**Arihant Education Foundation's**
**Arihant College of Arts, Commerce and Science,Bavdhan,Pune-21**
**Department of Science**
**T.Y.BSc. SYLLABUS STRUCTURE AS PER NEP-2020**
**Semester - V**

| Sr. No | Verticals | Course Code | Course Title | Credits | Theory/ Practical | No. of Lectures | | Marking Evaluation | | Total Marks |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Per Week | Total Lectures | Int.Exam | Ext.Exam | |
| 1 | Major Core (Any One) | PHY 301 MJ | Mathematical Physics-II | 2 | Theory | 2 | 30 | 15 | 35 | 50 |
| | | BOT-301-MJ-T | Taxonomy of Cryptogams | 2 | Theory | 2 | 30 | | | |
| | | PHY 302 MJ | Solid State Physics-I | 2 | Theory | 2 | 30 | 15 | 35 | 50 |
| | | BOT-302-MJ-T | Advanced Plant Physiology | 2 | Theory | 2 | 30 | | | |
| | | PHY 303 MJ | Electrodynamics-I | 2 | Theory | 2 | 30 | 15 | 35 | 50 |
| | | BOT-303-MJ-T | Plant Breeding and Seed Technology | 2 | Theory | 2 | 30 | | | |
| | | PHY 304 MJ | Classical Mechanics | 2 | Theory | 2 | 30 | 15 | 35 | 50 |
| | | BOT-304-MJ-T | Cell and Molecular Biology | 2 | Theory | 2 | 30 | | | |
| | | PHY 305 MJP | General Physics Lab-V | 2 | Practical | 4 | 60 | 15 | 35 | 50 |
| | | BOT-305-MJ-P | Practical Based on BOT 301-MJ-T and BOT302-MJ–T | 2 | Practical | 4 | 60 | | | |
| | | PHY 306 MJP | General Physics Lab-VI | 2 | Practical | 4 | 60 | 15 | 35 | 50 |
| | | BOT-306-MJ-P | Practical Based on BOT 303-MJ-T and BOT304-MJ-T | 2 | Practical | 4 | 60 | | | |
| 2 | Major Elective (Any One) | PHY 310(B) MJ | Functional Nanomaterials | 2 | Theory | 2 | 30 | 15 | 35 | 50 |
| | | BOT-311-MJ-T | Plants Utilization | 2 | Theory | 2 | 30 | | | |
| | | PHY 311 MJP | Special Physics Lab-I | 2 | Practical | 4 | 60 | 15 | 35 | 50 |
| | | BOT-314-MJ-P | Practical Based on BOT-311-MJ-T | 2 | Practical | 4 | 60 | | | |
| 3 | VSC (Any One) | PHY 321 VSC P | Solar PV System: Design, and Maintenance | 2 | Practical | 4 | 60 | 15 | 35 | 50 |
| | | BOT-321-VSC-T | Intellectual Property Rights (IPR) | | Theory | 2 | 30 | | | |
| 4 | Minor (Any One) | BOT 2 C -342-MN-T | Nursery Management, Landscape Designing and Gardening | 2 | Theory | 2 | 30 | 15 | 35 | 50 |
| | | PHY-341-MN | Modern Physics: Concepts and Applications | 2 | Theory | 2 | 30 | | | |
| 5 | Field Project | BOT-331-FP | Field Project (FP) / CEP in Botany | 2 | Practical | 4 | 60 | 15 | 35 | 50 |
| | | PHY-331-FP | Field Project (FP) / CEP in Physics | 2 | Practical | 4 | 60 | | | |
| **Total** | | | | **22** | | | | | | **550** |

**Arihant Education Foundation's**
**Arihant College of Arts, Commerce and Science,Bavdhan,Pune-21**
**Department of Science**
**T.Y.BSc. SYLLABUS STRUCTURE AS PER NEP-2020**
**Semester -VI**

| Sr. No | Verticals | Course Code | Course Title | Credits | Theory/ Practical / Oral | No. of Lectures | | Marking Evaluation | | Total Marks |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Per Week | Total Lectures | Int.Exam | Ext.Exam | |
| 1 | **Major Core** | PHY 351 MJ | Atomic and Molecular Physics-I | 2 | Theory | 2 | 30 | 15 | 35 | 50 |
| | | BOT-351-MJ-T | Taxonomy of Phanerogams | 2 | Theory | 2 | 30 | | | |
| | | PHY 352 MJ | Quantum Mechanics-I | 2 | Theory | 2 | 30 | 15 | 35 | 50 |
| | | BOT-352-MJ-T | Genetics | 2 | Theory | 2 | 30 | | | |
| | | PHY 353 MJ | Statistical Mechanics-I | 2 | Theory | 2 | 30 | 15 | 35 | 50 |
| | | BOT-353-MJ-T | Plant Pathology and Protection | 2 | Theory | 2 | 30 | | | |
| | | PHY 354 MJ | Nuclear Physics-I | 2 | Theory | 2 | 30 | 15 | 35 | 50 |
| | | BOT-354-MJ-T | Biochemistry | 2 | Theory | 2 | 30 | | | |
| | | PHY 355 MJP | General Physics Lab-VII | 2 | Practical | 4 | 60 | 15 | 35 | 50 |
| | | BOT-355-MJ-P | Practical Based on BOT-351-MJ-T and BOT352-MJ-T | 2 | Practical | 4 | 60 | | | |
| | | PHY 356 MJP | Physics Lab-VIII (Project-I) | 2 | Practical | 4 | 60 | 15 | 35 | 50 |
| | | BOT-356-MJ-P | Practical Based on BOT-353-MJ-T and BOT354-MJ-T | 2 | Practical | 4 | 60 | | | |
| 2 | **Major Elective** | PHY 360(A) MJ | Lasers Technology | 2 | Theory | 2 | 30 | 15 | 35 | 50 |
| | | BOT-361-MJ-T | Agricultural Business Management | 2 | Theory | 2 | 30 | | | |
| | | PHY 361 MJP | Special Physics Lab-II | 2 | Practical | 4 | 60 | 15 | 35 | 50 |
| | | BOT-364-MJ-P | Practical Based on BOT-361-MJ-T | 2 | Practical | 4 | 60 | | | |
| 3 | **VSC** | PHY 371 VSC P | Modern Electric Vehicle Technology | 2 | Practical | 4 | 60 | 15 | 35 | 50 |
| | | VSC-373-BOT-P | Millets for Sustainable Human Welfare | 2 | Theory | 2 | 30 | | | |
| 4 | **OJT** | PHY-381 OJT | On Job Training (OJT) Physics | 4 | OJT | 4 | 120 | 30 | 70 | 100 |
| | | BOT-381 OJT | On Job Training (OJT) Botony | 4 | OJT | 4 | 120 | | | |
| **Total** | | | | **22** | | | | | | **550** |

# Savitribai Phule Pune University, Pune

**(Formerly, University of Pune)**

## Under Graduate Degree Program in Botany (B.Sc. Botany)

**(Faculty of Science & Technology)**

**Revised Syllabi as per National Education Policy (2020) for**

## T.Y.B.Sc. Botany (Semester V and VI)

**(For Colleges Affiliated to Savitribai Phule Pune University, Pune)**

**To be implemented from**

## Academic Year 2026-2027

**Framed by**

## BOARD OF STUDIES IN BOTANY

**Savitribai Phule Pune University,**

**Ganeshkhind, Pune -07.**

( Dr. Mahesh N. Ichhaporia )
Chairman - BoS Botany

**AIMS AND OBJECTIVES**

- To promote the possibility of self-employment in plant science and allied sectors.
- To bridge the gap between knowledge-based conventional education and market demands and to provide an alternative to those pursuing higher education.
- To enrich students' training and knowledge useful in botanical, agricultural, environmental, horticultural, and plant-based industries.
- To introduce the concepts of experimental design, scientific investigation, and research methodologies in Botany.
- To inculcate a sense of job responsibility while maintaining social and environmental awareness.
- To help students build a progressive and successful career in plant sciences, biotechnology, environmental management, and allied industries.

**PROGRAM OUTCOMES (POS)**

According to NEP-2020 criteria, the undergraduate degree in Botany program at Savitribai Phule Pune University affiliated colleges is structured to provide students with advanced field-related knowledge and essential fundamentals. Through a unique combination of required major core courses with in-depth exposure to multidisciplinary minor, elective, and vocational skill courses, students will acquire the fundamental and advanced knowledge essential for research, industries, environmental sustainability, and entrepreneurship.

With the knowledge gained in the field of Botany, this upgraded curriculum will develop educated, outcome-oriented students who are nurtured through discovery and learning, equipped with practical skills to solve real-life problems, and competent with recent pedagogical trends in education including E-learning, flipped classrooms, hybrid learning, and experiential learning. These candidates will become responsible citizens capable of contributing toward sustainable development and global scientific advancement.

**After successful completion of the Under Graduate (UG) Degree program, the students would be able to:**

- **PO1:** Attain thoughtful proficiency in the field of plant sciences and Botany.
- **PO2:** Acquire the ability to perform effectively in multidisciplinary domains.
- **PO3:** Attain the ability to apply scientific knowledge for investigation, innovation, biodiversity conservation, and sustainable development.
- **PO4:** Learn value-based ethical practices and principles committed to professional ethics.
- **PO5:** Incorporate 21st century skill-oriented self-directed and life-long learning.

- **PO6:** Obtain the ability to apply botanical knowledge in diverse contexts with a global perspective.
- **PO7:** Attain maturity to respond responsibly toward environmental and societal challenges.

**PROGRAM SPECIFIC OUTCOMES (PSOs)**

- **PSO1:** Recall the diversity, classification, evolution, morphology, anatomy, physiology, genetics, ecology, and developmental changes among lower and higher plant groups.
- **PSO2:** Understand advanced concepts in Botany and their applications in agriculture, biotechnology, environmental science, and conservation biology.
- **PSO3:** Acquire and utilize skills in plant propagation, tissue culture, organic farming, medicinal plant utilization, floriculture, horticulture, biodiversity conservation, and plant processing technologies.
- **PSO4:** Understand the importance of plants and plant resources in agriculture, environment, healthcare, and sustainable development.
- **PSO5:** Adapt scientific research methods for plant improvement, biodiversity studies, environmental monitoring, and entrepreneurship development.
- **PSO6:** Enrich critical thinking, scientific attitude, problem-solving ability, practical competence, and communication skills.
- **PSO7:** Apply botanical knowledge and plant resources for sustainable development, environmental conservation, and societal welfare while recognizing ethical values.
- **PSO8:** Demonstrate scientific understanding to identify research problems, design experiments, use appropriate methodologies, analyze and interpret data, and provide practical solutions while exhibiting organizational and management skills.

**1. Title of the Course: B.Sc. Botany (03 years) / B.Sc. with Honours in Botany (04 years)**

Syllabus revised for T.Y.B.Sc. Botany as per National Education Policy (NEP) 2020 for the Colleges Affiliated to Savitribai Phule Pune University, Pune.

**2. Faculty - Science and Technology**

**3. To be implemented - For T.Y.B.Sc. Botany (Semester V and Semester VI), from June 2026.**

**4. Preamble**

Botany is a fundamental branch of biological science dealing with the scientific study of plants and their relationship with the environment and human welfare. The subject includes various disciplines such as taxonomy, plant physiology, genetics, ecology,

microbiology, biotechnology, plant pathology, economic botany, horticulture, and environmental biology.

India is one of the richest countries in plant diversity and agriculture-based economy. Plants play an essential role in food security, medicine, environmental protection, industry, and sustainable development. Therefore, botanical education is important for understanding plant resources, conservation, crop improvement, environmental management, and emerging biotechnological applications.

The Botany program aims to provide students with theoretical knowledge and practical skills in plant sciences and allied areas. The curriculum emphasizes laboratory work, field studies, industrial exposure, research orientation, and entrepreneurship development. Students will gain hands-on experience in plant identification, herbarium techniques, tissue culture, nursery management, biodiversity assessment, medicinal plants, organic farming, environmental conservation, and other applied areas of Botany.

The course prepares students for employment opportunities in:

- Botanical Survey and Research Institutions
- Agricultural and Horticultural Industries
- Seed and Nursery Industries
- Plant Tissue Culture Laboratories
- Environmental Consultancy Services
- Forest and Biodiversity Departments
- Pharmaceutical and Herbal Industries
- Biotechnology Industries
- Educational Institutions
- NGOs related to environment and conservation
- Government and Semi-government organizations

The course focuses on skill development, scientific attitude, and practical exposure through laboratory experiments, field projects (FP), industrial visits, on job trainings (OJT) and community engagement programs (CEP). Greater emphasis is laid on practical learning and vocational applications to enhance employability and entrepreneurship opportunities among students.

The teaching centers will help develop trained and skilled man-power for industries, research organizations, and environmental sectors. Students can also become entrepreneurs in plant-based enterprises such as nurseries, medicinal plant cultivation, floriculture, landscaping, mushroom cultivation, organic farming, apiculture, and sericulture.

**Program Duration and Exit Options**

The UG Program lasts for **Three** years, Six Semesters / **Four** years, Eight semesters. Student may leave the program after the third year if, he/she would like to receive a three-year undergraduate degree.

If the student decides to withdraw after the first or second year, he/she will receive a UG Certificate or UG Diploma, depending on how many credits he/she is able to complete. Re-entering within three years to finish the degree program is allowed for students who leave with a UG certificate or UG diploma. A student must earn a minimum of 18 credits and a maximum of 26 credits each semester. It is recommended, nevertheless, that student should opt 22 credits per semester. This clause aims to give student the comfort of a flexible semester-based course load. However, Table 1 lists the minimum number of credits required to be earned in order to be awarded an Undergraduate Certificate / Undergraduate Diploma / Bachelor Degree / Bachelor's Degree with Honors in Botany.

**Table1**: **Type of Awards and Stages of Exit**

| Sr. No. | Type of Award | Stage of Exit | Mandatory Credits |
|---|---|---|---|
| 1. | **Undergraduate Certificate in Botany** | After successful completion of First year Semesters | **44** |
| 2. | **Undergraduate Diploma in Botany** | After successful completion of Second year Semesters | **88** |
| 3. | **Bachelor of Science in Botany** | After successful completion of Third year Semesters | **132** |
| 4. | **Bachelor of Science in Botany (Honours)** | After successful completion of Fourth year Semesters | **176** |

**5. Eligibility Criteria -**

The students who had opted Botany as one of the core subjects at F.Y.B.Sc. level as well as Botany as 'MAJOR SUBJECT and have qualified with minimum number of credits and ATKT rules as laid down by SPPU, Pune are eligible for applying at T.Y.B.Sc. Botany MAJOR subject. Admissions will be given as per the selection procedure / policies adopted by the college keeping in accordance with the conditions laid down by the Savitribai Phule Pune University, Pune. Reservation and relaxation are as per the State Government rules.

**6. Fee Structure –** As per the norms of Savitribai Phule Pune University, Pune.

**7. Duration of the Course**

**Certificate Course** - 01 year (Completion of 02 Semesters)

**Diploma Course** - 02 years (Completion of 04 Semesters)

**B.Sc. Degree** - 03 years (Completion of 06 Semesters)

**B.Sc. Degree with Honors** - 04 years (Completion of 08 Semesters)

**8. No. of semesters –** Two semesters per year

**9. Medium of instructions and teaching:** English

**10. Course Implementation Criteria for Theory and Practical:**

**a. Each semester comprises of 15 weeks** (12 weeks Actual Teaching + 3 weeks for Continuous Internal Evaluation).

**b. One Credit of the Theory = 15 clock hours** (Teaching 1 clock hour per week for each credit), (15 clock hours should comprised of 12 hours of Actual Teaching + 3 hours of Continuous Internal Evaluation – Assignments, Tutorials, Practice, Problem solving sessions, Group discussion, Study/Field visits, report preparation, viva-voce, PowerPoint presentations, Participation in Individual/Group Activity. Seminars and Unit Tests).

**c. One Credit of Practical = 30 clock hours** (2 clock hours per credit per week)

One Credit = 30 clock hours (24 hours' Actual Table work + 6 hours for in-time Journal completion, visit attendance, visit report preparation and Continuous Internal Evaluation of each practical).

**d. Practical for each course comprises of 02 Credits = 60 clock hours.** Therefore,

- Minimum 12 laboratory sessions of 04 clock hours must be conducted in one semester.
- In case of short practical, two practical's should be conducted in one session.
- Each practical of 04 clock hours in the laboratory should consist of: Table performance for concerned practical, proactive participation in each practical, regular attendance, careful observations, calculation, writing results and conclusion, and submission of on time practical journal in hand-written format.
- Pre-laboratory reading and post laboratory assignments should be given on each practical as a part of continuous internal evaluation.

**e. Practical Batch for the Practical based courses =** The practical batch for the practical based courses should comprise of **maximum 12 students**.

**f. Field Project (FP): 02 credits** (60 hours including field study / survey, actual laboratory work, regular observation recordings, field project report writing, compilation, presentations, Assignments etc.)

- **Number of students per Batch for the Field Project – 05 students per batch**
- **Student:Mentor ratio = 5:1**

**g. Community Engagement Program (CEP): 02 Credits** (60 hours including Community Engagement activities, proactive participation at Individual / Group level in the activity, labwork, Report writing, compilation, presentations, assignments etc.)

