1. Study of the morphology and anatomy of vegetative and reproductive parts of *Zamia*, *Cupressus*, *Podocarpus*, *Agathis*, *Araucaria* and *Gnetum* (reproductive structure only). 2. Conduct a field survey of gymnosperms in your	6	1, 5, 6

		locality and submit a report with geo-tagged photos. / Conduct a case study to summarize the reasons for the fast extinction of gymnosperms and submit a report based on your findings.		
5	**Teacher specific course components**			

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Discipline Specific Course (DSC) - 14

Discipline/Programme	**BOTANY**				
Semester	VII				
Type of Course	DSC				
Course Code	24UBOTDSC403				
Course Title	**MODERN TRENDS IN PLANT SYSTEMATICS**				
Course Level	400-499				
Course Summary	The morphological characters alone should not be considered in systematic classification of plants. Modern trends help plant taxonomists to look for more precise techniques in order to understand the relation between the genera and families. Complete knowledge of taxonomy is possible with the principles of various disciplines like cytology, palynology, phenology, biochemistry and numerical taxonomy. These have been found to be useful in solving some of the taxonomical problems by providing additional characters.				
Lecture/Tutorial/Practical Hours	60				
Credits	4	Theory	4	Practical	0
Pre-requisite, if any					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Explain the conceptual basis of plant classification and the concept of family, genus and species and the taxonomic diversity within species	U	PO1, PO2, PO8
2	Develop working skills in modern techniques in plant systematics	A	PO1, PO2, PO8
3	Choose appropriate tools of modern systematics for plant	A	PO1, PO2, PO8

	identification		
4	Determine evolutionary relationship between a group of species using molecular taxonomic tools and techniques	A	PO1, PO2, PO8
5	Construct phylogenetic trees based on molecular systematic data	C	PO1, PO2, PO8
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	**Conceptual basis of plant systematics (15)**			
	1.1	Phylogenetic classification - Angiosperm Phylogeny Group (APG) - Detailed Account.	5	1
	1.2	Hierarchy in classification. Concept of Family, Genera, Species, Subspecies and other infra-specific categories. Species concepts:Typological, Nominalistic and Biological species concepts (in plant perceptive).	7	1
	1.3	The new global taxonomy initiatives: Systematic Agenda-2020- Missions.	3	3
2	**Interdisciplinary approaches in plant systematics (17)**			
	2.1	Chemotaxonomy- Classification based on phytochemicals- phenolics, alkaloids, terpenoids and nonprotein amino acids. Serology and Taxonomy. Scope and limitations. **Learning Activity:** Students should refer to research articles and find out some cases where chemotaxonomic markers helped to establish their taxonomic identity.	6	3

	2.2	Cytotaxonomy – chromosome number, chromosome size, chromosome banding and behaviour of chromosomes during division **Learning Activity:** Students should familiarise themselves with the application of chemical data fromTLC/ HPTLC/ HPLC/GC for taxonomy.	6	3
	2.3	Palynotaxonomy- Pollen morphological characters and their significance in taxonomy and evolution- Polarity, symmetry, NPC of pollen, exine stratification, excrescences, L/O pattern. PollenAtlas **Learning Activity:** Semipermanent pollen preparations by acetolysis method /any other alternative methods and study of different pollen morphotypes.	5	3
3	**Ultrastructural systematics (9 hours)**			
	3.1	Stereo Microscopes, Scanning Electron Microscopy, Transmission Electron Microscopy, Microphotography (Image analyser software) for micromorphological studies - Trichomes and seed morphology **Learning Activity:** Study of plant surface attributes (trichomes/spines/etc.) / pollen characters with the help of Stereo Microscope /SEM.	9	2,3
4	**Numerical and molecular systematics (18 hours)**			
	4.1	Numerical Taxonomy (Phenetics): Theory and principles, Dendrogram. **Learning Activity:** Practical based on numerical taxonomy- Construct OTU tables examining morphological characters of selected plants.	8	2,3
	4.2	Molecular taxonomy - concepts, scope and limitations, Plant DNA barcoding- Molecular markers- isozymes, AFLP, Internal Transcribed	10	3,4

		Spacer (ITS), rbcL, matK. NCBI, Similarity search tools- BLAST, FASTA,Cladistics (Monophyletic, polyphyletic and paraphyletic groups), Phylogenetic tree construction, methods and tools- MEGA, PHYLIP. Interpreting data. Detailed study. **Learning Activity:** Construct phylogenetic trees using MEGA/PHYLIP or Sequence similarity searching through NCBI BLAST		
5	**Teacher specific course components**			

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Discipline Specific Course (DSC) - 15

Discipline/Programme	Botany					
Semester	VIII					
Type of Course	DSC					
Course Code	24UBOTDSC404					
Course Title	**PLANT BIOCHEMISTRY**					
Course Level	400-499					
Course Summary	Plant Biochemistry delves into the intricate molecular processes that govern the growth, development, and metabolism of plants. This course provides a comprehensive understanding of key biochemical pathways and molecules crucial for plant survival and adaptation. Through the exploration of carbohydrates, amino acids and proteins, enzymes, and fats, students will uncover the fundamental principles underlying plant biochemistry and their significance in agricultural, ecological, and biotechnological contexts.					
Lecture/Tutorial/Practical Hours	75					
Credits	Total	4	Theory	3	Practical	1
Pre-requisite, if any	Basic 12th standard knowledge in chemistry					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO
1	Analyze the structure and function of carbohydrates, demonstrating understanding through the application of biochemical principles to explain their roles in cellular processes.	An	PO1, PO2, PO3, PO4, PO6, PO 8
2	Evaluating the structure, properties, and functions of amino acids and proteins	E	PO1, PO2, PO3, PO5, PO7, PO 8

3	Evaluate enzyme kinetics, regulation, and mechanisms of action of enzymes	E	PO1, PO3, PO3, PO5, PO7, PO 8
4	Analyze, compare, and contrast the regulation and biochemical significance of lipid metabolism	An	PO1, PO2, PO3, PO 4, PO5, PO6, PO7, PO 8
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)			

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	**Carbohydrates (10 hours)**			
	1.1	Carbohydrates: Definition, Classification	1	1
	1.2	Monosaccharides: Classification - based on carbon number, based on functional group, structure of common aldose and ketose sugars (open chain and ring structure), Epimers.	4	1
	1.3	Oligosaccharides: Structure, formation; common examples – sucrose, lactose, maltose, Reducing and non - reducing sugars.	2	1
	1.4	Polysaccharides: Classification, functions – structure of cellulose, starch and glycogen.	2	1
	1.5	Sugar derivatives - Glycoproteins, proteoglycans, mucoproteins. (Brief introduction)	1	1
2	**Amino acids and Proteins (10 hours)**			
	2.1	Amino acids – General structure, Optical activity of amino acids, Classification based on R group	3	2
	2.2	Proteins, Primary structure – peptide bond. Secondary structure – Ramachandran plots, α-helix, β sheet. Tertiary structure – forces that stabilize tertiary structure. Quaternary structure, domains, motif.	7	2
3	**Enzymes (15 hours)**			
	3.1	Principles of catalysis: Activation energy of a reaction. General characters of enzymes -specificity, catalytic	4	3

		power, regulation. IUB system of enzyme classification and naming.		
	3.2	Mechanism of enzyme activity: Formation of ES complex, acid-base catalysis, covalent catalysis, metal ion catalysis, proximity and orientation effect, strain and distortion theory. Factors affecting enzyme activity. Enzyme Kinetics: Michaelis-Menton kinetics, Lineweaver-Burk plot. (Brief study)	6	3
	3.3	Regulation of enzyme activity: Allosteric effect, reversible covalent modification, Control proteins, proteolytic activation. Enzyme inhibition	2	3
	3.4	Cofactors and coenzymes: Essential ions, Coenzymes; structure and role of metabolite coenzymes – ATP; structure and role of vitamin derived coenzymes – NAD+, NADP+, FAD, FMN,TPP, PLP, Biotin.	3	3
4	**Fatty acid metabolism (10 Hours)**			
	4.1	Fatty acid – Definition, Structure, Classification.	1	4
	4.2	fat breakdown – β oxidation, Energetics, oxidation of very long chain fatty acids.	4	4
	4.3	Fatty acid biosynthesis	3	4
	4.4	Glyoxylate cycle	2	4
5	**Practical (30 hours)**			
	5.1	General test for carbohydrates- Molisch's test, Benedicts's tests, Fehling's test.	2	1
	5.2	Colour test for starch – Iodine test.	1	1
	4.3	Colour tests for proteins in solution. Biuret test, Xanthoproteic test.	2	2
	4.4	Detect the presence of any three major organic compounds in the given food stuff/material viz. reducing /non-reducing sugar/fat/ proteins/starch/sucrose.	10	1,2,3,4

	4.5	Quantification of carbohydrates using colorimeter - Anthrone test	5	1
	4.6	Estimation of protein using colorimeter.	5	2
	4.7	Isolation and assay of amylase enzyme from germinating Pea seeds/appropriate plant material.	5	3
5	**Teacher specific course components**			

References:

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Discipline Specific Course (DSC) - 16

Discipline/Programme	**BOTANY**				
Semester	VIII				
Type of Course	MAJOR-DSC				
Course Code	24UBOTDSC405				
Course Title	**PLANT BREEDING AND PROPAGATION TECHNIQUES**				
Course Level	400-499				
Course Summary	The course Plant breeding and Plant propagation techniques deals with different types of plant breeding, hybridization and crop improvement techniques. This course outlines various horticultural practices for propagation of plants including artificial methods and tissue culture technique.				
Lecture/Tutorial/Practical Hours	75				
Credits	4	Theory	3	Practical	1
Pre-requisite, if any	Nil				

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Outline divisions and components of Horticulture.	U	PO1
2	Describe the role of breeding methods in producing improved varieties of crop plants.	U	PO2
3	Illustrate how different plant growing structures are employed in Horticulture	A	PO2, PO3
4	Examine how cell differentiation occur in callus	An	PO1
5	Design aquaponics, hydroponics and aeroponics based irrigation systems for improved crop yield	A	PO1, PO2, PO8
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)			

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	**Plant breeding (15 hours)**			
	1.1	Introduction to Plant Breeding: Objectives and achievements, Domestication and centres of origin of cultivated plants. Plant introduction - Primary and Secondary, Plant Breeding centres – IRRI, ICAR institutes, State Agricultural Universities.	3	1
	1.2	Hybridization- objectives, Intergeneric and interspecific, Emasculation- different methods, Heterosis, Inbreeding depression, Use of male sterility and apomixis in plant breeding.	5	1, 2
	1.3	Breeding for resistance - Biotic (disease)- Vertical and horizontal Abiotic (drought) stresses.	3	2
	1.4	Mutation breeding: Achievements and limitations, Physical and chemical mutagens, Spontaneous and induced mutations, effects of mutation. Gamma gardens- Structure, Principles and working. Role of genetic engineering in crop improvement and nutritional quality- eg: Pokkali rice mutant varieties	4	2

2	**Horticulture (15 hours)**			
	2.1	Introduction to Horticulture: Nature and scope. Objectives of horticulture. Divisions of horticulture, Fruit and vegetable zones of India. Career opportunities in horticulture. NHM, MIDH, AHM, VFPCK	3	1
	2.2	Basic components of Horticulture a. Soils: Types, Physical characteristics b. Climate: – Light, temperature, photoperiod, relative humidity, rainfall, altitude c. Common garden implements and tools d. Manures, Fertilizers: chemical fertilizers and organic fertilizers methods of application. e. Irrigation and water management: system of irrigation, surface irrigation, sub soil irrigation, overhead system of irrigation. Artificial propagation of plants (brief account) Garden components and garden adornments (brief account)	8	1
	2.3	Plant growing structures Greenhouse, Polyhouses, Mist chambers, Hot beds. Modern trends in horticulture- Aquaponics, Hydroponics, Aeroponics, Nutrient Film Technique. Horticulture therapy.	4	5
3	**Tissue culture (15 hours)**			
	3.1	Tissue culture regeneration of plants (a) Adventitious regeneration: Direct regeneration, indirect regeneration. Factors influencing adventitious regeneration; genotype, explant – orientation of explant, position on mother plant. (b) Somatic embryogenesis: General aspects, initiation of embryogenic cultures, maturation of somatic embryos, regeneration of plants, factors regulating somatic embryogenesis, differences between somatic and zygotic embryos. Encapsulation of somatic embryos, synthetic seed production; desiccated and hydrated types. Applications and limitations of synthetic seeds.	5	4
	3.2	Somaclonal variation: (a) Isolation of somaclonal variants, molecular basis	4	2

		of somaclonal variation. (b) Origin of somaclonal variation – pre-existing variability, in vitro induced variability; Reasons– changes in ploidy level, changes in chromosome structure, gene mutations, gene amplifications, changes in extra nuclear genes, activation of transposable elements, DNA methylation. (c) Applications of somaclonal variation.		
	3.3	Production of ploidy variants: (a) Haploids: Androgenesis - pretreatment of anther/pollen grains, media and growth regulators, Induction and stage of pollen development, regeneration, androgenic embryos, factors affecting androgenesis. Microspore culture - protocol, advantages over anther culture. (b) Gynogenesis: Developmental stage at inoculation, in vitro maturation of embryo sacs, origin of embryos, triggering factors – pretreatment, medium. Uses and limitations of haploid plants. (c) Triploids: importance of triploid plants, conventional production of triploid plants, endosperm culture-advantages and limitations.	6	4
4	**Practical (30 hours)**			

	4.1	**Students are expected to do minimum 5 practicals** 1. Identification of soil types based on particle size 2. Preparation of bio fertilizer and field application (Trichoderma culture and application). 3. Preparation and application of growth regulators (Coconut milk and root hormones). 4. Students are expected to submit any artificially propagated plants done by him (Cutting/Budding / Grafting/ Layering). 5. Identify and submit a layout of suitable irrigation techniques applicable in our local area. 6. Submit a photographic report on novel plant propagation tools. 7. Prepare aquaponics/ Hydroponics/ Aeroponics/ Nutrient Film 8. Hybridization techniques in self- and cross-pollinated plants- Emasculation 9. Visit a plant breeding station to familiarize with breeding programmes. Submit a report of the visit. 10. Preparation of MS medium from stock solutions. 11. Isolation, preparation, sterilization and inoculation of different explants like shoot tip, node, anther, embryo and cambium. 12. Production of mutated cells/tissues/plants	30	2, 3, 4, 5
5	**Teacher specific course components**			

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2. Long, Bob. (2012). The EZ Guide to Gardening without Soil. Bonjour Limited Holdings LLC.
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4. Beyl, C. A., & Trigiano, R. N. (2008). Plant propagation: concepts and laboratory exercises. CRC Press.
5. Murphy, D. J. (2007). Plant breeding and biotechnology: societal context and the future of agriculture. Cambridge University Press.
6. Sully G. (2020). Hydroponics: A Beginner's Guide to Grow Fruits, Vegetables And Herbs At Home (Hydroponic System + Homesteading + Horticulture + Gardening). Biribbi.
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8. Garret D. (2020). Aquaponics for Beginners - A step by step complete guide for beginners on how to build their Aquaponics.
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10. Jacobson, A. (2016) The Essential Aquaponics Guide - A Step-By-Step Aquaponics Gardening Guide to Growing Vegetables, Fruit, Herbs, and Raising Fish at the Same Time
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Discipline Specific Elective (DSE) – 01

