PDEA's

Prof. Ramkrishna More Arts Commerce and Science College (Autonomous), Akurdi, Pune - 411044

Affiliated to

Savitribai Phule Pune University (SPPU)

Choice Based Credit System

(CBCS) under

Autonomy & NEP-2020

M.Sc. Program in Botany

(Faculty of Science)

Syllabus

M.Sc. II Botany

To be implemented from Academic Year 2023-2024

Board of Studies: Botany

P. D. E. A's.

Prof. Ramkrishna More College, Akurdi, Pune 411044

Graduate and Honours Degree Course Framework under Autonomy as per NEP-2023

Department of Botany

MSc Botany Part I					
Sem	**Major Courses**	**Major Elective Courses**	**Minor Courses**	**VSC**	**IKS**
I	5 theory + 2 Practical Plant Systematics - I (Algae & Fungi) Advanced Cell Biology Genetics & Plant Breeding Plant organism Interaction Floriculture and Pomoculture	1 Theory + 1 Practical Crop Physiology or Biodiversity	**RM** **4 credits** BORMT -471 Research Methodology BORMP -472 Practical on Research Methodology	0	0
II	5 theory + 2 Practical Plant Systematics - II (Bryophytes and Pteridophytes) Advanced Molecular Biology Biostatistics Plant Evolution Tools and Techniques in Plant Science	1 Theory + 1 Practical Applied Biotechnology and Nanotechnology or Pharmacognosy	**0**	0	0
MSc Botany Part II					
III	3 theory + 2 Practical Gymnosperm and Palaeobtany Advanced Physiology and Phytochemistry Ecology and Sustainable Development	1 Theory + 1 Practical Cytogenetics or Secondary Metabolites of Plants	Research Project 4 credits		
IV	3 theory + 1 Practical Angiosperms and Palynology Bioinformatics and Entrepreneurship Industrial botany	1 Theory + 1 Practical Bio-remediation and Bioprospecting or Artificial Intelligence in Botany	Research Project 6credits		

PDEA's Prof. Ramkrishna More College, Akurdi, Pune 44 Dept of Botany

B.Sc.(Honours) in Botany is intended to provide a broad framework within which both the undergraduate programs in Botany help to create an academic base that responds to the need of the students to understand the basics of Botany and its ever evolving nature of applications in explaining all the observed natural phenomenon as well as predicting the future applications to the new phenomenon with a global perspective. The curriculum framework is designed and formulated in order to acquire and maintain standards of achievement in terms of knowledge, understanding and skills in Botany and their applications to the natural phenomenon as well as the development of scientific attitudes and values appropriate for rational reasoning, critical thinking and developing skills for problem solving and initiating research which are competitive globally and are on par in excellence with the standard Higher Education Institutions (HEI) in the advanced countries of America, Asia and Europe. The multicultural fabric of our nation requires that the institutions involved in implementing this curriculum framework also work hard towards providing an environment to create, develop and inculcate rational, ethical and moral attitudes and values to help the creation of knowledge society needed for scientific advancement of our nation.

Goals:

The Department has formulated three broad educational goals for the undergraduate degree programs:

Botany knowledge: To provide students with the basic foundation in Botany the interplay of theory and experiment, and to motivate scientific enthusiasm and curiosity and the joy of learning.

Problem solving skills: To provide students with the tools needed to analyse problems, apply experimentation, and synthesize ideas.

Employment and technical skills: To provide the students with technical skills necessary for successful careers in Botany and related or alternative careers for which a physics foundation can be very useful. These include computers and communication skills (oral and written).

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Guidelines for Syllabus Design of all courses under Autonomy and NEP-2023

All HOD's and Teachers Involved in syllabus design under Autonomy and NEP-2023 are informed that you have to design syllabus as per the following general guidelines.

1. **One semester** = 15 weeks (12 weeks actual teaching and 3 weeks for internal evaluation, tutorials, problem solutions, student difficulty solution, etc.)
2. **1-credit theory** = 15 hours i.e. for 1 credit, 1 hour per week teaching is to be performed.

   15 hours of 1-credit are splinted as 12 hours actual teaching + 3 hours Tutorial (practice problem solving sessions, repeated discussion on difficult topics, discussion on student's difficulties, questions discussion and internal evaluation)
3. **1-credit practical** = 30 hours. Thus, 1 credit practical = 2 contact hours in laboratory per week

   30 hours splinted as 24 hours' actual table work and 6 hours for journal competition, oral on each practical and other internal evaluation.
4. **Each theory course of any type** (major, minor, VSC, VEC, OE/GE, VEC, SEC, CC, etc.) **is of 2 credits**.
   - **a. Theory per semester:** Contact hours = 24 teaching + 6 tutorials (problem solving sessions, repeated discussion on difficult topics, difficult solution, questions discussion and internal evaluation)
   - **b.** Each course will be of two modules, One module = 15 hours
   - **c.** Each module may consist of one or more than one chapter.
5. **Each practical course of any course is of 2 credits = 60 hours per semester**
   - **a.** Minimum 12 laboratory sessions must be conducted in one semester.
   - **b.** Each laboratory sessions should be 4 hours.
   - **c.** If practical is short, then two short practicals should be included in one laboratory sessions.
   - **d.** In 12 laboratory sessions maximum 2 demonstration sessions or table work sessions may be included and must be designed carefully for 4 hours sessions.
   - **e.** 4 hours laboratory sessions include - performing table work (practical), calculation, writing results and conclusion, and submission of practical in written form to practical in charge.
   - **f.** Prelab oratory reading and post laboratory work / questions should be assigned on each practical and this will be the part of internal evaluation.
6. **Design syllabus of each theory and practical course as per above guidelines.**
   a. **Theory syllabus** should be given module wise and chapter wise.

b. **Theory syllabus** should include name of topic, number of teaching hours allotted, detailed point wise syllabus, page numbers, references book no.

c. It is recommended that**, design syllabus of one theory course from maximum two references books** and they will be called as main reference books/text books. Below that, you can add names of more reference books and they will be supplementary reference books.

d. **Syllabus of practical** must be given practical wise. Name of experiment and aim of the experiment should be clearly mentioned. Mention reference book number or bibliography for each practical. At least 16 practicals must be included in syllabus from which 12 practical will be actually conducted. If practical is short then two short practicals will be considered as one practical.

e. At the end of syllabus of theory and practical course, a list of references book should be given number wise.

f. **At the end of each theory and practical course 6 CO should be given.**

7. Question Paper Pattern- As per S.P. Pune University Nomes.

8. Eligibility- As per S.P. Pune University Nomes.

9. Programme Outcomes.

i. **Critical Thinking in Plant Science**: Knowledge about plant diversity with respect to its morphological, anatomical, cytological, molecular, embryological, phyto-physiological, biochemical taxonomical and phylogenetic studies.

ii. **Modern tool usage**: They become competent enough in various analytical and technical skills related to plant sciences. Students are also familiarized with the use of bioinformatics tools and databases and in the application of statistics to biological data. Select, apply appropriate resources, and modern biological tools and techniques including taxonomic tools, ecological tools Microscopy, Chromatography, Spectrophotometry, Separation techniques, various Culture techniques and breeding techniques for the fulfilment of societal needs.

iii. **Design/development of solutions**: The student completing the course is able to identify various life forms of plants, design and execute experiments related to basic studies. Design nursery and horticultural practices.

iv. **The Botanist and society:** Apply reasoning informed by the contextual knowledge to assess societal, food, fodder, fiber, medicine, health, safety issues and the consequent responsibilities relevant to the botanical practices.

v. **Environment and sustainability:** Implement problem solving and laboratory skills pertaining to biological techniques and apply strategies for plant conservation, maintaining ecological balance and sustainable development through various ways including conservation practices and Phytoremediation.

vi. **Ethics and Effective Citizenship:** Recognize different value systems, understand the moral dimensions of decisions, and accept responsibility for them.

vii. **Individual and team work:** - Adapt scientific methods in plant research and create educator and entrepreneurs.

viii. **Communication:** Communicate effectively on plant sciences with the scientific as well as with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

ix. **Project management and finance:** Enhances skills in handling scientific instruments, experiments and projects for planning and executing biological research and various plant science related drudgery in the community for fulfillment of financial assistance.

x. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change. The student completing the course is capable to perform short research projects using various tools and techniques in plant sciences and develop scientific temperament and research attitude.

10. Program Specific Outcome (PSO)

PSO 1: To apply knowledge in emerging and varied fields of Botany including Anatomy, Morphology, Reproduction, Evolution, Ecology, Physiology, Biochemistry, Genetics and Molecular biology, Taxonomy, Systematics of various life-forms with special reference to plants as well as Plant interactions with microbes and insects and biocontrol and biofertilizers.

PSO 2: To develop leadership and executive skills and understand the need for lifelong learning to be a competent professional. She/he even has an edge over other students as they will be trained in skill enhancement courses like Plant Tissue Culture, biocontrol and biofertilizers as well as Biotechnology.

PSO 3: To acquire and disseminate knowledge in the community and study the changing Environment in our planet. Documentation and report writing on experimental protocols, results and conclusions, study tours and field visits etc.

PSO 4: To be acquainted with good laboratory practices with respect to plant science and safety measures for higher studies and research.

11. Rules and Regulations:

1. **National Credit Framework (NCrF):** For creditisation and integration of all higher education qualifications leading to a certificate/ diploma/ degree with multiple entry and exit options, college will refer to National Credit Framework (NCrF) which encompasses the qualification frameworks for higher education, vocational and skill education and school education, namely National Higher Education Qualification Framework (NHEQF), National Skills Qualification Framework (NSQF) and National School Education Qualification Framework (NSEQF) respectively.

2. Structure of Four years multidisciplinary UG Programme and Five Years Integrated Multidisciplinary Master's Degree Programmes with Multiple Entry and Exit Options at Different Levels:

(i) Students will have the flexibility to enter four years multidisciplinary Under Graduate Programme in odd semesters and exit a programme after the successful completion of even semesters as per their future career needs.

(ii) Students will get a Certificate after a One year programme (minimum 40 Credits), a Diploma after two years (minimum 80 Credits), a Bachelor's degree after three years (minimum 120 Credits), and a Bachelor's degree with Research or Honours after Four years (minimum 160 Credits).

3. Qualification Type and Credit Requirements of Four Years Multidisciplinary Degree Programme with Multiple Entry and Exit Options

(i) Details of qualifications, minimum credit requirements, exit credit courses, year and semester are as under:

Levels	Qualification Title	Credit Requirements		Semester	Year
		Minimum	Maximum		
4.5	UG Certificate	40	44	2	1
5.0	UG Diploma	80	88	4	2
5.5	Three Years Bachelor's degree	120	132	6	3
6.0	Bachelor's degree Honour's with Major	160	176	8	4
	Bachelor's degree Honour's with Major	160	176	8	4
7.0	Master's Degree	200	220	10	5
8.0	Ph. D.	----	-----	-----	----

(ii) An exit 6-credit bridge course(s) lasting two months, including at least 6-credit job specific internship/apprenticeship that will help the graduates acquire job-ready competencies required to enter the workforce will be an additional requirement for the award of the undergraduate Certificate/ Diploma/ three year Bachelor's Degree.

(iii) On exit, the students will have the option to re-enter the programme in the college, or in a different higher education institution. Re-entry at various levels for lateral entrants in academic programmes should be based on the earned and valid credits as deposited and accumulated in the Academic Bank of Credits (ABC) through Registered Higher Education Institutions (RHEI) and proficiency test records.

(iv) Eligibility for admission to the fourth year of four-year **Honours with Research Degree Programmes** as per UGC guidelines: Minimum CGPA of 7.5 or minimum 75% at three-year degree.

(v) PG curriculum, as illustrated below, have flexibility a) One-year Post-Graduate Diploma (PGD), b) Two year Post-graduate Programme and c) 5 Years Master's degree programmes with multiple Entry and Exit options at different levels.

(a) Post-Graduate Diploma (PGD): Programme duration- One year (2 semesters) after any bachelor's degree, min. 40 credits

(i) UGC: 1-Year (2 semesters) Post-Graduate Diploma (PGD) after 3-years Bachelor's degree: Level 6.0

(ii) UGC: 1-Year (2 semesters) PGD after 4 years Bachelor's degree (Honors/ Research): Level 6.5

(b) Master's Degree:

(i) UGC: 2-Years (four semesters) Master's Degree after obtaining a 3-years Bachelor's degree, Minimum 40 credits/year, second year devoted entirely to research, PG – 2nd year: Level 6.5

OR

(i) 1-Year (two semesters) Master's Degree after obtaining a 4-year Bachelor's degree (Honours/Research): Minimum 40 credits: Level 6.5 (c) Level 8 represents Ph. D. Research Degree.

(d) A 5-year Integrated Bachelor's and Master's programme shall have a minimum of 220 credits.