- **Number of students per Batch for the CEP – 05 students per batch**

- **Student:Mentor ratio = 5:1**

**h. On Job Training (OJT): 04 Credits** (120 hours including duration from enrollment of the student to the concerned institution / center / industry under the supervision of the one mentor from the host institution and another subject mentor from the respective college of the student. Besides the regular attendance, continuous interaction with the mentors, proactive participation at Individual / Group level during the training program, completion of the Job / duties in time assigned during the tenure, punctuality, honesty, time management, Report writing, compilation, presentations, assignments etc.)

- **Student:Mentor ratio = 5:1**

**11. Examination and Evaluation Pattern:**

**a. For each Semester having 15+35 Pattern (applicable only for the academic year 2026-27):** The examinations will be conducted semester wise for both Theory as well as Practical courses and applicable only for the academic year 2026-27.

- **Theory Paper of 02 Credits -**
  - Internal Exam **(15 M)** + University Theory Exam **(35 M)** = **Total 50 M**
  - **Internal Exam evaluation criteria: 10 M written exam + 05 M Assignment submission.**

| Written Paper exam | Assignment submission |
|---|---|
| Question Pattern: ½ mark questions of MCQ, True/False statements, Definitions, Answer in one line, etc. | Assignment to be given to the students on the topics taught in due course of time. |
| **10 Marks** | **05 Marks** |
| **Duration: 40 Minutes** | **-----** |

  - **Duration:** For Internal written exam of **10M** = **40 Min.**

    For University written Exam = **02 hours.**

- **Practical Paper of 2 Credits -**
  - Internal Exam **(15 M)** + University Practical Exam **(35 M)** = **Total 50 M**
  - **Internal Practical Exam evaluation criteria: For 15 M**

| Attendance to the regular practical | Journal completion and certification in due time | Attendance to study visit and Report preparation | Viva-voce / Assignment submission in due time | Total Marks |
|---|---|---|---|---|
| **03 M** | **04 M** | **04 M** | **04 M** | **15 M** |

  - **Duration:** For Internal exam = Continuous and semester-end evaluation

    For University Exam = 04 hours.

**b. For each Semester having 20+30 Pattern (to be implemented from the academic year 2027-28 onwards):** The examinations to be conducted semester wise for both Theory as well as Practical courses with 20+30 pattern will be implemented from the academic year 2027-28.

- **Theory Paper of 02 Credits -**
  - Internal Exam **(20 M)** + University Theory Exam **(30 M)** = **Total 50 M**
  - **Internal Exam evaluation criteria: 10 M written exam + 10 M Assignment submission.**

| Written Paper exam | Assignment submission |
|---|---|
| Question Pattern: ½ mark questions of MCQ, True/False statements, Definitions, Answer in one line, etc. | Assignment to be given to the students on the topics taught in due course of time. |
| **10 Marks** | **10 Marks** |
| **Duration: 40 Minutes** | **-----** |

  - **Duration:** For Internal written exam of **10M** = **40 Min.**
    For University Exam = **02 hours.**

- **Practical Paper of 2 Credits -**
  - Internal Exam **(20 M)** + University Practical Exam **(30 M)** = **Total 50 M**
  - **Internal Practical Exam evaluation criteria: For 20 M**

| Attendance to the regular practical | Journal completion and certification | Attendance to study visit and Report preparation | Viva-voce / Assignment submission | Total Marks |
|---|---|---|---|---|
| **05 M** | **05 M** | **05 M** | **05 M** | **20 M** |

  - **Duration:** For Internal exam = Continuous and semester-end evaluation
    For University Exam = **04 hours.**

- **Evaluation criteria for Field Project of 2 Credits -**

- The field project of each student should be evaluated for Total 50 Marks (**15 Marks for Internal + 35 Marks for External evaluation, applicable only for the academic year 2026-27** and **20 Marks for Internal + 30 Marks for External evaluation, only applicable from the academic year 2027-28 onwards**).
- **During Internal Evaluation of FP, following points should be considered:**

1. Selection and appropriateness of the field project topic.
2. Punctuality and participation of the student.
3. Field work and scientific observations.

4. Interaction with the mentor / FP coordinator.
5. Regular attendance
6. Maintenance of field diary and records.
7. Viva voce, presentation.

- **The criteria for External Evaluation of FP should include:**

1. Originality and significance of the project and its relevance to Botany.
2. Soundness of methodology, research design, and field approach.
3. Quality and accuracy of data collection, analysis, and interpretation.
4. Validity and significance of findings and conclusions.
5. Clarity, organization, and effectiveness of the project report and presentation.

- **Evaluation criteria for Community Engagement Program (CEP) of 2 Credits -**

- **Evaluation Criteria:** The role of each student in CEP should be evaluated for Total 50 Marks (**15 Marks for Internal + 35 Marks for External evaluation, applicable only for the academic year 2026-27** and **20 Marks for Internal + 30 Marks for External evaluation, applicable only from the academic year 2027-28 onwards**).
- **During Internal Evaluation of CEP following points shall be considered:**

1. Effectiveness of program design and planning.
2. Student participation and engagement in community activities.
3. Effectiveness of student communication with community members.
4. Demonstration of botanical knowledge and environmental awareness skills.
5. Maintenance of program records and documentation.

- **The criteria for External Evaluation of CEP shall include:**

1. Clarity, organization, and effectiveness of the report and presentation.
2. Assessment of the program's impact on the local community and environment.
3. Evaluation of student learning outcomes and skill development.
4. Assessment of the program's effectiveness in achieving environmental and social objectives.

- **Evaluation criteria for On Job Training (OJT) of 4 Credits -**

- **Evaluation Criteria:** The role of each student in OJT should be evaluated for Total 100 Marks (**30 Marks for Internal + 70 Marks for External evaluation, applicable only for the academic year 2026-27** and **40 Marks for Internal + 60 Marks for External evaluation, applicable only from the academic year 2027-28 onwards**).
- **During Internal Evaluation following points shall be considered:**

1. Regularity, punctuality, and discipline during On Job Training.

2. Active participation and involvement in assigned workplace activities.
3. Technical skills and practical knowledge demonstrated during training.
4. Problem-solving ability and application of subject knowledge in workplace situations.
5. Communication skills and professional interaction with supervisors and coworkers.
6. Ability to work independently as well as in a team.
7. Maintenance of daily work records, logbook, and training documentation.
8. Overall attitude, sincerity, and professional ethics during training.

- **The criteria for External Evaluation shall include:**

1. Clarity, organization, and effectiveness of the training report and presentation.
2. Assessment of practical skills and technical competency gained during training.
3. Evaluation of understanding of workplace operations and management practices.
4. Assessment of professional ethics, teamwork, and workplace adaptability.
5. Evaluation of problem-solving skills and decision-making ability.
6. Assessment of the relevance and quality of the work completed during training.
7. Evaluation of overall learning outcomes and skill development achieved through training.
8. Assessment of the effectiveness of the training in achieving academic and professional objectives.

**12. Award of Class/Grade and Degree:** The class / grade and degree for the courses of each semester will be followed as per the norms and conditions laid down by SPPU, Pune.

**13. Important Note:**

**a.** There shall be at least a short tour/field visit/industrial visit (1-2 days) per year for all UG students. Tours are the part of curriculum and obligatory to each student, failing which they will not be considered eligible to appear for the practical examination. Under unavoidable circumstances, if the student fails to attend the tour, he/she have to produce justifiable evidence for not attending the tour. However, in lieu of tour the candidate will have to complete the work assigned by the Department.

**b.** The documents to be produced by each student at the time of practical examination (at the end of each Semester) are:

- Submission of practical records (Journals).
- Submission of a Tour / Visit report duly signed by the concerned practical In-charge and Head of the Department.
- Any submissions / assignments, etc. based on the practical course.

## Question paper pattern for Theory (2 Credit courses)

## (Applicable only for the Academic year 2026-27)

A student will have to solve the question paper of 35 marks for external exam. The paper setter should set the paper on entire syllabus, including optional questions. As the course is of 02 Credits (30 clock hour lectures), paper setter should allot 2.03 marks per lecture and accordingly, questions should be set for 30 lectures, 61 marks on entire syllabus.

## Question Paper Pattern

***Time: 2 Hours]*** ***[Max. Marks: 35***

***Instructions to candidates:***

***1) All questions are compulsory.***

***2) Follow the instructions given for each question.***

***3) Draw neat labeled diagram wherever necessary.***

**Que. 1) Answer any five of the following in one sentence.** **05 Marks**

**i.**

**ii.**

**iii.**

**iv.**

**v.**

**vi.**

**Que. 2a) Write any one of the following.** **06 Marks**

**i.**

**ii.**

**Que. 2b) Write any one of the following.** **04 Marks**

**i.**

**ii.**

**Que. 3a) Solve any one of the following.** **06 Marks**

**i.**

**ii.**

**Que. 3b) Solve any one of the following.** **04 Marks**

**i.**

**ii.**

**Que. 4) Write notes on (Any four).** **10 Marks**

**a.**

**b.**

**c.**

**d.**

**e.**

**f.**

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## Question paper pattern for Theory (02 Credit courses)

## (To be applicable from the Academic year 2027-28 onwards)

A student will have to solve the question paper of 30 marks. The paper setter should set the paper on entire syllabus for total 52 marks, including optional questions. As the course is of 02 Credits (30 clock hour lectures), paper setter should allot 1.73 marks per lecture and accordingly, questions should be set for 30 lectures, 52 marks on entire syllabus.

## Question Paper Pattern

***Time: 2 Hours]*** ***[Max. Marks: 30***

***Instructions to candidates:***

***1) All questions are compulsory.***

***2) Follow the instructions given for each question.***

***3) Draw neat labeled diagram wherever necessary.***

**Q.1) Answer <u>any Six</u> of the following in one sentence.** **[6]**

**a)**
**b)**
**c)**
**d)**
**e)**
**f)**
**g)**
**h)**

**Q.2a) Answer <u>any One</u> of the following. (Long answer question).** **[5]**

**1.**
**2.**

**Q. 2b) Write <u>any One</u> of the following. (Short answer question).** **[3]**

**1.**
**2.**

**Q.3a) Answer <u>any One</u> of the following. (Long answer question).** **[5]**

**1.**
**2.**

**Q. 3b) Write <u>any One</u> of the following. (Short answer question).** **[3]**

**1.**
**2.**

**Q.4) Write note on (<u>any Four</u>).** **[8]**

**a)**
**b)**
**c)**
**d)**
**e)**
**f)**

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## CREDIT FRAMEWORK FOR T.Y.B.Sc. BOTANY, SEMESTER – V (Level 5.5 / 300)

| COURSE DETAILS | COURSE CODE | COURSE TITLE | CREDITS |
|---|---|---|---|
| **Vertical – 1 (V1)** | | | |
| **Major Core Courses – (4 T + 2 P) x 2 C = 12 C** | BOT-301-MJ-T | Taxonomy of Cryptogams | **2 C** |
| | BOT-302-MJ-T | Advanced Plant Physiology | **2 C** |
| | BOT-303-MJ-T | Plant Breeding and Seed Technology | **2 C** |
| | BOT-304-MJ-T | Cell and Molecular Biology | **2 C** |
| | BOT-305-MJ-P | Practical Based on BOT 301-MJ-T and BOT-302-MJ–T | **2 C** |
| | BOT-306-MJ-P | Practical Based on BOT 303-MJ-T and BOT-304-MJ-T | **2 C** |
| **Major Elective Courses – (1 T + 1 P ) x 2 C= 4 C (Any one from basket)** | BOT-310-MJ-T | Advances in Agro-tourism | **2 C** |
| | BOT-311-MJ-T | Plants Utilization | |
| | BOT-312-MJ-T | Computational Botany | |
| | BO- 313-MJ-P | Practical Based on BOT-310-MJ-T | **2 C** |
| | BOT-314-MJ-P | Practical Based on BOT-311-MJ-T | |
| | BOT-315-MJ-P | Practical Based on BOT-312-MJ-T | |
| **Vertical – 2 (V2)** | | | |
| **Minor Courses – (1 T = 2 C) (Any one from basket)** | BOT-341-MN-T | Vegetable Seed Production | **2 C** |
| | BOT-342-MN-T | Nursery Management, Landscape Designing and Gardening | |
| | BOT-343-MN-T | Feed and Fodder Production Technology | |
| **Vertical – 3 (V3)** | | | |
| **GE / OE - (0C)** | ------- | ------- | **0 C** |
| **Vertical – 4 (V4)** | | | |
| **Vocational Skill Courses (VSC) – (1 T/ P= 2 C) (Any one from basket)** | BOT-321-VSC-T | Intellectual Property Rights (IPR) | **2 C** |
| | BOT-322-VSC-P | Stress Physiology of Agricultural Crops | |
| | BOT-323-VSC-P | Advanced Plant Biotechnology | |
| **SEC – (0 C)** | ------ | ------- | **0 C** |
| **Vertical – 5 (V5)** | | | |
| **IKS - (0 C)** | ----- | ------ | **0 C** |
| **AEC – (0 C)** | ------- | ------ | **0 C** |
| **VEC – (0 C)** | ------- | ------- | **0 C** |
| **Vertical – 6 (V6)** | | | |
| **FP / CEP – (2 C)** | BOT-331-FP / BOT-331-CEP | Field Project (FP) / Community Engagement Programme (CEP) in Botany | **2 C** |
| **CC – (0 C)** | ------- | ------- | **0 C** |
| | | **Total Credits (V1+V2+V3+V4+V5+V6)** | **22 C** |

## CREDIT FRAMEWORK FOR T.Y.B.Sc. BOTANY, SEMESTER – VI (Level 5.5 / 300)

| COURSE DETAILS | COURSE CODE | COURSE TITLE | CREDITS |
|---|---|---|---|
| **Vertical – 1 (V1)** | | | |
| **Major Core Courses – (4 T + 2 P) x 2 C = 12 C** | BOT-351-MJ-T | Taxonomy of Phanerogams | **2 C** |
| | BOT-352-MJ-T | Genetics | **2 C** |
| | BOT-353-MJ-T | Plant Pathology and Protection | **2 C** |
| | BOT-354-MJ-T | Biochemistry | **2 C** |
| | BOT-355-MJ-P | Practical Based on BOT-351-MJ-T and BOT-352-MJ-T | **2 C** |
| | BOT-356-MJ-P | Practical Based on BOT-353-MJ-T and BOT-354-MJ-T | **2 C** |
| **Major Elective Courses – (1 T + 1 P) x 2C = 4 C (Any one from basket)** | BOT-360-MJ-T | Phyto-clinical Techniques | **2 C** |
| | BOT-361-MJ-T | Agricultural Business Management | |
| | BOT-362-MJ-T | Botany in relation to Apiculture and Sericulture | |
| | BOT-363-MJ-P | Practical Based on BOT-360-MJ-T | **2 C** |
| | BOT-364-MJ-P | Practical Based on BOT-361-MJ-T | |
| | BOT-365-MJ-P | Practical Based on BOT-362-MJ-T | |
| **Vertical – 2 (V2)** | | | |
| **Minor Courses – (0 C)** | ---------- | | **0 C** |
| **Vertical – 3 (V3)** | | | |
| **GE / OE - (0 C)** | ------- | ------- | **0 C** |
| **Vertical – 4 (V4)** | | | |
| **Vocational Skill Courses (VSC) – (1 T/ P = 2 C) (Any one from basket)** | VSC-371-BOT-P | Advances in Fermentation Technology | **2 C** |
| | VSC-372-BOT-P | Commercial Mushroom and SCP Production Technology | |
| | VSC-373-BOT-P | Millets for Sustainable Human Welfare | |
| **SEC – (0 C)** | ------ | ------- | **0 C** |
| **Vertical – 5 (V5)** | | | |
| **IKS - (0 C)** | ----- | ------ | **0 C** |
| **AEC – (0 C)** | ----- | ------ | **0 C** |
| **VEC – (0 C)** | ------- | ------- | **0 C** |
| **Vertical – 6 (V6)** | | | |
| **OJT – (4 C)** | BOT-381-OJT | On Job Training (OJT) in Botany | **4 C** |
| **CC – (0 C)** | ------- | ------- | **0 C** |
| | | **Total Credits (V1+V2+V3+V4+V5+V6)** | **22 C** |
| | | **Total Credits for TYBSC - Semester V (22 C) + Semester VI (22 C)** | **44 C** |

**Exit Option: Award of Three-Year UG Degree (B.Sc. Botany) in Major with 132 Credits OR Continue with Major and Minor.**

# SEMESTER - V

# SEMESTER - V

| COURSE DETAILS | COURSE CODE | COURSE TITLE | CREDITS |
|---|---|---|---|
| Vertical – 1 (V1) | | | |
| Major Core Courses – (4 T + 2 P) x 2 C = 12 C | BOT-301-MJ-T | Taxonomy of Cryptogams | 2 C |
| | BOT-302-MJ-T | Advanced Plant Physiology | 2 C |
| | BOT-303-MJ-T | Plant Breeding and Seed Technology | 2 C |
| | BOT-304-MJ-T | Cell and Molecular Biology | 2 C |
| | BOT-305-MJ-P | Practical Based on BOT-301-MJ-T and BOT-302-MJ–T | 2 C |
| | BOT-306-MJ-P | Practical Based on BOT 303-MJ-T and BOT-304-MJ-T | 2 C |

## T.Y.B.Sc. Botany [Semester - V]

## Course Category –Major Core Course (MJ)

## Course Code – BOT-301-MJ-T

## Course Title: Taxonomy of Cryptogams

**[No. of Credits: 2 C]** **[No. of Lectures: 30 L]**

**COURSE OBJECTIVES:**

1. To understand the origin, diversity, and evolution of cryptogams.
2. To study the morphology, anatomy, reproduction, and life cycles of lower plants.
3. To learn the classification and taxonomy of algae, fungi, bryophytes, and pteridophytes.
4. To understand the ecological and evolutionary importance of cryptogams.
5. To develop skills in cryptogamic herbarium preparation and digital database usage.