Discipline/Programme	BOTANY				
Semester	**III**				
Type of Course	DSE				
Course Code	24UBOTDSE201				
Course Title	**ETHNOBOTANY**				
Course Level	200-299				
Course Summary	This course will deal with ethnobotany's essence and methodology, unveiling its role in understanding plant-human relationships. Delve into historical influences, tracing trade, religion, and politics' impact on India's ethnobotanical diversity. Investigate the Western Ghats' medicinal flora and traditional knowledge, fostering appreciation for indigenous plants and cultural practices. Through lectures and fieldwork, gain practical skills in ethnobotanical research, empowering you to document and preserve India's botanical heritage. This course cultivates a holistic understanding of ethnobotany's significance in bridging disciplines and nurturing sustainable relationships between people and plants in India's diverse ecosystems.				
Lecture/Tutorial/Practical Hours	60				
Credits	4	Theory	4	Practical	0
Pre-requisite, if any	Should have basic knowledge of Botany and have a natural intelligence				

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the concept of ethnobotany and its scope in the study of plants and human cultures.	R	**PO 1, PO 2, PO 8**
2	Familiarize the methodology of ethnobotanical research	U	**PO 2, PO 3**
3	Analyze the impact of trade routes, religious practices, and political dynamics on the ethnic diversity and ethnobotanical knowledge of India	An	**PO 4, PO 5, PO 6, PO 7**
4	Investigate the rich diversity of medicinal plants found in the Western Ghats ecosystem, along with the associated traditional knowledge systems.	U	**PO 4, PO 5, PO 6, PO 7**
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)			

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	**Introduction to Ethnobotany (10 Hours)**			
	1.1	Introduction, concept, scope, and objectives; Ethnobotany as an interdisciplinary science. The relevance of ethnobotany in the present context.	3	1
	1.2	Centers of Ethnobotanical studies in India. FRLHT-Foundation for the Revitalization of Local Health Traditions, JNTBGRI.	3	1
	1.3	Contributions of J.W. Harshberger, E.K.Janakiammal, S.K.Jain & P.Pushpangadan	4	1
	2.1	**Ethnobotanical Research (20 Hours)**		

2		● Investigation Methods: Individual Interviews Participant Observation, Free Listing, Participatory Methodologies, Triangulation of Methods	2
	2.2	● Indices used for Ethanobotanical studies: Informant Consensus Factor (Fic), Fidelity Level (FL), Performance Index (Ip), Use Value Index (UV), Cultural Importance Index (CI), Cultural Value Index (CV), Jaccard Index (JI)	2
	2.3	● Tribal communities of Kerala state: focusing on customs and beliefs related to Ethnobotany - Kani, Kurichiya, Cholanaikan, Malampandaram ● Field study – Filed visit to a tribal settlement and familiarize the ethnobotanical knowledge	2
3	**Ethnobotany of India (15 Hours)**		
	3.1	The influence of trade, religion and polity on the ethnic diversity and ethnobotany of the western peninsular India: Period up to 5th Century, Period up to 15th Century, Period after 15th Century	3
	3.2	Traditional Use of Herbal Plants for the Treatment of Diabetes in India	3
	3.3	Ethnobotany of Turmeric and Its Medicinal Importance	3
	3.4	Ethnobryology, Ethnobotany of Mangroves	3
4	**Ethnobotany of Western Ghats (15 Hours**)		
	4.1	Threatened Medicinal Plants of the Western Ghats. In situ Conservation of Medicinal Plants in the Western Ghats– FRLHT's Experience	4
	4.2	Medicinal Flora and Related Traditional Knowledge of Western Ghats: A Potential Source for Community-Based Malaria Management through Endogenous Approach-Case Study	4
	4.3	Wild Plants of the Western Ghats - Food and Nutrition Plant Fibers, Medicinal, Dye Yielding, Constructions, Wild Ornamental Plants, Sacred Plants, Resin and Gum Yielding Plants, Other Uses	4

	4.4	The Kani Tribe and Arogyappacha, Scientific Investigation on Arogyappacha and Development of the Herbal Drug Jeevani	4
5	Teacher Specific Course content		

References

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4. Pullaiah, T., Krishnamurthy, K. V., & Bahadur, B. (2016). Ethnobotany of India, Volume 3: North-East India and the Andaman and Nicobar Islands. CRC Press.
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17. McMahon, M., Anton, M.K., and Vincent, R.E. (2001). Hartmann's Plant Science: Growth, Development, and Utilization of Cultivated Plants, 3rd ed. Prentice Hall Publication.
18. Shashi, S. S.(1995). Tribes of Kerala (Encyclopedia of Indian tribes Series-8). Ammol Publication Pvt. Ltd. Ansari Road, Daryagang, New Delhi
19. Sinha K. R. & Sinha S. (2001). Ethnobiology (Role of Indegenous and Ethnic Societies in Biodiversity Conservation, Human Health Protection and Sustainnable Development), Surabhi Publication, Jaipur

Discipline Specific Elective (DSE) – 02

Discipline/Programme	**Botany**				
Semester	V				
Type of Course	DSE				
Course Code	24UBOTDSE301				
Course Title	**BIOTECHNOLOGY AND GENETIC ENGINEERING**				
Course Level	300-399				
Course Summary	The course is designed as a comprehensive exploration to the field of Plant Biotechnology. The course aims to familiarize students with the key developments in the sphere of Plant Biotechnology and to discuss the potential applications of biotechnology in crop improvement and for novel uses for plants.				
Lecture/Tutorial/Practical Hours	60				
Credits	4	Theory	4	Practical	0
Pre-requisite, if any	General overview and key concepts of Biotechnology				

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO
1	Choose methods for *in vitro* regeneration of plants from explants including shoot and root organogenesis	Evaluate	PO1, PO2, PO3, PO7
2	Construct vectors for specific purposes like gene expression, replication and selection markers.	Evaluate	PO1, PO2, PO3
3	Develop proficiency in fundamental gene cloning techniques.	Apply	PO1, PO2, PO3
4	Compare different gene transfer methods based on efficiency and specificity.	Analyze	PO1, PO2,PO3
5	Explain the applications of plant genetic engineering in the field of agriculture, medicine, environment, and industry.	Apply	PO1, PO2, PO3,

			PO6, PO7, P O8, PO6
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)			

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	**Plant Tissue Culture (15 Hours)**			
	1.1	Introduction to Plant Biotechnology, concept of totipotency, callus, basic infrastructure of tissue culture lab, sterilization methods, composition, and preparation of culture media; role of hormones in morphogenesis, direct and indirect organogenesis; somatic embryogenesis (brief account only).	6	1
	1.2	● Tissue culture applications -micropropagation, Haploids -androgenesis, virus elimination, Embryo rescue. ● Secondary metabolite production– hairy root culture, bioreactors: design of simple bioreactor, application in secondary metabolite production, cryopreservation for germplasm conservation. ● Protoplast isolation, culture and fusion, somatic hybridisation, and applications – cybrids.	9	1
2	**Recombinant DNA Technology (29 Hours)**			
	2.1	● Restriction Endonucleases (Types I-IV, biological role and application); T4 DNA Ligase; Cloning Vectors: Properties of ideal cloning vector, features of cloning vectors -pCAMBIA, Ti plasmid, BAC, Lambda phage, Cosmid, YAC ● Expression vectors, Shuttle vector (Brief account only)	7	2
	2.2	Recombinant DNA technology: rDNA definition, steps involved (outline), bacterial transformation and selection of recombinant clones, PCR- mediated cloning, Plasmid construct- general design; construction of genomic and cDNA libraries, screening		

		of recombinant DNA- complementation (Blue white screening), colony hybridization Biotechnology instrumentation and Lab visit **Preferable:** Working of PCR machine, Agarose gel electrophoresis, UV transilluminator demonstration if facilities are available.	14	3
	2.3	● Methods of gene transfer: Direct gene transfer- electroporation, microinjection, microprojectile /particle bombardment, In-direct gene transfer- Agrobacterium mediated gene transfer. ● Selection of transgenic plants– selectable marker (antibiotic and herbicide) and reporter genes (GUS, GFP).	8	4
3	**Application of Biotechnology (7 Hours)**			
	3.1	Herbicide resistant plants (Glyphosate Resistant Crops- Soybean); Transgenic crops with improved quality traits (Golden rice); Improved horticultural varieties (*Moondust carnations*)	4	5
	3.2	Role of transgenics in bioremediation (Superbug); Industrial enzymes (Aspergillase, Protease, Lipase); Genetically Engineered Products– Edible vaccine.	3	5
4	**Advances in Plant Biotechnology (9 Hours)**			
	4.1	● Gene editing tools (CRISPR- Cas9) and its role in transgenic plant development and gene function studies (Brief account only). ● Synthetic biology and plant metabolic engineering for improved crop traits, Developing climate resilient crops (Brief account only). ● Ethical considerations in plant biotechnology. ● Biosafety considerations and IPR associated with GM crops.	9	5

5	**Teacher specific course components**

References:

1. Chawla H. S (2009): Introduction to Plant Biotechnology 3rd Edition, Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi.
2. Desmond S. T Nicholl (2008): An Introduction to Genetic Engineering; Studies in Biology. Cambridge University Press. 3rd Edition.
3. Keshavachandran R and Peter K V (2008): Plant Biotechnology: Methods in Tissue Culture and Gene Transfer. Orient Blackswan.
4. Razdan M K. (2015): Introduction to Plant Tissue Culture. Oxford and IBH, MKM Publishers 2nd. Edition

Suggested readings:

1. Smita Rastogi and Neelam Pathak (2009). Genetic Engineering. Oxford University Press. New Delhi.
2. Timir Baran Jha and Biswajit Ghosh (2016): Plant Tissue Culture. Platinum Publishers. Revised 2nd Edition. Kolkata
3. Razzaq, A., Saleem, F., Kanwal, M., Mustafa, G., Yousaf, S., Imran Arshad, H. M., & Joyia,

   F. A. (2019). Modern trends in plant genome editing: an inclusive review of the CRISPR/Cas9 toolbox. *International Journal of Molecular Sciences*, *20*(16), 4045.
4. Liu, D., Hu, R., Palla, K. J., Tuskan, G. A., & Yang, X. (2016). Advances and perspectives on the use of CRISPR/Cas9 systems in plant genomics research. *Current Opinion in Plant Biology*, *30*,70-77
5. Liu, W., & Stewart, C. N. (2015). Plant synthetic biology. *Trends in Plant Science*, *20*(5), 309- 317.
6. DeLisi, C. (2019). The role of synthetic biology in climate change mitigation. *Biol Direct*, 14

Discipline Specific Elective (DSE) – 03

Discipline/Programme	**BOTANY**				
Semester	V				
Type of Course	DSE				
Course Code	24UBOTDSE302				
Course Name	**PHYTOGEOGRAPHY AND FORESTRY**				
Course Level	300-399				
Course Summary	The course 'Phytogeography, Forestry and ecotourism' deals with the study of distribution of plant community, its management and conservation.				
Lecture/Tutorial/Practical Hours	60				
Credits	4	Theory	4	Practical	0
Pre-requisites, if any	Nil				

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Explain various theories and principles related to plant distribution	U	1,6
2	Identify and categorize the interactions in the ecosystem and factors affecting the plant growth	An	1,2

3	Describe the principles and practices in forest management	U	1
4	Evaluate and appreciate the role of youth, Clubs, organizations in conservations.	Ap	3,4,7
5	Appreciate the role of ecotourism projects in nature conservations	Ap	3,7,9,10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)			

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	**Plant and Environment (17 hours)**			
	1.1	Ecological complexes and factors affecting plants growth and distribution. Biotic factors: interactions – positive and negative	3	2
	1.2	Topographic factors: altitude and aspects. Edaphic factors – soil profile and physical and chemical properties of soil, soil formation	4	2
	1.3	Climatic factors: temperature and pressure, water - precipitation, humidity, soil water holding capacity, light - global radiation	3	2
	1.4	Morphological, anatomical, and physiological adaptation of plants to the environment with references to biomes.	7	2
2	**Phytogeography (16 hours)**			
	2.1	Definition, principles governing plant distribution, factors affecting plant distribution	2	1

	2.2	Plant distribution- distribution of plants- continuous, discontinuous, and endemic. Theories of plant distribution – migration hypothesis, long distance dispersal hypothesis, theory of continental drift, age area hypothesis, land bridge theory.	5	1
	2.3	World Biomes - aquatic and terrestrial, Climatic, vegetational and botanical zones of India.	4	1
	2.4	Remote sensing **-** Definition and data acquisition techniques. Application of remote sensing in vegetation classification, understanding environmental issues and ecosystem management. Geographic information system (GIS).	5	1
3	**Forestry (17 hours)**			
	3.1	Introduction to forestry: Classification of forests (Champion and Seth, 1968). Major types of forests in India. Silviculture; principles and practices- clear felling system, coppice system. Common plants in silviculture. Sustainable forest management approaches with reference to Kerala - timber plantation, agroforestry, social forestry, JFM	6	3
	3.2	Forest Ecosystems and biodiversity- Forest ecology and ecosystem services. Biodiversity- definition, values of biodiversity, levels of biodiversity. Biodiversity loss, Concept of endemism. Types of endemism.	5	3
	3.3	Species extinction – Rate of species extinction, reasons to stop extinction- methods to save species. Threats to forest biodiversity, IUCN- threat categories. IUCN account of biodiversity, red data book and hot spots.	6	4
4	**Ecotourism (10 hours)**			

	4.1	Ecotourism definition, Elements and characteristics of ecotourism. Types of ecotourism – Heritage ecotourism, coastal ecotourism, cultural ecotourism, festival ecotourism, ayurvedic ecotourism. positive and negative impacts of ecotourism.	5	5
	4.2	Major ecotourism centers in Kerala – Gavi, Thattekadu, Thenmala. Learning activity: Visit an ecotourism center and identify the ecotourism components of the ecotourism and submit a report.	2	5
	4.3	Wildlife tourism and its opportunities with reference to Kerala- Periyar tiger reserve, Tholpetty wildlife sanctuary	3	5
5	**Teacher specific course components**			

References

1. Woodward, S. L. (2009). Introduction to biomes. Greenwood Press.
2. Britannica Educational Publishing. (2010). Biomes and Ecosystems. Britannica Educational Publishing.
3. Stiling, P. D. (2015). Ecology: global insights & investigations. Mcgraw-Hill Education.
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7. Ballantyne, R., & Packer, J. (2013). International Handbook on Ecotourism. Edward Elgar Publishing.

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8. Raven, C. (2006). Forestry. Infobase Publishing.
9. Fennell, D. A. (2002). Ecotourism. Routledge.
10. Newsome, D., Dowling, R. K., & Moore, S. A. (2005). Wildlife tourism. Channel View Publications.
11. Dr Jennifer Hill, & Dr Tim Gale. (2012). Ecotourism and Environmental Sustainability. Ashgate Publishing, Ltd.
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14. Begon, M., Harper, J. L., & Townsend, C. R. (2006). Ecology: individuals, populations, and communities. Blackwell Science.