(e) Master's and doctoral programmes, while providing rigorous research-based specialization, should also provide opportunities for multidisciplinary work, in academia, government, research institutions, and industry.

4. Lateral Entry/ Re-entry at higher Levels after exit from lower levels of four years multidisciplinary UG degree programme:

(i) The credit points earned and accumulated shall be used to determine the eligibility for taking admission to various programs at multiple levels, subject to fulfilment of the broad principles laid down under NCrF. Students who leave with a Certification, Diploma, or a Basic Bachelor's Degree will be eligible to re-enter the programme at the exit level to complete or progress to the next level through lateral entry mode. Depending upon the academic and physical facilities available, the State Universities/ Autonomous Colleges (Higher Education Institutions or HEI) may earmark specific seats/ intake for lateral entry into the second year/ third year/ fourth year of a four years multidisciplinary UG degree programme as approved by Professional Standard Setting Bodies (PSSB/Govt. of Maharashtra/ statutory council of affiliating University plus any consequential vacancies caused by exits to an ongoing programme (four-year Degree Programme and Integrated Master's or second year Master's). Lateral entry or Re-entry is open to those students if he/she has either –

(a) successfully completed the first year/second year/third year of the particular four years multidisciplinary degree programme in any ABC registered HEI with valid credits in ABC and re-entering into the second year/third year/fourth year, respectively of the same four years degree programme of any ABC registered HEI, within stipulated/ permissible period of years as decided by Statutory Councils of that HEI

OR

(b) Already successfully completed a multidisciplinary four-year first-degree programme and is desirous of and academically capable of pursuing another multidisciplinary four years first- degree programme in an allied subject.

(ii) A student will be allowed to enter/re-enter only at the odd semester. Re-entry at various levels for lateral entrants in academic programmes should be based on the earned and valid credits as deposited and accumulated in Academic Bank of Credits (ABC) through Registered Higher Education Institutions (RHEI) and proficiency test records. However, in terms of the admission eligibility requirements, the student shall belong to the same faculty/ discipline in terms of Major Subject i.e., the Major subject of his earlier Programme and the Major subject of the new Programme for which he is seeking admission must be from the same faculty/discipline. Reservation for lateral entry will be executed as per the Government of Maharashtra norms.

5. Distribution of Credits across Multidisciplinary Four Years Degree Programme: (i) Four-year multidisciplinary degree programme with Honours/ Specialization Degree will have Internship and Core /Major Courses with a minimum of 22 credits per sem. in the Fourth Year.

(ii) Four-year multidisciplinary degree programme with Research will have Research Projects, Seminars, Dissertations and Internships with a minimum of 22 credits per Sem. in the Fourth Year.

(iii) Students shall select a 'Major or Core Subject/ Discipline' and a '**Minor Subject/Discipline' from the lists of various Subject Combinations and Options provided the Colleges.** In general, for the four years multidisciplinary bachelor's degree programme, the distribution of credits will be as follows:

(a) Disciplinary/interdisciplinary Major/ Core Subject (minimum of 68 credits)- Mandatory and Elective Courses

(b) Disciplinary/interdisciplinary Minor Subject (maximum of 22 credits)

(c) Skill based/Vocational studies corresponding to the Major/ Core Subject (8 credits)

(d) Field projects/internship/apprenticeship/community engagement and service corresponding to the Major/ Core Subject (14-22 credits) with a maximum of six credits per Semester

(e) Generic/ Open Electives through Baskets of Elective Courses (12 credits),

(f) Ability Enhancement Courses including Languages, Literature and Environmental Studies (12 credits),

(g) In-built modules on the Indian Knowledge System (IKS) in Major/ Core Subject at Level 4.5 – 2 credits

(h) Value-based Education, Life Skills and Professional Ethics: Co-curricular Courses such as Sports and Culture, NSS/NCC and Fine/ Applied/Visual Arts (8 credits). **Student can earn some credits (SEC/VSC/GE/OE) in the form of online from-**

(i) The National Skills Qualifications Framework (NSQF) organizes qualifications for Vocational and Skill Courses in a series of 8 levels based on professional knowledge, professional skills, core skills and responsibilities, in the increasing order of complexity and competency.

(ii) University Grants Commission (Credit Framework For Online Learning Courses through Study Webs of Active-Learning for Young Aspiring Minds) Regulations, 2021, **permits up to 40 per cent of the total courses being offered in a particular programme in a**

semester through the Online Learning Courses offered through the Study Webs of Active- Learning for Young Aspiring Minds (SWAYAM) platform.

6. Examination and Assessment Process:

(i) The basic principle of the credit framework is that credits are a function of the successful completion of a program of study/ vocational education/ training and assessment. No credit can be earned by the student unless the student is assessed for the achievement of the desired competencies and outcome of a program.

(ii) Exit options are provided with certification, diploma and basic Bachelor's degrees to the students at the end of the second, fourth and sixth semesters of a four years multidisciplinary degree programme. Students will receive a Bachelor's degree with Honours/ Research on successfully completing of all eight semesters of the UG Program either at a stretch or with opted exits and re-entries.

(iii) For the smooth success of four-year multidisciplinary degree programme with multiple entry and exit systems, the examination mode will be based on the combination of innovative trends in formative (informal and formal tests administered during the learning process) and summative (evaluation of students learning at the end of an instructional unit) examination modes. This is in line with the UGC Report on 'Evaluation Reforms in Higher Educational Institutions (2019)'.

(iv) **Evaluation of each student in each course will be done as follows** a. Each theory or practical course will be of 2 credits = 50 mark

b. Internal evaluation 30% weightage (15 mark)

c. External evaluation 70% weightage (35 marks)

d. Students should secure 40% marks in each type of evaluation for successful completion of a course (student should secure at least 6 marks in internal and 14 marks in external evaluation).

(v) Evaluation Pattern.

a. Internal evaluation - Two written test, each of 20 marks will be conducted i. e. two tests on two modules. 1st assignment after completing 6 weeks of teaching and 2nd on completion of 13th week of teaching. Question paper should be designed so that evaluation of CO, PO, PSO can be performed. 10 marks out of 15 will be assigned from these written tests. Remaining 5 marks will be assigned from other types of evaluation such as seminars, orals, poster presentation, open book challenging tests, surprise test, objective test on whole syllabus of the course (at least 40 questions of objective type must be designed), etc. for 5 marks at least two different types technique must be utilized.

b. External Evaluation - External evaluation will be done at the end of semester. For theory, 35 marks written examination will be conducted and time of examination will be 2-hours.

7. Declaration of Results:

(i) Declaration of result is based on the Semester Grade Point Average (SGPA) earned towards the end of each semester or the Cumulative Grade Point Average (CGPA) earned at the completion of all eight semesters of the programme and the corresponding overall alpha-sign or letter grades as given in Table 2. If some candidates exit at the completion of the first, second or third year of the four years Undergraduate Programmes, with Certificate, Diploma or Basic Degree, respectively, then the results of successful candidates at the end of

the second, fourth or sixth semesters shall also be classified on the basis of the CGPA obtained in the two, four, six or eight semesters, respectively. Successful candidates at the end of the tenth semester of the integrated Master's Degree Programmes shall also be classified on the basis of CGPA obtained in the ten semesters of the Programmes. Likewise, the successful candidates of one year or two semesters Master's Degree Programme are also classified on the basis of the CGPA of two semesters of the Master's Degree Programme.

Table-: Grades on degree certificate/mark sheet will be assigned to the students as per the following table

Semester GPA/ Program CGPA Semester/Program	% of Marks	Alpha-Sign / Letter Grade Result
9.00-10.00	90-100	O (outstanding)
8.00 - <9.00	80.00 – <90.00	A+ (Excellent)
7.00 - <8.00	70.00-<80.00	A (Very Good)
6.00 - <7.00	60.00-<70.00	B+ (Good)
5.50 - <6.00	55.00-<60.00	B (Above Average)
5.00 - <5.50	50.00-<55.00	C (Average)
4.00 - <5.00	40.00-<50.00	P (Pass)
Below 4.00	< 40	F (Fail)
Ab	----------	Absent

(ii) A student obtaining Grade F shall be considered failed and will be required to reappear in the examination. For non-credit courses 'Satisfactory' or "Unsatisfactory' shall be indicated instead of the letter grade and this will not be counted for the computation of SGPA/CGPA.

8. Award of Major and Minor Degree:

(i) A student pursuing four-year multidisciplinary UG programme will be awarded an appropriate Honours/ Research degree in Major/ Core Subject on completion of VIII Semester with the minimum of 176 credits if he secures in that Subject at least 50% of the total credits for that programme. He shall thus study the specific number of Mandatory Core Courses, Core Electives, Vocational and Skill Courses and Field projects/ Internships connected to Core Subjects in eight semesters so as to cover at least 50% of the total credits.

(ii) In case of Research Degree, a student shall pursue research project and write dissertation in that Major in the VII and VIII semesters.

On the basis of above rules and regulations under NEP-2020 following course frame work is adopted by the Prof. Ramkrishna More Arts, Commerce and Science College, Akurdi, Pune-411044 for the completing of four years honours degree in Major and Minor subjects.

Equivalence to Previous i.e. 2019 CBCS pattern of SPPU

2019 CBCS pattern M.Sc. II Sem III	NEP 2020; 2023 CBCS Pattern M.Sc. II Sem III
BOUT 231 Botany Theory Paper 1-Computational Botany	BOMAT 631 Gymnosperm and Palaeobotany
BOUT 232 Botany Theory Paper 2- Developmental Botany	BOMAT 632 Advance plant physiology and Phytochemistry
BOUT 233 Botany Theory Paper 3- Plant Physiology	BOMAT 633 Ecology and Sustainable development
BOUP 235 Botany Practical Paper based on BOUT 231, BOUT 232, BOUT 233	BOMAP 634 Practical based on BOMAT 631 and 632
BODT 234 Plant Ecology	BOMAP 635 Practical based on BOMAT 632 and 633
BODP 234 Botany Practical Paper based on BODT 234	BOMET 631A Secondary Metabolites
	BOMEP 632A Secondary Metabolites
	BORPP 631 Research Project
	PGDST 631 Skill Development I

Equivalence to Previous syllabus i.e. CBCS 2023 pattern, NEP-2020

NEP-2024 CBCS Pattern M.Sc.II Sem III		NEP-2023 CBCS Pattern M.Sc.II Sem III	
Course Code	**Course name**	**Course Code**	**Course name**
BOMAT 631	Gymnosperm and Palaeobotany	BOMAT 631	Gymnosperm and Palaeobotany
BOMAT 632	Advanced plant physiology and Phytochemistry	BOMAT 632	Advanced plant physiology and Phytochemistry
BOMAT 633	Ecology and Sustainable development	BOMAT 633	Ecology and Sustainable development
BOMAP 634	Practical based on BOMAT 631 and 632	BOMAP 634	Practical based on BOMAT 631 and 632
BOMAP 635	Practical based on BOMAT 632 and 633	BOMAP 635	Practical based on BOMAT 632 and 633
BOMET 631A	Secondary Metabolites	BOMET 631A	Secondary Metabolites
BOMEP 632A	Practical based on Secondary Metabolites	BOMEP 632A	Practical based on Secondary Metabolites
BORPP 631	Research Project	BORPP 631	Research Project
PGSDT 631	Skill Development I	PGSDT 631	Skill Development I

Equivalence to Previous i.e. 2019 CBCS pattern of SPPU

2019 CBCS pattern M.Sc. II Sem IV	NEP 2020; 2023 CBCS Pattern M.Sc. II Sem IV
BOUT 241 Botany Theory Paper 1- Botanical Techniques	BOMAT 641 Angiosperm and Palynology
BOUT 242 Botany Theory Paper 2- Advanced Ecology	BOMAT 642 Bioinformatics and Entrepreneurship
BODT 243 Advanced Plant Physiology	BOMAP 643 Practical based on BOMAT 641
BOUP 245 Botany Practical paper based on BOUT 241 and BOUT 242	BOMAP 644 Practical based on BOMAT 642
BODP 243 Botany Practical paper based on BODT 243	BOMET 641A Bioremediation and Bioprospecting
BODP 244 PG Dissertation	BOMEP 642A Practical based on Bioremediation and Bioprospecting
	BORPP 641 Research Project
	PGSDT 641 Skill Development II