**COURSE OUTCOMES (COS):**

**CO 1:** To able, understand diagnostic characters of representative of major groups.
**CO 2:** To acquire knowledge of traditional and applied aspects of cryptogams in India.
**CO 3:** To understand classification systems of cryptogams.
**CO 4:** To understand the taxonomic principles applied to cryptogams.
**CO 5:** To develop right understanding of preparation herbarium specimens and identification by using databases.

| Sr. No. | Topic Details | No. of Lectures |
|---|---|---|
| | **CREDIT I** | **15 L** |
| **1.** | **Introduction to Cryptogams**<br>1.1 Introduction and definition<br>1.2 General characteristics of cryptogams<br>1.3 Geological time scale with reference to major events: Origin of cryptogams, Great oxygenation event, endosymbiotic theory, Silurian–Devonian colonization of land. | **03** |
| **2.** | **Algae**<br>2.1 Introduction and definition<br>2.2 General characteristics of algae<br>2.3 Outline Classification of algae according to H C Bold and M J Wynne 1985 up to classes with examples.<br>2.4 Life Cycle of *Anabaena*, *Spirogyra, Chara*, *Sargassum* with reference to taxonomic position, occurrence, thallus structure, and reproduction. | **06** |
| **3.** | **Fungi**<br>3.1 Introduction and definition<br>3.2 General characteristics of fungi<br>3.3 Classification of fungi according to Alexopoulous up to classes with examples<br>3.4 Life Cycle of *Mucor, Saccharomyces, Puccinia,* and *Cercospora* with reference to taxonomic position, occurrence, thallus structure, and | **06** |

| | | |
|---|---|---|
| | reproduction. | |
| | **CREDIT II** | **15 L** |
| **4.** | **Bryophytes**<br>4.1 Introduction and definition<br>4.2 General characters of bryophytes<br>4.3 Classification of Bryophytes according to G.M. Smith (1955) up to classes with examples.<br>4.4 Comparative account of Life cycle of *Marchantia, Anthoceros* and *Funaria* with reference to taxonomic position, morphology, anatomy, and reproduction. | **04** |
| **5.** | **Pteridophytes**<br>5.1 Introduction and definition<br>5.2 General characteristics of pteridophytes,<br>5.3 Classification of pteridophytes according to K.R. Sporne (1975) up to classes with examples<br>5.4 Life cycle of *Psilotum, Selaginella, Equisetum*, and *Pteris* with reference to taxonomic position, morphology, anatomy, reproduction, sporophytes and gametophytes.<br>5.5 Origin of Pteridophytes, Algal and Bryophyte origin.<br>5.6 Evolution of Pteridophytes- Telome theory and Enation theory.<br>5.7 Carboniferous forests and pteridophytes dominance. | **07** |
| **6.** | **Cryptogamic herbarium and Data bases**<br>6.1 Concept and Preparation of Cryptogam Herbaria with reference to algae by floating-out on paper method; fungi, lichen and bryophytes by air drying methods (Pocket method); and pteridophytes by pressing method.<br>6.2 E- herbarium or virtual herbarium: Definition, Components, Technique, Standardization; advantages and disadvantages of virtual herbarium.<br>6.3 Data bases concept and need: Electronic repository, Relational structure, Metadata integration.<br>6.4 Digital databases: Global Biodiversity - The Global Biodiversity international facility (GBIF); Algae Base; Index Fungorum, The Bryophyte Portal, Pteridophyte Collections Consortium (PCC). | **04** |

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18. Vashishta B R Botany for degree students Pteridophytes

# T.Y.B.Sc. Botany [Semester - V]

## Course Category – Major Core Course (MJ)

## Course Code – BOT-302-MJ-T

## Course Title: Advanced Plant Physiology

**[No. of Credits: 2 C]** **[No. of Lectures: 30 L]**

**COURSE OBJECTIVES:**

1. To understand the fundamental physiological processes occurring plants.
2. To explain the mechanisms of photosynthesis and respiration.
3. To understand plant growth and development.
4. To understand the mechanism of translocation of organic solutes in plants.
5. To study the factors regulating dormancy breaking and germination in plants.

**COURSE OUTCOMES (COS):**

**CO 1:** Students will be able to understand and explain photosynthetic process in plant.
**CO 2:** Students will be able to explain the mechanism of translocation.
**CO 3:** Students will be able to explain the mechanism of respiration.
**CO 4:** Students will be able to understand the process, regulation and significance of plant senescence.
**CO 5:** Students will understand the plant growth and development.
**CO 6:** Student will be able to explain the mechanism and regulation of seed dormancy and germination.

| Sr. No. | Topic Details | No. of Lectures |
|---|---|---|
| | **CREDIT I** | **15 L** |
| **1.** | **Photosynthesis**<br>1.1. Introduction and definition<br>1.2. Structure and organization of chloroplast<br>1.3. Photosynthetic pigments and their role<br>1.4 Photosystem I and II<br>1.5. Light Reaction<br>1.5.1. Electron transport Chain (ETC)<br>1.5.2. Photophosphorylation: Cyclic and Non-cyclic<br>1.6. Dark Reaction (Photosynthetic Carbon Reduction):<br>1.6.1. C3 pathway<br>1.6.2. C4 pathway<br>1.6.3 CAM pathway<br>1.7. Photorespiration (C2 cycle)<br>1.8. Significance of photosynthesis | **07** |
| **2.** | **Respiration**<br>2.1. Introduction and definition<br>2.2. Types of respiration:<br>2.2.1. Aerobic respiration<br>2.2.2. Anaerobic respiration<br>2.3. Mechanism of aerobic respiration: | **05** |

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|---|---|---|
| | 2.3.1. Glycolysis,<br>2.3.2. TCA cycle,<br>2.3.3. Electron transport chain,<br>2.3.4. Oxidative phosphorylation (Chemi-osmotic hypothesis)<br>2.4. Pentose Phosphate pathway<br>2.5. Significance of respiration. | |
| **3.** | **Translocation of Organic Solutes**<br>3.1. Introduction, definition<br>3.2. Components of Phloem<br>3.3. Evidences for Phloem transport<br>3.4. Mechanism of Translocation<br>3.3.1 Pressure flow theory (Munch Hypothesis)<br>3.3.2. Diffusion theory<br>3.5. Loading and unloading of phloem,<br>3.6. Source to sink relationship | **03** |
| | **CREDIT II** | **15 L** |
| **4.** | **Growth and Development**<br>4.1 Introduction and definition<br>4.2 Grand period of growth and Phases of growth<br>4.3 Methods of growth measurement<br>4.4. Factors affecting Growth<br>4.4.1 External factors<br>4.4.1.1. Climatic factors: Temperature, Light, Humidity, Wind, Water, Atmospheric gases<br>4.4.1.2. Edaphic factors<br>4.4.1.3. Biological factors<br>4.4.2 Internal factors<br>4.4.2.1. Genetic factor<br>4.4.2.2. Nutritional factors<br>4.4.2.3. Hormonal factors | **04** |
| **5.** | **Plant Movements**<br>5.1 Introduction,<br>5.2 Classification of Plant Movements,<br>5.3 Paratonic Growth Movements:<br>5.3.1. Phototropism,<br>5.3.2. Geotropism,<br>5.3.3. Hydrotropism,<br>5.3.4. Chemotropism,<br>5.3.5. Thigmotropism<br>5.4 Nastic Movements:<br>5.4.1. Nyctinastic<br>5.4.2. Seismonastic | **03** |
| **6.** | **Seed dormancy and germination**<br>6.1 Introduction and definition of seed dormancy<br>6.2 Types of seed dormancy<br>6.2.1 Physical dormancy | **04** |

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|---|---|---|
| | 6.2.2 Morphological dormancy<br>6.2.3 Physiological dormancy<br>6.3. Causes of Seed dormancy<br>6.4. Methods to break seed dormancy<br>6.5. Metabolic changes during seed germination<br>6.6. Vigor Index | |
| **7.** | **Nitrogen Metabolism**<br>7.1 Introduction and definition<br>7.2. Nitrogen cycle<br>7.2.1. Nitrogen fixation<br>7.2.2. Nitrification<br>7.2.3 Assimilation of nitrate and nitrite<br>7.2.4. Ammonification<br>7.2.5 Denitrification<br>7.3. Synthesis of Amino acids<br>7.3.1 Trans-amination<br>7.3.2 Reductive amination | **04** |

**REFERENCES:**

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## T.Y.B.Sc. Botany [Semester - V]

## Course Category – Major Core Course (MJ)

## Course Code – BOT-303-MJ-T

## Course Title: Plant Breeding and Seed Technology

**[No. of Credits: 2 C]** **[No. of Lectures: 30 L]**

**COURSE OBJECTIVES:**

1. To understand the principles, scope, and history of plant breeding.
2. To study conventional and modern methods of plant breeding.
3. To learn the concepts of hybridization, selection, and mutation breeding.
4. To understand the importance of seed technology in agriculture.
5. To study seed production, processing, certification, and testing methods.
6. To understand seed storage, seed pathology, and seed protection measures.

**COURSE OUTCOMES (COS):**

**CO1:** Students will explain the basic principles and objectives of plant breeding.
**CO2:** Students will describe different methods of plant breeding and their applications.
**CO3:** Students will perform basic procedures involved in seed production and processing.
**CO4:** Students will identify different classes of seeds and seed certification procedures.
**CO5:** Students will analyse seed quality through purity, moisture, and germination tests.
**CO6:** Students will understand seed storage practices and management of seed-borne diseases and pests.

| Sr. No. | Topic Details | No. of Lectures |
|---|---|---|
| | **CREDIT I – Plant Breeding** | **15 L** |
| **1.** | **Introduction to Plant Breeding**<br>1.1 Introduction and definition<br>1.2 Scope and objectives<br>1.3 History of Plant Breeding | **01** |
| **2.** | **Conventional methods of plant breeding - I: Plant Introduction**<br>2.1 Definition and concept of plant introduction<br>2.2 Types - primary and secondary<br>2.3 Procedure<br>2.4 Merits and demerits with important achievements | **02** |
| **3.** | **Conventional methods of plant breeding - II: Selection**<br>3.1 Definition and concept of selection<br>3.2 Types - mass selection, pureline selection and clonal selection.<br>3.3 Advantage, disadvantages and achievements of selection | **03** |
| **4.** | **Conventional methods of plant breeding - III: Hybridization**<br>4.1 Definition, concept and objectives of hybridization<br>4.2 Precaution to be taken during hybridization<br>4.3 Types: inter-varietal and distant<br>4.4 General procedure of hybridization<br>4.5 Methods of hybridization: Pedigree and bulk | **05** |

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|---|---|---|
| | 4.6 Hybrid vigour and Heterosis<br>4.7 Important achievements | |
| **5.** | **Modern Methods of Plant Breeding**<br>**5.1 Mutation breeding**<br>5.1.1 Definition and concept of mutation breeding; Mutants, Mutagenesis and Mutagen<br>5.1.2 Types of mutation - Spontaneous and Induced<br>5.1.3 Mutagens - Physical and Chemical<br>5.1.4 Induced Mutagenesis - Methodology<br>5.1.5 Application and limitations of mutation breeding<br>**5.2 Plant Biotechnology**<br>5.2.1 Definition, concept and applications with prominent examples | **04** |
| | **CREDIT II – Seed Technology** | **15 L** |
| **6.** | **Introduction to Seed Technology**<br>1.1 Definition and Concept of Seed<br>1.2 Seed as a basic input in agriculture<br>1.3 Difference between seed and grain<br>1.4 Classes of seed: Nucleus, Breeder, Foundation and Certified<br>1.5 Role of seed technology<br>1.6 Seed legislation – introduction, Seed legislation in India (Seed Act) | **03** |
| **7.** | **Seed Production and Seed Processing**<br>7.1 Introduction<br>7.2 International Seed Testing Association (ISTA), National Seed Corporation<br>7.3 Role of National Seed Corporation (NSC) and State Seed Corporation (SSC)<br>7.4 General principles and methods for Seed Production<br>7.5 Seed Processing | **03** |
| **8.** | **Seed Certification**<br>8.1 Definition, Objectives and Concept of seed certification<br>8.2 General Process and phases of seed certification<br>8.3 Field inspection and duties of seed inspector | **02** |
| **9.** | **Seed Testing**<br>9.1 Physical Purity Analysis - Definition of purity components, Physical Purity Work Board, Procedure/Methodology<br>9.2 Moisture Testing - Concept, Hot Air oven method, Digital Moisture Meter<br>9.3 Germination testing - Definition and objectives, Methods for germination testing: Paper Sand and Soil; Seedling evaluation: Normal Seedlings, Abnormal Seedlings, Multigerm Seed Units and Non-germinated Seeds | **03** |
| **10.** | **Seed Pathology and Entomology**<br>10.1 Definition<br>10.2 Seed borne pathogens - Fungi, Bacteria and Viruses<br>10.3 Influence of seed borne pathogens on seed production<br>10.4 Common insect pest and its impact on seed production | **02** |

| | | |
|---|---|---|
| **11.** | **Seed Storage**<br>11.1 Definition and concept<br>11.2 Seed treatment<br>11.3 Management of seed storage structures<br>11.4 Sanitization, Dehumidification, Fumigation | **02** |

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## T.Y.B.Sc. Botany [Semester - V]

## Course Category – Major Core Course (MJ)

## Course Code – BOT-304-MJ-T

## Course Title: Cell and Molecular Biology

**[No. of Credits: 2 C]** **[No. of Lectures: 30 L]**

**COURSE OBJECTIVES:**

After completing this course, students will be able to:

1. Understand the basic structure and function of the cell.
2. Describe the organization and functions of cellular organelles.
3. Explain the molecular basis of DNA, RNA, and protein synthesis.
4. Understand cell division and regulation of gene expression.
5. Recognize basic applications of molecular biology in biotechnology.

**COURSE OUTCOMES (COS):**

Upon successful completion, students will be able to:

**CO1:** Explain cell structure and cellular functions.
**CO2:** Describe DNA replication, transcription, and translation.
**CO3:** Differentiate mitosis and meiosis.
**CO4:** Understand basic gene regulation mechanisms.
**CO5:** Identify applications of molecular biology techniques.

| Sr. No. | Topic Details | No. of Lectures |
|---|---|---|
| | **CREDIT I – Cell Biology** | **15 L** |
| **1.** | **Introduction to Cell Biology**<br>1.1 Introduction and definition<br>1.2 History of Cell Biology,<br>1.3 Units of measurement for cell,<br>1.4 Prokaryotic and Eukaryotic cell<br>1.5 Interdisciplinary nature of Cell Biology | **02** |
| **2.** | **Cell Structure**<br>2.1 Cell wall<br>2.2 Plasma membrane<br>2.3 cytoplasmic matrix | **02** |
| **3.** | **Cell organelles**<br>3.1 Mitochondria<br>3.2 Chloroplast,<br>3.3 Endoplasmic Reticulum (ER),<br>3.4 Golgi apparatus,<br>3.5 Lysosomes,<br>3.6 Vacuoles,<br>3.7 Peroxisomes<br>3.8 Glyoxysomes | **04** |
| **4.** | **Nucleus** | **03** |

| | | |
|---|---|---|
| | 4.1 Morphology and ultrastructure of Nucleus, Nucleolus and Nucleolar organizer<br>4.2 Nuclear envelope - structure of nuclear pore complex<br>4.3 Transport of molecules across nuclear envelope | |
| **5.** | **Chromosomes**<br>5.1 Euchromatin and heterochromatin Histones<br>5.2 Packing of DNA into chromosomes in eukaryotes,<br>5.3 Karyotype and ideogram,<br>5.4 Giant chromosome - Polytene chromosomes and Lampbrush chromosomes. | **04** |
| | **CREDIT II – Molecular Biology** | **15 L** |
| **6.** | **Genetic material**<br>6.1 Historical perspective from 1953 to 2020<br>6.2 Griffith's and Avery's transformation experiments<br>6.3 Hershey-Chase bacteriophage experiment | **02** |
| **7.** | **DNA replication - Prokaryotes and Eukaryotes**<br>7.1 Molecular mechanism of DNA replication<br>7.2 Enzymes involved in both prokaryotic and eukaryotic DNA replication and their inhibitors (antibiotics) | **03** |
| **8.** | **Transcription - Prokaryotes in details and passing remarks on Eukaryotes**<br>8.1 Types of RNA: mRNA, tRNA, rRNA<br>8.2 Types of promoters<br>8.3 Types of RNA polymerase enzymes in eukaryotes<br>8.4 Molecular mechanism of transcription | **04** |
| **9.** | **Translation (Prokaryotes and Eukaryotes)**<br>9.1 Definition<br>9.2 Concept and properties of genetic code<br>9.3 Molecular mechanism of translation | **03** |
| **10.** | **Regulation of gene expression**<br>10.1 Concept of operon, *lac* operon and *trp* operon<br>10.2 Positive and negative control<br>10.3 One gene one enzyme hypothesis | **03** |

**REFERENCES:**


1. Cell and Molecular Biology, S. C. Rastogi
2. Cytology, T. S. Verma and V. K. Agarwal 3. Cell Biology, C. B. Pawar
3. Cell and Molecular Biology, P. K. Gupta
4. Fundamentals of Molecular Biology, Veer Bala Rastogi
5. Fundamentals of Molecular Biology, G. K. Pal and Ghaskadabi
6. Cell Biology, Molecular Biology, Genetic, Evolution and Ecology, Verma and Agarwal
7. Cell and Molecular Biology, Robertis and DeRobertis
8. Molecular Cell Biology, 4th Edition, Lodish S. Baltimore
9. Molecular Biology of Gene, Watson J. D.
10. Biochemistry and Molecular Biology of Plants, Buchanan B. B.
11. Molecular and Cell Biology, Wolfe S.L.