Discipline Specific Elective (DSE) – 04

Discipline/Programme	**BOTANY**				
Semester	VI				
Type of Course	DSE				
Course Code	24UBOTDSE303				
Course Title	**GREEN TECHNOLOGY AND SUSTAINABLE DEVELOPMENT**				
Course Level	300-399				
Course Summary	This program emphasizes on green systems and the environment, energy technology efficiency and sustainability. These chemical processes make hazardous products which are made green, safe and economically acceptable by using biotechnology.				
Lecture/Tutorial/Practical Hours	60				
Credits	4	Theory	4	Practical	0
Pre-requisite, if any	Nil				

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Interpret the relevance and the concept of green technology for sustainable development.	U	PO4, PO5

2	Examine the various cleaner development mechanisms.	An	PO2, PO8
3	Outline the concepts related to conventional and non- conventional energy.	R	PO2 , PO8
4	Evaluate and implement the environmental regulations and standards.	E	PO1, PO6
5	Identify and implement the concepts on various energy efficient systems and green buildings.	A	PO1, PO2, PO8
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)			

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	**Introduction to Green chemistry and sustainability (20 hours)**			
	1.1	Twelve principles of green chemistry, green technology-definition, importance, and applications.	3	1
	1.2	Green technology (Cleantech) initiatives and sustainable business startups in India – Ace Green Recycling, Digital green, EnCashea, Banyan nation, Green ventures.	2	1
	1.3	Extraction procedures: Green methods of synthesis- microwave assisted synthesis, super critical fluids- extraction, process and applications.	5	1
	1.4	Introduction, Concepts- Social, economic and environmental sustainability; Sustainable development, Nexus between Technology and Sustainable development; Millennium Development Goals (MDGs)	5	3

		and Sustainable Development Goals (SDGs).		
	1.5	Basic concepts of Conventional and non-conventional energy, General idea about Solar energy, Fuel cells, Wind energy, Small hydro plants, bio-fuels, Energy derived from Oceans and Geothermal energy	5	3
2	**Cleaner development mechanism and technologies (10 hours)**			
	2.1	Cleaner development mechanism- reuse, reduce and recycle, raw material substitution; wealth from waste; Zero waste concept, carbon credits, carbon trading, carbon sequestration.	5	2
	2.2	Bioremediation: Recent Advances with special reference to Phyto nanotechnology	5	2
3	**Environmental management standards and green future (15 hours)**			
	3.1	Eco-labelling, ISO 14001:2019 framework and benefits, Scope and goal of Life Cycle Analysis (LCA), Bio-mimicking, Environment Impact Assessment (EIA), (Brief account).	5	4
	3.2	Green future: Agenda of green development; reduction of ecological footprint; Water Conservation and Audit, major challenges and their resolution for implementation of green technologies; green practices to conserve natural resources	5	5

	3.3	Green buildings: Definition- Features and benefits, outlined examples; LEED certified building; Eco-mark certification, Eco-mark in India. Green planning: role of governmental bodies, land use planning, concept of green cities, green belts.	5	5
4	**Experiential learning (15 hour)**			
	4.1	Prepare a report on eco-friendly initiatives taking place in your locality.	3	1, 5
	4.2	Familiarizing with renewable energy gadgets.	3	1, 5
	4.3	Green Tech Trip- Visit to any well-maintained green technology institutes or establishments.	6	4, 5
	4.4	Make a report on eco-mark certification products.	3	5
5	**Teacher specific course components**			

References

1. Mackenthun, K.M., (1998). *Basic Concepts in Environmental Management*, Lewis Publication, London.
2. Purohit, S. S., (2008) *Green Technology - An approach for sustainable environment*, Agrobios Publication.
3. Anastas P.T. and Wavner J.C. (1998) *Green Chemistry: Theory and Practice*, Oxford University Press.
4. Lancaster M., (2002) *An Introductory Text on Green Chemistry*, Royal Society of Chemistry, Cambridge.
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6. Bharat, J., Khan B.H, (2006) *Cleaner Production and its implementation in Industries GCPC. Non conventional energy resources*, Tata McGraw-Hill, New Delhi.
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Discipline Specific Elective (DSE) – 05

Discipline/Programme	**BOTANY**				
Semester	VI				
Type of Course	DSE				
Course Code	24UBOTDSE304				
Course Title	**PLANT CHEMICAL ECOLOGY**				
Course Level	300-399				
Course Summary	Plant chemical ecology is a branch of ecology that focuses on the study of chemical interactions between plants and other organisms in their environment. It explores the chemical compounds produced by plants, how these compounds mediate interactions with other living organisms, and the ecological consequences of these interactions. The primary aim is to understand how chemical signals influence plant interactions with herbivores, pollinators, pathogens, neighbouring plants, and other organisms.				
Lecture/Tutorial/Practical Hours	60				
Credits	4	Theory	4	Practical	0
Pre-requisite, if any	Basic knowledge in plant defence and plant secondary metabolites				

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO
1	Distinguish the diverse array of plant secondary metabolite and its orchestration in various interactions	E	1, 2, 3
2	Explain the significance of herbivore-induced plant volatiles to attract predators or parasitoids of the herbivores	An	1, 2, 7
3	Estimate the phenomenon of allelopathy in the germination or growth of competing plant species, influencing the composition of plant communities	E	1, 2, 5, 7
4	Illustrate the role of volatile organic compounds (VOCs) in plant communication	An	1, 2, 5, 7
***Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)**			

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	**Chemical Defences (10 hours)**			
	1.1	Biosynthesis and storage of secondary metabolites in plants – PPBP (Ref: 1, 2, 3)	3	1
	1.2	Plant chemicals against pathogens; Terpenoids, Phenolics, Nitrogen compounds – Alkaloids and Cyanogenic glycosides (Ref: 1, 2, 3)	3	1
	1.3	Proteins and Enzymes that specifically inhibit pathogen – Defensins, Digestive enzyme inhibitors, Protease inhibitors, Hydrolytic enzymes. (Ref: 1, 2, 3)	4	1
2	**Herbivore-Induced Plant Defences (10 hours)**			
	2.1	Introduction on Herbivore-Associated Molecular Patterns (HAMPs) (Ref: 4,5,6,7,8)	3	2
	2.2	Biosynthesis of HIPVs (Herbivore-induced plant volatiles) (Ref: 4,5,6,7,8)	4	2
	2.3	Role of HIPVs in plant defense against herbivores (Ref: 4,5,6,7,8)	4	2
3	**Allelopathy (20 hours)**			
	3.1	Introduction to Allelopathy (Ref: 9, 10)	2	3

	3.2	Ecological importance and consequences of Allelopathy (Ref: 9, 10)	5	3
	3.3	Direct allelopathy, Apparent competition, Apparent predation (Ref: 9, 10)	3	3
	3.4	Biogeographical Variation in Allelopathy (Ref: 9, 10)	3	3
	Practicum	Allelopathic Potential of some local plants on the seeds of weedy plants.	7	3
4	**VOCs and Plant Communication (20 hours)**			
	4.1	Roles of volatile organic compounds (VOCs) – any five compounds involved in plant communication (Ref: 11,12)	2	4
	4.2	Plant-plant signalling - above-ground signalling (Ref: 11,12)	2	4
	4.3	The Chemistry of Plant-Plant Signalling (Ref: 11,12)	2	4
	4.4	Plant-plant signalling - below-ground Signalling (Ref: 11,12)	2	4
	4.5	Self and nonself recognition in plants (Ref: 11,12)	2	4
	Practicum	Isolation of VOCs using hydrodistillation, Hot Extraction, Cold Pressing etc. (Ref: 14,15)	5	4
		Familiarize the isolation and synergistic/ antagonistic activities of VOCs using VOC chambers (Ref: 14,15)	5	4
		Experiential learning by visiting suitable labs working in chemical ecology	8	4
5	**Teacher specific course components**			

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Discipline Specific Elective (DSE) – 06

Programme	**BOTANY**				
Semester	IV				
Type of Course	DSE				
Course Code	24UBOTDSE305				
Course Title	**PLANT ECOLOGY, CONSERVATION AND SUSTAINABLE DEVELOPMENT**				
Course Level	300-399				
Course Summary	The course 'Plant Ecology, Conservation and Sustainable development' deals with the study of how organisms interact with their environment and sustainable development deals with management of natural ecosystems.				
Lecture/ Tutorial/ Practical Hours	60				
Credits	4	Theory	4	Practical	0
Pre-requisite, if any	There are no specific prerequisites for this course.				

CO No.	Expected Course Outcome	Learning Domains *	PO
1	Analyze the concept of ecological hierarchy and the significance of ecological interactions.	An	PO1, PO2, PO4, PO5, PO6, PO7
2	Appraise the efficacy of conservation ecology strategies and create responsible citizens.	C	PO1, PO2, PO3, PO4, PO5, PO6, PO7
3	Critically assess and justify the inevitability of sustainable development practices.	E	PO1, PO2, PO4, PO5, PO6, PO8
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)			

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	**Introduction to Plant Ecology (7.5 hours)**			
	1.1	Definition and scope of plant ecology, branches of ecology, ecological hierarchy - organism, population, community, ecosystem, Biosphere	3	1
	1.2	Types of ecosystems - Terrestrial (Grassland, desert and forest), Aquatic (freshwater and marine).	4.5	1
2	**Autecology & Synecology (22.5 hours)**			
	2.1	Study of plant populations, population characteristics - size, density, dispersion, natality, mortality, survivorship curve, immigration and emigration, population growth, Environmental resistance, biotic potential, carrying capacity.	6	1
	2.2	Community structure and organization- Key concepts: species interactions, species diversity, habitat, niche, ecological indicators, ecotone and edge effect, Foundation species, Keystone species, Umbrella species. **Learning Activity**: familiarise with different sampling methods (Quadrat/ Transect)	5	1
	2.3	Ecological Succession: types, processes and impacts of Hydrosere & Xerosere.	4	1
	2.4	Structure and function of ecosystem: Ecosystem components- abiotic and biotic, Productivity – primary and secondary-gross and net productivity. Decomposition in nature, homeostasis in ecosystem. Ecological energetics: energy flow, trophic levels, food chain and food web, ecological pyramids. Biogeochemical cycles of C, N and S.	7.5	1
	Conservation Ecology (15 hours)			
	3.1	Definitions: Genetic, Species and Ecosystem/Community diversity (Alpha, beta and gamma diversity), biosphere, biodiversity hotspots, megadiversity countries.	5	2

3		Threats to biodiversity: habitat loss and fragmentation-landslides, landslip, cloud burst, dam issues, Quarry issues, Ecologically Fragile Lands (EFL), man-wildlife conflicts, climate change.		
	3.2	Conservation strategies - Definition and goals. In-situ and ex-situ conservation. IUCN - categories, red data book. Global conservation efforts - Rio Earth summit - Agenda 21, Kyoto protocol, IPCC-COP28 (Brief account). Montreal protocol. Conservation strategies and efforts in India, wetland conservation - Ramsar sites in Kerala - State Wetland Authority Kerala (SWAK). Ecorestoration process- basic concepts and its ways.	6	2
	3.3	Technological Approach to Assessment and Conservation-Environmental Impact Assessment (EIA) brief account only. Application of remote sensing technology, Global Navigational Satellite Systems (GNSSs) and Geographic Information Systems (GIS) in studying plant distribution, land cover changes and monitoring ecosystems.	4	2
4	**Sustainable Development - theory and practice (15 hours)**			
	4.1	Sustainable development - definition, principles. The three pillars of sustainability. Global Responses to Sustainable Development (Paris Convention - 2030 Sustainable Development Goals (SDGs)).	6	3
	4.2	Triple Bottomline of Sustainability: Food-Water-Energy nexus. Footprints: Ecological and Carbon. Carbon-stock assessment.	6	3
	4.3	Impact of developmental processes on Biodiversity; Sustainable development (based on any suitable model). HDI (Human Development Index) and SDI (Sustainable Development Index). Rainwater harvesting and responsible tourism.	3	3
5	**Teacher specific course components**			

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SUGGESTED READINGS

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Discipline Specific Elective (DSE) – 07

Discipline/Programme	**Botany**				
Semester	VI				
Type of Course	DSE				
Course Code	24UBOTDSE306				
Course Title	**SCIENCE PERSPECTIVES AND METHODOLOGY**				
Course Level	300-399				
Course Summary	The course discusses various aspects of research – like how to find a research problem, the major sources of literature for research, the major steps in research, methods of report writing, Biophysics and statistics in research.				
Lecture/Tutorial/Practical Hours	60				
Credits	60	Theory	60	Practical	0
Pre-requisite, if any	Nil				

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO
1	Discuss the basic concepts of research, outline a research problem in Biology and design a project based on it.	An	PO1, PO2, PO3, PO4, PO 6, PO7, PO8
2	Identify and compile the various sources of literature for research and write a research report in an accepted format.	A	PO 1, PO2, PO3, PO 5, PO6, PO 7, PO8
3	Familiarize various instruments used in biology and to understand the basic principle and working of the same	U	PO1, PO2, PO3, PO4, PO 6, PO7, PO8
4	Evaluate the data using various statistical tools and interpret the results.	E	PO1, PO2, PO6, PO7, PO8
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)			

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	**Major Steps in research (22 hours)**			
	1.1	Objectives of research. Major steps, purpose, Types of research	2	1
	1.2	Literature sources, names of reputed National and International journals in life science (Minimum 2 international & 3 national); reprint acquisition - INFLIBNET, PubMed, NCBI. **Learning activity:** 1. Preparation of a list of references (not less than 10) on a given topic of biological science 2. Preparation of Review on a given topic using online and print resources	6	1,2
	1.3	Definition of the problem; Identification of the objective(s); literature review (brief account only), introducing working hypothesis, design of the study – basic principles and significance; sampling for data – methods, Identification and collection of data, types of data – Primary and Secondary; Collection of primary data – observation method, interview method, questionnaire method, through schedules; analysis and interpretation of data, Report writing (Brief account).	11	1,2
	Preparation of project report (3 hours)			
	1.4	Preparation of dissertation - IMRAD system – Preliminary pages – Title pages – Certificate, Declaration, Acknowledgement, Table of contents, Abstract; Main text - Introduction and review of literature, Materials and methods, Results, Discussion, Conclusion; End matter – Bibliography and Appendix.	3	1,2
2	**Biophysics (15 hours)**			
	2.1	Beer-Lambert's Law, Principles and applications of colorimeter, spectrophotometer	2	3
	2.2	pH:- concept of pH, pH scale, methods to measure pH ; pH paper and pH meter	3	3

	2.3	Microscopy – Types and application	6	3
	2.4	Electrophoresis; PAGE, Agarose gel electrophoresis (Principle and applications only)	4	3
3	**Biometrics (23 hours)**			
	3.1	Statistical terms, and symbols (Brief study only). Sampling: concept of sample, sampling methods - random and non-random sampling.	4	4
	3.2	Diagrammatic and graphic representation - line diagram, bar diagram, pie diagram, histogram, frequency curve.	3	4
	3.3	Measures of central tendency: mean, median, mode, (discrete and continuous series). Measures of dispersion: standard deviation. Probability and distribution patterns: normal distribution, binomial distribution. Tests of significance (Z – test, t–test and Chi-square test). **Learning activity:** 1. Problems related to a. Measures of central tendency b. Measures of dispersion c. Probability d. Test of significance (Z – test, t – test, Chi-square test)	16	4
5	**Teacher specific course components**			