Equivalence to Previous syllabus i.e. CBCS 2023 pattern, NEP-2020

NEP-2023 CBCS Pattern M.Sc.II Sem IV		NEP-2024 CBCS Pattern M.Sc.II Sem IV	
Course Code	**Course name**	**Course Code**	**Course name**
BOMAT 641	Angiosperm and Palynology	BOMAT 641	Angiosperm and Palynology
BOMAT 642	Bioinformatics and Entrepreneurship	BOMAT 642	Bioinformatics and Entrepreneurship
BOMAP 643	Practical based on BOMAT 641	BOMAT 643	Industrial Botany
BOMAP 644	Practical based on BOMAT 642	BOMAP 644	Practical based on BOMAT 641, 642 & 643
BOMET 641A	Bioremediation and Bioprospecting	BOMET 641A	Bioremediation and Bioprospecting
BOMEP 642A	Practical based on Bioremediation and Bioprospecting	BOMEP 642A	Practical based on Bioremediation and Bioprospecting
BORPP 641	Research Project	BORPP 641	Research Project
PGSDT 641	Skill Development II	PGSDT 641	Skill Development II

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M.Sc Program in Botany

(Faculty of Science)

Syllabus

Major Course

M.Sc. II Botany

To be implemented from Academic Year 2024-2025

Board of Studies: Botany

P. D. E. A's, Prof. Ramkrishna More ACS College Akurdi Pune-411044

Credit Framework for M. Sc. Part-II Class

Semester-III				
Major Compulsory				
Sr. No.	**Major/Elective paper**	**Code**	**Major/ Elective**	**credits**
1	Gymnosperm & Palaeobotany	BOMAT-631	Major Core	4C-T
2	Plant Physiology & Phytochemistry	BOMAT-632	Major Core	4C-T
3	Ecology & Sustainable Development	BOMAT-633	Major Core	2C-T
4	Practical Based on BOMAT 631 and 632	BOMAP-634	Major Core	2C-P
5	Practical Based on BOMAT 632 and 633	BOMAP-635	Major Core	2C-P
Major Elective (any one theory and any one practical paper)				
6	Secondary Metabolites	BOMET-631(A)	Major Elective Theory	2C-T
	Cytogenetics	BOMET-631(B)		2C-T
7	Practical Based on BOMET 631A	BOMEP-632(A)	Major Elective practical	2C-P
	Practical Based on BOMET 631B	BOMEP-632(B)		2C-P
Research Project Compulsory				
8	Research Project (RP)	BORPP-631	Research Project	4C-P
9	Skill Development I	PGSDT-631	SEC	2C
Semester-IV				
Major Compulsory				
1	Angiosperm & Palynology	BOMAT-641	Major Core	4C-T
2	Bioinformatics & Entrepreneurship	BOMAT-642	Major Core	4C-T
3	Industrial Botany	BOMAT- 643	Major Core	2C-T
4	Practical Based on BOMAT 641, 642& 643	BOMAP-644	Major Core	2C-P
Major Elective (any one theory and any one practical paper)				
5	Bioremediation & Bioprospecting	BOMET-641(A)	Major elective Theory	2C-T
	Artificial Intelligence in Botany	BOMET-641(B)		2C-T
6	Practical Based on BOMET 641A	BOMEP-642(A)	Major elective Practical	2C-P
	Practical Based on BOMET 641B	BOMEP-642(B)		2C-P

Research Project Compulsory				
7	Research Project (RP)	BORPP-641	Research Project	6C-P
8	Skill Development II	PGSDT- 641	SEC	2C

NEP 2020

M.Sc. Second Year

Course : Major **Total Credit : 4**

Code : BOMAT 631 **Course Type : Theory**

Subject : Gymnosperms & Palaeobotany **Total Lecture : 60**

Module I	**Origin & Evolution of Gymnosperms**	**15L**
Chapter 1	**General aspects of gymnosperms**: Introduction of gymnosperms with special reference to its salient features, Affinities and dissimilarities with other groups like Pteridophytes and angiosperms, Origin and evolutionary tendencies in Gymnosperm, Distribution of gymnosperms in India, endangered gymnosperms and their conservation	**8L**
Chapter 2	**Fossil groups:** Study of morphology, structure, life history, interrelationship, and phylogeny of the fossils with special emphasis on: i. Pteridospermales: *Glossopteris* ii. Cycadeoideales (Bennettitales): *Williamsonia, Cycadeoidea* (Bennittites). iii. Pentoxylales: *Pentoxylon.* iv. Sphenopsidales: *Calamites*. v. Lycopsidales: *Lepidodendron*	**7L**
Module II	**Living Gymnosperm**	**15L**
Chapter 3	**Classifications of gymnosperms as per David Bierhorst (1971)**	**1L**
Chapter 4	**Cycadopsida** General Characters, Morphology, anatomy, reproductive organs, and affinities of Cycadales	**1L**
Chapter 5	**Coniferopsida** General Characters, Morphology, anatomy, reproductive organs, and affinities of i. Cordaitales: *Cordaites.* ii. Ginkgoales: *Ginkgo*. iii. Coniferales: *Araucaria, Cupressus, Thuja.* iv. Taxales: *Taxus*	**7L**
Chapter 6	**Gnetopsida :** General characters, morphology, anatomy, reproductive organs and affinities of i. Ephedrales: *Ephedra* ii. Gnetales: *Gnetum* iii. Welwitschiales: *Welwitschia*	**6L**
Module III	**Palaeobotany**	**15L**
Chapter 7	**Preservation & Geologic time scale:** Preservation of plants as fossils: Definition; taphonomy; environment for fossilization; modes of preservation; types; major rock types, rock cycle and rocks containing Fossils; systematics, reconstruction and nomenclature	**8L**

Chapter 8	**Geologic Time:** Geologic timescale, relative vs numerical age, physical and biological principles for defining relative and numerical ages	**7L**
Module IV	**Aspects of Palaeobotany**	**15L**
Chapter 9	**Colonization of Land by Plants:** Geologic time, environment, vegetative and reproductive adaptations to land-dwelling, fossil evidences - transitional plants with land adaptive features, early non-vascular land plants (bryophytes), early vascular land plants (Pteridophyte)	**7L**
Chapter 10	**Aspects and Appraisal of Paleobotany:** Palaeobotanical study in exploring - mysteries in the living planet; origin, evolution, diversification and extinction of species; plant-animal interaction and coevolution; plate movement, geological age and correlation of strata; Paleogeography, Paleoclimate; fossil fuel.	**8L**

References:

1. Vashista B.R, Sinha A.K and Singh V.P. (2005). Botany for degree students – Gymnosperms, S. Chand's Publication
2. Stewart, W.N. & Rathwell, G.W. (1993). Palaeobotany and Evolution of Plants. Cambridge University Press, London
3. Bhatnagar, S.P. & Moitra, A. (2013). Gymnosperms. New Age International Publishers, New Delhi
4. Sporne K.K. – Gymnosperm. Prescott G.W. (1969).
5. Ramanujan, C.G.K. 1979. Indian Gymnosperms in Time and Space.

Course Outcome:

After Completion of this course students are able to,

- This course aims to provide students with theoretical and practical knowledge on biology and diversity of Gymnosperms.
- To understand the range of variation in structural and reproductive diversity among different gymnosperm groups.
- To impart knowledge on the distribution, conservation status and economic and ecological importance of Gymnosperms ➢ Know the plant relationships phylogenetic systematics. ➢ Evolution pattern of the fossilization

NEP 2020
M.Sc. Second Year

Course : Major **Total Credit : 4**

Code : BOMAT 632 **Course Type : Theory**
Subject : Advanced Plant Physiology & Phytochemistry **Total Lecture : 60**

Module I	**Plant Metabolism**	**15L**
Chapter 1	**Photosynthesis**: Definition, mechanism of photosynthesis 1: Light reaction - Red drop and Emerson Effect and Two pigment system, Mechanism of Photosystem II: Dark reaction – Calvin Cycle (C3 Plants), Hatch & Slack Cycle (C4 Plants), kranz anatomy, CAM pathway, Light-regulated enzymes, inhibitors of the photosynthetic process, factors affecting photosynthesis- Internal & external factors	**8L**
Chapter 2	**Respiration:** Definition & Significance of respiration, Types of respiration, Glycolysis, TCA cycle and Pentose phosphate pathway (PPP) & its significance Glyoxylate pathway, oxidative phosphorylation, gluconeogenesis, Cyanide resistance pathway, Pasteur's effect – Anaerobic respiration, Aerobic respiration, bioluminescence, factors affecting rate of respiration- internal & external effect	**7L**
Module II	**Growth & Stress Physiology**	**15L**
Chapter 3	**Growth:** Growth, Plant growth regulators- auxins, cytokinin's, gibberellins, abscisic acid, ethylene, wound hormone- florigen, anthesin, vernalin, **Photoperiodism**: short-day pants, long-day plants, day-neutral plants, photoperiodic induction, **Vernalization**: Theory of vernalization, vernalization process, Mechanism of vernalization **Phytochrome**: concept, mode of phytochrome action, phytochrome activities, cryptochrome	**6L**
Chapter 4	**Seed Dormancy**: Seed germination, seed viability, seed dormancy and method to break it, **Stress physiology:** Definition, Types: biotic and abiotic stress, Effect of stress on plants, abiotic & biotic tolerance mechanism, mechanism of action of stress hormone - Brassinosteroids, Polyamines, Jasmonic Acids, Salicylic Acids	**6L**
Chapter 5	**Biological clock-** concept of biological clocks, physiology of the biological clocks, location of biological clocks and their chemical composition	**3L**
Module III	**Phytochemistry & its Techniques**	**15L**
Chapter 6	**Introduction to Phytochemistry**: Brief history of phytochemistry, relationship to other sciences, Importance of phytochemistry, Phytochemicals, classification, sources, and functions, the role of phytochemicals in plant disease management, future prospects for phytochemists, Computer-aided phytochemical studies, biostatistics as a tool for phytochemists, biostatistics in phytochemical research, major phytochemical societies and funding agencies, progress in phytochemical research	**8L**

Chapter 7	Selection of plant material, collection and identification, drying and grinding, choice of solvent, Factors affecting selection of an extraction process, Extraction process: Plant tissue homogenization, serial exhaustive extraction, Soxhlet extraction, maceration, decoction, infusion, digestion, sonication, percolation, Methods of extraction, separation, isolation (Chromatographic techniques) and characterization of secondary metabolites (Spectroscopic techniques). Quality control of plant drugs: Classical and modern approaches	**7L**
Module IV	**Phytochemicals**	**15L**
Chapter 8	**Carbohydrates** – sugar alcohols, starch, cellulose derivatives, gums and mucilages. **Phenolic compounds produced by plants**: types, biological activity, drugs – Senna, Aloe, Hypericum, Capsicum **Glycosides:** general account, biosynthesis, glycosidal drugs; Cyanogenic glycosides and glucosinolate compounds. **Alkaloids**: definition, properties, classification, alkaloidal drugs – *Datura stramonium, Atropa belladonna, opium, Cinchona, tea, ergot, Rauvolfia, Holarrhena, Catharanthus* – alkaloidal constituents, uses.	**7L**
Chapter 9	**Steroidal compounds**: different types, biological activity, and genera pharmaceutical importance **Carotenoids:** types, apocarotenoids, bioactivities **Lipids:** fatty acids, nomenclature, fats, fixed oils, waxes **Volatile oil:** composition, drugs-clove, Mentha, Eucalyptus, Foeniculum, Cinnamomum, citronella **Resins:** Chemistry, different types, uses.	**8L**

References:

1. A Textbook of Plant Physiology, Biochemistry and Biotechnology By Verma S. K., Verma M · 2008.
2. Plant physiology by Taiz L & Zeiger E. 1991.
3. Plant physiology and development by Taiz L
4. Plant physiology, development and metabolism by Bhatla S. C & Lal M. A. 2018.
5. Principles of plant physiology by Stiles W. 1994.
6. Plant Physiology 4 edition by Pandey S. N & Sinha B. K. 200
7. Bruneton J., 1999. Pharmacognosy, Phytochemistry, Medicinal Plants, Intercept Ltd., Paris

Course Outcome:

After Completion of this course students are able to,

- To understand, know and discuss the concept of the physiological processes of plants
- Demonstrate an understanding of the biochemical processes of photosynthesis, glycolysis, citric acid cycle, and electron transport.
- Fundamental processes such as photosynthesis, respiration, and plant hormone functions.
- During this course, you also will learn how plant growth and development and their movements, photoperiodism, and photomorphogenesis, under different environmental conditions.
- To understand and explain the processes of growth and development of plants

NEP 2020

M.Sc. Second Year

Course :	**Major**	**Total Credit**	**: 2**
Code :	**BOMAT 633**	**Course Type**	**: Theory**
Subject :	**Ecology & Sustainable Development**	**Total Lecture**	**: 30**

Module I	**Ecology**	**15L**
Chapter 1	• **Introduction to Plant Ecology:** Definition, concept, scope, interdisciplinary nature, autecology and synecology, and branches of ecology. • **Population Ecology:** Characteristics, population growth curves, regulation, life history strategies (r and K selection), and metapopulation concepts. • **Plant Communities:** Analytical and synthetic characteristics, classification, ecological amplitude, ecads, ecotones, ecotypes, ecospecies, and coenospecies. • **Dynamics and Development:** Succession and climax, population ecology, and ecological niches.	**8L**
Chapter 2	**Ecosystems:** Study of different types of ecosystem. Biogeochemical cycles of nutrients in ecosystem. Ecological adaptation of plants in different ecosystems. Environmental pollution and its consequences	**7L**
Module II	**Sustainable Development**	**15L**
Chapter 3	**Toxicity of Environment:** Principles and mechanism of toxicity; toxicants in the environment, factors affecting concentration of toxicants in environment, **Biotransformation:** Bioaccumulation, biomagnification (a general account); ecotoxicology of herbicides, **Toxicity of heavy metals:** Pb, Hg, Cd and As (general account of each): mutagens and immunotoxic agents Risk and hazards: Risk analysis, risk management, environmental toxicants and human health – role of FAO, WHO and EPA	**5L**
Chapter 4	**Environmental Impact Assessment:** Environmental impact assessment (EIA): introduction, origin and development, aims and objectives of EIA, development of EIA in India.	**3L**
Chapter 5	Requirements for impact assessment: main steps of impact assessment: pre-study study period and post-study period activities. Methods of EIA: adhoc method, checklists, matrix, networks, evaluation systems, modelling and computer-aided Assessment	**4L**
Chapter 6	Writing of environmental impact statement, environmental management plan, environmental auditing, cost and benefit analysis; role of public participation in environmental decision making	**3L**

References:

1. Ambasht R.S., and N.K. Ambasht (2003). Modern Trends in Applied Terrestrial Ecology. Springer
2. Ambasht R.S. and N.K. Ambasht (2017). A Textbook of Plant Ecology (15/E). CBS Publishers & Distributors-New Delhi
3. Kormondy, E. J. (Ed.) (1999). Concepts of Ecology. Prentice Hall
4. Ramade, F. (1981). Ecology of Natural Resources. John Wiley and Sons.