## T.Y.B.Sc. Botany [Semester - V]

## Course Category – Major Core Course (MJ)

## Course Code – BOT-305-MJP

**Course Title: Practical based on BOT 301 MJ-T and BOT 302 MJ-T**

**[No. of Credits: 2 C]** **[No. of Lectures: 60 L]**

**COURSE OBJECTIVES:**

1. To study the morphology, anatomy, and reproduction of algae, fungi, bryophytes, and pteridophytes.
2. To understand the systematic and taxonomic position of important cryptogamic plants.
3. To develop practical skills in identification and microscopic observation of lower plants.
4. To learn physiological experiments related to photosynthesis and respiration in plants.
5. To study seed germination, seed dormancy, and seed vigor analysis techniques.
6. To develop scientific observation and field study skills through botanical excursions and report writing.

**COURSE OUTCOMES (COS):**

**CO1:** Students will identify important genera of algae, fungi, bryophytes, and pteridophytes.
**CO2:** Students will explain the morphology, anatomy, and reproduction of cryptogamic plants.
**CO3:** Students will perform physiological experiments using standard laboratory techniques.
**CO4:** Students will analyze photosynthetic pigments and respiratory activities in plants.
**CO5:** Students will evaluate seed germination percentage and vigor index in plant materials.
**CO6:** Students will prepare scientific tour reports based on botanical field observations.

| Sr. No. | Titles of the Practical | No. of Practical |
|---|---|---|
| | **CREDIT I - Practical based on BOT-301-MJ-T** | |
| **1.** | Study of Algae with reference to systematic position, thallus structure and reproduction of *Anabaena,* and *Spirogyra.* | **1 P** |
| **2.** | Study of Algae with reference to systematic position, thallus structure and reproduction of *Chara* and *Sargassum*. | **1 P** |
| **3.** | Study of Fungi with reference to systematic position and thallus morphology of *Mucor* and *Saccharomyces.* | **1 P** |
| **4.** | Study of Fungi with reference to systematic position, and thallus morphology of *Puccinia* and *Cercospora.* | **1 P** |
| **5.** | Study of Bryophyte with reference to systematic position, thallus morphology and gametophyte structure of *Marchantia, Anthoceros* and *Funaria* | **1 P** |
| **6.** | Study of Pteridophyte with reference to taxonomic position, morphology and anatomy of sporophyte and reproductive structure of *Psilotum* and *Selaginella* | **1 P** |
| **7.** | Study of *Equisetum* and *Pteris* with reference to taxonomic position, morphology and anatomy of sporophyte and reproductive structure | **1 P** |
| | **CREDIT II - Practical based on BOT-302-MJ-T** | |
| **8.** | Estimation of chlorophyll a and b by Spectrophotometry | **1 P** |

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|---|---|---|
| **9.** | Separation of photosynthetic pigment by Paper / Thin Layer chromatography. | **1 P** |
| **10.** | To determine diurnal fluctuation in TAN values of CAM plants. | **1 P** |
| **11.** | Comparison of the rate of respiration in any two parts of a plant. | **1 P** |
| **12.** | Demonstration of -<br>A. Ringing Experiment<br>B. Respiration in Roots<br>C. Nitrogen rich biofertilizers<br>D. Arc indicator<br>E. Cytokinins delay of senescence<br>F. Nyctinastic movement in plant (in *Mimosa*)<br>G. Effect of auxins on rooting | **1 P** |
| **13.** | Study of seed priming treatments to break seed dormancy and enhance the rate of seed germination. | **1 P** |
| **14.** | Calculate seed germination percentage and vigor index in any suitable plant material | **1 P** |
| **15.** | Botanical excursion, herbarium preparation technique for Algae, Fungi, Bryophytes and Pteridophytes. Submission of Herbarium and Tour Report, with photographs. | **1 P** |

## T.Y.B.Sc. Botany [Semester - V]

## Course Category – Major Core Course (MJ)

## Course Code – BOT-306-MJP

## Course Title: Practical based on BOT 303 MJ-T and BOT 304 MJ-T

**[No. of Credits: 2 C]** **[No. of Lectures: 60 L]**

**COURSE OBJECTIVES:**

1. To develop practical skills in plant breeding and hybridization techniques.
2. To study pollen viability, floral morphology, and mutation effects in crops.
3. To learn methods of seed testing, purity analysis, and germination studies.
4. To understand the life cycle and management of common seed insect pests.
5. To study plant cell structure, mitosis, and meiosis using microscopic techniques.
6. To understand basic molecular biology techniques including DNA isolation and PCR concepts.

**COURSE OUTCOMES (COS):**

**CO1:** Students will perform emasculation, pollination, bagging, and tagging techniques in crops.
**CO2:** Students will analyse seed quality through moisture, purity, and germination tests.
**CO3:** Students will identify common seed insect pests and suggest control measures.
**CO4:** Students will prepare and observe mitotic and meiotic stages in plant cells.
**CO5:** Students will calibrate microscopes and measure cell dimensions accurately.
**CO6:** Students will isolate plant genomic DNA and explain basic molecular biology processes.

| Sr. No. | Title of the Practical | No. of Practical |
|---|---|---|
| | **CREDIT I – Practical based on BOT-303-MJ-T** | |
| **1.** | Demonstration of Hybridization Techniques - Emasculation, Hand Pollination, Bagging and Tagging in any suitable crop - cotton / tomato / pulses | **1 P** |
| **2.** | Breeding methods in self and cross-pollinated crops (Interactive). | **1 P** |
| **3.** | Study of pollen viability and floral morphology of crops. | **1 P** |
| **4.** | Effect of chemical mutagens on seed germination and seedling growth. | **1 P** |
| **5.** | To test seed moisture by hot air oven method and study germination methods - Paper, Sand and Soil | **1 P** |
| **6.** | Physical purity analysis of seed sample. | **1 P** |
| **7.** | To study any one common seed insect pest w.r.t to their life cycle, way of infestation/damage, symptoms and control measures. | **1 P** |
| **8.** | Visit to a Plant Breeding Research Centre/Seed Industry and report submission. | **1 P** |
| | **CREDIT II – Practical based on BOT-304-MJ-T** | |
| **9.** | Study of plant cell structure in different plant tissues (e.g., Hydrilla leaf, Onion epidermal peel, and Rhoeo leaf) and Calibration of the ocular micrometer and measurement of cell dimensions (e.g., pollen grains or stomatal guard cells). | **1 P** |

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| **10.** | Study of mitosis: Preparation of onion root tip squash using Acetocarmine /Aceto-orcein staining and identification of different stages: Prophase, Metaphase, Anaphase, and Telophase. | **1 P** |
| **11.** | Study of meiosis in onion or *Tradescantia* / *Rhoeo* flower buds. | **1 P** |
| **12.** | Preparation of fixatives; Acetocarmine and Aceto-orcein stains. Demonstration of ultrastructure of Nucleus, Chloroplast, Mitochondria, ER, and Golgi complex using Electron Micrographs (TEM/SEM). | **1 P** |
| **13.** | Isolation of plant genomic DNA by suitable method and its estimation by DPA method. | **2 P** |
| **14.** | Demonstrations of:<br>A. The Semi-conservative mode of DNA replication through 3D models or charts<br>B. The process of Transcription through 3D models or charts<br>C. The role of Taq Polymerase, Primers, and Thermal Cyclers in PCR<br>D. Polytene and Lampbrush chromosomes from permanent slides or micrographs | **1 P** |

# SEMESTER - V

| COURSE DETAILS | COURSE CODE | COURSE TITLE | CREDITS |
|---|---|---|---|
| Vertical – 1 (V1) | | | |
| Major Elective Courses – (1 T + 1 P ) x 2 C= 4 C (Any one from basket) | BOT-310-MJ-T | Advances in Agro-tourism | 2 C |
| | BOT-311-MJ-T | Plants Utilization | |
| | BOT-312-MJ-T | Computational Botany | |
| | BOT-313-MJ-P | Practical Based on BOT-310-MJ-T | 2 C |
| | BOT-314-MJ-P | Practical Based on BOT-311-MJ-T | |
| | BOT-315-MJ-P | Practical Based on BOT-312MJ-T | |

## T.Y.B.Sc. Botany [Semester - V]

## Course Category – Major Elective Course

## Course Code – BOT-310-MJ-T

## Course Title: Advances in Agro-tourism

**[No. of Credits: 2 C]** **[No. of Lectures: 30 L]**

**COURSE OBJECTIVES:**

1. To develop advanced understanding of Agro-tourism as a sustainable rural enterprise.
2. To study modern innovations, digital tools, and smart technologies used in Agro-tourism.
3. To train students in Agro-tourism entrepreneurship, business planning, and financial sustainability.
4. To analyze environmental, socio-economic, and policy aspects of Agro-tourism development.
5. To develop skills in research, case study analysis, and project-based learning in Agro-tourism.
6. To promote rural livelihood enhancement through value addition and experiential tourism.

**COURSE OUTCOMES (COS):**

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

**CO 1:** Design and manage advanced Agro-tourism models professionally.
**CO 2:** Prepare business and feasibility plans for Agro-tourism enterprises.
**CO 3:** Apply digital marketing and smart tourism technologies.
**CO 4:** Evaluate sustainability and environmental impacts of Agro-tourism.
**CO 6:** Conduct field surveys and research studies related to rural tourism.
**CO 7:** Develop entrepreneurial and leadership skills in Agro-tourism management.

| Sr. No. | Topic Details | No. of Lectures |
|---|---|---|
| | **CREDIT I** | **15 L** |
| **1.** | **Advanced concepts in agro-tourism**<br>1.1 Introduction to Agro-tourism - Definition, scope, and the intersection of agriculture and tourism.<br>1.2 Evolution of Agro-tourism: Global and Indian perspectives<br>1.3 Agro-tourism as a tool for rural economy diversification<br>1.4 Experiential tourism and farm experience design<br>1.5 Agro-tourism and Sustainable Development Goals (SDGs) | **02** |
| **2.** | **Activities and management of agro-tourism centres**<br>2.1 Introduction<br>2.2 Agricultural activities<br>2.3 Animal-based activities<br>2.4 Cultural and recreational activities<br>2.5 Adventure and nature-based activities<br>2.6 Management of agro-tourism centres | **02** |
| **3.** | **Planning and development of agro-tourism**<br>3.1 Introduction | **03** |

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|---|---|---|
| | 3.2 Site Selection for agro-tourism centres<br>3.3 Infrastructure requirements<br>3.4 Recreational and educational facilities<br>3.5 Benefits of agro-tourism centres<br>3.6 Challenges in agro-tourism development | |
| **4.** | **Agro-tourism planning and infrastructure development**<br>4.1 Business models in Agro-tourism<br>4.2 Feasibility analysis and site planning<br>4.3 Infrastructure planning and eco-friendly design<br>4.4 Risk management and safety standards<br>4.5 Legal requirements and licensing procedures | **04** |
| **5.** | **Agro-tourism entrepreneurship and financial management**<br>5.1 Agro-tourism entrepreneurship development<br>5.2 Business plan preparation<br>5.3 Cost–benefit analysis and revenue models<br>5.4 Funding sources: Government schemes, subsidies, PPP models<br>5.5 Accounting and financial sustainability | **04** |
| | **CREDIT II** | **15 L** |
| **6.** | **Digital and smart agro-tourism**<br>6.1 Digital tourism platforms and online booking systems<br>6.2 Social media branding and influencer marketing<br>6.3 GIS and smart farming integration in tourism<br>6.4 Virtual farm tours and immersive technologies (AR/VR concept)<br>6.5 Customer data management and analytics | **03** |
| **7.** | **Sustainable practices and environmental management**<br>7.1 Eco-tourism principles in Agro-tourism<br>7.2 Organic farming and biodiversity conservation<br>7.3 Waste management and renewable energy use<br>7.4 Water conservation and climate adaptation strategies<br>7.5 Responsible tourism and ethical practices | **04** |
| **8.** | **Cultural Heritage and rural experience development**<br>8.1 Preservation of rural traditions and indigenous knowledge<br>8.2 Local food systems and farm-to-table tourism<br>8.3 Folk art, festivals, and cultural interpretation<br>8.4 Community participation and stakeholder engagement<br>8.5 Women and youth empowerment through agro-tourism | **04** |
| **9.** | **Agro-tourism policy, research and case studies**<br>9.1 National and Maharashtra agro-tourism policies (advanced analysis)<br>9.2 Government schemes supporting agro-tourism enterprises<br>9.3 Successful Agro-tourism case studies (India and International)<br>9.4 Impact assessment methods<br>9.5 Research methodology in agro-tourism studies | **04** |

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2. Mahendra S. Dev (1996). *Agricultural Policy Framework for Maharashtra: Issues and Options*. Indira Gandhi Institute of Development Research, Mumbai.
3. DimitriosBuhalis (2003). *e-Tourism: Information Technology for Strategic Tourism Management*. Financial Times Prentice Hall.
4. Pauline J. Sheldon (2002). *Tourism Information Technology*. CAB International.
5. Michael L. Kasavana& John J. Cahill (2007). *Managing Computers in the Hospitality Industry*. AH&LA, USA.
6. Saxena, S., & Chopra, P. (2010). *Computer Applications in Management*. Vikas Publishing House Pvt. Ltd., New Delhi.
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9. Government of Maharashtra (2008). *Maharashtra Krishi Paryatan Vistar Yojana (MKPVY)*, Agri-Tourism Development Corporation (ATDC), Pune.
10. Ministry of Tourism, Government of India. *National Tourism Policy Documents and Guidelines*.
11. Food and Agriculture Organization (FAO). Reports on Rural Tourism and Sustainable Agriculture.

**WEB RESOURCES**

1. Agri Tourism Development Corporation – www.agritourism.in
2. Ministry of Tourism – www.tourism.gov.in
3. National Council of Agricultural Research – www.icar.org.in
4. FAO Official Website – www.fao.org

## T.Y. B.Sc. Botany [Semester - V]

## Course Category –Major Elective Course

## Course Code – BOT-311-MJ-T

## Course Title: Plants Utilization

**[No. of Credits: 2 C]** **[No. of Lectures: 30 L]**

**COURSE OBJECTIVES:**

1. To understand the concept and scope of plant utilization.
2. To study economically important plants used as food and medicine.
3. To learn about industrial and commercial uses of plant resources.
4. To understand nutraceuticals and functional plants.
5. To promote sustainable utilization and conservation of plant resources.
6. To develop awareness about the role of plants in human welfare.