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Discipline Specific Elective (DSE) – 08

Discipline/Programme	BOTANY				
Semester	VI				
Type of Course	DSE				
Course Code	24UBOTDSE307				
Course Title	**PLANT ANIMAL INTERACTIONS AND POLLINATION BIOLOGY**				
Course Level	**300-399**				
Course Summary	Students will have the opportunity to learn the fascinating world of plant-animal interactions happening around us. It also provides chances to experience various plant animal interactions by means of hands-on training or field observations. Students will get opportunities to understand the evolutionary perspectives of plant-animal interactions. They also learn what are the applications of plant-animal interactions.				
Lecture/Tutorial/ Practical Hours	60				
Credits	4	Theory	4	Practical	0
Pre-requisites, if any	Nil				

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	COs	POs
1	Recollect the basic principles and practices in plant animal interactions and pollination biology	Un	1, 8
2	Apply the basic principles and practices	Ap	1,2,8
3	Implementing best practices of pollination biology	An	1,2,8
4	Conduct various practices and apply best suitable techniques in plant animal interactions	E	1,2,8

5	Derive new methods for plants whose mechanisms are not known	C	1,2,8
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)			

COURSE CONTENT

Module	Units	Description	Hrs	CO No.
1	**Introduction to Plant-Animal interactions (15 hrs)**			
	1.1	Introduction and an overview of plant-animal interactions, significances.	2	1,2
	1.2	Types of plant animal interactions- Competitions and predations (carnivorous plants), granivory, frugivory, herbivory, parasitism, mutualism, commensalism, mentalism, neutralism).	2	1,2
	1.3	Evolutionary perspectives of plant animal interactions	2	1,2
	1.4	Consequences of a variety of interactions on the evolution of traits in both animals and plants.	2	1,2
	1.5	Plant sexuality, breeding system of plants.	2	1,2
	1.6	Hands-on training on identifying types of various plant animal interactions with apt evidence and examples.	5	1,2,3, 4,5
2	**Herbivory and Pollination (15 hrs)**			
	2.1	Herbivory; definition with example, frugivory- seed and seedling predation with example	1	1,2
	2.2	Mechanisms of plants to respond to herbivory (chemical and physical defenses - mechanism).	2	1,2,3
	2.3	Herbivores respond to plant attributes (chemical traits, nutritional quality, architecture, etc.)	2	1,2
	2.4	Pollination; Syndromes - Types with examples	4	1,2,3
	2.5	Adaptations of pollinators and plants for pollination.	2	1,2
	2.6	Hands-on on different pollination syndromes	4	1,2,3, 4,5
3	**Advanced fields in plant-animal interactions (15 hrs)**			
	3.1	Species interaction (plant-animal & animal - plant); Evolution of competitive ability.	4	1,2
	3.2	Multi-trophic interactions (bi-, tri- and tetra- trophic interactions)	3	1,2

	3.3	Chemical ecology of species interactions	3	1,2
	3.4	Animal mediated plant galls, special glands (e.g. Nasonov glands) and secretions (e.g. Salivary gland secretions of phytophagous arthropods) for animal mediated interactions.	5	1,2,3, 4,5
4	**Co-evolution and Field Pollination experiments (15 hrs)**			
	4.1	Co-evolution of Predator-Prey system: Fig-Fig Wasp system, plant parasitic system.	2	1,2
	4.2	Seduction and deception by plants leading to pollen dispersal and dissemination in angiosperms	6	1,2
	4.3	Collection and demonstration of plant materials with evidence of plant animal interactions and identification of interactions. Field Study	7	1,2,3, 4,5
5	**Teacher specific course content**			

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Discipline Specific Elective (DSE) – 09

Discipline/Programme	**BOTANY**				
Semester	VII				
Type of Course	DSE				
Course Code	24UBOTDSE401				
Course Title	**SCIENTIFIC RESEARCH, AN IN-DEPTH APPROACH**				
Course Level	400-499				
Course Summary	This course equips the students to conduct research in the field of their interest. Course discuss various aspects of research like - identification of research problems, formulation of hypothesis, collection of literature, analysis and interpretation of data, hypothesis testing, preparation of research reports, project proposal, and use of statistics in research. The course also discusses various ethical concerns related to research.				
Lecture/Tutorial/Practical Hours	60				
Credits	4	Theory	4	Practical	0
Pre-requisite, if any	Interest in scientific observations				

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO
1	Develop research aptitude and solve the problems to new situations in a scientific way by comprehensive literature reviews utilizing physical and digital databases	A	1, 2, 6, 8
2	Express various research findings in different platforms through suitable formats	C	1, 2, 3, 7, 8
3	Compose the fundamental components of a research proposal/report or presentation based on research ethics	C	1, 2, 3, 6, 7, 8
4	Estimate proper statistical tools for analyzing the data in scientific research	An	1, 2, 7, 8
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)			

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	**Introduction to research and review of literature (10 hours)**			
	1.1	Need for research, generation of a research problem, Critical and creative thinking.	5	1
	1.2	Features of a Scientific Library; Computerized catalogue; Journals (Current and Back- volumes); indexing journals, abstracting journals, research journals, review journals, e-journals. Learning Activity: Visit a scientific library or documentation center and submit a report on the features observed.	3	1
	1.3	Online and Open access Initiative – PubMed and PubMed Central, Science Direct, Medline, INFLIBNET, N-list and Shodhganga,	2	1
2	**Academic communication (20 hours)**			
	2.1	Writing Dissertation/Thesis: General Format (IMRAD-System) and General principles in writing: Front matter -	5	2

		title page, certificate, acknowledgements, and contents page. ● Body of the Dissertation/Thesis: introduction, review of literature, material(s) and method(s), heading(s), result(s): table(s) and illustration(s), marginal indicator(s), caption(s), camera-ready copy; discussion, summary and conclusion; references, abstract(s) and appendix. (Discussion or practical assessment or group assignment)		
	2.2	Reference styles – APA, MLA, Harvard, Chicago. Reference Management system: Mendeley, Zotero (Brief Account), Endnote. **Learning Activity:** Preparation of at least 20 references on a given topic in APA reference style using any reference management system (Mendeley/Zotero/Endnote).	5	2
	2.3	(i) Formats for preparation of Research paper and short communications – title, author name and affiliations, Abstract, Keywords, Introduction, methods, results, discussion, conclusion, acknowledgement, references. (ii) Format and preparation of review articles. (iii)Preparation of presentations of research findings in Seminars and Workshops. **Learning Activity:** Submit a short review paper to the instructor based on a topic of choice.	6	2
	2.4	Selection of Appropriate Journal for publishing, Method for submitting research papers to journals (Elsevier/Springer). Peer review process, Responding to comments by reviewers. Authorship: Corresponding Author, Co-authorship. Indices for Assessment of Journals and Authors: Impact factor of journals; author citation and citation indices: h–index, i – index.	4	2
3	**Preparation of Research proposals for funding and Ethics in Research (10 hours)**			

	3.1	Proposal Ideation/ Ideation process; Title, introduction, literature review and abstract; aim and scope; present status; location of experiments; materials and methods; justification; expected outcome; date of commencement; estimated date of completion; estimated cost; references; funding agencies. **Learning activity:** Prepare a project proposal to submit a funding agency.	6	3
	3.2	Plagiarism, Forms of plagiarism and tools to detect plagiarism (Urkund or Turnitin).	4	3
4	**Statistics in research (20 hours)**			
	4.1	Principles - Replication, Randomization and Local Control. Common designs in biological experiments: Completely Randomized Design (CRD), Randomized Block Design (RBD), Latin Square Design (LSD), and Factorial Design (FD).	5	4
	4.2	Data collection – sampling and types of sampling, Probability - Definition, mutually exclusive and independent events. Linear Regression and Correlation (*Simple and Multiple*).	5	4
	4.3	Statistical Inference-Estimation-Testing of Hypothesis: - t- Test, Chi-square Test (Goodness of fit, Independence or Association, Detection of Linkages), F-test, ANOVA. Statistical data analysis using any of the following Software – *SPSS / R* / Past. **Learning activity:** 1. Test the significance of a given data using the t-Test, Chi square -test. 2. Analysis of a set of data for Correlation / Regression (Scatter diagram). 3. Determine the probability of different types of events. 4. Perform statistical data analysis using a given data in SPSS/ R /Past software.	10	4
5	**Teacher specific course components**			

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Discipline Specific Elective (DSE) – 10

Discipline/Programme	**BOTANY**				
Semester	VII				
Type of Course	MAJOR-DSE				
Course Code	24UBOTDSE402				
Course Title	**PHYTOCHEMISTRY AND PHARMACOGNOSY**				
Course Level	400-499				
Course Summary	Phytochemistry is the study of the chemicals produced by plants, particularly the secondary metabolites which are synthesized as a measure for self-defense, and its medicinal, industrial, and commercial applications. The proper understanding of phytochemicals is essential for drug discovery and for the development of novel therapeutic agents against major diseases. Pharmacognosy is the study and science of medicine from natural sources. Natural medicines have been used for many thousands of years to enhance human health and treat diseases, and modern pharmaceutical medicine is largely dependent on drugs originally discovered in and isolated from natural sources. This course introduces phytochemistry, discusses the relationship of phytochemistry with other sciences and the importance of pharmacognosy.				
Lecture/Tutorial/Practical Hours	60				
Credits	4	Theory	4	Practical	0
Pre-requisite, if any	Nil				

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	To learn the importance of phytochemical and pharmaceutical drugs. s	U,R	PO1
2	Understand the principle involved and learn the extraction and isolation techniques.	U,R	PO1, PO8
3	Classify the different phytochemicals and pharmaceutical drugs.	A	PO2
4	Execute various phytochemical tests and procedures using different laboratory equipment.	An	PO3
5	Preparation of drugs and evaluate various adulterants in pharmaceutical drugs	E,A	PO2, PO6, PO8
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)			

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	**Introduction to Phytochemistry, Plant Secondary Metabolites (15 hours)**			
	1.1	Definition, history and scope of Phytochemistry.	15	1,2,4
	1.2	Recent advances in the field of chemotaxonomy.		
	1.3	Phytochemical approach to economic botany.		
	1.4	Classification, structure and function of medicinally important plant products: glycosides, tannins, alkaloids, phenolic compounds, saponins, terpenoids, steroids, flavonoids, gums and mucilage.		
	1.5	Qualitative analysis of tannins, phenolics, flavonoids and alkaloids, terpenoids, glycosides (Activity).		
2	**Extraction and characterization of phytochemicals (15 hours)**			

	2.1	Solvents- Polar, Intermediate, Non polar, Green solvents	15	2,4
	2.2	**Extraction techniques**- Factors, Traditional (Cold extraction, Hot extraction, Soxhlet- Clevenger apparatus) and modern extraction techniques (Supercritical extraction, Microwave, Ultrasonic, Enzyme assisted extraction) Extraction of volatile oils – Distillation types, Expression, Enfluerage.		
	2.3	Fractionation using Separating funnel, rotary evaporator **Separation techniques**- TLC, Column Chromatography, HPLC; Characterization techniques- GC-MS, LC-MS/MS, UV-VIS Spectrometry, IR Spectrometry (FTIR)		
	2.4	Demonstration/Activity – TLC and column chromatography **<u>Activity</u>**- Fractionation using separating funnel, rotary evaporator **<u>Demonstration</u>**- Soxhlet apparatus/Clevenger apparatus,		
3	**Introduction to Pharmacognosy (9 hours)**			
	3.1	Definition, history, scope and development;	9	1,4
	3.2	Plants in Medicine: Indigenous traditional drugs, traditional system of medicine, herbal medicine, folk medicine, unani, siddha, ayurveda, homoeopathy and Chinese medicine,		
	3.3	**Ethnopharmacology**- definition, contemporary approaches to find new lead compounds from plants using bioassay guided isolation and computational methods (*in-silico* docking).		
	3.4	Interaction with subject expert in the field of Ayurvedic medicine for industrial exposure. **(Activity)**		
	Classification and evaluation of drugs, sources and techniques of drug production			

4	**(21 hours)**			
	4.1	Therapeutic classification of crude drugs	21	2,3,4,5
	4.2	Morphological, microscopical and organoleptic evaluation of crude drugs;		
	4.3	Drug preparation and storage. Collection and preparation of crude drugs for the market.		
	4.4	Quality control of drugs- Adulteration of drugs, tools for identification.		
	4.5	Plant secondary metabolites as drugs- Compounds from plants with anti-microbial, anti-cancer, anti-malarial, anti-diabetic properties, antiaging properties (examples)		
	4.6	Techniques for production of drugs– purification, filtration, adsorption, solubilization, absorption, suspension and emulsification		
	4.7	Histochemical localization of starch grains- rice, potato.		
	4.8	Histochemical analysis of plant components: Starch grains in rice and potato **(Activity)**		
	4.9	Estimation of water content, dry matter and ash content **(Activity)**		
	5.0	Training on *in-silico* docking methods **(Activity)**		
5	**Teacher specific course content**			

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Discipline Specific Elective (DSE) – 11

Discipline/Programme	**BOTANY**				
Semester	VII				
Type of Course	DSE				
Course Code	24UBOTDSE403				
Course Title	**MODERN TRENDS IN GENOMICS**				
Course Level	400-499				
Course Summary	The Plant Genomics course offers a comprehensive examination of the molecular intricacies governing plant life, emphasizing genomic principles. Students delve into the structural nuances of plant genomes, exploring chromosomal organization, gene structure, and the role of repetitive DNA elements. Functional genomics techniques, such as transcriptomics and proteomics, are explored alongside an in-depth look at cutting-edge tools like next-generation sequencing. Comparative genomics sheds light on the evolutionary aspects of plant genomics, while mapping and sequencing techniques provide insights into genome structure. The course equips students with the emerging trends in plant genomics research are explored, ensuring students are prepared for careers at the intersection of genomics and plant biology.				
Lecture/Tutorial/Practical Hours	60				
Credits	4	Theory	4	Practical	0
Pre-requisite, if any	Basics of molecular biology and genetics				

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO
1	Explain the basics of genome organization	U	1, 2, 3, 4, 5
2	Illustrate the processes in genome mapping	An	1, 2, 3, 7
3	Distinguish various sequencing technologies and its applications in plant science	An	1, 2, 3, 7
4	Consider various functional genomics aspects in plant science research	E	1, 2, 3, 4, 7
5	Choose comparative genomic tools in evolutionary studies	E	1, 2, 3, 4, 6, 8
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)			

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	**Structural genomics (15 hours)**			
	1.1	Introduction to genomics	1	1
	1.2	Brief overview of prokaryotic and eukaryotic genome organization	2	1
	1.3	Extra-chromosomal DNA: Mitochondrial and chloroplast genomes	2	1
	1.4	Genetic mapping and physical mapping.	2	1, 2
	1.5	Construction of linkage maps using molecular markers – RFLP, RAPD, AFLP, SSLP, SNP	5	1, 2
	1.6	Physical mapping – restriction mapping, STS mapping, EST	3	1, 2
2	**Genome sequencing (20 hours)**			
	2.1	Sanger's DNA sequencing method; Genome sequencing strategies-Whole genome, clone-by-clone and hybrid approaches.	5	3
	2.2	Next generation sequencing technologies- ● Pyrosequencing, ● Reversible terminator sequencing,	10	3