5. Odum, E. P. (1991). Fundamentals of Ecology (III Edn). Saunders and Com

Course Outcome:

After successful completion of this course, students will be able to understand,

- Understand mechanisms by which organisms interact with other organisms and with their physical environment
- Describe biotic and abiotic factors that influence the dynamics of populations
- Appreciate the inter-relationship between organisms in population and communities
- Understand t h e principles of toxicology and the harmful effects of toxic metals on humans and environment
- Realize the role of various International Organizations for the protection and safeguard of environment

NEP 2020
M.Sc. Second

Course: Major Practical **Total Credit : 2**
Code : BOMAP 634 **Course Type : Practical**
Subject : Practical Based on BOMAT631 and BOMAT632 **Total Practical : 4 Hours/Practical**

Sr No.	Practical Based on Gymnosperm and Palaeobotany	8P
1	Morphological and/or anatomical (double staining) and/or reproductive studies of the following members with the help of live material/or herbarium specimens and/or a) **Cycadopsida:** i. *Glossopteris* ii. *Williamsonia* iii. *Cycadeoidea* iv. *Pentoxylon* b) **Coniferopsida** i. Cordaitales: *Cordaites* ii. Ginkgoales: *Ginkgo*. iii. Coniferales: *Araucaria.* iv. *T*axales: *Taxus* c) **Gnetopsida*:*** i. Ephedrales: *Ephedra* ii. Gnetales: *Gnetum* iii. Welwitschiales: *Welwitschia*	**6P**
2	Study of the following with the help of slides and/or specimens. i) Impression, ii) Compression, iii) Petrifaction, iv) Coal ball.	**1P**
3	Exploratory trip for plant collection	**1P**
	Practical Based on Advanced Plant Physiology based on (BOMAT 632)	**4P**
1	Estimation of soluble proteins in germinating and non-germinating seed by Lowry and Bradford's method	**2P**
2	Estimation of total amino acid in germinating and non-germinating seed	**1P**
3	Preparation of solution of different concentrations, Buffers, Conductivity, and pH Measurements	**1P**

References:

- **B.P. Pandey:** *College Botany (Vol. II)* – The "gold standard" for anatomy and morphology of all listed genera.
- **Vashishta, Sinha & Kumar:** *Botany for Degree Students: Gymnosperms* – Best for detailed life cycles of *Ginkgo*, *Taxus*, and *Gnetum*.
- **Arnold:** *An Introduction to Paleobotany* – Excellent for understanding fossil types (Impressions/Coal balls).
- **S. Sadasivam & A. Manickam:** *Biochemical Methods* – Contains exact protocols for Lowry/Bradford protein assays and amino acid estimation.

- **Taiz & Zeiger:** *Plant Physiology* – The best resource for the theoretical background of seed germination and metabolism.
- **K. Wilson & J. Walker:** *Principles and Techniques of Biochemistry* – Ideal for learning buffer preparation, pH, and conductivity measurements.
- **Bentley & Trimen:** *Practical Manual of Plant Diversity* – Good for double-staining techniques.
- **S.S. Choudhary:** *Practical Botany* – Covers specific lab specimens and slide identification.

Course Outcome

After successful completion of this course, students will be able to understand,

- The morphological characters and classification of different gymnosperm groups.
- The habit, habitat and occurrence of different subdivisions of gymnosperm.
- The cellular components are used to generate and utilize energy in cells.

NEP 2020
M.Sc. Second Year

Course : Major Practical **Total Credit : 2**
Code : BOMAP 635 **Course Type : Practical**
Subject : Practical Based on BOMAT632 and BOMAT633 (Phytochemistry & Ecology) **Total Practical : 4 Hours/Practical**

Sr No.	Practical Based on (BOMAT 632) Phytochemistry	6P
1	Laboratory safety and basic laboratory operation	1P
2	Study the different extraction methods used for phytochemical analysis.	1P
3	Estimation of Alkaloid/ Caffeine/ Piperine.	1P
4	Estimation of carbohydrates by using suitable plant material.	1P
5	Estimation of phenolic compound by using suitable plant material	1P
6	Glycoside isolation and identification tests of cardiac glycoside (digoxin)	1P
	Practical Based on (BOMAT 633) Ecology & Sustainable development (Any Four)	4P
1	To determine the minimum size of the quadrat by species-area curve method	1P
2	To study the community characteristics by quadrat method by determining frequency, density and abundance of different species in the community	1P
3	To study life forms of plants in a selected area using Raunkiaer's scheme	1P
4	To study the Physico-chemical properties of different soil samples	1P
5	To estimate dissolved oxygen content in polluted and non-polluted water samples by BOD method	1P
6	Exploratory trip for plant collection/ visit to National Parks/Wildlife Sanctuaries/Botanical Gardens/Herbaria	1P

References:

- **J.B. Harborne:** *Phytochemical Methods* – The primary reference for extraction techniques and identifying alkaloids, glycosides, and phenolics.
- **S. Sadasivam & A. Manickam:** *Biochemical Methods* – Best for practical protocols on carbohydrate and phenolic estimations.
- **K.R. Aneja:** *Laboratory Manual of Plant Biotechnology* – Covers lab safety, basic operations, and extraction procedures.

- **Kokate, Purohit & Gokhale:** *Pharmacognosy* – Excellent for specific isolation and tests for Digoxin (cardiac glycosides) and Piperine.
- **P.S. Verma & V.K. Agarwal:** *Environmental Biology (Principles of Ecology)* – Detailed guide for quadrat methods (frequency, density, abundance) and Raunkiaer's life forms.
- **E.P. Odum:** *Fundamentals of Ecology* – Core theory for community characteristics and sustainable development.
- **R.K. Trivedy & P.K. Goel:** *Chemical and Biological Methods for Water Pollution Studies* – The standard manual for BOD and water/soil analysis.
- **M.C. Dash:** *Fundamentals of Ecology* – Helpful for species-area curve methods and practical field techniques.

Course Outcome

After successful completion of this course, students will be able to understand,

- The basic principles of inheritance at the molecular, cellular, and organism levels.
- Students will learn the different plant data analysis
- Appreciate the inter-relationship between organisms in population and communities
- Realize the role of various International Organizations for the protection and safeguarding of environment

NEP 2020

M.Sc. Second Year

Course : Major **Total Credit : 4**

Code : BOMAT 641 **Course Type :Theory**

Subject : Angiosperms and Palynology **Total Lecture : 60**

Module I	**Components of Plant Taxonomy**	**15L**
Chapter 1	**Introduction to Plant taxonomy:** Classification, taxonomy, systematics; historical background of angiosperm classification (concept of artificial, natural and phylogenetic approaches to classification). Natural System by Bentham and Hooker	**3L**
Chapter 2	Takhtajan's system of classification (outline and merits & demerits); Angiosperm Phylogeny Group (APG) (outline of APG classification).	**3L**
Chapter 3	Plant description: taxonomic characters and character states; vegetative and floral characters; diagnostic characters; characters and definition of taxa; Primitivenesss and advanced characters	**4L**
Chapter 4	**Rules & Regulations of Classification:** History, Principles, Important rules and recommendations with examples, governance of code, Appendices; Name of hybrids. Aspects of Taxonomy (identification, nomenclature, classification, systematics, molecular systematics); Phases of taxonomy (exploration, consolidation, experimental or biosystematics, encyclopedic)	**5L**
Module II	**Plant Families**	**15L**
Chapter 5	**Morphology & Importance of Plant Families:** Study of plant families with respect to general characters, morphological variations, systematic position, economic importance and affinities following APG –IV system of classification: Nymphaeaceae, Annonaceae, Amaryllidaceae, Aracaceae, Poaceae, Papaveraceae, Leguminoceae, Brassicaceae, Euphorbiaceae, Apocynacae, Asteraceae, Apiaceae	**15L**
Module III	**Palynology**	**15L**
Chapter 6	**Pollen Adaptation and Viability:** Introduction to palynology, spore pollen morphology: units, polarity, symmetry, shape, size, aperture; NPC system for numerical expression of apertural details; evolution of aperture types.	**7L**
Chapter 7	Pollen wall and extraexinous wall materials: Sporoderm stratification and sculptures; LO- analysis; sporopollenin; pollen wall development; Ubisch body; pollen connecting threads, perine, pollen-kit	**5L**
Chapter 8	Pollen grains adaptation: Pollen grains adaptation in different habitats and pollination types; pollen wall adaptation and significance; Hermomegathic mechanism.	**3L**
Module IV	**Branches of Palynolgy**	**15L**
Chapter 9	**Entomopalynology & Copropalynology:** Spore/Pollen Viability and Storage: Estimation; variations; responsible factors; short- and long-term storage; significance. Pollen limitation and plant diversification: Definition; ecological and evolutionary relevance. Adaptive radiation; Isolating mechanisms	**7L**

Chapter 10	Natural spore/pollen traps: Types, their implications in floristic & environment reconstruction. Branches of palynology & application: Branches of palynology; palynology in taxonomic & phylogenetic deductions; palynology in academic & applied aspects including melissopalynology, medical palynology, forensic palynology, entomopalynology & copropalynology	**8L**

References:

1. Cronquist, A. 1981. An Integrated System of Classification of Flowering Plants. Columbia University Press, New York**.**
2. Davis, P**. H. and** V. H. Heywood 1991. Principles of Angiosperm Taxonomy. Today and Tomorrow Publications, New Delhi.
3. P.K.K. Nair. Pollen Morphology of angiosperms Darbeshwar Roy Crop Evolution & Genetic Resources.
4. P.K.K. Nair: Essentials of Palynology
5. Moor & Moor: Pollen analysis
6. Harrison, H. J. (1971). New Concepts in Flowering Plant Taxonomy. Hieman & Co- 7. Heywood, V. H. and Moore, D. N. (1984). Current Concepts in Plant Taxonomy. Academic.
8. Jeffrey, C. (1968). An Introduction to Principles of Plant Taxonomy.