**COURSE OUTCOMES (COS):**

After completing this course, students will be able to:

**CO1:** Explain the scope and importance of plant utilization.
**CO2:** Identify major cereals, pulses, fruits, and vegetables.
**CO3:** Describe medicinal and industrial plant resources.
**CO4:** Understand nutraceutical and functional plants.
**CO5:** Analyse sustainable utilization practices.
**CO6:** Apply knowledge of plant resources in agriculture and industry.

| Sr. No. | Topic Details | No. of Lectures |
|---|---|---|
| | **CREDIT I - Fundamentals of Plant Utilization** | **15 L** |
| **1.** | **Introduction to plant utilization**<br>1.1 Concept and scope of economic botany<br>1.2 Historical background of plant utilization<br>1.3 Centres of origin and domestication of crop plants | **03** |
| **2.** | **Cereals and Millets**<br>2.1 Origin, morphology, and economic importance<br>2.2 Major cereals: Rice, Wheat, Maize, Barley, and Sorghum<br>2.3 Nutritional significance of millets | **04** |
| **3.** | **Pulses and Oil yielding plants**<br>3.1 Importance of legumes in nutrition<br>3.2 Groundnut, Soybean, Mustard – uses and products<br>3.3 Edible oils and their significance | **04** |
| **4.** | **Fruits, Vegetables, and Spices**<br>4.1 Economic importance of selected fruits and vegetables<br>4.2 Spices and condiments: Cardamom, Black Pepper, Vanilla, Tamarind, Turmeric, Fennel, Fenugreek, Nutmeg<br>4.3 Post-harvest importance | **04** |

| | CREDIT II - Medicinal and Industrial Plant Resources | 15 L |
|---|---|---|
| **5.** | **Nutraceutical and functional plants**<br>5.1 Introduction, Definition of nutraceuticals and functional foods<br>5.2 Difference between food and nutraceuticals, Concept of health-promoting plants<br>5.3 Nutraceutical Plants: Turmeric - anti-inflammatory activity; Amla - vitamin C source; Garlic – cardiovascular benefits; Ginger – digestive properties<br>5.4 Importance in Human Health - Prevention of chronic diseases, Boosting immunity, Role in metabolism, Improving nutritional status | **03** |
| **6.** | **Medicinal Plants**<br>6.1 Importance - Traditional and modern medicinal systems, Role in Ayurveda and herbal medicine<br>6.2 Active Principles / Bioactive Compounds: Alkaloids - therapeutic properties; Glycosides - cardiac and laxative action; Tannins - astringent properties; Essential oils - aromatic and medicinal uses.<br>6.3 Study of Selected Medicinal Plants:<br>6.3.1 *Azadirachta indica* (Neem) - Botanical description, Active compounds (Azadirachtin), Antibacterial and antifungal uses,<br>6.3.2 *Withania somnifera* (Ashwagandha) - Roots as medicinal part, Stress-relieving and tonic properties.<br>6.3.3 *Rauvolfia serpentina* (Sarpagandha) - Root alkaloids (Reserpine) - Use in hypertension<br>6.4 Cultivation and Processing - Nursery raising, Harvesting methods, Drying and storage, Quality control, Marketing of medicinal plants | **05** |
| **7.** | **Fibre, Latex, and Timber yielding plants**<br>7.1 Fibre Yielding Plants<br>7.1.1 Cotton - Source: Seed hairs; Uses: Textile industry, medical cotton<br>7.1.2 Jute - Source: Stem fibres, Uses<br>7.2 Latex Yielding Plants<br>7.2.1 Rubber (*Hevea brasiliensis*) - Latex secretion, Tapping methods, Coagulation and processing, Uses.<br>7.3 Timber Yielding Plants - Characteristics of good timber, Teak, Sal, and Deodar, Uses.<br>7.4 Forest Products - Gums and resins, Tannins and dyes, Non-timber forest products (NTFPs) | **04** |
| **8.** | **Sustainable Utilization of Plant Resources**<br>8.1 Overexploitation of Plant Resources - Deforestation, Habitat destruction, Loss of biodiversity, Unsustainable harvesting<br>8.2 Conservation of Plant Resources.<br>8.3 Role in Rural Economy - Employment generation, Cottage industries, Tribal livelihood, Herbal trade<br>8.4 Sustainable Harvesting Practices- Controlled collection, Crop rotation, Regeneration techniques, Eco-friendly methods<br>8.5 Environmental and Social Importance - Climate regulation, Soil conservation, Water cycle maintenance, Social awareness | **03** |

**REFERENCES**


1. Kochhar, S.L. Economic Botany in the Tropics. Macmillan India Ltd., New Delhi.
2. Wickens, G.E. Economic Botany. Springer, London.
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14. Kokate, C.K., Purohit, A.P. & Gokhale, S.B. Pharmacognosy. NiraliPrakashan, Pune.
15. Bendre, A. & Kumar, A. A Textbook of Economic Botany. Rastogi Publications, Meerut.

## T.Y.B.Sc. Botany [Semester - V]

## Course Category – Major Elective Course

## Course Code – BOT-312-MJ-T

## Course Title: Computational Botany

**[No. of Credits: 2 C]** **[No. of Lectures: 30 L]**

**COURSE OBJECTIVES:**

1. Develop a clear understanding of the role of biostatistics in biological and life science research.
2. Identify different types of biological data, variables, and sampling strategies used in scientific investigations.
3. Apply descriptive statistical methods to summarize and represent biological datasets effectively.
4. Understand probability concepts and statistical distributions relevant to biological phenomena.
5. Design simple biological experiments using principles of randomization, replication, and control.
6. Perform and interpret basic statistical tests such as t-test, chi-square test, correlation, and ANOVA.
7. Analyse and visualize real biological datasets using jamovi for scientific interpretation.

**COURSE OUTCOMES (COS):**

**CO1:** Explain fundamental biostatistical concepts and terminology used in biological sciences.
**CO2:** Classify and organize biological data and present it through tables, graphs, and statistical summaries.
**CO3:** Evaluate biological variation using measures of central tendency and dispersion.
**CO4:** Apply appropriate probability models and hypothesis testing methods to biological problems.
**CO5:** Conduct and interpret statistical comparisons between experimental groups.
**CO6:** Examine relationships among biological variables using correlation and regression analysis.
**CO7:** Perform data analysis and generate scientific outputs using jamovi, enabling evidence-based biological conclusions.

| Sr. No. | Topic Details | No. of Lectures |
|---|---|---|
| | **CREDIT I** | **15 L** |
| **1.** | **Introduction to Computational Botany**<br>1.1 Definition and concept<br>1.2 Role in biological and botanical research<br>1.3 Applications in computational botany<br>1.4 Population v/s Sample<br>1.5 Parameter v/s Statistic<br>1.6 Variables and attributes<br>1.7 Qualitative v/s Quantitative data<br>1.8 Discrete and continuous variables | **04** |

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|---|---|---|
| **2.** | **Data Collection and Classification, Types of Biological Data**<br>2.1 Primary v/s Secondary data<br>2.2 Classification of biological data<br>2.3 Frequency distribution<br>2.4 Class intervals<br>2.5 Types of Biological Data **-** Measurement scales, Nominal, Ordinal, Interval, Ratio | **03** |
| **3.** | **Sampling Methods**<br>3.1 Definitions - Population, sample, parameter, statistic<br>3.2 Need of sampling, Advantages<br>3.3 Simple random sampling - with and without replacement<br>3.4 Stratified and systematic sampling - applications in plant science<br>3.5 Non-random sampling<br>3.6 Sampling errors or outliers in biological studies | **04** |
| **4.** | **Tabular and Graphical Representation**<br>4.1 Tables, parts of table and frequency tables<br>4.2 Histogram and Frequency polygon<br>4.3 Line graph, Bar chart and Stacked Bar chart<br>4.4 Pie diagram<br>4.5 Scatter plot and Radar Plot | **04** |
| | **CREDIT II** | **15 L** |
| **5.** | **Measures of Central Tendency and Dispersion**<br>5.1 Definition and concept of Mean (Arithmetic Mean), Median, Mode<br>5.2 Interpretation of Mean, Median, Mode<br>5.3 Mean-Median-Mode relationship<br>5.4 Range<br>5.5 Mean Deviation<br>5.6 Variance<br>5.7 Standard Deviation (SD)<br>5.8 Coefficient of Variation (CV)<br>5.9 Importance of variability in plant modelling | **03** |
| **6.** | **Probability and Probability Distributions**<br>6.1 Random experiments, events – simple, compound, mutually exclusive, independent (only concepts)<br>6.2 Definitions of probability, types- classical and empirical<br>6.3 Basic probability distributions – Binomial, Poisson, Normal (concepts and applications)<br>6.4 Standard deviation and probability area | **02** |
| **7.** | **Hypothesis Testing and Experimental Design**<br>7.1 Null and Alternate hypothesis; Types of errors - Type I and Type II with one suitable example each; Degrees of freedom (concept), level of significance, critical region, p-value<br>7.2 Experimental Design- Completely Randomized Design (CRD), Randomized Block Design (RBD), Factorial design,<br>7.3 Key types of experimental Errors - Random Error, Systematic Error, Blunders | **02** |

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| **8.** | **Statistical Tests for Biological Data**<br>Tests of Significance<br>8.1 Z test: only concept<br>8.2 Student's t-test: One sample, independent and Paired - one example each<br>8.3 Chi-square test - Goodness of fit, Test of independence - one example each<br>8.4 Introduction to ANOVA, Types: One-way ANOVA, Two-way ANOVA with one example each<br>8.5 F test - only concept<br>8.6 Post-hoc comparison (basic idea) e.g. Tukey's HSD - only concept | **04** |
| **9.** | **Correlation and Regression**<br>9.1 Definition of correlation, types, scatter diagram.<br>9.2 Karl Pearson's coefficient of correlation and Spearman's rank correlation coefficient. Their test of significance.<br>9.3 Linear regression (concept), equations, definition and properties of regression<br>9.4 Comparison of regression and correlation coefficients. | **03** |
| **10.** | **Computational Biostatistics using JAMOVI**<br>13.1 Introduction to JAMOVI<br>13.2 Needs of software in modern biology<br>13.3 Installation and interface of JAMOVI | **01** |

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## T.Y.B.Sc. Botany [Semester - V]

## Course Category – Major Elective Course

## Course Code – BOT-313-MJ-P

## Course Title: Practical based on BOT-310-MJ-T

**[No. of Credits: 2 C]** **[No. of Lectures: 60 L]**

**COURSE OBJECTIVES:**

1. To understand the concept and models of Agro-tourism in India.
2. To study the planning and management of Agro-tourism enterprises.
3. To learn the preparation of feasibility reports and business plans for Agro-tourism.
4. To understand marketing strategies and digital promotion of Agro-tourism.
5. To study sustainable and eco-friendly practices in Agro-tourism development.
6. To develop field-based knowledge through surveys, visits, and project preparation.

**COURSE OUTCOMES (COS):**

**CO1:** Students will explain different Agro-tourism models and their applications.
**CO2:** Students will prepare feasibility reports and business plans for Agro-tourism centres.
**CO3:** Students will design farm-based tourist activities and eco-friendly infrastructure layouts.
**CO4:** Students will apply digital marketing tools for Agro-tourism promotion.
**CO5:** Students will analyse tourist behaviour and sustainable rural tourism practices.
**CO6:** Students will prepare field reports and project proposals related to Agro-tourism.

| Sr. No. | Title of the Practical | No. of Practical |
|---|---|---|
| 1. | Study of different Agro-tourism models in India – Case study based analysis. | 1 P |
| 2. | Preparation of a feasibility report for starting an Agro-tourism centre - site selection, resources and market analysis. | 1 P |
| 3. | Designing a farm experience activity for tourists - hands-on farming, crop harvesting, dairy activities etc. | 1 P |
| 4. | Preparation of a basic Agro-tourism business plan. | 1 P |
| 5. | Cost–benefit analysis of a small Agro-tourism enterprise. | 1 P |
| 6. | Study of Government schemes and subsidies available for Agro-tourism development in Maharashtra and India. | 1 P |
| 7. | Designing eco-friendly infrastructure layout for an Agro-tourism farm. | 1 P |
| 8. | Preparation of a digital marketing plan for Agro-tourism using social media platforms. | 1 P |
| 9. | Study of online tourism platforms and booking systems used in Agro-tourism. | 1 P |
| 10. | Survey of tourists' preferences and behaviour in rural tourism. | 1 P |
| 11. | Study of sustainable practices in Agro-tourism - organic farming, waste management, renewable energy. | 1 P |
| 12. | Documentation of rural traditions, local food systems and cultural activities for tourism promotion. | 1 P |
| 13. | Visit to an Agro-tourism centre and submition of a detailed field report. | 2 P |

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| **14.** | Preparation and presentation of an Agro-tourism project proposal. | **1 P** |

## T.Y.B.Sc. Botany [Semester - V]

## Course Category – Major Elective Course

## Course Code – BOT-314-MJ-P

## Course Title: Practical based on BOT-311-MJ-T

**[No. of Credits: 2 C]** **[No. of Lectures: 60 L]**

**COURSE OBJECTIVES:**

1. To study the morphology and economic importance of major crop plants.
2. To understand the nutritional and industrial uses of cereals, millets, pulses, and oil yielding plants.
3. To learn phytochemical screening and analysis of medicinal plants.
4. To study nutraceutical and therapeutic properties of economically important plants.
5. To understand processing, value addition, and utilization of plant resources and forest products.
6. To develop field-based knowledge of medicinal and economically important plants.

**COURSE OUTCOMES (COS):**

**CO1:** Students will identify important economic plants based on their morphology and uses.
**CO2:** Students will compare nutritional values of cereals and millets.
**CO3:** Students will perform phytochemical screening of medicinal plants.
**CO4:** Students will evaluate nutraceutical and therapeutic properties of plant extracts.
**CO5:** Students will explain processing and value addition methods of plant products.
**CO6:** Students will document and assess economically important plant species during field visits.

| Sr. No | Title of the Practical | No. of Practical |
|---|---|---|
| 1. | Comparative morphological and economic analysis of selected cereals and millets w.r.t. external morphology, diagnostic characters, and economic significance of any two cereal and millet crops. | 1 P |
| 2. | Investigation of vegetative and reproductive morphology, nutritional and industrial uses of any two species of pulses and oil yielding plants. | 1 P |
| 3. | Comparative quantitative and qualitative assessment of nutritional components to evaluate dietary significance of Cereals and Millets – *Oryza sativa*, *Triticum aestivum, Zea mays, Sorghum bicolor, Pennisetum glaucum*. | 2 P |
| 4. | Functional assessment of nutraceutical properties w.r.t. evaluation of antioxidant and therapeutic properties of plant extracts of *Curcuma longa, Phyllanthus emblica, Allium sativum, Zingibe rofficinale.* | 1 P |
| 5. | Phytochemical screening and bioactive compound analysis w.r.t. qualitative detection of major phytoconstituents such as alkaloids, glycosides, tannins, and essential oils of medicinal plants *Azadirachta indica, Withania somnifera, Rauvolfia serpentine.* | 2 P |
| 6. | Study of fibre morphology, extraction techniques, and industrial importance of Fibre Yielding Plants - *Gossypium hirsutum, Corchorus capsularis,* and *Cocos nucifera*. | 1 P |

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|---|---|---|
| **7.** | Survey, field-based documentation and economic assessment of plant resources – *Ocimum tenuiflorum, Aloe vera,* and *Tinospora cordifolia* in field/herbal garden conditions. | **1 P** |
| **8.** | Processing and quality analysis of latex and rubber (*Hevea brasiliensis*) w.r.t. latex extraction, coagulation, processing, and product evaluation. | **1 P** |
| **9.** | Post-harvest handling and value addition w.r.t. evaluation of preservation techniques and value-added product development of Fruits and Spices – *Elettaria cardamomum, Piper nigrum, Curcuma longa, Foeniculum vulgare, Trigonella foenum-graecum.* | **2 P** |
| **10.** | Sustainable utilization and conservation assessment w.r.t. conservation strategies, sustainable harvesting, and economic importance of Plant Resources -*Tectona grandis, Shorea robusta, Azadirachta indica*. | **1 P** |
| **11.** | Evaluation of Timber and Non-Timber Forest Products (NTFPs) w.r.t. physical properties and uses of one timber specimen along with gums and resins of economic importance. | **1 P** |
| **12.** | Visit to Herbal Garden / Natural Vegetation. (Documentation, identification, and ecological assessment of medicinal and economically important plant species during field visit.) | **1 P** |

## T.Y.B.Sc. Botany [Semester - V]

## Course Category – Major Elective Course

## Course Code – BOT-315-MJ-P

## Course Title: Practical based on BOT-312-MJ–T

**[No. of Credits: 2 C]** **[No. of Lectures: 60 L]**

**COURSE OBJECTIVES:**

1. To understand the basics of biological data analysis using jamovi.
2. To learn data visualization techniques for biological research.
3. To study methods for testing normality and statistical significance of biological data.
4. To understand parametric tests such as t-test and ANOVA.
5. To learn correlation and regression analysis in biological studies.
6. To understand non-parametric statistical tests used in biological research.