		• ion torrent method, • PacBio long range sequencing, • Helicos true single molecule sequencing • Nanopore sequencing. • SoLid Sequencing Applications of NGS in modern world (Any five applications)		
	2.3	Sequence assembly – methods used. (Reference and de novo)	1	3
	2.4	Genome Annotation, Gene Ontology (GO)	2	3
	2.5	Important findings of the completed genome projects: Arabidopsis genome project, Tomato genome project and Banana Genome project. (Article discussion)	2	3
3	**Functional Genomics (15 hours)**			
	3.1	Transcriptome/RNA seq, Exome sequencing	2	4
	3.2	Expression profiling using Real time quantitative PCR (RT-qPCR).	2	4
	3.3	Methyl sequencing	1	4
	3.4	Gene expression analysis using dot blotting and microarrays.	2	4
	3.5	Chromatin immunoprecipitation sequencing (ChIP Seq) and its applications.	2	4
	3.6	Gene editing using CRISPR-Cas9 technology, its applications	1	4
	Practicum	Experiential Session: Provide the students a captivating day-long laboratory excursion, offering an exclusive visit to a state-of-the-art sequencing facility.	5	4
4	**Comparative genomics (10 hours)**			
	4.1	Gene identification by comparative genomics	1	5
	4.2	Comparative genomics as a tool in evolutionary studies (molecular phylogeny): Orthologous, Analogous, Paralogous and Xenologous genes	2	5
	4.3	Metagenomics. (A brief account with its applications)	2	5

	Practicum	Experiential Session: Phylogenetic analysis using genomic tools (MEGA or Phylip)	5	5
5	**Teacher specific course components**			

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Discipline Specific Elective (DSE) – 12

Discipline/Programme	**BOTANY**				
Semester	VIII				
Type of Course	DSC				
Course Code	24UBOTDSE404				
Course Title	**DATA MANAGEMENT FOR PLANT SCIENCE**				
Course Level	**400-499**				
Course Summary	Course dealing with data management and analysis for plant science. The student will be able to understand how to design scientific research, especially field experiments. The course also ensures students learn how to enter, sort, analyse and explain data by means of graphical representation.				
Lecture/Tutorial/ Practical Hours	60				
Credits	4	Theory	4	Practical	0
Pre-requisites, if any	Nil				

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains*	PO's
1	Recall the basic principles and methods in data management in Plant Science	U	1,8
2	Deduce data sorting, editing, and proofreading	Ap	1,2,8
3	Plan the data collection and analysis	An	1,2,8
4	Determining the type of data analysis and tools	E	1,2,8
5	Creating graphical representation of data and interpretation	C	1,2,8
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)			

COURSE CONTENT

Module	Units	Description	Hours	COs
1	**Introduction to Data Management (15 hrs)**			
	1.1	Data and Data Collection, data management, and data management systems.	4	1,2
	1.2	Different types of data in plant science.	3	1,2
	1.3	Methods of data Collection	2	2,3
	1.4	Design for data collection in plant science.	2	1,3
	1.5	Types of data collection; Scientific data, data using sensors, Computer generated data.	4	1,3
2	**Structure of data (15hrs)**			
	2.1	Standards of data, Units of data	1	1,2
	2.2	Determining limits of data collection, Data entry.	2	1,2
	2.3	Data sorting, data checking for errors, Data Analysis, graphical representation of data.	6	1,2
	2.4	Hands-on on Collection and analysis of different types of data.	6	1,2
3	**Software for Data Management (15hrs)**			
	3.1	Tools for Data Management - Introduction and importance.	3	1,3,4,5
	3.2	MS Excel as a data analysis platform, Diversity analysis, and other Statistical analysis for plant science using MS excel.	2	1,3,4,5
	3.3	Introduction to R software as a data analysis tool.	4	1,3,4,5
	3.4	Creating data, Sources of data, Ingestion & Storage of data, Structure, attribution and relationships, Versioning, Sharing, Exchange & Re-Use, Archiving.	2	1,3,4,5
	3.5	Hands-on on different tools.	4	1,3,4,5
	Online Data Management (15 hrs)			
	4.1	Metadata - Definition, types, significance and applications.	2	1,2

4	4.2	Identification of metadata, Metadata standards, Master Data Register (MDR), Creating metadata.	2	1,2,3
	4.3	Data on the web - Managing data online.	1	1,2,3
	4.4	Data integration, Information retrieval, Asking structured queries over the web.	2	2,4,5
	4.5	Handling online metadata.	8	3,4,5

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Discipline Specific Elective (DSE) – 13

Discipline/ Programme	**BOTANY**				
Semester	VIII				
Type of Course	DSE				
Course Code	24UBOTDSE405				
Course Title	**FIELD BOTANY**				
Course Level	**400-499**				
Course Summary	Students will have opportunities to learn various field botany techniques. The course offers a comprehensive understanding on various techniques in various subjects in plant science. Students get opportunities to hands-on training on various techniques in field botany aspects. It also covers data and basic data management.				
Lecture/Tutorial /Practical Hours	60				
Credits	4	Theory	4	Practical	0
Pre-requisites, if any	Nil				

CO No.	Expected Course Outcome	Learning Domains*	PO's
1	Recall the basic principles and methods in field botany	U	1,8
2	Apply various field botany techniques	Ap	1,2,8
3	Analyse the results of field data	An	1,2,8
4	Concluding the experimentation with reasoning	E	1,2,8
5	Creating graphical representation of data and interpretation	C	1,2,8
***Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)**			

COURSE CONTENT

Module	Units	Description	Hours	COs
1	**Introduction to Field Botany (15 hrs)**			
	1.1	Introduction to field studies. Significances of field studies. Areas of Botany that require field studies - Ecology, Taxonomy, Pollination biology, Ethnobotany, Horticulture and Nursery management, Lower groups of plants.	4	1
	1.2	Field experimentation – design of experiments, field sampling. Continuous monitoring, long term monitoring.	4	1
	1.3	Field data collection – Types of data, variables and parameters, designing a survey/field study.	3	1
	1.4	Plant preservation technique. Flower and floral parts, fruits and seeds, herbarium technique.	4	1,2,3,4,5
2	**Area Specific Field Studies- Ecology and Plant Identification (15 hrs)**			
	2.1	Ecology – Quadrat and transect method, plant census, Diversity studies.	3	1,2,3
	2.2	Ecology – field studies on pollution and climate change.	3	1,2,3
	2.3	Types of inflorescence and fruits, Field identification of plants.	3	1,2,3
	2.4	Technical terms used in field plant identification, field data collection, taxonomy related studies.	2	1,2,3
	2.5	Identification of flowering plants to species level using technical and popular identification keys.	4	1,2,3,4,5
3	**Area Specific Field Studies – Pollination Biology (15 hrs)**			
	3.1	Pollination biology – Phenology, understanding floral parts.	4	1,2,3
	3.2	Emasculation, breeding system experiments, floral visitation data.	4	1,2,3
	3.3	Effective pollinator confirmation studies.	2	1,2,3

	3.4	Hands on training on reproductive biology and pollination ecology of plants in bloom encountered in the field.	5	1,2,3,4,5
4	**Area Specific Field Studies – Lower Groups (15 hrs)**			
	4.1	Algae and Fungi – Data collection, identification, sample preparation and preservation in the field.	5	1,2
	4.2	Bryophytes and Pteridophytes - Data collection, identification, sample preparation and preservation in the field.	5	1,2
	4.3	Photographing plants using mobile. Using photographs for online sharing. Identification and archiving field photographs using online platforms.	5	1,2,3,4,5
5	**Teacher specific course content**			

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Discipline Specific Course (DSC) Minor – 01

Discipline/Programme	BOTANY				
Semester	**I**				
Type of Course	DSC				
Course Code	24UBOTDSC-M101				
Course Title	**PLANT SCIENCE AND ITS ADVANCEMENTS**				
Course Level	100-199				
Course Summary	The course entitled 'Fascinating World of Plant Science and Technology' aims to impart an understanding on the significance of plants to the future generation. Students will be familiarized with eminent botanists and their contributions to plant science. They will be introduced to the major plant groups and their uniqueness in terms of size, shape, habitat and associations. Students are expected to develop a passion to explore the plant kingdom as well as to make serious attempts to conserve plants. Knowledge about traditional and modern approaches in plant sciences and major branches related to plant science will also be acquired.				
Lecture/Tutorial/Practical Hours	75				
Credits	4	Theory	3	Practical	1
Pre-requisite, if any	Should have basic knowledge of Botany and have a natural intelligence				

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO
1	Comprehend the relevance of plants in nature, important milestones in the history of botany, and human efforts to realize life on Earth.	U	1, 5, 3, 8
2	Illustrate the diversity and evolutionary trends throughout the plant world that lay a solid foundation for the branch of natural philosophy, botany.	An	1, 2, 3,6, 8
3	Develop basic skills on instruments and techniques used in Botanical studies.	A	2
4	Facilitate awareness on the areas of research and potentials in the field of plant science.	A	1, 2, 7
5	Design experiments and communicate ideas, which would translate into a lasting and practical basis for building a career based on botany	C	1, 2, 7, 8
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)			

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	**Exploring the Plant Kingdom (23 Hours)**			
	1.1	A Journey Through Botanical History: Contributions of eminent botanists/naturalist: (a) Theophrastus, (b) Carl Linnaeus (c) John Ray (d) Nicolai Ivanovich Vavilov (c) Itty Achudan (d) Janaki Ammal Brief overview of Botany, citing events that changed the course of world history: Rice, Potato, Sugarcane and *Penicillium notatum, Phytophthora infestans*	4	1
	1.2	Plants and the Planet: maintaining ecological balance **<u>Learning Activity</u>**: Group Discussion on • Usefulness and benefits of plants • Significance of Plants as problem solver of our planet.	3	1

	1.3	Distinguishing characters and evolutionary trends in the **morphology** of major groups of plants: Algae, Bryophytes, Pteridophytes, Gymnosperms and Angiosperms. **<u>Learning Activity:</u>** An explorative nature walks to understand biodiversity of a selected locality: Paddy Field / Wetland ecosystem / Sacred Groves / Any other locality which harbors biodiversity and represents most of the major plant groups.	10	2
	1.4	Wonders of the plant world: • Unusual foods: Fungi (Mushrooms), Lichen (*Parmelia*), *Chlorella* as food supplement in aerospace programmes. • Psychoactive plants and zoopharmacognosy: Marula plant (*Sclerocarya birrea*); Lemurs eating tamarind and fig leaves. Biomimicry: Nature as model: Lotus effect® technology in paint industry; *Citrus maxima* fruit wall inspired design of crash absorbing structures. • Special Adaptations: Insectivorous plants, Heliotropism in sunflowers, Pseudocopulation strategy in orchids. • Gigantic plants: e.g. *Sequoiadendron giganteum*. • Plants that live in extreme environments: volcanoes: Haleakala silversword, desert: Saguaro cactus, arctic: Arctic poppy	6	2
2	**Traditional and Modern Approaches in Plant Science (17 Hours)**			
	2.1	Traditional approach and methods: (A) Exploration: Field Visit. (B) Collection of plant material: significance & tools used. (C) Preservation: Killing Agent: (Formalin), Fixing Agent: (FAA). Wet Preservation: Museum jar preservation. dry preservation: herbarium. (D) Free-hand sectioning: Transverse section (TS), Longitudinal section (LS)	4	3
	2.2	(E) Description: Description of plants. (F) Classification: Artificial, Natural and Phylogenetic (Definition and One	2	3

		Example Each). (G) Documentation: Significance of scientific diagrams and field books.		
	2.3	Modern Approaches: (A)Sectioning: Microtomy (Definition and purpose of rotary microtome, sledge microtome and ultramicrotome). (B) visualization techniques: parts and applications of simple & compound microscope, applications of electron microscope (SEM & TEM). (C) Separation techniques (Principle and Application): (i) Chromatography: TLC and Paper chromatography. (ii) Centrifugation: tabletop centrifuge and ultracentrifuge. (iii) Electrophoresis: agarose gel electrophoresis (AGE).	6	3
	2.4	A few current approaches and applications: (A)Molecular techniques (General Account and Applications): PCR, DNA barcoding (B) Remote Sensing (Brief Account): Application of Remote sensing and GIS for mapping of natural resources. (C) Use of Internet of Things (IoT), Deep learning and artificial intelligence (AI): Detection of water stress and disease detection in smart/precision Farming. **<u>Learning Activity 3:</u>** Visit to a laboratory to familiarize with a few of the instruments mentioned above.	5	3, 5
3	**Major Branches and Scope of Plant Science (5 Hours)**			
	3.1	Brief account and research potential in: Plant systematics, Ecology, Plant anatomy, Plant physiology, Genetics, Ethnobotany, Crop improvement & Plant genetic engineering	5	4, 5
4	**Practical (30 hours)**			
	4.1	Field Activities (Mandatory) • Conduct a two days field trip and survey, to appreciate the diversity of plant kingdom and to identify plants belonging to all the major groups discussed in theory. Prepare a set of 12 geo-tagged photographs containing at least one representative from each Major group.	15	2

	4.2	Laboratory Activities (Conduct Any Three) • Prepare a report and presentation on Botanists who made significant contributions to science • Familiarize students with a compound microscope and dissecting / simple microscope. Assess the magnifications of the microscope you are examining. Compare the real image (Naked eye) with the magnified virtual image of an appropriate plant specimen and make illustrations of magnified specimens. • Prepare temporary, single stained hand sections (TS and LS; one each) of appropriate plant specimens for light microscopic studies. • Design a working model for detecting Moisture of Soil/ Temperature and Humidity of Air, utilizing Arduino microcontroller kit/ Raspberry pi or other microcontroller boards and appropriate sensors. Possibilities to utilize IoT, as part of the model may be explored, if needed. • Prepare an extract of leaves of appropriate plant material and perform centrifugation using a table top centrifuge, decant to separate the pigments (Supernatant) from the debris (Pellet).		
5	**Teacher specific course components**			

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Discipline Specific Course (DSC) Minor– 02

Discipline/Programme	**BOTANY**				
Semester	II				
Type of Course	DSC				
Course Code	24UBOTDSC-M102				
Course Title	**PLANT RESOURCE MANAGEMENT**				
Course Level	100-199				
Course Summary	The course aims to impart knowledge on the importance of plants and plant-based products in everyday life. Several plant resources-based industries are successfully established in our society. Plethora of opportunities and innovations in plant science research are also discussed. Plant crafting and plant architect opportunities are explored. The course is designed to equip students with technical knowhow on business prospects and develop skills needed to successfully convert them into entrepreneurial ventures. On completion, learners will be able to develop ideas and enable them to be professionally competent so as to convert their ideas to successful business opportunities. This course aims at molding a successful entrepreneur through various avenues of Plant Science				
Lecture/Tutorial/Practical Hours	75				
Credits	4	Theory	3	Practical	1
Pre-requisite, if any	Should have basic knowledge on plants resources and its importance in everyday life				