Course Outcome:

After the completion of the course, students are able to,

- The course of Plant Taxonomy deals with history and importance of taxonomy
- It deals with classification of angiosperms and enables the students to understand different systems of classifications, both classical and modern.
- The students are made to understand principles and methods of identification including construction of keys, plant nomenclature and ICN.
- The course will enable students to understand the role of other approaches of biology to unravel mysteries of Plant Taxonomy.
- Explain the adaptations in pollen
- Understand the fossil history plants

NEP 2020
M.Sc. Second Year

Course : Major **Total Credit : 4**
Code : BOMAT 642 **Course Type : Theory**
Subject : Bioinformatics and Entrepreneurship **Total Lecture : 60**

Module I	**Importance of Genomics and Proteomics**	**15L**
Chapter 1	**Introduction to Genomics:** Nucleotide sequence databases, its Analysis and Identification. Goals of the Human Genome Project. Concept of maps, physical maps, shotgun libraries. DNA polymorphism, nucleotides, DNA sequences. Coding sequences (CDS) Untranslated regions (UTR's) cDNA library. Expressed sequence tags (EST) Approach to gene identification Masking repetitive DNA	**3L**
Chapter 2	**Introduction to Proteomics:** Introduction to Proteomics Classification of Proteomics Tools and techniques in proteomics: 1. 2-D gel electrophoresis, 2. Gel filtration 3. PAGE, 4. Affinity chromatography, 5. HPLC, 6. Isotope-Coded Affinity Tag, 7. Mass spectroscopy for protein analysis, 8. MALDI-TOF Electrospray ionization (EST), 9. Tandem mass spectroscopy (MS/MS) analysis 10. Tryptic digestion and peptide fingerprinting (PMF). 11. Protein Micro array in protein expression, 12. Profiling and diagnostics, drug target discovery. 13. 3-dimensional structure determination by X-ray and NMR. 14. Phylogenetic analysis: Evolution, elements of phylogeny, methods of phylogenetic analysis, Phylogenetic tree of life, comparison of genetic sequence of organisms, phylogenetic analysis tools (Phylip, ClustalW)	**3L**
Module II	**Basics of Bioinformatics**	**15L**
Chapter 3	**Data and Database** 1. Types of Biological data: Genomic DNA, Complementary DNA, Recombinant DNA, Expressed sequence tags, Sequence-Tagged Sites, Genomic survey sequences. 2. Primary Databases: GenBank, EMBL, DDBJ. 3. Composite Databases: NRDB, UniProt. 4. Literature Databases: Open access and open sources, PubMed, PLoS, Biomed Central, NAR databases. 5. Bioinformatic Resources: NCBI, EBI, ExPASy, RCSB	**6L**

Chapter 4	**Genome Databases:** 1. Viral genome database: ICTVdb 2. Bacterial Genomes database: Genomes OnLine Database and Microbial Genome Database. 3. Genome Browsers: Ensembl, VEGA genome browser, KEGG, UCSC Genome Browser	**6L**
Chapter 5	**Structure and derived databases** 1. Primary structure databases: PDB, MMDB. 2. Secondary structure databases: SCOP, Catalytic Site Atlas (CSA)	**3L**
Module III	**Protein Structure Prediction**	**15L**
Chapter 6	Homology modeling Prediction of protein structure from sequences Functional sites Protein folding problem Protein folding classes.	**6L**
Chapter 7	Protein identification and characterization: 1. AACompIdent 2. TagIdent 3. PepIdent 4. MultiIdent 5. PepSea 6. PepMAPPER 7. FindPept Primary structure analysis and prediction, Secondary structure analysis and prediction, motifs, profiles, patterns, and fingerprints search. Methods of sequence-based protein prediction	**9L**
Module IV	**Entrepreneurship**	**15L**
Chapter 8	**Introduction:** Meaning and concept of entrepreneurship, History of entrepreneurship development, Role of entrepreneurship in economic development	**4L**
Chapter 9	**The Entrepreneur:** Why to become an entrepreneur the skills/traits required to be an entrepreneur Creative thinking of the entrepreneur Entrepreneurial decision process	**5L**
Chapter 10	**Communication:** Importance of communication barriers and gateways to communication Power of talk, personal selling, risk-taking & resilience, negotiation	**4L**

Chapter 11	**Factors influencing entrepreneurship**: Psychological factors Social factors Economic factor Environmental factors	**2L**

References:

1. Cynthia Gibas, Per Jambeck, Developing Bioinformatics Computer Skills O'Reilly MediaInc 2001.
2. David Edwards, Jason Eric Stajich, David Hansen, Bioinformatics Tools and Applications, Springer, 2009.
3. S C Rastogi, N Mendiratta and P Rastogi, " Bioinformatics: Methods and Applications", ISBN: 978-81-203-4785-4, PHI Learning Private Limited, 2015.
4. David W Mount, Bioinformatics: Sequence and genome analysis, Cold Spring Harbor Laboratory Press, 2 nd Edition, 2004.
5. Attwood, T.K., Parry, D.J., Smith, Introduction to Bioinformatics, Pearson Education, 2005.
6. Stan Tsai C., Bio macro molecules: Introduction to Structure, Function and Informatics, John Wiley & Sons, 2007.

Course Outcome:

After the completion of the course, students are able to,

- Demonstrate different biological databases and tools.
- Apply algorithms for searching the biological databases.
- Categorize sequence alignment methods.
- Implement phylogenetic tree construction algorithms.
- Predict gene and protein secondary structure.
- Analyse genomic sequence.

NEP 2020
M.Sc. Second Year

Course : Major | **Total Credit : 2**
Code : BOMAT 643 | **Course Type : Theory**
Subject : Industrial Botany | **Total Lecture : 30**

Module I	**Industrial Botany I**	**15L**
Chapter 1	1.1 Concept of Industrial Botany. 1.2 Plant resources and industries: Food, fodder, fibers, medicines, timber, dyes, gum, tannins. (Two examples of each resource and the relevant industries with which they are associated). 1.3 **Floriculture Industry:** Introduction to floriculture, Important floricultural crops, open cultivation practices, harvesting and marketing of Tuberose. Greenhouse technology: Concept, advantages and limitations. Cultivation practices (greenhouse technology), harvesting and marketing of Rose and Gerbera. 1.4 **Plant Nursery Industry: Concept** and types of nurseries: ornamental plant nursery, fruit plant nursery, medicinal plant nursery, vegetable plant nursery, orchid nursery, forest nursery (with reference to infrastructure required, outputs, commercial applications and profitability), Propagation methods: Seed propagation, natural vegetative propagation and artificial vegetative propagation.	**8L**
Chapter 2	2.1 **Plant Tissue Culture Industry:** Concept of tissue culture. Banana (Musa spp.) – Disease-Free Propagation, Orchids – Mass Propagation and Preservation Potato Virus Y and its Impact, Commercial significance. 2.2 Agri **industries:** Organic Farming: Concept, need of organic farming, types of organic fertilizers, advantages and limitations, Seed industries: Importance of seed industries, seed production, seed processing and seed marketing with reference to cotton, Major seed industries and corporations of India. 2.3 **Mushroom Industries:** Mushroom cultivation: Plant resources, cultivation practices of Oyster mushroom, uses of mushrooms, value added products, commercial significance.	**7L**
Module II	**Industrial Botany II**	**15L**
Chapter 3	**3.1 Bio-fuel Industry:** Introduction and advantages, Concept of biofuel and its need, Plants used for biofuel production, Biodiesel production from Caster, Commercial significance. **3.2 Bio-pesticide Industry:** Concept of bio-control; Integrated Pest Management (IPM), Importance of bio pesticides, Types of bio pesticides: Indiara, Azadiractin, Commercial significance.	**5L**
Chapter 4	**4.1 Industrial Mycology:** Introduction, Important genera of fungi used in various industries and their products, Products and applications of Trichoderma, Penicillium, Aspergillus and yeast, Commercial significance. **4.2 Bio-Fertilizer Industry:** Bio fertilizers: concept and need, Types of biofertilizers, Nitrogen fixing bio fertilizers, Rhizobium, Blue green algae. Anabaena associated with Azolla, Phosphate solubilizing biofertilizer, Bacteria and Fungi, Commercial significance.	**3L**
Chapter 5	**5.1 Fruit Processing Industry:** Fruit processing: concept and need, Cold storage, Types of fruit processing (canned fruits, dried fruit chips, fruit pulp, squash, jam, jelly, pickle and ketchups), Commercial significance.	**4L**

Chapter 6	**6.1 Plant Pharmaceutical Industry.** 6.2 Concept and advantages,Types of pharmaceutical products: Churna, Asava and Arishta, Drug plants with reference to botanical source, active principles and medicinal uses of Adathoda zeylanica, Tinospora cordifolia and Asperagus racemosus, Manufacture of Churna (Triphala churna), Arishta (Ashokarishta) and Asava (Kumariasava), Concept of nutraceuticals and cosmeceuticals.Commercial significance of Amla and Aloe.	**3L**

References:

1. References: 1. The Complete Book on Organic Farming and Production of Organic Compost, NPCS Board of Consultants & Engineers, Asia Pacific Business Press Inc.
2. The Organic Farming Manual: A Comprehensive Guide to Starting and Running a Certified Organic Farm, Ann Larkin Hansen, Storey Publications.
3. Deore and Laware (2011). Liquid Organic Fertilizer: An Approach towards Organic Vegetable Production. LAP LAMBERT Academic Publishing (2011)
4. A Pharmacognosy and Pharmacobiotechnology. New Age international (P) Limited, Publishers (formerly Wiley Eastern Limited)
5. Kokate C.K. Practical Pharmacognosy, Vallabh Prakashan, New Delhi,
6. Kokate C.K. Purohit A.P. and Gokhale S.B. Pharmacognosy, Nirali Prakashan Pune.

Course Outcome:

After successful completion of this course, students will be able to understand,

- Understand knowledge of industrial processes.
- Describe the applications of plant-based products.
- Identify and classify the major plants and plant-based materials used in various industrial applications, such as food, pharmaceuticals, textiles, biofuels, and chemicals.
- Understanding the role of biofuels in energy production, including plant-based bioethanol and biodiesel.
- Understand the economic significance of plant-based raw materials in industrial production.

NEP 2020
M.Sc. Second Year

Course : Major Practical **Total Credit : 2**
Code : BOMAP 644 **Course Type : Practical**
Subject : Practical based on BOMAT 641, 642 & 643 **Total Practical : 4 Hours/Practical**
(Practical based on Angiosperm and Palynology,Entrepreneurship & Bioinformatics and Industrial Botany)

Sr. No.	Practical Based on (BOMAT 641) Angiosperms & Palynology	5P
1	Studies on the families (As per APG - IV system of classification) Any one example from any locally available eight families (Nymphaeaceae, Annonaceae, Amaryllidaceae, Aracaceae, Poaceae, Papaveraceae, Leguminoceae, Brassicaceae, Euphorbiaceae, Apocynacae, Asteraceae, Apiaceae.)	3P
2	Preparation and uses of botanical keys (bracket and indented keys) and Collection, processing and preservation of 25 herbarium specimens to be student at the time of examination.	1P
3	Study of Allergic Plants and their Pollens and study of Pollen Fertility by TTC or Acetocarmine Methods.	1P
Sr. No.	**Practical Based on (BOMAT 642) Bioinformatics and Entrepreneurship**	**6P**
4	Study of Database and Database Searching.	1P
5	Pairwise comparison of Nucleotide and Protein sequences.	1P
6	Determining phylogenetic relationships using DNA and protein sequences.	1P
7	Disease gene identification using OMIM and SNP database.	1P
8	Genome analysis and comparison of genome using UCSC and ENSEMBLE browser.	1P
9	Study of Instruments used in Bio-informatics (2-D gel electrophoresis, Gel filtration PAGE, Affinity chromatography, HPLC, DNA Sequencer).	1P
Sr. No.	**Practical Based on (BOMAT 643) Industrial botany**	**4P**
10	Identification of economically important plants & Extraction and testing of plant products.	2P
11	Study the cultivation and harvesting of edible mushroom.	1P
11	Industrial /Field visit to the local flora plant collection and herbarium preparation and submission.	1P

References:

- **Gurucharan Singh:** *Plant Systematics* – Best for the APG-IV system, family descriptions, and constructing botanical keys.
- **B.P. Pandey:** *Taxonomy of Angiosperms* – A standard guide for herbarium preparation and family studies.

- **P.K.K. Nair:** *Essentials of Palynology* – Covers pollen morphology, allergic plants, and fertility testing (TTC/Acetocarmine).
- **K. Bhattacharya:** *A Textbook of Palynology* – Good for identifying common pollen types and their clinical significance.
- **S.C. Rastogi:** *Bioinformatics: Methods and Applications* – Covers database searching (NCBI/BLAST), sequence alignment, and phylogeny.
- **Arthur Lesk:** *Introduction to Bioinformatics* – Excellent for understanding genome browsers (UCSC/Ensemble) and SNP databases.
- **Keith Wilson & John Walker:** *Principles and Techniques of Biochemistry and Molecular Biology* – The go-to reference for HPLC, PAGE, and DNA sequencing instrumentation.
- **S.L. Kochhar:** *Economic Botany* – Comprehensive for identifying economically important plants and their products.
- **S.C. Tiwari & P. Kapoor:** *Mushroom Cultivation* – A practical guide for the cultivation and harvesting of edible mushrooms.
- **B.P. Pandey:** *Economic Botany* – Useful for field visits and understanding industrial applications of plant-derived materials.