**COURSE OUTCOMES (COS):**

**CO1:** Students will perform biological data analysis using JAMOVI.
**CO2:** Students will create graphical representations of biological data.
**CO3:** Students will apply t-tests and Chi-square tests for data interpretation.
**CO4:** Students will analyze biological data using one-way and two-way ANOVA.
**CO5:** Students will perform correlation and regression analysis on biological datasets.
**CO6:** Students will apply non-parametric tests for analysis of biological research data.

| Sr. No. | Title of the Practical | No. of Practical |
|---|---|---|
| 1. | Introduction to Biological Data Analysis using JAMOVI. | 1 P |
| 2. | Data Visualization for Biological Research. | 1 P |
| 3. | Testing Normality of Biological Data. | 1 P |
| 4. | Student t-Test using Biology data set - One sample and independent. | 1 P |
| 5. | Student t-Test using Biology data set - Paired t-Test. | 1 P |
| 6. | Chi-Square Test in Biological Data. | 1 P |
| 7. | One-way ANOVA for Biological Data set. | 1 P |
| 8. | Two-way ANOVA for Biological Data set. | 2 P |
| 9. | Post-Hoc Analysis (Tukey post-hoc test). | 1 P |
| 10. | Correlation analysis using biology data set. | 1 P |
| 11. | Regression analysis using biology data set. | 1 P |
| 12. | Non-Parametric test in biological research Mann–Whitney U. | 1 P |
| 13. | Non-Parametric tests in biological research Wilcoxon Signed Rank. | 1 P |
| 14. | Non-Parametric tests in biological research Kruskal–Wallis. | 1 P |

**Note:** The above-mentioned practical should perform using JAMOVI software.

# SEMESTER - V

| COURSE DETAILS | COURSE CODE | COURSE TITLE | CREDITS |
|---|---|---|---|
| Vertical – 2 (V2) | | | |
| Minor Courses – (1 T = 2 C) (Any one from basket) | BOT-341-MN-T | Vegetable Seed Production | 2 C |
| | BOT-342-MN-T | Nursery Management, Landscape Designing and Gardening | |
| | BOT-343-MN-T | Feed and Fodder Production Technology | |

## T.Y.B.Sc. Botany [Semester - V]

## Course Category – Minor Course (MN)

## Course Code – BOT-341-MN-T

## Course Title: Vegetable Seed Production

**[No. of Credits: 2 C]** **[No. of Lectures: 30 L]**

**COURSE OBJECTIVES:**

1. To understand the basic knowledge of different aspects of vegetable seed production.
2. To imbibe the knowledge of hybridization techniques.
3. To impart the knowledge about breeding and recent advances of vegetable seed production.
4. To make the students aware of the vegetable crops.
5. To gain the knowledge regarding Vegetable Nursery Management.

**COURSE OUTCOMES (COS):**

**CO1:** Students will learn about concept of different aspects of vegetable seed production.
**CO2:** Students are able to learn pollination, emasculation, Bagging and tagging.
**CO3:** Understand recent advances in vegetable seed production of hybridization techniques.
**CO4:** Get knowledge of aware about the breeding and recent advances of vegetable seed Production.
**CO5:** They will gain the knowledge regarding plant Population Improvement.

| Sr. No. | Topic Details | No. of Lectures |
|---|---|---|
| | **CREDIT I** | **15 L** |
| **1.** | **Introduction to Vegetable Seed Production**<br>1.1 Concept and objectives of vegetable Seed production<br>1.2 History of vegetable seed production<br>1.3 Present status and importance of vegetable seed production<br>1.4 Top five vegetable seed industries in India. | **03** |
| **2.** | **Classification of vegetable crops**<br>2.1 Classification based on botanical family<br>2.2 Classification based on growing season<br>2.3 Classification based on life cycle - Annual, Biennials and Perennials<br>2.4 Classification based on plant part used for consumption<br>2.5 Classification based on Method of Cultivation - Direct sown crops and Transplanted crops. | **03** |
| **3.** | **Vegetable Farming**<br>3.1 Introduction<br>3.2 Types: Home or Kitchen garden, Market garden, Truck garden<br>3.3 Processing of Vegetable: Primary Processing, Secondary Processing and Value-added processing. | **04** |

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|---|---|---|
| **4.** | **Hybridization techniques in Vegetable crops**<br>4.1 Introduction and objectives<br>4.2 Use of male sterility and self-incompatibility in hybrid seed production.<br>4.3 Steps involved in hybridization: Selection of parents, Emasculation, Pollination, Bagging and tagging; Collection of seeds.<br>4.4 Important breeding methods used to develop improved varieties and hybrids - Simple, Back cross and Test cross.<br>4.5 True potato seed (TPS) production technique.<br>4.6 Advantages of hybridization techniques in vegetable crops. | **05** |
| | **CREDIT II** | **15 L** |
| **5.** | **Vegetable Nursery Management**<br>5.1 Introduction<br>5.2 Types of Nursery beds:<br>5.2.1 Raised bed<br>5.2.2 Flat bed<br>5.2.3 Hi-tech Nursery and Soil less raising of seedlings<br>5.3 Transplantation technique of seedlings<br>5.4 Precautions in raising healthy seedlings | **03** |
| **6.** | **Breeding methods in Vegetable crops**<br>6.1 Introduction<br>6.2 Selection methods<br>6.2.1 Pure line selection<br>6.2.2 Pedigree selection<br>6.2.3 Bulk method | **03** |
| **7.** | **Population Improvement**<br>7.1 Introduction<br>7.2 Objectives of population improvement<br>7.3 Methods of population improvement:<br>7.3.1 Mass Selection<br>7.3.2 Progeny Selection<br>7.4 Application and achievements of Population Improvement. | **04** |
| **8.** | **Seed Production Technique in Vegetables**<br>8.1 Seed production procedure in the plants - Brinjal, Tomato, Bitter guard and Onion with reference to….<br>8.1.1 Land requirement<br>8.1.2 Isolation<br>8.1.3 Nursery management<br>8.1.4 Cultural practices<br>8.1.5 Rouging<br>8.1.6 Plant protection<br>8.1.7 Harvesting<br>8.1.8 Seed extraction method<br>8.1.9 Seed drying<br>8.1.10 Storage | **05** |

**REFERENCES:**


1. Vegetables-B. R. Choudhary, 2014. Kalyani Publishers, New Delhi
2. Handbook of Agriculture- Indian Council of Agricultural Research, New Delhi
3. Plant breeding-B.D Singh, Kalyani Publishers, New Delhi
4. Essentials of Plant Breeding- Phundan Singh, 2008
5. Experimental Seed Science and Technology -Umaraniet. al. 2006., Agrobios, Jodhpur
6. Plant Breeding: Principles and Methods- Phundan Singh, 2009. Kalyani Publishers, New Delhi.
7. Seed Technology-Agrawal, 2005. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi
8. Principles of crop production-Reddy, 2008. Kalyani Publishers, New Delhi
9. Bassett, M.J. (1986) Breeding vegetable crops. AVI Publishing Comp. Dennis R. Decoteau (2000) Vegetable Crops. Prentice Hall.
10. Desai BB, Katecha, PM & Salunke DK.1997. Seed Hand Book: Biology, Production, Processing and Storage. Marcel Dekker.

## T.Y.B.Sc. Botany [Semester - V]

## Course Category –Minor Courses (MN)

## Course Code – BOT-342-MN-T

## Course Title: Nursery Management, Landscape Designing and Gardening

**[No. of Credits: 2 C]** **[No. of Lectures: 30 L]**

**COURSE OBJECTIVES:**

1. To understand the fundamental concepts, infrastructure requirements, and operational techniques of plant nurseries.
2. To gain practical knowledge of sexual and asexual plant propagation methods.
3. To learn the aesthetic and ecological principles of landscape designing.
4. To acquire skills in garden planning, execution, and maintenance.
5. To explore the entrepreneurial scope in commercial nursery and landscaping businesses.

**COURSE OUTCOMES (COS):**

**CO 1:** Proficiency in various plant propagation methods and technique.
**CO 2:** Design and manage nursery infrastructure.
**CO 3:** Apply aesthetic principles to landscapes.
**CO 4:** Categorize and select ornamental flora.
**CO 5:** Develop Technical Maintenance Skills.
**CO 6:** Formulate entrepreneurial strategies.

| Sr. No. | Topic Details | No. of Lectures |
|---|---|---|
| | **CREDIT I – Nursery Management** | **15 L** |
| **1.** | **Introduction and Infrastructure of Nursery**<br>1.1 Definition, objectives, scope, and types of nurseries.<br>1.2 Site selection and layout for a nursery site - Allocation of space for different activities.<br>1.3 Importance and design of polyhouses, net houses, mist chambers, and cold frames.<br>1.4 Types of potting media - soil, coco peat, perlite, vermiculite, sphagnum moss<br>1.5 Sterilization of media<br>1.6 Types of containers required in nursery management | **04** |
| **2.** | **Plant Propagation Techniques**<br>2.1 Sexual Propagation: Seed viability, seed dormancy - types and breaking methods; seed treatment, and sowing techniques.<br>2.2 Vegetative/Asexual Propagation: Cuttings - root, stem, leaf; Layering - simple, air layering/gootee; Grafting - approach, veneer, cleft; and Budding - T-budding, patch budding.<br>2.3 Micropropagation: Brief introduction to commercial tissue culture applications in nurseries. | **05** |
| **3.** | **Nursery Operations and Maintenance**<br>3.1 Pruning, training, repotting, and hardening of plants. | **04** |

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| | 3.2 Irrigation and Nutrition: Types of irrigation – drip and sprinkler; water management; application of organic manures and inorganic fertilizers.<br>3.3 Common nursery pests, fungal, and bacterial diseases.<br>3.4 Integrated Pest Management (IPM) and safe use of agrochemicals. | |
| **4.** | **Economics and Marketing**<br>4.1 Management: Cost analysis, budgeting, and essential record-keeping in nursery business.<br>4.2 Marketing: Supply chain management, packaging of plants, marketing strategies, and exploring online retail platforms. | **02** |
| | **CREDIT II: Landscape Designing and Gardening** | **15 L** |
| **5.** | **Introduction and Principles of Landscaping**<br>5.1 Definition, scope, and objectives of landscape architecture.<br>5.2 Role of a botanist/horticulturist in landscaping.<br>5.3 Core Principles of landscaping: Unity; balance - symmetrical and asymmetrical; proportion; rhythm; focal point/accent; and harmony.<br>5.4 Colour Theory in landscaping. | **04** |
| **6.** | **Elements of Landscape Design**<br>6.1 Soft Elements: Trees - Avenue, Shade, Flowering; Shrubs; Climbers; Creepers; and Ground covers - Palms, Ferns, and Cacti/succulents.<br>6.2 Hard Elements: Paths, walkways, fences, pergolas, trellises, arches, and water features – fountains and ponds.<br>6.3 Lawn Management: Selection of grass species; Site preparation; Planting methods - Turfing, Dibbling, Sprigging; and maintenance - Mowing, Weeding, and Rolling. | **05** |
| **7.** | **Types of Gardens and Special Gardening**<br>7.1 Garden Styles: Features of Formal (e.g., Mughal, Persian), Informal (e.g., English, Japanese), and Free-style gardens.<br>7.2 Specialized Gardens: Terrace/Roof gardens, Vertical gardens (green walls), and Rock gardens.<br>7.3 Indoor Gardening: Selection of indoor plants, light and humidity requirements, Bonsai, Terrariums, and Kokedama. | **04** |
| **8.** | **Execution and Maintenance**<br>8.1 Irrigation required for landscaping.<br>8.2 Maintenance and management of landscape plants. | **02** |

**REFERENCES:**


1. Bose, T. K., & Mukherjee, D. (1972). Gardening in India. Oxford & IBH Publishing Co.
2. Kumar, N. (1997). Introduction to Horticulture. Rajalakshmi Publications, Nagercoil.
3. Randhawa, G. S., &bMukhopadhyay, A. (1986). Floriculture in India. Allied Publishers.
4. Ray, P. K. (2012). Plant Nursery Management: How To Start And Operate A Plant Nursery. Scientific Publishers.
5. Trivedi, P. P. (1987). Home Gardening. ICAR, New Delhi.

## T.Y.B.Sc. Botany [Semester - V]

## Course Category – Minor Course (MN)

## Course Code – BOT-343-MN-T

## Course Title: Feed and Fodder Production Technology

**[No. of Credits: 2 C]** **[No. of Lectures: 30 L]**

**COURSE OBJECTIVES:**

1. To understand basic concepts and the importance of feed and fodder.
2. To study classification and types of feeds.
3. To learn feed processing, preservation, packaging, and marketing.
4. To identify important cereal and legume fodder crops.
5. To understand scientific fodder production practices.

**COURSE OUTCOMES (COS):**

**CO 1:** Explain the role of feed and fodder in livestock production.
**CO 2:** Classify feeds and describe their nutritional importance.
**CO 3:** Understand feed manufacturing and preservation methods.
**CO 4:** Identify major fodder crops and their characteristics.
**CO 5:** Apply basic fodder production and marketing practices.

| Sr. No. | Topic Details | No. of Lectures |
|---|---|---|
| | **CREDIT I – Feed Production Technology** | **15 L** |
| **1.** | **Introduction to Feed**<br>1.1 Introduction, definition and characteristics of Feed<br>1.2 Importance in the livestock, fishery and poultry industry<br>1.3 Importance and scope of feed<br>1.4 Feed: role in food security and rural economy | **03** |
| **2.** | **Classification and types of feeds**<br>2.1 Basic Classification of Feeds - Roughages, Concentrates and Supplements<br>2.2 Roughages: Types - Green fodder, Dry fodder, Silage and hay with examples and nutritional significance<br>2.3 Concentrates: Energy feeds - cereals; Protein feeds - oilseed cakes and meals; Importance in ration formulation<br>2.4 Supplements and feed additives: Mineral mixtures; Vitamin supplements; Feed additives - probiotics, enzymes, and antibiotics.<br>2.5. Role in balanced ration | **05** |
| **3.** | **Feed & Mineral Mixture Manufacturing Process**<br>3.1. Introduction to the principles of material handling, Processing of feeds and forages.<br>3.2. Feed Processing methods: grinding, mixing, pelleting, crumbling, flaking, popping, extrusion. Roughage processing methods, dry processing methods, wet processing methods.<br>3.3. Principles of mixing and compounding feeds. | **04** |

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| | 3.4 Preservation of feeds | |
| **4.** | **Packaging and Marketing**<br>4.1. Introduction–importance of packaging.<br>Packaging materials: characteristics of basic packaging materials - paper board, corrugated paper, and fibre board; Glass, metal, plastics, foils and laminates, retort pouches, earthen pots, wood, and leaves, Package forms.<br>4.2. Legal requirements of packaging materials and product information, Coding and labelling of packages.<br>4.3. Principles and methods of packaging,<br>4.4 Disposal of waste packaging materials.<br>4.5 Market price determination under perfect competition in the short and long run. | 03 |
| | **CREDIT II – Fodder Production Technology** | **15 L** |
| **5.** | **Introduction to Fodder**<br>5.1 Introduction and characters of fodder and forage<br>5.2 Indigenous and exotic fodders and by-products<br>5.3 Importance and scope of fodders | **03** |
| **6.** | **Important grasses as a Fodder**<br>6.1 Introduction of cereals as a fodder<br>6.2 Study of the following cereal fodders with respect to botanical name, family name, common name, centre of origin, morphological diagnostic characters, fodder value, importance of forage and its by-products: Elephant grass and Maize | **03** |
| **7.** | **Important Legumes as a Fodder**<br>7.1 Importance of legumes as fodder<br>7.2 Study of the following legume fodders with respect to botanical name, family name, common name, centre of origin, morphological diagnostic characters, forage and its by-products: Berseem and Lucerne (alfalfa) | **04** |
| **8.** | **Fodder Crop Production Practices**<br>8.1 Concept and advantages of mixed fodder cropping: Cereal-legume fodder mixtures<br>8.2 Land preparation, sowing methods and seed rate<br>8.3 Fodder production through hydroponics with any one example<br>8.4 Storage and Marketing | **05** |

**REFERENCES:**

1. Ranjhan, S.K. (1998). *Animal Nutrition and Feeding Practices in India*.Indian Council of Agricultural Research, New Delhi.
2. Reddy, D.V. (2001). *Principles of Animal Nutrition and Feed Technology*. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
3. Kellems, R.O. & Church, D.C. (2010). *Livestock Feeds and Feeding*. Prentice Hall, USA.
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13. FAO (2018). *Hydroponic Fodder Production Manual*.Food and Agriculture Organization, Rome.
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# SEMESTER - V

| COURSE DETAILS | COURSE CODE | COURSE TITLE | CREDITS |
|---|---|---|---|
| Vertical – 4 (V4) | | | |
| Vocational Skill Courses (VSC) – (1 T/ P= 2 C) (Any one from basket) | BOT-321-VSC-T | Intellectual Property Rights (IPR) | 2 C |
| | BOT-322-VSC-P | Stress Physiology of Agricultural Crops | |
| | BOT -323-VSC-P | Advanced Plant Biotechnology | |

## T.Y.B.Sc. Botany [Semester - V]

## Course Category – Vocational Skill Courses (VSC)

## Course Code – BOT-321-VSC-T

## Course Title: Intellectual Property Rights (IPR)

**[No. of Credits: 2 C]** **[No. of Lectures: 30 L]**

**COURSE OBJECTIVES:**

1. To understand basic concepts of Intellectual Property Rights (IPR).
2. To introduce students to patents, copyrights, and trademarks in simple terms.
3. To explain protection of plant varieties and farmers' rights.
4. To create awareness about the importance of IPR in agriculture and biodiversity.