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO
1	Identify and assess plant resources in various contexts.	U	1, 2, 3, 8
2	Understand the problems are approaches in agriculture, health and in environmental contexts critically	U	1, 2, 4, 7
3	Summarize the foundational knowledge about sustainable agriculture, horticultural activities, organic farming, nursery management and mushroom cultivation to human welfare.	U	2, 3, 5, 7, 8
4	Develop an understanding of entrepreneurial opportunities in plant science and fostering an entrepreneurial mindset	C	1, 2, 3, 4, 7
5	Reframe the significance of the plant world, gain insights into the potentials of personal prosperity and career opportunities in plant science.	E	1, 2, 6, 8
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)			

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	**Introduction to Plant Resources (15 Hours)**			
	1.1	Plants in everyday life: (General an outline with an example) ● Importance as food, ● Source of medicine, ● Cultural and aesthetic value. ● Role of plants in maintenance of air, water and soil quality, ● Plants as ecological indicators, ● Bio-control agents, ● Plant based bio manure, ● Plant-based bioplastics and ● Plant based biofuels.	2	1
	1.2	Plants as resource: (General account with special reference to the following): ● Drug yielding plants: Sarpagandha, *Vinca* - drug and its uses	10	1

		● Plant as staple food: Rice, Cassava - morphology of useful part and nutritional benefits ● Plant as source of fibre: Cotton and Coir - useful part and commercial aspects ● Rubber yielding plants: Pará rubber tree - commercial aspects ● Plants yielding essential oils: Eucalyptus and lemongrass – Industrial values ● Vegan Cosmetics: ● Cleanser: Cucumber, Rose ● Hair and Skin care products: Amla. Henna, Bhringaraj, Tulsi, Turmeric		
	1.3	Plant-based industries: (Basic outline only neede) ● Fruit production and processing: Dry Fruits and Canning. ● Fruit and Vegetable-based products: Squash, Syrup, Pulp, Paste, Ketchup, Soup, Vegetable Sauces, Jam and Jellies. ● Bamboo and Cane-based products. ● Production of Nutraceuticals.	3	1
2	**Exploring Plant Science Research (15 Hours)**			
	2.1	Introduction to plant science research: Significance in addressing global challenges like: Climate change, Food Security, Biodiversity conservation - brief account	2	2
	2.2	Innovation in plant Science: (Mention only) Crop improvement-Flood resistant rice, Green Revolution (Norman Borlaug- high Yielding Wheat), Genetic engineering - Bt-Cotton, gene editing for disease resistance, Synthetic biology – brief account	3	2
	2.3	Brief account on research institute in India, which identifies plant science / botany as a thrust area for investigation. Botanical Survey of India (BSI), National Bureau of Plant Genetic Resources (NBPGR), National Rice Research Institute (NRRI), Indian Institute of Sugarcane Research (IISR), Institute of Forest	10	2

		genetics and Tree Breeding (IFGTB), Jawaharlal Nehru Tropical Botanic Garden and Research Institute (JNTBGRI), Kerala Forest Research Institute (KFRI), Central Plantation Crops Research Institute (CPCRI), Central Tuber Crops Research Institute (CTCRI), Rubber Research Institute of India (RRII) and ICRISAT (International Corp Research Institute for Semi-Arid Tropics)		
3	**Insights into Botanical Entrepreneurship and Sustainable Future (15 Hours)**			
	3.1	Introduction to entrepreneurship: ● Definition and significance in the context of plant science. Basic traits and skills for entrepreneurs. ● Brief exploration of successful plant-based startups and their impact- Grow the Funguy, Vgrow, Jackfruit 360, Synthite, Coonfresh, Purple Pod, Paul & Mike etc.	3	4
	3.2	Identifying problems or opportunities within the plant science domain. ● Steps in the entrepreneurial journey: Overview of market assessment, enterprise selection, and resource mobilization. Schemes for Financial Assistance. Brief introduction to IPR, copyrights and GI tags.	4	4
	3.3	● Career paths in Botany: Few of the industries where a botanist can work: Research Lab/Institutions, Chemical Industry, Food Companies, Arboretum, Forest Services, Biotechnology Firms, Oil Industry, Land Management Agencies, Seed and Nursery Companies, Plant Health Inspection Services, National Parks, Biological Supply Houses, Plant Resources Laboratory and Educational Institutions ● Opportunities in Green World: General – (Scientific assistant, Plant geneticist, Computational biologist, Field botanist, Naturalist, Biotechnologist, Molecular	8	5

		Biologist, Nursery Manager, Plant Researcher, Teacher/Professor, Plant Pathologist, Ecologist, Plant Biochemist, Environmental Conservationist, Plant Microbiologist, Environment Consultant, Horticulturist, Plant explorer, Taxonomist, Cytologist, Biological Technician, Park Ranger, Nursery or Greenhouse manager, Farming consultant, Paleobotanist) ● Government opportunities (General discussion): Staff Selection Commission (SSC), Institute of Banking Personnel Selection (IBPS) and State bank of India (SBI), Kerala Public Service Commission (PSC), Union Public Service Commission (UPSC)/Civil services, CDS exam, Junior research fellowship (JRF), senior research fellowship (SRF), National Eligibility Test (NET) and Indian Forest Service exam (Discussion) **<u>Activity 2:</u>** Conduct a one-day workshop for students to confer awareness on academic progression, research, career and entrepreneurial prospects and opportunities in Botany.		
4	**Practical (30 hours)**			
	4.1	Field Activities (Mandatory) ❖ Conduct one day industrial visit: To plant-based industry in your near vicinity. ❖ Prepare a detailed report on functioning, products and marketing with the support of proper evidence and Geo-tagged photographs	10	2, 3, 4, 5, 7
	4.2	Laboratory Activities (Conduct any Two) ❖ Online course on Botanical entrepreneurships ❖ Industry visits and report preparation	20	2, 3, 4, 5, 7

		❖ Group discussion on entrepreneurial ideas and report preparation ❖ Video preparation on botanical ideas		
5	**Teacher specific course components**			

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Discipline Specific Course (DSC) Minor– 03

Discipline/Programme	**BOTANY**				
Semester	III/IV				
Type of Course	DSC				
Course Code	24UBOTDSC207				
Course Title	**FLORICULTURE AND OLERICULTURE**				
Course Level	200-299				
Course Summary	Floriculture and Olericulture course focus on the science and techniques involved in the production of vegetables and flowers. It covers various aspects of floral and vegetable crop production, including cultivation, harvesting and post-harvest handling.				
Lecture/Tutorial/Practical Hours	75				
Credits	4	Theory	3	Practical	1
Pre-requisite, if any	Nil				

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Identify the components, importance of floriculture	R, U	PO1
2	Describe the methods of production of cut flower and loose flowers	R, U	PO2
3	Identify different methods of olericulture	R	PO2
4	Practice production of different value-added products	A	PO3, PO8
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)			

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	**Introduction to Floriculture and Production of Cut Flowers and Loose flowers (20 Hours)**			
	1.1	Floriculture: History and scope of Floriculture. • Components of floriculture: ornamental gardening, commercial floriculture, landscape gardening, arboriculture • Commercial floriculture: importance, scope and significance	2	1,2
	1.2	Production Technology of Cut Flowers and Loose flowers - Scope of cut flowers in global trade, Global Scenario of cut flower production. **Cut Crops**- Rose, chrysanthemum, gerbera, gladioli, tuberose, orchids, aster. **Loose Crops**- Jasmine, marigold, gomphrena.	5	1,2,3
	1.3	**Nursery management**- media for nursery, special nursery practices; Growing environment, open cultivation, protected cultivation, soil requirements, artificial growing media, soil decontamination techniques, planting methods, influence of environmental parameters, light, temperature, moisture, humidity and CO_2 on growth and	8	2,3

		flowering. Cut flower standards and grades, harvest indices, harvesting techniques, post-harvest handling, Pre- cooling, pulsing, packing, Storage & transportation, marketing.		
	1.4	**Flower arrangement**: principles, different styles: Fresh, dry and artificial. Techniques to prolong the vase life of flowers. Types of value-added products, value addition in loose flowers - garlands, veni, floats, floral decorations. Value addition in cut flowers - flower arrangement, styles, Ikebana, moribana, free style, bouquets, button-holes, flower baskets, corsages, floral wreaths, garlands, etc.; Selection of containers and accessories for floral products and decorations.	5	2
2	**Introduction to Olericulture (11 Hours)**			
	2.1	**Olericulture** - Introduction, Classification-botanical, cultural, thermo classification. Food value of common vegetables grown in Kerala. Types of vegetable farming - kitchen, garden, terrace garden, market garden, truck garden.	3	1,2
	2.2	**Cultivation-**planting season, preparation of soil, seed selection, seeding, transplanting- thinning, mulching. Irrigation, manuring, plant protection methods	3	3
	2.3	Harvesting and post harvesting operations of the following corps. **Warm season vegetables**: brinjal, chilli, cucumber, bitter guard, lady's finger, cephalandra, amaranth, coleus, musa **Cool season vegetables**: cabbage, carrot, beet, onion, peas and beans. Pre and post-harvest changes in vegetables: role of growth regulators and stimulants in vegetable production: changes during cooking and processing- spoilage of vegetables-factors	5	

		influencing spoilage- microbial spoilage-		
	Value added products (15 Hours)			
3	3.1	Value added products from vegetables. Problems and prospects of vegetable cultivation in Kerala	5	2,3
	3.2	Mushroom as a vegetable: cultivation of edible mushrooms; button, paddy straw and oyster mushroom. Spawn production, utilization of paddy straw and other agro wastes in cultivation, pest and disease control. Value added products from mushrooms	5	4
	3.3	Value added products from cut flowers and loose flowers. Role of government to promote floriculture and olericulture in India Agencies promoting cultivation of vegetables and flowers. Role of agricultural and flower shows to promote the cultivation	5	1
4	**Practicals (30 Hours)**			
	4.1	1. Identification of commercially important floricultural crops. 2. Propagation technique in Hibiscus /Rose /Chrysanthemum/tuberose. 3. Propagation technique in Gladiolus/ carnation Petunia 4. Sowing of seeds and raising of seedlings of a flowering plant/ vegetable. 5. Training and pruning of rose/Jasminum. 6. Drying and preservation of flowers. 7. Use of chemicals and other compounds for prolonging the vase life of cut flowers. 8. Flower arrangement practices. 9. Preparation of bouquets, garland 10. Identification of post-harvest techniques 11. Preparation of one value added product using vegetable/fruit/mushroom	30	1,3,4
5	**Teacher specific module**			

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Multidisciplinary Course (MDC) – 01

Programme	**BOTANY**					
Semester	I					
Type of Course	MDC					
Course Code	24UBOTMDC101					
Course Title	**ECOTOURISM AND ITS NOVEL TRENDS**					
Course Level	100-199					
Course Summary	The course titled "Ecotourism and its novel trends" provides a comprehensive exploration of sustainable tourism practices and their impact on the environment. The course describes the principle, scope, and role of ecotourism in achieving conservation goals, community engagement and benefits, ecotourism resources, planning steps of ecotourism and the role of international non-governmental organizations in ecotourism.					
Lecture/Tutorial/Practical Hours	45					
Credits	Total	3	Theory	3	Practical	0
Pre-requisite, if any	There are no specific prerequisites for this course.					

	CO No. Expected Course Outcome	**Learning Domains ***	**PO**
1	Describe the fundamental principles and concepts of ecotourism	U	PO4, PO5, PO6
2	Summarize the components of ecotourism and the role of NGOs in ecotourism	U	PO1, PO4, PO5, PO7
3	Examine the characteristics and functioning of various centers of ecotourism in India	An	PO1, PO2, PO4
4	Explain the role of ecotourism in conservation enterprises, livelihood security and sustainable development	E	PO1, PO4, PO5, PO6, PO7
5	Design an ecotourism plan and management strategies based on the case studies from successful ecotourism projects.	C	PO1, PO2, PO3, PO4, PO5, PO6,

			PO7, PO8
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)			

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	**Introduction to Ecotourism and Biodiversity Conservation (15 hours)**			
	1.1	Definition, principles, relevance and scope, do's and don'ts of tourists in ecotourism, ecotourism impact on the environment. Eco-friendly practices, responsible and sustainable tourism.	3	1
	1.2	Components of ecotourism - biodiversity conservation, education, empowerment of local community, environmental awareness, cultural diversity and respect, responsible marketing, economic and social benefits.	3	1,2
	1.3	Ecotourism Resources – Natural, Geographical, Cultural festivals, historical monuments and Natural heritage sites. Terms associated with ecotourism - Adventure tourism, geotourism, wildlife tourism, canopy walkway, ecolabelling, greenwashing, hydel tourism, Ecoshops, Eco-lodges.	3	1, 3
	1.4	Ecotourism activities - Adventure sports, cultural activities, educational workshops, photography, community development.	2	3
	1.5	Biodiversity and its conservation – significance of in situ conservation, Protected areas – national parks, wildlife and bird sanctuaries, forest reserves. Endemism and biodiversity Hotspots - Western Ghats as a source of Ecotourism.	4	3,4
2	**Ecotourism Prospects, Potential and Planning (15 hours)**			
	2.1	Prospects and potential of Ecotourism in India, Ecotourism resources in India. e.g. Sundarbans, Kaziranga National Park.	3	3
	2.2	Ecotourism in Kerala, Ecotourism centres in Kerala. **Learning activity:** collection of details regarding services and activities provided by various Ecotourism centers in	3	3

		Kerala using official websites or btrochures.		
	2.3	Ecotourism Planning: Steps of Ecotourism Planning - Preliminary assessment, stakeholder engagement, ecotourism goals and objectives, carrying capacity, infrastructure, visitors management, conservation of ecosystem in the area, community involvement and benefits.	4	3, 4, 5
	2.4	Ecotourism and livelihood security - Community-based ecotourism (CBET) as a tool for conservation, challenges in CBET, Joint Forest Management	2	4
	2.5	Role of NGOs: Role of international agencies in ecotourism – The International Ecotourism Society (TIES), World Wide Fund for Nature (WWF) and United Nations World Tourism Organization (UNWTO).	3	2
3	**Practicum (15 hours)**			
	3.1	Case study on Thenmala Ecotourism program and Periyar Tiger Reserve.	6	1, 2, 3, 4, 5
	3.2	Field visit to an ecotourism site to observe and analyse the sustainable practices and submission of a detailed report.	15	1, 2, 3, 4, 5
	3.3	Identify and prepare a checklist of plants, birds and animals having economic, ecological and cultural significance as an ecotourism attraction.	4	1, 2, 3, 4
	3.4	Examine the current state of natural resources and develop suitable messages and appropriate media for educating different target groups.	5	1, 3, 4, 5
4	**Teacher specific course components**			

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Multidisciplinary Course (MDC) – 02