Course Outcome:
After the completion of the course, students are able to,

- Understand the morphological characteristics of angiosperms.
- Know the preparation and uses of botanical keys.
- Understand the pollen structure and viability ➢ Understand the different allergic reactions of pollen.
- Search and retrieve the biological data from the database.
- Perform qualitative and quantitative bio-molecular data analysis by using standard methods.
- Identify and understand the mutative genes.
- Know the principle and working mechanism of instruments used in Bioinformatics

PDEA's

Prof. Ramkrishna More Arts Commerce and Science College (Autonomous), Akurdi, Pune - 411044

Affiliated to

Savitribai Phule Pune University (SPPU)

Choice Based Credit System

(CBCS) under

Autonomy & NEP-2020

M.Sc Program in Botany

(Faculty of Science)

Syllabus

Major Elective Course

M.Sc. II Botany

To be implemented from the Academic Year

2023-2024

Board of Studies: Botany

NEP 2020

M.Sc. Second Year

Course : Major Elective | **Total Credit : 2**

Code : BOMET631A | **Course Type : Theory**

Subject : Secondary Metabolites | **Total Lecture : 30**

Module I	**Secondary Metabolites of Plants**	**15L**
Chapter 1	**Introduction to Secondary Metabolites.** • Definition and classification of secondary metabolites. Importance and roles of secondary metabolites in plants. Historical perspective and milestones in secondary metabolite research. • Metabolic Pathways and overview of biosynthetic pathways of major classes of secondary metabolites (e.g., alkaloids, terpenoids, phenolics). Enzymes and genes involved in secondary metabolite biosynthesis. Regulation of secondary metabolite biosynthesis,	**6L**
Chapter 2	**Extraction, separation, and characterization of secondary metabolites.** • Techniques for separation and identification of secondary metabolites. Extraction, purification, and isolation of secondary metabolites. Spectroscopic methods (NMR, mass spectrometry, UV-Vis, IR) for structural elucidation. • Chromatographic techniques (HPLC, GC, HPTLC, Preparative and Reverse phase columns, Mobile phase selection and detectors in HPLC, HPTLC, and GC). • Interpretation of data for UV, IR, NMR, 1H NMR, 13C NMR & Mass spectroscopy for purification and structural elucidation of phyto-constituents	**9L**
Module II	**Roles of Secondary metabolites**	**15L**
Chapter 3	**Roles of Secondary metabolites in plants.** • Ecological roles of secondary metabolites in defense, communication, and symbiotic interactions. Evolutionary aspects of secondary metabolite biosynthesis and diversification. Ecological significance of secondary metabolite-mediated interactions in ecosystems. • Role of secondary metabolites in Defense mechanism, Antioxidant activity, Attractants for Pollinators and Seed Dispersers, Allopathy, Regulation of Plant Growth and Development, Communication and Signaling, Stress Adaptation, Chemical Communication with Microorganisms. • Applications in agriculture, pharmaceuticals, cosmetics, and other industries.	**8L**

Chapter 4	**Recent Advances in Secondary Metabolites** • **(Recent Discoveries 2020-2025)** Novel fungal metabolites, New terpenoids/alkaloids with clinical potential, Plant-based innovations (e.g., cannabinoids, artemisinin derivatives). • **Biotechnological Approaches** Plant tissue culture for metabolite production, Metabolic engineering and synthetic biology, Use of elicitors and hairy root cultures. • Future Directions Integrated biofoundaries, Single-cell metabolomics, AI-driven de novo design of natural products.	**7L**

References:

1. Secondary Metabolism in Plants and Animals" by David S. Seigler.
2. "Plant Secondary Metabolism Engineering: Methods and Applications" edited by Rishikesh B. Antre, Hemant R. Chhipa, and Anil K. Sharma.
3. Bioactive Natural Products: Detection, Isolation, and Structural Determination" by Steven M. Colegate and Russell J. Molyneux,
4. Medicinal Natural Products: A Biosynthetic Approach" by Paul M. Dewick.
5. The Biochemistry of Plants: Secondary Metabolism" edited by Thomas W. Goodwin.
6. Plant Secondary Metabolites: Occurrence, Structure, and Role in the Human Diet" edited by Alan Crozier, Mark R. Fenwick, and Hiroshi Ashihara.

Course Outcome:

After Completion of this course, students are able to,

- Students should gain a comprehensive understanding of secondary metabolites in plants.
- Students should be able to identify different classes of secondary metabolites, such as alkaloids, terpenoids, phenolics, and their derivatives, and classify them based on their chemical structures and biosynthetic pathways.
- Students should understand the ecological roles of secondary metabolites in plants.
- Students should be familiar with the biotechnological applications of secondary metabolites in agriculture.
- Students should learn various techniques for extracting, isolating, purifying, and analyzing secondary metabolites from plant sources, including chromatography, spectroscopy, and mass spectrometry methods.
- Students should be able to integrate knowledge from multiple disciplines, including plant biology, biochemistry, ecology, pharmacology, and biotechnology, to understand the multifaceted roles of secondary metabolites in plants.

NEP 2020
M.Sc. Second Year

Course : Major Elective **Total Credit : 2**
Code: BOMET 631B **Course Type : Theory**
Subject: Cytogenetics **Total Lecture : 30**

Module I	**Basics of Cytogenetics**	**15L**
Chapter 1	**Introduction to Genetics:** a) Mendelian genetics b) Applications of Mendelian genetics c) Chromosomal theory of inheritance	**3L**
Chapter 2	**Development of Genetics:** a) Pre-Mendelian Genetics b) Post Mendelian Developments in Genetics c) Beginning of the Era of DNA and Molecular Genetics	**3L**
Chapter 3	**Cytoplasmic inheritance:** a) Maternal effect b) Plastid Inheritance c) Mitochondrial Inheritance d) Interaction between nuclear and cytoplasmic genes	**4L**
Chapter 4	**Quantitative inheritance:** a) Multiple Factor Hypothesis b) Polygenic Inheritance c) Quantitative traits d) Inheritance of quantitative traits e) QTL mapping	**5L**
Module II	**Structure and Function of Chromosome**	**15L**
Chapter 5	**Chromosomes:** a) Architecture of chromosome in Prokaryotes and Eukaryotes b) Structure of Chromosome c) Preparation of chromosome for karyotype d) Role of karyotype in chromosome evolution e) Chromosome Banding Techniques	**5L**
Chapter 6	**Structural alterations of chromosome** a) Deletion, duplication, inversion, translocation b) Complex translocation heterozygotes c) Robertsonian translocations d) BA translocations	**3L**

Chapter 7	**Numerical alterations of chromosomes:** a) Aneuploids: method of production, meiotic behavior, applications b) Polyoploids: Method of identification of autopolyploids and allopolyploids, c) Advantages of autopolyploids versus allopolyploids	**4L**

References

1. Antherley A. G, Girton J. R and Mcdonald J. F(1999). The Science of Genetics. Saunders College Publishing, Harcourt Brace College Publishers N. Y.
2. Auerbach C(1976). Mutation Research Problems, Results and Perspectives. Chapman and Hill Ltd London.
3. Principles of Genetics, Snustad and Simmons, (4th Ed. 2005), John Wiley & Sons, USA
4. Modern Genetic Analysis: Integrating Genes and Genomes, Griffiths, J.F., Gelbart, M., Lewontin, C. and Miller, W. H. Freeman and Company , New York, USA
5. Genetics, J. Russell, Benjamin-Cummings Publishing Company, San Francisco, California, USA

Course Outcome

After successful completion of this course, students will be able to understand,

- The course will be focusing to develop the understanding on Chromosome, structure, forms, special types and study of asymmetry in the karyotypes.
- It also will deal with the development of understanding on different types of structural chromosomal aberrations and their consequences on the growth and development of the Cell and Organism.
- The course will enable students to learn about numerical chromosomal changes and the evolutionary consequences.
- The course will help students understand and appreciate the anomalies in chromosomal behavior and their impact on the survival of species.
- The students will be made to understand the Molecular approaches for study of Cytology and Cytogenetics

NEP 2020
M.Sc. Second Year

Course : Major Elective Practical **Total Credit : 2**
Code : BOMEP 632A **Course Type : Practical**
Subject : Practical based on BOMET 631A **Total Lecture : 4 Hours/Practical**
(Practical on Secondary Metabolites of Plants)

Sr No.	Practical Based on Secondary Metabolites of Plants	12P
1	Identification of groups of various secondary metabolites from different plant samples. Alkaloids, Saponins, Tannins, Terpenoids, Phenols.	1P
2	Isolation and quantification of secondary metabolites from suitable plant material using suitable extraction techniques.	1P
3	Extraction of secondary metabolites from suitable plant material using Soxhlet Extraction	1P
4	Separation of secondary metabolites using thin-layer chromatography (TLC)..	1P
5	To separate and isolate secondary metabolites from a plant extract using column chromatography, and to analyze the fractions for the presence of specific compounds	1P
6	Perform antioxidant assays (e.g., DPPH scavenging assay) on suitable plant material.	1P
7	Perform antioxidant assays (e.g., Radical scavenging assay) on suitable plant material.	1P
8	Determine the flavonoid content of suitable plant materials using a colorimetric assay method.	1P
9	Quantification of Total phenolic content from suitable plant material using Folin-Ciocalteu (FC) method.	1P
10	Extraction and quantification of terpenoids from suitable plant material using solvent extraction method.	1P
11	Set up an HPLC system for separation and quantification of specific secondary metabolites and Discuss the importance of retention time and peak identification.	1P
12	Identify and analyse volatile secondary metabolites from suitable plant material by using Gas chromatography. Identify and analyse volatile secondary metabolites and Interpret the mass spectra for compound identification.	1P

References:

- **J.B. Harborne:** *Phytochemical Methods: A Guide to Modern Techniques of Plant Analysis* – The "bible" for identifying alkaloids, saponins, tannins, and terpenoids.
- **K.R. Aneja:** *Laboratory Manual of Plant Biotechnology* – Excellent for the assembly and operation of **Soxhlet extraction** units.
- **Egon Stahl:** *Thin-Layer Chromatography: A Laboratory Handbook* – Best for TLC Rf values and solvent systems for plant extracts.
- **S.M. Khopkar:** *Basic Concepts of Analytical Chemistry* – Clear explanations for **Column Chromatography**, **HPLC** (retention time), and **GC-MS** interpretation.

- **S. Sadasivam & A. Manickam:** *Biochemical Methods* – Detailed protocols for **Total Phenolic Content** (Folin-Ciocalteu) and **Flavonoids**.
- **Alam, Bristi, & Rafiquzzaman:** *Review on in vivo and in vitro methods evaluation of antioxidant activity* – Standardized steps for **DPPH** and radical scavenging assays.

Course Outcome:

After the completion of the course, students are able to,

- Understand the morphological characteristics of angiosperms.
- Know the preparation and uses of botanical keys.
- Understand the pollen structure and viability
- Understand the different allergic reactions of pollen.

NEP 2020
M.Sc. Second Year

Course : Practical based on BOMET631B **Total Credit : 2**
Code : BOMEP 632B **Course Type : Practical**
Subject : Cytogenetics **Total Practical : 4 Hours/Practical**

Sr No.	Practical Based on Cytogenetics	12P
1	Preparation of Fixatives and Stains	1P
2	Study of various stages of mitosis	1P
3	Study of various stages of Meiosis	1P
4	Induction of C metaphase in suitable plant material	1P
5	Induction of Polyploidy in suitable plant material	2P
6	Study of Chromosomes karyotype by using suitable plant material	2P
7	Study of meiotic configuration in suitable plant material	2P
8	Study of Polygenic Inheritance.	1P
9	Neurospora tetrad analysis	1P

Refernces:

- **Ram J. Singh:** *Practical Manual on Plant Cytogenetics* – The standard for root tip squash (mitosis) and pollen mother cell (meiosis) techniques.
- **S.S. Prasad:** *Practical Botany (Vol. II)* – Best for the preparation of fixatives (Carnoy's) and stains (Acetocarmine/Orcein).
- **A.K. Sharma & A. Sharma:** *Chromosome Techniques: Theory and Practice* – The definitive source for **C-metaphase** induction and **Polyploidy** using Colchicine.
- **G.K. Kulkarni:** *Karyotype Analysis* – Simple guide for chromosome measurement and idiogram preparation.
- **Gardner, Simmons, & Snustad:** *Principles of Genetics* – Clear explanation of **Polygenic Inheritance** and biometrical methods.
- **Monroe Strickberger:** *Genetics* – Provides the step-by-step logic for **Neurospora tetrad analysis** and gene mapping

Course Outcome

After the completion of the course, students are able to

- Identify different stages of cell cycle
- Understand the chromosomes morphology
- Demonstrate the karyotype for chromosomal study

PDEA's

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Choice Based Credit System (CBCS) under Autonomy & NEP-2020

M.Sc. Program in Botany

(Faculty of Science)

Syllabus for Minor Course

To be implemented from Academic Year 2023-2024

Structure of Course

M.Sc. Botany syllabus						
Year	**Sem**	**Course Type**	**Course code**	**Course Name**	**Credits**	**Lectures or Practical**
Second Year	**3**	**Research Project**	**BORPP 631**	**Research Project**	**4**	**Practical**

[Compulsory Paper, Four Credits] [Equivalent to 120 h]

GUIDELINE TO CARRY OUT PROJECTWORK

1. **Duration of Project work: -** One semester, 120 Laboratory hours. Each week 2 laboratory sessions of 4 hours should be allotted to each students.
2. College should allot research guide (mentor) to each student. ***Each student should be allotted separate project.***
3. **Choice of Research Problem and Workout:** Student should select research-based project with the help of his mentor. Research problem should be related to any branch of chemistry but preferably to any branch of analytical chemistry. Outline should be prepared by student with the help of mentor to perform and complete research project within stipulated time.
4. **Internal Evaluation and Schedule for Submission of Project Work:**

a. Experiment work must be completed by a student within 12 weeks from the commencement of the IIIrd semester.
b. Internal evaluation will be performed by mentor and one internal examiner when project is near to completion (10th week of semester).
c. Hard copy of the project work (two copies) should be submitted to department at the end of semester (15th week after commencement of IIIrd semester).