**COURSE OUTCOMES (COS):**

**CO 1:** Understand basic types of IPR and their importance.
**CO 2:** Identify how inventions and plant varieties are protected.
**CO 3:** Explain farmers' rights and biodiversity conservation issues.
**CO 4:** Apply basic IPR knowledge in agriculture and plant science.

| Sr. No. | Topic Details | No. of Lectures |
|---|---|---|
| | **CREDIT I** | **15 L** |
| **1.** | **Introduction to IPR**<br>1.1 Definition and concept of Intellectual Property with examples<br>1.2 Types of Intellectual Property -Patent, Copyright, Trademark and GI with at least two examples of each<br>1.3 Importance of IPR in daily life and agriculture with examples<br>1.4 Basic idea of origin and development of IPR<br>1.5 National and International IPR Framework | **03** |
| **2.** | **Patent**<br>2.1 Definition and concept of Patent<br>2.2 Categories of Patent with examples - New product, New process or method and Improvement in existing technology<br>2.3 Basic requirements - Novelty, Usefulness and Non-obviousness<br>2.4 Simple idea of patent procedure<br>2.5 Examples related to Plants and Biotechnology – Examples - Pharmaceutical drug formulation, Agricultural machinery such as improved seed drill, etc.<br>2.6 Overview of Indian Patent Act | **04** |
| **3.** | **Copyright and Trademark**<br>3.1 Copyright – Definition, concept and characteristics<br>3.2 Rights of Author - Rights in Books and Publications, ISBN for Books, ISSN for Journals and Research Articles<br>3.3 Duration of protection<br>3.4 **Trademark** - Meaning and importance<br>3.5 Types of Trademarks - Brand name, Logo and Symbol with examples | **05** |

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| | 3.6 Basic idea of Registration<br>3.7 Examples w.r.t. agricultural products and companies<br>3.7.1 Agricultural product - Aashirvaad Atta, Fortune Sunflower Oil etc.<br>3.7.2 Agricultural company - Bayer Crop Science, Syngenta etc. | |
| **4.** | **Design and Geographical Indication (GI)**<br>4.1 Design – Concept of industrial design<br>4.2 Importance in product appearance<br>4.3 Geographical Indication (GI) – Concept with examples - Basmati rice, Darjeeling Tea, Alphonso Mango, Nagpur Orange, Kashmir Saffron<br>4.4 Difference between GI and Trademark<br>4.5 Importance of GI in agriculture and rural economy | **03** |
| | **CREDIT II** | **15 L** |
| **5.** | **Plant Variety Protection (PVP)**<br>5.1 Concept of Plant Variety Protection (Examples - Disease resistant rice variety, High-yield hybrid tomato variety)<br>5.2 Importance in agriculture<br>5.3 Farmers rights - saving and using seeds<br>5.4 Simple idea of registration and protection | **04** |
| **6.** | **Plant Breeders' Rights (PBR)**<br>6.1 Concept and Importance<br>6.2 Basic idea of UPOV ( International Union for the Protection of New Varieties of Plants)<br>6.3 Introduction to PPV and FR Act, 2001<br>6.4 Rights of Breeders and Farmers<br>6.5 Advantages and disadvantages of PBR<br>6.6 Case studies w.r.t. crop varieties | **06** |
| **7.** | **Biodiversity and IPR**<br>7.1 Introduction to Convention on Biological Diversity<br>7.2 Importance of biodiversity conservation (Example - Protection of traditional biological resources: Neem, Turmeric,<br>7.3 Recognition and protection through Geographical Indications (GI) - Basmati Rice, Darjeeling Tea,<br>7.4 Protection of new plant varieties through IPR - Pusa Basmati 1121, Sonalika Wheat<br>7.5 Role of traditional knowledge | **02** |
| **8.** | **IPR Management and Awareness**<br>8.1 Importance of protecting inventions<br>8.2 Basic idea of commercialization - selling ideas and products<br>8.3 Role of IPR in agriculture and biotechnology<br>8.4 Case studies w.r.t. medicinal plants and seeds | **03** |

**REFERENCES:**

1. B.D. Singh – Plant Breeding: Principals and Methods
2. Cell for IPR Promotion and Management http://cipam.gov.in/
3. Introductory material from World Intellectual Property Organization
4. Journal of Intellectual Property Rights (JIPR): NISCAIR

5. Neeraj, P., &Khusdeep, D. (2014). Intellectual Property Rights. India, IN: PHI learning.
6. Office of the Controller General of Patents, Designs & Trademarks http://www.ipindia.nic.in/
7. World Intellectual Property Organization https://www.wipo.int/about-ip/en/
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## T.Y.B.Sc. Botany [Semester - V]

## Course Category – Vocational Skill Courses (VSC)

## Course Code – BOT-322-VSC-P

## Course Title: Stress Physiology of Agricultural Crops

**[No. of Credits: 2 C]** **[No. of Lectures: 60 L]**

**COURSE OBJECTIVES:**

1. To understand the principle and working of instruments used in plant physiology and biochemistry.
2. To study the effects of salinity and drought stress on crop plants.
3. To learn physiological and biochemical methods used in stress analysis of plants.
4. To evaluate seed germination and seedling growth under stress conditions.
5. To study biochemical changes such as proline, protein, chlorophyll, and enzyme activity in stressed plants.
6. To develop practical skills through laboratory experiments and institutional visits.

**COURSE OUTCOMES (COS):**

**CO1:** Students will operate basic instruments used in physiology and biochemistry laboratories.
**CO2:** Students will conduct pot culture experiments under salinity and drought stress conditions.
**CO3:** Students will analyse morphological and physiological responses of stressed plants.
**CO4:** Students will estimate biochemical parameters such as proline, protein, and chlorophyll content.
**CO5:** Students will evaluate membrane stability, stomatal characteristics, and relative water content in plants.
**CO6:** Students will understand research methodologies used in plant stress physiology and biochemistry.

| Sr. No. | Title of the Practical | No. of Practical |
|---|---|---|
| 1. | Principle and working of instruments used in physiology and biochemistry: UV- Visible Spectrophotometer, Electric Conductivity Meter, pH Meter, Hot Air Oven, Centrifuge and Micropipette. | 1 P |
| 2. | Setup a pot culture experiment to impose salinity/drought stress in crop plants to study various physiological and biochemical parameters. | 2 P |
| 3. | Evaluation of seed germination and seedling growth parameters under Salinity/water stress in relation to control condition. | 1 P |
| 4. | Study of comparative morphological parameters in control and stressed crop plants. | 1 P |
| 5. | Study of stomatal frequency and stomatal index under stress condition. | 1 P |
| 6. | Determination of Relative Water Content (RWC) under drought/ salt stress by Barrs and Weatherley (1962) method. | 1 P |
| 7. | *In situ* localization of superoxide and hydrogen peroxide under stress condition. | 1 P |
| 8. | Estimation of proline content in leaves of stressed plants by using Bates *et* | 1 P |

| | | |
|---|---|---|
| | *al.* (1973) method. | |
| **9.** | Estimation of peroxidase activity under stress condition by using Vidyasekharan and Durairaj (1973) method. | **1 P** |
| **10.** | Determination of Membrane Stability Index (Electrolyte Leakage Test) of stressed crop plants by Deshmukh *et al.* (1991) method. | **1 P** |
| **11.** | Estimation of chlorophyll content under stress condition by Arnon's (1949) method. | **1 P** |
| **12.** | Estimation of chlorophyll stability index in two varieties or species of crops under stress condition. | **1 P** |
| **13.** | Estimation of total soluble protein content in crop plants under stress condition by Lowry *et al.* (1951) method. | **1 P** |
| **14.** | Visit to National Institute of abiotic stress management/ nearby Krishi Vigyan Kendra / MPKV, Rahuri / Any Agricultural Institute. | **1 P** |

## T.Y.B.Sc. Botany [Semester - V]

## Course Category – Vocational Skill Courses (VSC)

## Course Code – BOT-323-VSC-P

## Course Title: Advanced Plant Biotechnology

**[No. of Credits: 2 C]** **[No. of Lectures: 60 L]**

**COURSE OBJECTIVES:**

1. To impart hands-on training in plant tissue culture techniques including media preparation, sterilization, callus induction, and micropropagation.
2. To develop skills in handling basic biotechnology laboratory instruments such as autoclave, laminar air flow cabinet, micropipettes, centrifuge, and gel electrophoresis unit.
3. To train students in isolation, purification, quantification, and analysis of plant genomic DNA and plasmid DNA using standard molecular techniques.
4. To provide practical exposure to molecular tools such as PCR, restriction digestion, and molecular marker analysis used in plant biotechnology.
5. To introduce students to basic plant genetic transformation methods and screening of transformants.
6. To cultivate scientific temper through experimental design, data recording, result interpretation, laboratory safety practices, and preparation of practical records/reports.

**COURSE OUTCOMES (COS):**

**CO1:** Demonstrate knowledge of fundamental principles of plant tissue culture, genetic engineering, and molecular plant biotechnology.

**CO2:** Prepare culture media, maintain aseptic conditions, and perform in vitro propagation techniques including callus induction and micropropagation.

**CO3:** Isolate, quantify, and analyse plant genomic DNA and plasmid DNA using standard molecular biology techniques such as PCR and gel electrophoresis.

**CO4:** Apply molecular markers (RAPD/SSR) and basic bioinformatics tools for plant genetic analysis and crop improvement studies.

**CO5:** Explain and perform basic plant transformation techniques including *Agrobacterium*-mediated methods and evaluate transgenic confirmation strategies.

**CO6:** Develop laboratory skills, data interpretation ability, scientific documentation, and ethical awareness related to plant biotechnology research and applications.

| Sr. No. | Title of the Practical | No. of Practical |
|---|---|---|
| 1. | Preparation of buffers, reagents and stock solutions for Plant Tissue Culture. | 1 P |
| 2 | Basics and Lab Setup: Lab organization, safety, aseptic techniques, Calibration and use of micropipettes, water bath, centrifuge, shaker, Incubator, Electrophoresis units, Gel-Doc. | 1 P |
| 3. | Initiation of callus culture from leaf explants and production of secondary metabolites (production can be interactive). | 1 P |
| 4. | Micropropagation: Shoot tip and meristem cultures (banana/rose/coleus). | 1 P |
| 5. | Hardening and acclimatization of *in vitro* plants (Primary and Secondary). | 1 P |
| 6. | Demonstration of anther (E.g. *Datura*), endosperm Culture and Production of | 1 P |

| | | |
|---|---|---|
| | Haploids and Triploids (eg. Wheat/Maize) respectively (production can be interactive). | |
| **7.** | Isolation of genomic DNA from plant tissues using CTAB method) followed by its quantitative and qualitative analysis using UV spectrophotometry (260:280 ratio). | **2 P** |
| **8.** | Separation of DNA by Agarose Gel Electrophoresis. | **1 P** |
| **9.** | Separation of Proteins by Poly Acrylamide Gel Electrophoresis (PAGE) analysis. | **2 P** |
| **10.** | Introduction to *Agrobacterium*-mediated transformation methods (can be interactive). | **1 P** |
| **11.** | PCR amplification of plant DNA and marker analysis (RAPD/SSR) (can be interactive). | **1 P** |
| **12** | Problems on Genetic Engineering (Problem set on Restriction digestion/Vectors). | **1 P** |
| **13.** | Visit to Plant Tissue Culture Laboratory / Research Unit in Biotechnology. | **1 P** |

**REFERENCES:**


1 Bhojwani S. S. &RazdanM. K., *Plant Tissue Culture: Theory and Practice*

2 Dodds J.H. & Roberts L.W., *Experiments in Plant Tissue CultureCaldentey K.M.O. et al.,Plant Biotechnology and Transgenic Plants*

3 A Plant Biotechnology Laboratory ManualKerala Agricultural UniversityGamborg& Phillips Plant Cell, Tissue, and Organ Culture: Fundamental Methods (Springer)

4 Plant Tissue Culture: Techniques and Experiments by Roberta H. Smith: A practical, experiment-based manual.

5 Practical Manual for Plant Tissue Culture(Grin Verlag): A practical guide covering basic techniques.

6 Plant Tissue Culture: A Lab Manual(by S.K. Dey& S.K. Ghosh): A comprehensive guide designed for UG and PG students.

7 Laboratory Manual for Plant Biotechnology by H.S. Chawla: An in-depth manual for biotechnology practices.

8 Plant Tissue Culture- A Lab Manual by DipuSamanta, Debleena Roy.

# SEMESTER - V

| COURSE DETAILS | COURSE CODE | COURSE TITLE | CREDITS |
|---|---|---|---|
| Vertical – 6 (V6) | | | |
| FP / CEP – (2 C) | BOT-331-FP / BOT-331-CEP | Field Project (FP) / Community Engagement Programme (CEP) in Botany | 2 C |

# T.Y.B.Sc. Botany [Semester - V]

## Course Category – On Job Training (OJT)

## Course Code – BOT-331-FP / BOT-331-CEP

## Course Title: Field Project (FP) / Community Engagement Programme (CEP) in Botany

**[No. of Credits: 2 C]** **[No. of Lectures: 60 L]**

## Guidelines for Field Project (FP) in Botany

**A. Purpose of Field Project:**

Field projects help students gain practical knowledge of plant science through field observation, data collection, experimentation and environmental study. It enhances scientific thinking, research skills and understanding of biodiversity and ecosystem management.

**B. Objectives of Field Project:**

1. To develop field-based scientific and observational skills.
2. To understand plant diversity and ecological relationships.
3. To train students in collection, identification and documentation of plant species.
4. To encourage research aptitude and environmental awareness.
5. To provide practical exposure to botanical applications in agriculture, forestry and conservation.

**C. Expected Outcomes:**

After completion of field project, students will be able to:

1. Conduct botanical field surveys independently.
2. Identify and document plant species scientifically.
3. Analyze ecological and environmental data.
4. Prepare scientific reports and herbarium records.
5. Understand conservation and sustainable utilization of plant resources.

**D. Suggested Areas for Field Projects:** Students may select projects related to:

- Plant biodiversity assessment
- Medicinal plants survey
- Ethnobotanical studies
- Weed flora analysis
- Pollination ecology
- Nursery and plantation management
- Urban gardening
- Seed germination studies
- Soil and water conservation
- Study of invasive plant species
- Apiculture and bee flora
- Sericulture and host plants
- Mangrove or forest vegetation studies
- Algal or fungal diversity
- Organic farming practices

**E. Field Project Activities:**

1. Selection of study area/topic.
2. Field survey and plant collection.
3. Identification and classification of plant species.
4. Preparation of herbarium specimens.
5. Recording ecological observations.
6. Collection and analysis of field data.
7. Preparation of charts, maps or photographs.
8. Report writing and presentation.

**F. Student Responsibilities:**

1. Follow environmental ethics during field visits.
2. Avoid damage to natural habitats.
3. Maintain field notebook and records.
4. Work cooperatively in groups.
5. Follow safety measures during fieldwork.
6. Submit project report within scheduled time.

**G. Role of Teacher/Supervisor:**

1. Guide students in topic selection and methodology.
2. Monitor field activities and progress.
3. Assist in identification and data interpretation.
4. Evaluate reports and presentations.

**H. Evaluation Criteria:**

| Component | Marks (%) |
|---|---|
| Field Work and Participation | 30% |
| Data Collection and Analysis | 25% |
| Project Report compilation | 25% |
| Presentation / Viva Voce | 20% |

# Guidelines for Community Engagement Program (CEP) in Botany

**A. Purpose of Community Engagement:**

Community engagement programs connect students with society through activities related to environmental conservation, sustainable agriculture, medicinal plants, biodiversity awareness and green initiatives.

**B. Objectives of Community Engagement Program:**

1. To create environmental awareness among the community.
2. To promote sustainable use of plant resources.
3. To encourage social responsibility among students.
4. To apply botanical knowledge for community welfare.
5. To develop communication and leadership skills.

**C. Expected Outcomes:**

After completion of the program, students will be able to:

1. Apply botanical knowledge for social and environmental benefit.
2. Demonstrate leadership and communication skills.
3. Promote environmental sustainability practices.
4. Develop awareness about conservation of plant resources.
5. Strengthen community participation in green initiatives.

**D. Suggested Community Engagement Activities:** Students may organize or participate in:

- Tree plantation drives
- Herbal garden establishment
- Medicinal plant awareness campaigns
- Kitchen garden promotion
- Organic farming awareness
- Biodiversity conservation programs
- Plastic-free and green campus campaigns
- Pollinator conservation awareness
- Seed collection and distribution programs
- Water conservation awareness
- Vermicomposting demonstrations
- Awareness on invasive weeds
- Farmer interaction programs
- School awareness activities on plants and environment

**E. Implementation Guidelines:**

1. Identify community needs and suitable activity.
2. Coordinate with local bodies, NGOs or schools.
3. Prepare activity plan and schedule.
4. Conduct awareness programs using posters, demonstrations and lectures.
5. Encourage community participation.
6. Maintain documentation and feedback records.

**F. Student Responsibilities:**

1. Participate actively and responsibly.
2. Maintain discipline and teamwork.
3. Respect local culture and community practices.
4. Use eco-friendly materials and practices.
5. Submit activity report with photographs and outcomes.

**G. Role of Faculty Coordinator:**

1. Guide students in planning and execution.
2. Coordinate with community organizations.
3. Monitor student participation and impact.
4. Evaluate reports and outcomes.