Discipline/Programme	**BOTANY**					
Semester	II					
Type of Course	MDC					
Course Code	24UBOTMDC102					
Course Title	**OUTDOOR GARDEN MANAGEMENT**					
Course Level	100 - 199					
Course Summary	This course provides a comprehensive exploration of gardening and landscaping principles, equipping students with the knowledge and skill to create and maintain beautiful sustainable outdoor spaces. Students will earn foundational knowledge in nursery management techniques, includingpropagation and soil preparation. The course will familiarise students with essential tools, components and structures used in garden designing. Exploring eco-friendly practices in garden design can contribute to environmental conservation.					
Lecture/Tutorial/Practical Hours	45					
Credits	Total	3	Theory	3	Practical	0
Pre-requisite, if any	Basic understanding of Biology					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Estimate the basics of ornamental and landscapegardening	An	PO1

2	Review the principles of gardening and nurserymanagement	U	PO1
3	Recollect the basic knowledge of plant growth structuresused in gardening	R	PO1
4	Explain various propagation techniques used in anursery	U	PO3, PO8
5	Apply the knowledge of gardening and landscaping todesign a garden	A,C	PO2, PO5, PO8
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)			

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	**Introduction to Gardening and nursery techniques (15 hours)**			
	1.1	Introduction to landscaping, gardening and commercial floriculture – importance and prospects	2	1
	1.2	Types of plants in landscaping– Trees, shrubs, climbers, annuals, herbaceous perennials, bulbous crops, palms, ferns, cacti & succulents, aquatic ornamentals.	2	1, 2
	1.3	Types of gardens- fruit garden, ornamental garden, herbal garden, kitchen garden, Kids Garden (brief account) Modern gardening – container, vertical, hydroponics Indoor plants (Money plant, Snake plant, Monstera, ZZ plant, Aglaonema)	4	1, 2
	1.4	Horticultural practices related to gardening – training, pruning and mulching, its benefits. Nursery bed preparation, transplantation	2	1, 2

	1.5	Vegetative propagation methods – naturaland artificial Cuttings – leaf, stem and root, layering–air layering, simple layering, grafting- approach grafting, Tongue grafting, budding- T budding, patch budding	5	4
2.	**Tools and structures in gardening and principles of landscaping (15 hours)**			
	2.1	Nursery layout & structures: Polyhouse, mist chamber, rain shelter, potting shed, composting shed Irrigation- Sprinkler irrigation.	3	3
	2.2	Gardening tools & implements Garden spade, rake, fork, garden shears, secateurs, grafting & budding knife, pruning saw, mowers, brush cutter, garden tillers	2	2
	2.3	Garden components and adornments (brief account only)	2	2
	2.4	Rockery, Terrarium, Kokedama, Bonsai, Topiary (brief account only)	2	2, 3
	2.5	Principles of Landscape design Types of landscapes, Sustainable landscaping Elements of art- colour, line, form, scale.	3	2, 5
	2.6	Steps in developing a Landscape Design Brief Account Only a) Site analysis- b) Identification of functional requirements; c) site development by exploiting natural forms; d) Elements in landscape design- form, water, garden furniture, lights, paving etc. e) study of plant trees, shrubs and ground cover, indoor plants etc.	3	2, 5

3	**Practicum (15 hours)**			
	3.1	Visit to a well-established nursery/Garden and submit a detailed report	8	1,2,3,4, 5
	3.2	TTC test for assessing seed viability	2	4
	3.3	Preparation of potting mixture	2	2
	3.4	Hands on training for air-layering, approach /tongue grafting and T-budding techniques	6	4
	3.5	Identification of Garden tools andimplements.	2	2,3,4
	3.6	Designing of Terrarium	4	3,5
	3.7	Designing of Kokedama balls/ bottle gardens	4	3,5
	3.8	Hydroponics – wick system	2	
4	**Teacher specific course components**			

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Multidisciplinary Course (MDC) – 03

Discipline/Programme	**BOTANY**					
Semester	III					
Type of Course	MDC					
Course Code	24UBOTMDC201					
Course Title	**AGRI-BASED MICROENTERPRISES**					
Course Level	200 - 299					
Course Summary	This course is designed to equip participants with the knowledge and skills necessary to establish and manage successful agri-based microenterprises. Focusing on key sectors such as organic farming, horticulture, tissue culture, and mushroom cultivation, the course provides a comprehensive understandingof sustainable and profitable agribusiness practices.					
Lecture/Tutorial/Practical Hours	45					
Credits	Total	3	Theory	3	Practical	0
Pre-requisite, if any	Nil					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Summarize key principles in organic farming, horticulture, tissue culture and mushroom cultivation, fruits and vegetable technology including sustainable practices and business considerations.	U	PO1, PO5
2	Develop hands-on skills in composting techniques, artificial vegetative propagation practices, tissue culture techniques and mushroom cultivation	A	PO2, PO3

3	Apply the skills of organic farming, horticultural practices, tissue culture techniques, fruits and vegetable technology and mushroom cultivation, as an entrepreneurial venture.	A	PO3, PO7, PO8
4	Administer a mushroom cultivation project in a small-scale level	A	PO3, PO8
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)			

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	**Organic farming (8 Hours)**			
	1.1	**Introduction to Organic farming**- principles, advantages, Sustainable agriculture (brief account)	1	1
	1.2	**Common organic manures** – bone meal, cow dung, poultry waste, oil cakes, green manure (special referenceto major element in the composition) Preparation of compost- vermicompost, vermiwash;familiarize KHAMBA compost **Biofertilizers**-Definition and Types – *Rhizobiumand Azolla*. **Activity**-Hands on training on Vermicomposting **Activity**-Preparation of compost and establishing a smallkitchen garden. Submit a report with geotagged photos	5	1, 2, 3

	1.3	**Biological control Agents**- *Trichoderma*, *Bacillus***;Biopesticides** – Tobacco and Neem decoction. **Activity** - Prepare and submit any one Biopesticideformulation.	2	1,3
2	**Horticulture and Plant tissue culture (20 Hours)**			
	2.1	Preparation of potting mixture, Garden tools and implements, Methods of plant propagation- Vegetative and Artificial methods (cutting, grafting, budding and layering); Use of growth regulators for rooting. **Hands on training -** Artificial methods of propagation - budding and grafting **Activity** - Demonstration of budding (T and Patch)	5	1,2,3
	2.2	**Gardening** - Types of gardens – Ornamental, kitchen garden, water garden and aqua scaping, Aquarium plants(brief). Pruning tools, thinning out, heading back. **Garden components** (Brief account only), Bonsai, terrarium, Kokedama. **Activity-** Submit a self- made terrarium/ kokedama/ aquarium (use only natural materials)	5	1,3
	2.3	**Plant tissue culture**- Totipotency, Explant, Callus, Media. Infrastructure of a tissue culture laboratory. Basic steps involved in plant tissue culture Visit to a well- established tissue culture lab/ nursery/mushroom cultivation unit	10	1,2,3
	Mushroom cultivation and Fruit and vegetable technology (17 Hours)			
	3.1	Structure of a Mushroom, Ecological, economical and medicinal significance of Mushrooms, Edibleand poisonous mushroom.	2	1
	3.2	**Types of commercially cultivated mushrooms** - buttonmushroom, oyster mushroom and milky mushroom	1	1

3	3.3	Spawn -Definition. Cultivation methodology of Oyster mushroom. Layout and set up of a mushroom house (small scale) Processing of mushrooms and Value added products-mushroom - pickle, candy, dried mushroom, mushroom powder	4	1,2,3, 4
	3.4	Horticultural types of fruits (based on ripening behaviour) and vegetables (based on botanical features), Concept of shelf life and perishable fruits, Ripening and biological ageing.	10	1,3
	3.5	**Fruit preservation-**Room temperature (Juice, syrup, squash), heat treatment (Jelly, jams), Dehydration (sundrying, application of sugar syrup, salt), freezing **Vegetable preservation**-packaging and storage, dehydration techniques, vegetable products (flakes,chips, dried powder), frozen vegetables, Preservation byCanning and bottling. **<u>Activity-</u>** • Prepare and submit any one fruit/vegetable/mushroom value added product using methods prescribed in the syllabus • Preparation of bed for mushroom cultivation using polybag method • Visit and submit an audio visual documentary on any one small scale entrepreneurship activity with reference to the skills mentioned in the syllabus • Submit a proposal on any plant- based entrepreneurship.		
4.	**Teacher specific course component**			

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Skill Enhancement Course (SEC) – 01

Programme	**BOTANY**					
Semester	IV					
Type of Course	SEC					
Course Code	24UBOTSEC201					
Course Title	**FLOWER ARRANGEMENT AND FRUIT CARVING**					
Course Level	200 - 299					
Course Summary	This course aims to develop basic skills in flower arrangement and fruit carving. The course also describes the principle, scope, techniques and value addition of flower arrangement and fruit carving. It enables students to provide innovative designs in flower arrangement and in sculpturing fruits and vegetables according to the modern trends. This can be a stepping stone for new entrepreneurial ventures.					
Lecture/Tutorial/Practical Hours	45					
Credits	Total	3	Theory	3	Practical	---
Pre-requisite, if any	There are no specific prerequisites for this course.					

CO No.	Expected Course Outcome	Learning Domains *	PO
1	Develop basic skills in techniques of flower arrangement, fruit and vegetable carving.	C	PO2, PO8
2	Summarize the elements of design in flower arrangement.	U	PO1
3	Identify tools and techniques of flower arrangement, fruit and vegetable carving.	R	PO2
4	Demonstrate important value addition processes in flower arrangement, fruit and vegetable carving.	U	PO2, PO8
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)			

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	**Flower Arrangement (22.5 hours)**			
	1.1	History and scope of Floriculture. Common flowers and foliage used:- Flowers - Roses, lilies, *Gladiolus*, Dahlias, *Chrysanthemum*, Gerberas, Asters, Carnations, Lotuses, Anthurium, Marigold, Orchids, *Gypsophila*, Bottlebrush, Goldenrods. Foliage – Ferns, Asparagus, Palm leaves (e.g. umbrella palms), *Cupressus*, *Podocarpus, Cycas*. Principle of flower arrangement. **Learning activity:** Submission of geo-tagged photographs of common cut flowers and foliage in Kerala.	4	1, 3
	1.2	Broad categories of flower arrangement styles - Line and Mass arrangements. Basic styles within the Line and Mass flower arrangements. a) Traditional /Classical/Western Style b) Eastern style/ Japanese style/ Ikebana c) Free Style/ Modern style	5	1, 2, 3
	1.3	Tools and equipment used in flower arrangement - wases, flower holders, floral foam, Pin-holders/kenzan or needle-point holders, Chicken wire/'wire mesh' or 'wire netting', Prong, Florist's cone/ flower tube' or 'flower funnel'. Mister, Secateurs, Cocktail sticks or a toothpick, Cut-flower preservatives. Types of plant materials – a) Flowers (dominant/ focal/ point material) b) Fillers (secondary material) c) Foliage (line material) Accessories used in flower arrangement (brief account only). **Learning activity:** Value addition of cut flowers and	9	1, 2, 3, 4

		foliage as bouquets, button-holes, flower baskets, corsages, floral wreaths, garlands with fresh cut flowers and foliage.		
	1.4	Identification of plants for dry flower making. Styles in dry flower making. **<u>Learning activity</u>**: hands on work on preparation of dry flowers and its value addition as flower baskets, bouquets, potpourris, wall hangings, button holes, greeting cards and wreaths.	4.5	1, 2, 3, 4
2	**Fruit and Vegetable Carving (22.5 hours)**			
	2.1	History and scope of fruit and vegetable carving. Common vegetables and fruits used; Basics of selecting raw materials.	2.5	1,3
	2.2	Uses of paring knife/ “bird’s beak” knife, peel zester, melon baller, ‘U’ shaped garnishing tool, “V” formed cutter, scoopers, grover. Carving knife holding angles and different types of cuts. Techniques to prevent colour change in cut fruits and vegetables.	5	1, 3
	2.3	Centerpiece design for buffet – Watermelon, pineapple (bird design), muskmelon, papaya. Floral designs for carving:- a) Tomato flowers – e. g. roses. b) Chilly & Capsicum flowers c) Carrot & Radish flowers d) Onion flowers e) Squash flowers Animal & fish designs **<u>Learning activity</u>**: 1. Invited lecture on fruit carving techniques. 2. Hands-on work on simple fruit and vegetable designs preparation - Apple swan, banana dolphin. 3. Hands-on work on centerpiece preparation for buffet.	15	1, 3, 4

		4. Hands-on work on large sculpture preparation (any one type) - • Floral designs - Flower bouquet using radish, beet root, strawberry, kiwi, apple, dragon fruit etc. • Animal designs. Fruit basket, serving bowls and plates using carrot, watermelon, musk melon and papaya etc.		
3	**Teacher specific course components**			

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Skill Enhancement Course (SEC) – 02

Discipline/Programme	**BOTANY**					
Semester	**V**					
Type of Course	SEC					
Course Code	24UBOTSEC301					
Course Title	**MUSHROOM CULTIVATION AND VALUE-ADDED PRODUCTS**					
Course Level	300 - 399					
Course Summary	The present course encompasses various aspects of mushrooms focusing on its importance as a valuable food supplement. The course also deals with various aspects of mushroom cultivation including the process, requirements and post-harvest steps. The value addition and marketing strategies connected to this field is also included.					
Lecture/Tutorial/Practical Hours	45					
Credits	Total	3	Theory	3	Practical	0
Pre-requisite, if any	Nil					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO
1	State the importance of Mushrooms and distinguish between edible and poisonous mushrooms	U	PO1, PO2, PO 3, PO 8
2	Appreciate the nutritive value and health benefits of mushrooms and implement edible mushroom cultivation techniques	A	PO1, PO 2, PO3, PO 4
3	Outline the possibilities of value addition in mushrooms	An	PO1, PO2 PO7
4	Develop entrepreneurship skills through product design and Generate marketing strategies for value-added products of mushrooms	C	PO1, PO2, PO3, PO4, PO5, PO7, PO8
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)			

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	**Introduction to Mushrooms and Nutritional Value (10 hours)**			
	1.1	General characters and morphology of mushrooms. Scope and significance of mushroom cultivation	3	1
	1.2	Identification of mushrooms - edible and poisonous. Distinguishing characters of button, oyster and milky mushrooms.	3	1
	1.3	Nutritional profile of mushrooms- Carbohydrates, proteins, amino acids, vitamins, minerals, fats and fibre.	2	2
	1.4	Health benefits of Mushrooms-anti-tumour, antiviral and antibacterial effect, in therapeutic diet (brief study)	2	2
2	**Mushroom Cultivation and Pest Management (23 hours)**			
	2.1	Mushroom cultivation: Requirements, structure and construction of mushroom house, Sanitation and sterilization	3	2,4
	2.2	Spawn preparation- requirements, spawn substrate selection, isolation of pure culture and nutrient media for pure culture, maintenance and storage of spawn. Learning activity: Hands-on training on mushroom bed preparation/spawn preparation	5	2,4
	2.3	Cultivation of Milky Mushroom (Calocybe indica), and Oyster Mushroom (Pleurotus sps.) using paddy straw. Learning activity: Training in Oyster mushroom cultivation	5	2,4
	2.4	Pest and disease management in mushroom cultivation (brief account), Spent mushroom substrate utilization- fodder, compost. Learning activity: Visit to a mushroom cultivation unit	10	1, 2
3	**Value Addition in Mushrooms (12 hours)**			
	3.1	Post-harvest processing of mushrooms- refrigeration / instant packing, freeze drying, dehydration, canning	3	3,4