Format for submission of project -

The hard copy of project should contain about 30-40 pages (*A_4 size paper, 1 inch margin from all sides, font - Times New Roman, Font size – 12 pt*). Should be divided into the following parts: a. Tittle page
b. Certificate of completion of Project Work from mentor and HOD.
c. Declaration by candidate regarding plagiarism
d. Index
e. **Chapter-1:** Introduction to problem (introduction, signification of research problems selected, aims

and objectives) **(3 to 5 pages)**

f. **Chapter-2:** Review of Literature (Related Research Problem) **(8-10 pages)**
g. **Chapter-3:** Material and Methods **(6-8 pages)**
h. **Chapter-4:** Results and Discussion **(12 – 15 pages)**
f. **Chapter-5:** Conclusions **(1-2 pages)**
g. Bibliography
h. Acknowledgement

GUIDELINE FOR SUBMISSION AND ASSESMENT OF PROJECT WORK

1. Internal assessment 30% marks and external assessment 70% marks of 100 marks.
2. At the end of III semester two hard copies of research project must be prepared and submitted for certification and get both copies certified.
2. The certified copy of research project should be produced at the time of university project Examination by the candidate.
3. **External evaluation of project** – Power point presentation (20-30 minutes) by candidate followed by viva- voce exam purely based in project work.

Marks will be assigned to i) Project work report (design of problem and experiments, experimental work, accuracy in interpretation of results, discussions on results) – 35 marks; ii) power point presentation and explanations given on results – 20 marks, iii) question-answers – 15 marks.

4. After university project examination i.e. external evaluation of research project one copy must be submitted to department and one must be retained by the candidate.

Note:

1. Project can be completed at college laboratory or in research laboratory recognized by SPPU / Government of Maharashtra / Government of India.
2. In case, student is performing project work outside the college laboratory, then department should allot internal guide to the student and such guide will monitor the progress of research work of student. External guide will be from research institute where student is performing the research work. Student should obtain certificate of project completion from external guide which should be duly signed by internal guide. In this case Internal Evaluation will be jointly done by external and internal guides.

Course Outcome:

After successful completion of this course, students will be able to…

1. Identify and formulate research problems.
2. Design and develop solutions to the problem.
3. Analyze and solve complex problems.
4. Write effective technical reports and present their findings.
5. Understand and apply research methodologies appropriate to their chosen field.
6. Critically evaluate existing research and identify gaps in knowledge.

PDEA's

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M.Sc. Program in Botany

(Faculty of Science)

Syllabus for Minor Course

To be implemented from Academic Year 2023-2024

Structure of Course

M.Sc. Botany syllabus					
Year	**Sem**	**Course Type**	**Course code**	**Course Name**	**Credits**
Second Year	**3**	**SEC**	**PGSDT-631**	**Skill Development I**	**2**

Course : Skill development I **Total Credit : 2**
Code : PGSDT 631 **Course Type : Theory**
Subject : Instrumentation and Laboratory Techniques in Botany **Total Lecture : 30 Lecture**

Module I	**Instrumentation and Laboratory Techniques**	**15L**
Chapter 1	**Chapter 1: Microscopic techniques** General Features of Microscope, Principles of microscopy, bright and dark field microscopes, Phase contrast, Fixation and staining techniques for electron microscope, Micrometry.	**7L**
Chapter 2	**Chapter 2: Herbarium techniques and Microtomy** Drying, Poisoning, Pressing, Labelling, cataloguing and Preservation. Principle , sample preparation , block preparation, sectioning, staining and mounting.	**5L**
Chapter 3	**Chapter 3: Histochemical techniques and Cytochemical technique** Localisation of specific compounds/reactions/activities in tissues.	**3L**
Module II	**Practical's based on Module I**	**6 P**
1	**Demonstrate The Live Cells Using Dark Field Microscopy.**	**1 P**
2	**Demonstrate The Particles Using Bright Field Microscopy.**	**1 P**
3	Measurements and calibration of microscopic structures.	**1 P**
4	**Preparation of Plant Specimens for Herbarium.**	**1 P**
5	**Identification of Plant Specimens using Herbarium Keys.**	**1 P**
6	**Enzyme-Histochemical Staining and Peroxidase Staining.**	**1 P**

References

1. Microscopy by Richard J. Richman - This book covers the fundamentals of microscopy, including optics, illumination, and sample preparation.
2. Practical Light Microscopy by Robert F. Spencer - This book provides a practical guide to light microscopy, including techniques for sample preparation, mounting, and staining.
3. Herbarium Methods: A Guide to the Preparation and Processing of Plant Specimens by The New York Botanical Garden (2020).
4. The Herbarium: A Guide to the Collection, Preservation, and Documentation of Plant Specimens by The Royal Botanic Gardens, Kew (2019).
5. Chromogenic Histochemistry: A Practical Guide" by D. J. G. M. van der Loos (2019) - This book provides a practical guide to chromogenic histochemistry, including tips and tricks for optimizing staining and troubleshooting common issues.
6. Acid phosphatase activity in human lung cancer: a cytochemical study (2020) by Zhang et al. in Journal of Clinical Pathology.

Course outcomes

- Demonstrate an understanding of the principles and operation of various laboratory instruments, including spectrophotometers, centrifuges, and microscopes.
- Identify and correct errors in laboratory data and procedures.
- Present laboratory results in a clear and organized manner.
- Think critically about laboratory data and results.

PDEA's

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M.Sc. Program in Botany

(Faculty of Science)

Syllabus for Minor Course

To be implemented from Academic Year 2023-2024

Structure of Course

M.Sc. Botany syllabus					
Year	**Sem**	**Course Type**	**Course code**	**Course Name**	**Credits**
Second Year	**3**	**Extra Credit**	**PGCRT-631**	**Cyber Security II**	**2**

Cyber Security II Syllabus

All PG Second Year Third Semester

Introduction to Cyber Security / Information Security II

Syllabus for 'Introduction to Cyber Security / Information Security' program* for students of University of Pune is given below.

The program will be of 4 credits and it will be delivered in 60 clock hours**.

*: Course material for this program will be developed by CINS

**: These clock hours also includes practical sessions and demonstrations wherever required.

1	**Module 3: Information and Network Security**	**13**	**25**
	Chapter 1: Access Control and Intrusion Detection	3	
	Chapter 2: Server Management and Firewalls	4	
	Chapter 3: Security for VPN and Next Generation Technologies	6	
2	**Module 4: System and Application Security**	**20**	**25**
	Chapter 1: Security Architectures and Models	5	
	Chapter 2: System Security	5	
	Chapter 3: OS Security	5	
	Chapter 4: Wireless Network and Security	5	

Module 3: Information and Network Security

Chapter 1: Access Control and Intrusion Detection

1. Overview of Identification and Authorization
2. Overview of IDS
3. Intrusion Detection Systems and Intrusion Prevention Systems

Chapter 2: Server Management and Firewalls

1. User Management
2. Overview of Firewalls
3. Types of Firewalls
4. DMZ and firewall features

Chapter 3: Security for VPN and Next Generation Technologies

1. VPN Security
2. Security in Multimedia Networks
3. Various Computing Platforms: HPC, Cluster and Computing Grids
4. Virtualization and Cloud Technology and Security

Module 4: System and Application Security

Chapter 1: Security Architectures and Models

1. Designing Secure Operating Systems
2. Controls to enforce security services
3. Information Security Models

Chapter 2: System Security

1. Desktop Security
2. email security: PGP and SMIME
3. Web Security: web authentication, SSL and SET
4. Database Security

Chapter 3: OS Security

1. OS Security Vulnerabilities, updates and patches
2. OS integrity checks
3. Anti-virus software
4. Configuring the OS for security
5. OS Security Vulnerabilities, updates and patches

Chapter 4: Wireless Networks and Security

1. Components of wireless networks
2. Security issues in wireless

Course : Major Elective **Total Credit : 2**
Code : BOMET641A **Course Type : Theory**
Subject : Bioremediation & Bioprospecting **Total Lecture : 30**

Module I	**Bioremediation**	**15L**
Chapter 1	**Introduction to Bioremediation:** Introduction, constraints and priorities of Bioremediation, Biostimulation of Naturally occurring microbial activities, Bio augmentation, in situ, ex situ, intrinsic & engineered bioremediation	**5L**
Chapter 2	**Bioremediation I**: Solid phase bioremediation, - land farming, prepared beds, soil piles, Phytoremediation. Composting, Bioventing & Biosparging; Liquid phase bioremediation - suspended bioreactors, fixed biofilm reactors	**6L**
Chapter 3	**Hazardous Waste Management:** Hazardous Waste Management biotechnology application to hazardous waste management - examples of biotechnological applications to hazardous waste management – cyanide detoxification - detoxification of oxalate, urea etc. - toxic organics –phenols. Concept of bioremediation (in-situ & ex-situ), Bioremediation of toxic metal ions-biosorption and bioaccumulation principles	**4L**
Module II	**Bioprospecting**	**15L**
Chapter 3	**Bioprospecting-Methods**- Major areas- sustainable utilization of bioresource practices-types- Challenges- Access and Benefit-sharing policies – INBio & Merck agreement- Kani tribes benefit sharing Model-Economically Valuable Products from plant, animals and other bioresources- Bio piracy issues	**5L**
Chapter 4	Screening for different bioactivity- Antimicrobial activity- Enzymes- Plant growth promoting Activity- Antifouling & biofilm activity- anti cancer activity- Anti diabetic activity. High throughput screening- Drug discovery and development.	**4L**
Chapter 5	**Bioprospecting Regulation:** Regulations on bio-prospecting, access and benefit Sharing (National Environmental Management: Biodiversity act, 2004)- Bioprospecting case studies – Regulatory innovations for bioprospecting in India- Regulation of Bio-Prospecting and Related Intellectual Property Rights in India	**6L**

References:

1. R. M. Atlas and R. Bartha - 1998 - Microbial Ecology - Fundamentals and applications. AddisonWesley Longman, Inc.
2. Rastogi&Sani,Microbes and Microbial Technology, 2011, pp 29-57, Molecular Techniques to Assess Microbial Community Structure, Function, and Dynamics in the Environment
3. Michael, I.Jeffry, Jeremy Firestone & Karen Bubna-Litic. (2008). Biodiverisy consevation, Law andlivelihoods:Bridging the north- south divide. (1st Edn.) New York: Cambridge University Press
4. Vanesha, Sunkel. (2010). Marine Bioprospecting and Natural Product Research. (1st Edn.) Germany: LAP Lambert Academic Publishing.

Course Outcome

After the completion of the course, students are able to,

- To diminish environmental hazards globally with legal regulations
- To recall hazards of toxic compounds on environment and human health.
- To understand the sustainable resource and benefit sharing
- To understand the screening process of various bioactive substances.

To know the various regulatory bodies of bioprospecting

NEP 2020
M.Sc. Second Year

Course : Major Elective **Total Credit : 2**
Code : BOMET641B **Course Type : Theory**
Subject : Artificial Intelligence in Botany **Total Lecture : 30**

Module I	**Introduction to AI**	**15L**
Chapter 1	**Introduction to AI** Role of AI in the Life Science Advantages and disadvantages of AI	**5L**
Chapter 2	**Use of AI** AI in Drug Designing AI in the Clinical Trials AI in Disease Diagnosis and Prognosis AI in the Agriculture	**6L**
Chapter 3	Ethics and regulation of AI in life sciences Future Prospects and challenges of AI in life sciences	**4L**
Module II	**Applications of AI**	**15L**
Chapter 3	Personalized Medicine - Introduction, Importance and Application	**2L**
Chapter 4	**Drug Discovery** Identification novel uses for existing drugs by AI AI in Human Surgery, Pharmacy	**6L**
Chapter 5	Biomarker identification electronic health records (EHRs) Pharmaceutical supply chain Uses AI to optimize its supply chain	**7L**

Research

1. George F. Luger, "Artificial Intelligence Structures and Strategies for Complex Problem Solving", 6th Edition, Addison Wesley Longman, Inc., MIT press, 2009.
2. Ivan Bratko," Prolog Programming for Artificial Intelligence ", 4th Edition, Addison-Wesley Publishing Company, 2011.
3. Stuart J. Russell and Peter Norvig, "Artificial Intelligence A Modern Approach", Third Edition, Prentice-Hall, Inc., 2010.
4. Amit Konar, "Artificial Intelligence and Soft Computing Behavioral and Cognitive Modeling of the Human Brain", CRC Press, 2000.