	3.2	Value-added products from mushrooms – soup powder, biscuits, chutney powder, pickles. Learning activity: Preparation of value-added products from mushrooms	5	3,4
	3.3	Marketing strategies for mushroom products	2	4
	3.4	Major problems in mushroom cultivation and solutions. self-employment schemes, Government aids	2	4
4	**Teacher specific course components**			

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Skill Enhancement Course (SEC) – 03

Discipline/ Programme	**BOTANY**					
Semester	**VI**					
Type of Course	SEC					
Course Code	24UBOTSEC302					
Course Title	**MACRO-PHOTOGRAPHY WITH AN EMPHASIS ON PLANT SCIENCE**					
Course Level	**300 - 399**					
Course Summary	The course ensures students to observe minute details of plant structures. Students will get hands-on training on how to take macro-photographs of plant structures and related processes including plant-animal interactions. Various techniques, tools and camera adjustments are dealt with in the course. Students will be trained to take macro photographs using mobile phones. Various computer tools that help enhance the quality of macro-photographs are also dealt with in the course.					
Lecture/Tutorial/ Practical Hours	60					
Credits	Total	3	Theory	2	Practical	1
Pre-requisites, if any	Nil					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PO's
1	Recall the basic principles and practices of macro photography	U	8
2	Manage camera, lenses and other tools to take quality macro photographs	Ap	1,8
3	Analyse features of macro-photographs	An	1,8
4	Determine the quality of macro-photographs	E	1,2,8

5	Take quality macro photographs of flowers, fruits, other plant parts and plant animal interactions	C	1,2,8
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Module	Units	Description	Hours	COs
1	**Introduction to Macro-photography (15 hrs)**			
	1.1	Introduction to photography and macrophotography	2	1
	1.2	Light control in photography	2	1
	1.3	Getting into DSLR, Basic features of DSLR and Compact camera for macro photography	2	1,2
	1.4	Camera Settings, Backgrounds for macrophotography, Camera maintenance	3	1,2
	1.5	Applications of macrophotography	2	1,2,3,4,5
	1.6	Hands-on on Settings of macrophotography	4	1,2,3,4,5
2	**Camera Settings for Macro-photography (30 hrs)**			
	2.1	Selection of plant materials, Selection of photo field and frame	2	2,3
	2.2	Lens Choice for Macro Photography	2	1,2,3
	2.3	Different types of macro and micro lenses and their characteristics, Use of Extension Tubes and closeup extension lenses	3	1,2
	2.4	Inexpensive Macro Tools – Flash and reflectors	2	1,2
	2.5	In built camera settings for macro photography	2	1,2
	2.6	Hands-on on Indoor Macro-Photography	4	1,2,3,4,5

	2.7	Camera Accessories and Field photography • Tripods and monopods and Remote shutter release • Lighting – indoor, Depth of Field Control • Camera Support and Shutter Releases • Focus Stacking, Focus Stacking Software	15	1, 2
3	**Practical (15 hrs)**			
	3.1	Macro photography of flowers using mobile	3	1,2,3,4,5
	3.2	Hands-on on Field Macro-photography by visiting a field	12	1,2,3,4,5
4	**Teacher Specific Course Content**			

References:

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Skill Enhancement Course (SEC) – 04

Discipline/Programme	Botany					
Semester	VI					
Type of Course	SEC					
Course Code	24UBOTSEC303					
Course Title	**BOTANY IN REAL WORLD SCENARIO**					
Course Level	300					
Course Summary	The course aims to prepare the students for an entrepreneurial journey by giving an overview of entrepreneurship. The course discusses the process of developing and independent idea into ventures. Different areas of opportunity.					
Lecture/Tutorial/Practical Hours	75					
Credits	Total	4	Theory	3	Practical	1
Pre-requisite, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO
1	Demonstrate knowledge of diverse botanical entrepreneurship and develop business acumen for botanical ventures	U, S	PO2, PO5, P07
2	Analyze and evaluate real world success stories of entrepreneurs from government initiatives and support schemes	A, S, E	PO2, PO5, PO5, PO7
3	Propose entrepreneurial ideas based on plant and plant-based product conducting preliminary research	C, A, S, Ap	PO1, PO2, PO5, PO8
4	Evaluate the success stories in entrepreneurship	C, A, S, Ap	PO2, PO5, PO6, PO7, PO8
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)			

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	**Fundamentals of Botanical Entrepreneurship (15 hours)**			
	1.1	Introduction to Entrepreneurship • Types and Characterization of Botanical Entrepreneurship • Explore various types: agribusiness, bio ventures, aesthetics • Characterize ventures based on botanical products • Analyze socio-economic factors driving entrepreneurial endeavours in botany	8	1, 4
	1.2	Entrepreneurship as Innovation, Risk Assessment and Solutions • Examine the role of innovation in botanical entrepreneurship • Assess risks specific to botanical ventures and propose strategic solutions	7	2, 4
2	**Bio Ventures, Business Planning, and Government Initiatives (15 hours)**			
	2.1	Overview of Key Botanical Industries in Kerala Explore Spirulina, mushroom, drumstick, and coconut industries. Case studies on successful ventures. Jackfruit 360 and Vegro Biotech startups and support mechanisms (KDISC, Bio 360, BioNest) Aesthetics in Kerala Botanical Entrepreneurship Explore the market for ornamental plants and flowers in Kerala Identify opportunities and challenges in the aesthetics industry	8	1, 4
	2.2	Fruit and Vegetable-Based Products Production of juices, squashes, and other fruit-based products considering Kerala's agricultural landscape Bamboo and Cane-Based Products, Nutraceuticals, and Oils Herbal medicines and cosmetics Government Initiatives and Support Scheme	7	2, 4

		• Kerala Startup Mission and Start Up India • MUDHRA Yojan and Stand-Up India • SC/ST Hub Initiative		
4	**Practical (30 hours)**			
	4.1	Conduct a workshop on ideation and brainstorming for entrepreneurial ideas in the botanical sector.	5	1
	4.2	Explore various botanical products and their potential markets and potential risks associated.	5	1,3,4
	4.3	Analyze case studies on successful ventures like jackfruit 360, wegrow etc and discuss key success factors and challenges faced by the ventures	4	1,3,4
	4.4	Study different methods of preservation and processing techniques of different fruits and vegetables	3	1,2
	4.5	Propose entrepreneurial ideas based on plant and plant products. Conduct preliminary research on market potential, feasibility, and challenges	3	1,2,4
	4.6	Visit successful botanical and conduct and record interviews with entrepreneurs	10	1,2,4,
5	**Teacher specific course components**			

References:

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18. Akther, F. (2023). Role of Skill India Programs in Fostering Entrepreneurship among Rural Youth in India. *Formosa Journal of Science and Technology*, *2*(10), 2891-2902.

SUGGESTED READINGS

1. Kerala startup mission handbook 2021

Value Addition Course (VAC) – 01

Programme	**BOTANY**					
Semester	IV					
Type of Course	VAC					
Course Code	24UBOTVAC201					
Course Title	**CONSERVATION BIOLOGY**					
Course Level	200 - 299					
Course Summary	The course provides a basic overview regarding the concepts in conservation biology. It also gives a basic outlook towards the need for biodiversityconservation and sustainable development. It also creates an awareness regarding the transition to green growth.					
Lecture/ Tutorial/ Practical Hours	45					
Credits	Total	3	Theory	3	Practical	Nil
Pre-requisite, if any	Nil					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Recall the concepts in conservation biology	K	1,4
2	Identify a variety of tools used by conservation biologists	U	1,4,10
3	Outline the concept and importance of sustainability	An	1,2,6
4	Examine the threats and adopt creative measures for biodiversity conservation	An	2,6,9,10
5	Assess the current status of biodiversity	E	2,4
6	Create an awareness in the society for the transition to thegreen growth	C	4,6,9

f**Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	**Conservation Biology (15 hours)**			
	1.1	Introduction to conservation Biology –Definition, career prospects in conservation biology, Conservation and management practices	3	1
	1.2	Conservation Techniques-Principles of conservation - ex-situ and in-situ conservation techniques, ecological restoration Statistical and computational tools used in conservation biology- Population Viability Analysis (PVA), Minimum Viable Population, Decision Analysis and Multiple-CriteriaApproaches	7	2
	1.3	Ecotourism-Ecotourism as a tool for conservation and sustainable development, difference between ecotourism and mainstream tourism, guidelines and green practices for ecotourism, impacts of tourism on culture and environment and its management-Examples, positive and negative impacts	5	1, 4
2	**Biodiversity (15 hours)**			
	2.1	Definition, types and importance	3	4
	2.2	Biodiversity loss- Causes, extinction, IUCN account of biodiversity, red data book, rare, endangered and threatened species (RET).	5	4,5
	2.3	Concept of endemism, Biodiversity hotspots in India.	2	4,5

	2.4	Biodiversity documentation- Case study- Students have to submit a brief report with geo-tagged photographs of the biodiversity of the nearby locality.	5	5
3	**Sustainable development (15 hours)**			
	3.1	Introduction -aim and impact of sustainable development	3	6
	3.2	Sustainable development - Basic characteristics, Coreelements, Principles and Goals	5	6
	3.3	Strategies and policies for sustainable development Examples of Sustainable development in daily life – Wind energy, solar energy, sustainable forestry, bio-composting, biogas production, water efficient fixtures, green spaces and sustainable construction.	7	6
4	**Teacher specific course components**			

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1. Ahmedullah M, Nayar M P (1987). Endemic plants of India
2. Elliott, Jennifer. 2012. An Introduction to Sustainable Development. 4th Ed. Routledge, London.
3. Gilpin, M. E. & Soulé, M. E. "Minimum viable populations: Processes of species extinction." In Conservation Biology: The Science of Scarcity and Diversity, ed. M. E. Soulé (Sunderland: Sinauer & Associates, 1986): 19–34.
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6. https://asuonline.asu.edu/newsroom/online-learning-tips/what-is-conservation-biology- ecology/
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Value Addition Course (VAC) – 02

Programme	**BOTANY**					
Semester	VI					
Type of Course	VAC					
Course Code	24UBOTVAC301					
Course Title	**ENVIRONMENTAL SCIENCE AND HUMAN RIGHTS**					
Course Level	300 - 399					
Course Summary	The course provides an in-depth exploration of key topics in environmental science and an understanding of various forms of pollution, their sources, impacts on human health and the environment, and mitigation strategies. It will cover global environmental issues, conservation efforts and conservation issues of the Western Ghats. Students will learn about conservation strategies and will examine environmental policies and laws. The course will explore the intersection of environmental sciences and human rights, including the right to a healthy environment, environmental justice, and the disproportionate impacts of environmental degradation. By fostering critical thinking and interdisciplinary approaches, students will be empowered to advocate for environmental justice and contribute to a more sustainable and equitable world.					
Lecture/ Tutorial/ Practical Hours	45					
Credits	Total	3	Theory	3	Practical	---
Pre-requisite, if any	There are no specific prerequisites for this course.					

Course Outcome

CO No.	Expected Course Outcome	Learning Domains *	PO
1	Discover the multidisciplinary nature of environmental science and its use to understand and address the global environmental issues.	An	PO1, PO2, PO4, PO7

2	Create responsible citizens on conservation of nature and natural resources and design novel mechanism for the sustainable utilization of natural resources.	C	PO1, PO2, PO4, PO5, PO6, PO7
3	Prioritize the control measures for air, water, and soil pollution by examining the environmental laws in India.	An	PO1, PO2, PO4, PO5, PO6
4	Assess the role of organizations, movements and contributors of environmental studies in conservation.	E	PO1, PO4, PO5, PO6
5	Appraise the relevance of human rights in real-world scenarios to make responsible citizens.	E	PO1, PO4, PO5, PO6
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)			

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	**Introduction to Environmental Science & Environmental Pollution (15 hours)**			
	1.1	Introduction to Environmental Science: Definition, scope & significance, multidisciplinary nature of environmental science.	2	1
	1.2	Natural Resources: a) Concept of natural resource b) Classification of natural resources (renewable and non– renewable) c) Sustainable practices for resource utilization	2	2
	1.3	Overview of Environmental Pollution: Definition and types of pollution. Overview of air, water, soil, noise, thermal, radioactive and light pollution.	2	1, 3
		Air pollution: Air pollutants, types, sources, effect of air pollution on plants and humans, control measures	3	1, 3
	1.4	Water pollution: Common pollutants, sources, impact, control measures; water quality standards - DO and BOD; eutrophication.	3	1, 3
	1.5	Soil Pollution: Causes, sources, solid waste, biodegradable, non-biodegradable, management of solid waste, composting, e–waste, waste management and recycling.	3	1,3
2	**Environmental issues, Conservation efforts and Environmental Legislation and Laws (15 hours)**			

	2.1	Environmental issues: a) Global warming, greenhouse effect, causes and consequences of climate change, ozone layer depletion. b) Carbon sequestration and Carbon foot print.	4	1
	2.2	Conservation efforts: a) Definition of biodiversity, importance, overview of threats to biodiversity b) International Conservation Organizations: Role of NGOs in conservation (e.g. Conservation International), United Nations Environment Programme (UNEP), International Union for Conservation of Nature (IUCN) - categories. c) Overview of Key International Treaties (e.g., Kyoto Protocol, Paris Agreement) d) Conservation issues of the Western Ghats – Madhav Gadgil committee report (brief study only). e) Organizations, movements and contributors of environmental studies and conservation: organizations and movements - WWF, Chipko; contributors - Salim Ali, Sunder Lal Bahuguna, Madhav Gadgil, Tulsi Gowda, Lakshmikutty Amma.	7	2, 4
	2.3	a) Environment (Protection) Act 1986 and Environment (Protection) Amendment Rules, (2023) b) Wildlife (Protection) Act, 1972, amended in 2022, c) Forest (Conservation) Act, 1980, Forest (Conservation) Amendment Bill 2023 d) Biological Diversity (Amendment) Act, 2023 [brief account only]. e) Corporate Environmental Responsibility (brief account only)	4	3
3	**Human Rights (15 hours)**			
	3.1	An Introduction to Human Rights, history of Human Rights, Generations of Human Rights, Universality of Human Rights, Basic International Human Rights Documents - UDHR, ICCPR, ICESCR. -Value dimensions of Human Rights.	4	5

	3.2	Human Rights and United Nations: Human Rights coordination within the UN system, Role of UN secretariat, Commission of Human Rights, Security Council and Human Rights, Committee on the Elimination of Racial Discrimination, Committee on the Elimination of Discrimination Against Women, Committee on Economic, Social and Cultural Rights, The Human Rights Committee	3	5
		Environment and human rights: right to clean environment and public safety; issues of industrial pollution; Conservation of natural resources and human rights (briefly).	3	5
	3.3	National Perspective in Human Rights: Human Rights in Indian Constitution, Fundamental Rights, Directive Principles of State Policy and Human Rights- Science, Technology and Human Rights- National Human Rights Commission- State Human Rights Commission- Human rights awareness in education.	5	5
4	**Teacher specific course components**			

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