Course Outcome

After the completion of the course, students are able to,

1. Understand the informed and uninformed problem types and apply search strategies to solve them.
2. Apply difficult real-life problems in a state space representation to solve them using AI techniques like searching and game playing.
3. Design and evaluate intelligent expert models for perception and prediction from an intelligent environment

NEP 2020
M.Sc. Second Year

Course : Major Elective **Total Credit : 2**
Code : BOMEP 642A **Course Type : Practical**
Subject : Practical based on BOMET641A **Total Practical : 4 Hours/Practical**

Sr No.	Practical Based on Bioremediation & Bioprospecting	12P
1	Low-density plastic/bioplastic degradation using bacterial isolates	**3P**
2	Biodiesel production using microalgae.	**3P**
3	To study the Bioinformatics approaches in bioremediation.	**2P**
4	Isolation of bio-emulsifier-producing organisms for degradation of aromatic compounds	**3P**
5	Demonstration of DNA finger-printing technique (Demonstration)	**1P**

References:

1. Bioremediation: *Bioremediation: Principles and Applications* by Ronald L. Crawford.
2. Microalgae & Biofuels: *Biodiesel from Microalgae* by Yusuf Chisti (Biotechnology Advances).
3. Bioinformatics: *Bioinformatics: Principles and Applications* by Ghosh & Mallick.
4. Molecular Techniques: *Molecular Cloning: A Laboratory Manual* by Sambrook & Russell.
5. Plastic Degradation: Alexander, M. *Biodegradation and Bioremediation* (Academic Press).
6. Bio-emulsifiers: Walter, V. *Screening Concepts for the Isolation of Biosurfactant Producing Microbes* (NCBI).
7. Bioinformatics in Remediation: Fulekar, M.H. *Bioinformatics: Applications in Life and Environmental Sciences*.

Course Outcome:
After the completion of the course, students are able to,

- An interest will be developed in the field of bioremediation.
- They will understand the concepts of biomass utilization.
- Students will understand the concepts and use of microbial degradation

Course : Major Elective **Total Credit : 2**
Code : BOMEP 642B **Course Type : Practical**
Subject : Practical based on BOMET641B **Total Practical : 4 Hours/Practical**

Sr No.	Practical Based on Artificial Intelligence in Botany	12P
1	Study of mobile phone applications for plants species identification	**1P**
2	Survey of plant diversity in any three local areas	**1P**
3	Study of alpha, beta and gamma diversity from local areas	**2P**
4	Generation of plant database for QR code	**2P**
5	Generation of QR codes of different plants	**2P**
6	Project work- Identification and submission of report of local plant diversity studied using AI enabled plant identification apps	**1P**

References:

- **iNaturalist**: An expansive, crowdsourced dataset that provides geolocation and user-verified tags for global flora.
- **Google Lens**: A versatile tool for general plant recognition using image search.
- **PictureThis**: An app focused on plant health and species identification.
- **Research Paper**: Utilizing Artificial Intelligence for Plant Species Identification — outlines various AI methods like CNNs for automated plant recognition.
- A Text book of Plant Diversity: Covers fundamental concepts of biodiversity and its role in ecosystems.
- Understanding Alpha, Beta, and Gamma Diversity: Clarifies species diversity at different spatial scales, from local (Alpha) to regional (Gamma).

Course Outcome

After the completion of the course, students are able to,

- Understand the phone based applications for plant identification.
- Generate the digital information of plant.
- Differentiate the type of diversity among the forest.
- Describe the plant and prepare the data sheet for AI applications.

PDEA's

Prof. Ramkrishna More Arts Commerce & Science College, Akurdi, Pune - 44

Affiliated to Savitribai Phule Pune University (SPPU)

Choice Based Credit System (CBCS) under Autonomy & NEP-2020

M.Sc. Program in Botany

(Faculty of Science)

Syllabus for Minor Course

To be implemented from Academic Year 2023-2024

Structure of Course

M.Sc. Botany syllabus						
Year	**Sem**	**Course Type**	**Course code**	**Course Name**	**Credits**	**Lectures or Practical**
Second Year	**4**	**Research Project**	**BORPP 641**	**Research Project**	**4**	**Practical**

[Compulsory Paper, Six Credits] [Equivalent to 180 h]

GUIDELINE TO CARRY OUT PROJECTWORK

1. **Duration of Project work: -** One semester, 180 Laboratory hours. In each week 3 laboratory sessions of 4 hours should be allotted to the students.
2. College should allot research guide (mentor) to each student.
3. **Choice of Research Problem and Workout:** Student should select research-based project with the help of his mentor. Research problem should be related to any branch of botany. Outline should be prepared by student with the help of mentor to perform and complete research project within stipulated time.
4. **Internal Evaluation and Schedule for Submission of Project Work:**

a. Experiment work must be completed by within 12 weeks from the start of IV semester.
b. Internal evaluation will be performed by mentor and one internal examiner when project is near to completion.
c. The final copy of the project work (two Copies) should be submitted to department at the end of semester (15^{th} week after commencement of IV semester.

Format for submission of project -

The project containing about 45-60 pages (*A_4 size paper, 1 inch margin from all sides, font - Times New Roman, Font size – 12 pt*). Should be divided into the following parts: - a. Tittle page
b. Certificate of completion of Project Work from mentor and HOD.
c. Declaration by candidate regarding plagiarism
d. Index
e. **Chapter-1:** Introduction to problem (introduction, signification of research problems selected, aims and objectives) (6-8 Pages)
f. **Chapter-2:** Review of Literature (Related Research Problem) (12-15 pages)
g. **Chapter-3:** Material and Methods (8-10 Pages)
h. **Chapter-4:** Results and Discussion (20-25 Pages)
f. **Chapter-5:** Conclusions (1-2 page)

g. Bibliography
h. Acknowledgement

GUIDELINE FOR SUBMISSION AND ASSESMENT OF PROJECT WORK

1. Internal assessment 30% marks of 150 marks and External assessment 70% marks of 150 marks.
2. At the end of IV semester two copies of research project must be submitted for certification and get both copies certified.
2. The certified copy of research project should be produced at the time of university project Examination by the candidate.
3. **Project External evaluation** – Power point presentation (20-30 minutes) by candidate followed by Viva- voce Exam purely based in project work. Marks will be assigned to i) Project work report (experimental work and accuracy in interpretation of results, discussions on results) – 50 marks; power point presentation and explanations given on results – 30 marks, question-answers – 25 marks.
4. After university project examination i.e. external evaluation of research project one copy must be submitted to department and one must be retained by the candidate.

Note:

1. Project can be completed at college laboratory or in research laboratory recognized by SPPU / Government of Maharashtra / Government of India.

2. In case, student is performing project work outside the college laboratory, then department should allot internal guide to the student and such guide will monitor the progress of research work of student. External guide will be from research institute where student is performing the research work. Student should obtain certificate of project completion from external guide which should be duly signed by internal guide. In this case Internal Evaluation will be jointly done by external and internal guides.

Pattern for External Evaluation

Theory: For the four credit papers (70 marks) (paper with two sections); question paper will be set section wise. Each section will be of 35 marks. For two credit paper will be of 35 marks. Question paper format will be as follows:

Course Outcome:

After successful completion of this course, students will be able to…

7. Identify and formulate research problems.
8. Design and develop solutions to the problem.
9. Analyze and solve complex problems.
10. Write effective technical reports and present their findings.
11. Understand and apply research methodologies appropriate to their chosen field.
12. Critically evaluate existing research and identify gaps in knowledge.

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Syllabus for Minor Course

To be implemented from Academic Year 2023-2024

Structure of Course

M.Sc. Botany syllabus					
Year	**Sem**	**Course Type**	**Course code**	**Course Name**	**Credits**
Second Year	**4**	**SEC**	**PGSDT-641**	**Skill Development II**	**2**

Course : Skill development II **Total Credit : 2**
Code : PGSDT 641 **Course Type: Theory**
Subject : Instrumentation and Laboratory Techniques in Botany **Total Lecture : 30**

Module I	**Instrumentation and Laboratory Techniques**	**15L**
Chapter 1	**Chapter 1: Spectrophotometer and Colorimeter** Principle and working, Types and Applications.	**7L**
Chapter 2	**Chapter 2: Electrophoresis technique** Principle and Working of Electrophoresis, Types of electrophoresis, Application of Electrophoresis.	**5L**
Chapter 3	**Chapter 3: Solvent Extraction techniques** Ethanol , Methanol, Decoction and Soxhlet Extraction	**3L**
Module II	**Practical's based on Module I**	**6 P**
1	**Measurement of Absorbance and Transmittance using a Spectrophotometer.**	**1 P**
2	**Separation of DNA using electrophoresis technique.**	**2 P**
4	**Measuring the Absorbance of a Solution using a Colorimeter**	**1 P**
5	**Extraction of secondary metabolites using Soxhlet apparatus.**	**2 P**

References:

1) Spectrophotometry, A Practical Approach" by H. B. C. Jenkins
2) "Spectrophotometry, A Laboratory Manual" by J. R. Ferraro
3) Electrophoresis, A Practical Approach" by J. M. Walker
4) "Principles of Electrophoresis" by J. P. Landers
5) Solvent Extraction by R. D. Hanson et al. (Journal of Chemical Education, 1997)
6) Soxhlet Extraction by J. M. R. da Silva et al. (Journal of Agricultural and Food Chemistry, 2004)

Course Outcomes

1) Demonstrate an understanding of the principles and operation of various laboratory instruments, including spectrophotometers, centrifuges, and microscopes.
2) Identify and correct errors in laboratory data and procedures.
3) Present laboratory results in a clear and organized manner.
4) Think critically about laboratory data and results.

Question Paper Pattern Courses Related to Botany

Marks: 30 **Time:** 2 Hour

Instructions to the Candidate:

1. All questions are compulsory.
2. Figures to right indicate full marks.
3. Use of Log table and scientific calculator is allowed./ Draw well labelled diagram wherever necessary.

Question -1A	**A. Solve/ Answer the following (Short Answers)** **i.** **ii.** **iii.** **iv.** **v.** **vi.**	Three def. type, two tricky questions and two questions problem type (if applicable)	**6 Marks**
Question -1B	**B. Solve any two of the following** **i.** **ii.** **iii.**	Note or Describe type questions	**4 Marks**
Question -2A	**A. Solve any two of the following** **i.** **ii.** **iii.**	Problem type or tricky reasoning type question	**6 marks**
Question -2B	**B. Solve the following** (Single question of four marks) **i.**	Write Note / Differentiate type questions	**4 Marks**
Question -3A	**A. Solve/ Answer any two of the following** **i.** **ii.** **iii.**	Problem type or Derive equation or Tricky discussion type question	**6 marks**

Question -3B	**B. Solve Any one of the following** **i.** **ii.**	Application type, Justification type question	**4 marks**

Pattern for 4 credit paper

Total No of Questions: 4 **Seat No**:

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Arts Commerce and Science College Akurdi (Autonomous), Pune, 411044

M. Sc. II Semester End Examination Semester -

NEP -2020; Pattern - 2024

Subject Code :

Subject:

Instructions to the Candidate 1.

1. All questions are compulsory.
2. Figures to right indicate full marks.
3. Use of log table and scientific calculator is allowed.

Time: 3 Hours
Marks: 60
Credits: 04

Section – I

Q-1-A] Answer the following. **[6 marks]**

1.
2.
3.
4.
5.
6.

Q-1: B] Attempt any one of the following **[4 marks]**

1.
2.

Q-2: A] Answer any two of the following **[6 marks]**

1.
2.
3.

Q-2: B] Answer any two of the following **[4 marks]**

1.
2.
3.

Q-3: A] Answer any two of the following. **[6 marks]**

1.
2.
3.

Q-3: B] Answer any one of the following **[4 marks]**

1.
2.

Section -II

Q-1-A] Answer the following. **[6 marks]**

1.
2.
3.
4.
5.
6.

Q-1: B] Attempt any one of the following **[4 marks]**

1.
2.

Q-2: A] Answer any two of the following **[6 marks]**

1.
2.
3.

Q-2: B] Answer any two of the following **[4 marks]**

1.
2.
3.

Q-3: A] Answer any two of the following. **[6 marks]**

1.
2.
3.

Q-3: B] Answer any one of the following **[4 marks]**

1.
2.