**H. Evaluation Criteria:**

| Component | Marks (%) |
|---|---|
| Participation and Teamwork | 30% |
| Planning and Execution | 25% |
| Community Interaction | 20% |
| Report and Documentation | 25% |

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# SEMESTER - VI

## CREDIT FRAMEWORK FOR T.Y.B.Sc. BOTANY, SEMESTER – VI (Level 5.5 / 300)

| COURSE DETAILS | COURSE CODE | COURSE TITLE | CREDITS |
|---|---|---|---|
| **Vertical – 1 (V1)** | | | |
| **Major Core Courses – (4 T + 2 P) x 2 C = 12 C** | BOT-351-MJ-T | Taxonomy of Phanerogams | **2 C** |
| | BOT-352-MJ-T | Genetics | **2 C** |
| | BOT-353-MJ-T | Plant Pathology and Protection | **2 C** |
| | BOT-354-MJ-T | Biochemistry | **2 C** |
| | BOT-355-MJ-P | Practical Based on BOT-351-MJ-T and BOT-352-MJ-T | **2 C** |
| | BOT-356-MJ-P | Practical Based on BOT-353-MJ-T and BOT-354-MJ-T | **2 C** |
| **Major Elective Courses – (1 T + 1 P) x 2C = 4 C (Any one from basket)** | BOT-360-MJ-T | Phyto-clinical Techniques | **2 C** |
| | BOT-361-MJ-T | Agricultural Business Management | |
| | BOT-362-MJ-T | Botany in relation to Apiculture and Sericulture | |
| | BOT-363-MJ-P | Practical Based on BOT-360-MJ-T | **2 C** |
| | BOT-364-MJ-P | Practical Based on BOT-361-MJ-T | |
| | BOT-365-MJ-P | Practical Based on BOT-362-MJ-T | |
| **Vertical – 2 (V2)** | | | |
| **Minor Courses – (0 C)** | ---------- | | **0 C** |
| **Vertical – 3 (V3)** | | | |
| **GE / OE - (0 C)** | ------- | ------- | **0 C** |
| **Vertical – 4 (V4)** | | | |
| **Vocational Skill Courses (VSC) – (1 T/ P = 2 C) (Any one from basket)** | VSC-371-BOT-P | Advances in Fermentation Technology | **2 C** |
| | VSC-372-BOT-P | Commercial Mushroom and SCP Production Technology | |
| | VSC-373-BOT-P | Millets for Sustainable Human Welfare | |
| **SEC – (0 C)** | ------ | ------- | **0 C** |
| **Vertical – 5 (V5)** | | | |
| **IKS - (0 C)** | ----- | ------ | **0 C** |
| **AEC – (0 C)** | ----- | ------ | **0 C** |
| **VEC – (0 C)** | ------- | ------- | **0 C** |
| **Vertical – 6 (V6)** | | | |
| **OJT – (4 C)** | BOT-381-OJT | On Job Training (OJT) in Botany | **4 C** |
| **CC – (0 C)** | ------- | ------- | **0 C** |
| | | **Total Credits (V1+V2+V3+V4+V5+V6)** | **22 C** |
| | | **Total Credits for TYBSC - Semester V (22 C) + Semester VI (22 C)** | **44 C** |

# SEMESTER - VI

| COURSE DETAILS | COURSE CODE | COURSE TITLE | CREDITS |
|---|---|---|---|
| Vertical – 1 (V1) | | | |
| Major Core Courses – (4 T + 2 P) x 2 C = 12 C | BOT-351-MJ-T | Taxonomy of Phanerogams | 2 C |
| | BOT-352-MJ-T | Genetics | 2 C |
| | BOT-353-MJ-T | Plant Pathology and Protection | 2 C |
| | BOT-354-MJ-T | Biochemistry | 2 C |
| | BOT-355-MJ-P | Practical Based on BOT-351-MJ-T and BOT-352-MJ-T | 2 C |
| | BOT-356-MJ-P | Practical Based on BOT-353-MJ-T and BOT-354-MJ-T | 2 C |

## T.Y.B.Sc. Botany [Semester - VI]

## Course Category – Major Course (MJ)

## Course Code – BOT-351-MJ-T

## Course Title: Taxonomy of Phanerogams

**[No. of Credits: 2 C]** **[No. of Lectures: 30 L]**

**COURSE OBJECTIVES:**

**1.** To aware students about the origin of the Phanerogams.
**2**. To equip students with the knowledge and skills to identify, classify and name Phanerogams.
**3.** To make students aware about the APG system of classification.
**4.** To make students aware about the species, speciation and endemism.
**5.** To make students aware about the basic terminologies and concepts in Phylogeny.
**6.** To make students aware about the gymnosperms and their recent classification and economic importance

**COURSE OUTCOMES (COS):**

**CO1:** Students will be able to identify and classify the Phanerogams.
**CO2:** Students will learn about the systems of classifications for Phanerogams.
**CO3:** Students will be able to classify the plants based on external morphology.
**CO4:** Students will understand the important terms and concepts in phylogeny.
**CO5:** Students will understand the concept of Species, speciation and endemism.

| Sr. No. | Topic Details | No. of Lectures |
|---|---|---|
| | **CREDIT I** | **15 L** |
| **1.** | **Introduction to Gymnosperms**<br>1.1 General Characteristics<br>1.2 Outline Classification of Gymnosperms by Chamberlain (1934)<br>1.3 Recent phylogenetic classification<br>1.4 Economic Importance | **03** |
| **2.** | **Study of life cycle of *Pinus***<br>2.1 Distribution, Morphology and Anatomy<br>2.2 Reproduction, Gametophyte, Sporophyte, Seed structure<br>2.3 Alternation of generations | **04** |
| **3.** | **Study of life cycle of *Gnetum***<br>3.1 Distribution, Morphology and Anatomy<br>3.2 Reproduction, Gametophyte, Sporophyte, Seed structure<br>3.3 Alternation of generations<br>3.4 Concept of double fertilization with special reference to *Gnetum* | **04** |
| **4.** | **Origin of angiosperms**<br>4.1 Origin of Angiosperms with reference to time, place and ancestry<br>4.2 Pseudanthial theory<br>4.3Transitional-Combinational Theory | **04** |
| | **CREDIT II** | **15 L** |

| | | |
|---|---|---|
| **5.** | **Species Concepts, Speciation and Endemism**<br>5.1 Species concept w.r.t. Biological, Taxonomic and Phylogenetic Species<br>5.2 Speciation - Allopatric, Sympatric and Parapatric<br>5.3 Introduction to Endemism<br>5.4 Types of endemism - Paleoendemism, Holoendemism and Neoendemism | **04** |
| **6.** | **Basic Terms and Concepts of Phylogeny**<br>6.1 Cladistics: Terms and concepts - Primitive and Advanced; Homology and Analogy<br>6.2 Parallelism and convergence - Monophyly, Paraphyly, Polyphyly, clades and grades<br>6.3. Methodology of Cladistics, Methods of illustrating evolutionary relationships - phylogenetic tree, cladogram | **03** |
| **7.** | **Classification**<br>7.1 Review of Classification systems - Artificial: Linnaeus; Natural: Bentham and Hooker system of classification<br>7.2 History of APG Classification<br>7.3 Principles of APG System<br>7.4 APG IV system of classification: Outline, Merits and Demerits | **02** |
| **8.** | **Study of flowering plant families**<br>8.1 Study of following families with reference to systematic position (as per Bentham and Hooker), Diagnostic characters, and any five examples with their economic importance<br>8.1.1 Brassicaceae and Fabaceae (Papilionaceae)<br>8.1.2 Asteraceae and Acanthaceae<br>8.1.3 Nyctaginaceae<br>8.1.4 Liliaceae and Poaceae | **06** |

**REFERENCES:**


1. An Introduction to Gymnosperms – Chamberlain, C. J. (1934). *Gymnosperms: Structure and Evolution*.
2. Morphology of Gymnosperms – Sporne, K. R. (1965). *The Morphology of Gymnosperms*. Hutchinson University Library.
3. Plant Systematics – Singh, G. (2019). *Plant Systematics: Theory and Practice*. Oxford & IBH Publishing.
4. Taxonomy of Angiosperms – Singh, V. and Jain, D. K. *Taxonomy of Angiosperms*. Rastogi Publications.
5. An Introduction to Plant Taxonomy – Jeffrey, C. (1982). *An Introduction to Plant Taxonomy*. Cambridge University Press.
6. Plant Taxonomy – Sharma, O. P. *Plant Taxonomy*. Tata McGraw Hill.
7. Plant Systematics – Simpson, M. G. (2019). *Plant Systematics*. Academic Press.
8. The Families of Flowering Plants – Hutchinson, J. *The Families of Flowering Plants*. Oxford University Press.
9. Botany for Degree Gymnosperms – Pandey, B. P. *Botany for Degree Students: Gymnosperms*. S. Chand Publications.

10. Botany for Degree Students Taxonomy of Angiosperms – Pandey, B. P. *Taxonomy of Angiosperms*. S. Chand Publications.
11. Systematic Botany – Sharma, R. N. *Systematic Botany and Economic Botany*.
12. Angiosperm Phylogeny Group – APG IV Classification Reports and Publications.

# T. Y. B. Sc. Botany [Semester-VI]

## Course Category – Major Core Course (MJ)

## Course Code – BOT-352-MJ-T

## Course Title: Genetics

**[No. of Credits: 2 C]** **[No. of Lectures: 30 L]**

**COURSE OBJECTIVES:**

1. To understand fundamental principles of inheritance.
2. To study classical Mendelian genetics and gene interactions.
3. To analyse inheritance patterns using genetic crosses
4. To learn about multiple alleles and special inheritance patterns.
5. To understand applications of genetics in plant science and agriculture.

**COURSE OUTCOMES (COS):**

**CO1:** Describe and explain the fundamental principles of Mendelian inheritance.
**CO2:** Perform and accurately interpret monohybrid and dihybrid genetic crosses.
**CO3:** Analyse various inheritance patterns, including incomplete dominance, co-dominance, and gene interactions such as epistasis.
**CO4:** Apply probability principles to solve numerical problems involving genetic ratios.
**CO5:** Relate chromosomal behaviour during meiosis to Mendel's laws of inheritance.

| Sr. No. | Topic Details | No. of Lectures |
|---|---|---|
| | **CREDIT I - Mendelian Genetics** | **15 L** |
| **1.** | **Introduction to Genetics**<br>1.1 History, Concept and Definition<br>1.2 Genetic Terminologies - Heredity, Inheritance, Variation, Gene, Genome, Allele, Locus, Traits, Genotype, Phenotype, Dominant, Recessive, Codominance, Homozygous, Heterozygous<br>1.3 Applications of Genetics. | **02** |
| **2.** | **Mendelian Genetics - I**<br>2.1 Monohybrid Cross<br>2.2 Law of Dominance and Law of Segregation<br>2.3 Incomplete Dominance<br>2.4 Co-Dominance | **03** |
| **3.** | **Mendelian Genetics - II**<br>3.1 Dihybrid Cross<br>3.2 Law of Independent Assortment<br>3.3 Back Cross<br>3.4 Test Cross | **04** |
| **4.** | **Neo - Mendelism**<br>4.1 Allelic and non-allelic interactions<br>4.2 Complementary genes (9:7)<br>4.3 Epistasis: definition and Concept - Recessive epistasis (9:3:4); Dominant epistasis (12:3:1) | **04** |

| | | |
|---|---|---|
| | 4.4 Inhibitory gene interaction (13:3)<br>4.5 Duplicate gene interaction (15:1) | |
| **5.** | **Multiple Alleles**<br>5.1 Introduction, Definition and Concept<br>5.2 Characteristics of Multiple Alleles<br>5.3 Self-Incompatibility in *Nicotiana*<br>5.4 ABO Blood Group in Humans. | **02** |
| | **CREDIT II - Inheritance and Mutation** | **15 L** |
| **6.** | **Cytoplasmic Inheritance**<br>6.1 Introduction, Definition and Concept<br>6.2 Chloroplast: Variegation in Four O 'Clock Plant<br>6.3 Mitochondrial Inheritance-Petite mutant in Yeast | **02** |
| **7.** | **Quantitative Inheritance**<br>7.1 Introduction, Definition and Concept<br>7.2 Example: Cob Length in Maize<br>7.3 Difference between Quantitative and Qualitative Traits | **02** |
| **8.** | **Linkage and Crossing Over**<br>8.1 Linkage: Definition and Concept<br>8.2 Types- Complete and Incomplete Linkage<br>8.3 Crossing Over: Definition and Concept<br>8.4 Types- Single and Double Crossing Over<br>8.5 Gene Mapping, Two point and three point test cross | **03** |
| **9.** | **Sex linked Inheritance**<br>9.1 Definition and Concept<br>9.2 Sex Chromosomes and Autosomes<br>9.3 Inheritance of X -linked Genes: Color blindness in Humans.<br>9.4 Inheritance of Y-Linked Genes: Hypertrichosis.<br>9.5 Sex influenced gene: Definition, Concept and example<br>9.6 Sex limited gene: Definition, Concept and example | **03** |
| **10.** | **Mutation**<br>10.1 Introduction, Definition and Concept<br>10.2 Types: Spontaneous and Induced Mutations<br>10.3 Application of mutation in crop improvement<br>10.4 **Structural and Numerical Changes in Chromosomes**<br>10.4.1 Structural Changes in chromosomes: Definition and Types - Deletions, Duplications, Inversions and Translocations.<br>10.4.2 Numerical changes in chromosomes: Definition and Types - Euploidy: Monoploidy, Diploidy and Polyploidy (Auto and Allopolyploidy); Aneuploidy: Monosomy, Nullisomy, Trisomy, and tetrasomy | **05** |

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1. Verma and Agarwal, Genetics, S. Chand Co, New Delhi.
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## T.Y.B.Sc. Botany [Semester - VI]

## Course Category – Major Core Course (MJ)

## Course Code – BOT-353-MJ-T

## Course Title: Plant Pathology and Protection

**[No. of Credits: 2 C]** **[No. of Lectures: 30 L]**

**COURSE OBJECTIVES:**

1. To equip students with the knowledge and skills to identify, classify the plant diseases.
2. To make students aware regarding the different types of plant disease, their taxonomy and Management strategies.
3. To create awareness regarding protection of plants from diseases using new technologies.
4. To study the role of environmental factors in disease development and control.

**COURSE OUTCOMES (COS):**

**CO1:** Students will be able to identify and classify the plant diseases..
**CO2:** Students will learn about the types of diseases and their management stategies.
**CO3:** Students will adopt new methodologies for plant protection.
**CO4:** Students will study the methods for disease control.

| Sr. No. | Topic Details | No. of Lectures |
|---|---|---|
| | **CREDIT I** | **15 L** |
| **1.** | **Introduction to Plant pathology**<br>1.1 Definition, Concept and Importance<br>1.2 Types of Pathogens and Classification of Diseases<br>1.3 Terms used in Plant Pathology - Inoculum, Parasite, Pathogen, Disease, Incubation, Host. | **02** |
| **2.** | **Disease development**<br>2.1 Causes of Plant diseases<br>2.2 Symptoms and signs of Plant diseases<br>2.3 Pathogenesis - Growth, reproduction, survival and dispersal of Plant pathogens<br>2.4 Disease Triangle | **03** |
| **3.** | **Study of Plant diseases**<br>3.1. Koch's Postulates<br>3.2. Microscopic and macroscopic techniques used in the study<br>3.3. Culture media preparation - PDA, methods for studying microorganisms using serial dilution, Pour Plate, streak plate and spread plate technique. | **03** |
| **4.** | **Bacterial Plant Diseases**<br>4.1 Study of Bacterial diseases w.r.t. causal organism, signs, symptoms and disease management of –<br>4.1.1 Citrus Canker<br>4.1.2 Bacterial Blight of Pomegranate<br>4.1.3 Tomato bacterial wilt | **03** |

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| **5.** | **Fungal Plant Diseases**<br>5.1 Study of Fungal diseases w.r.t. causal organism, signs, symptoms and disease management of –<br>5.1.1 Red Rot of Sugarcane,<br>5.1.2 Head smut of Jowar,<br>5.1.3 Tikka disease of groundnut,<br>5.1.4 Powdery mildew of cucurbits / grapes. | **04** |
| | **CREDIT II** | **15 L** |
| **6.** | **Viral Plant Diseases**<br>6.1 Study of Viral diseases diseases w.r.t. causal organism, signs, symptoms and disease management of –<br>6.1.1 Little Leaf of Brinjal<br>6.1.2 Tomato leaf curl virus | **03** |
| **7.** | **Non parasitic Diseases**<br>7.1 Abiotic factors responsible for injury or disease<br>7.2 Study of diseases - Black Heart of Potato, Chlorosis in Spinach and Mango Necrosis. | **04** |
| **8.** | **Defence strategies**<br>8.1 Defence by plants – Pre-existing and Induced.<br>8.2 Structural and enzymatic defence<br>8.3 Role of Phenolics, Phytoalexins, and Elicitors | **03** |
| **9.** | **Disease Management strategies**<br>9.1 Disease Forecasting<br>9.2 Cultural, Physical, Biological and Chemical methods<br>9.3 Role of Fungicides and bactericides in control<br>9.4 Microbial pesticides<br>9.5 Integrated Disease Management (IDM) | **05** |

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## T.Y.B.Sc. Botany [Semester - VI]

## Course Category –Major Core Course (MJ)

## Course Code – BOT-354-MJ-T

## Course Title: Biochemistry

**[No. of Credits: 2 C]** **[No. of Lectures: 30 L]**

**COURSE OBJECTIVES:**

1. Understand the chemical basis of life.
2. Describe the structure and function of major biomolecules.
3. Explain enzyme action and regulation.
4. Understand basic metabolic pathways.
5. Recognize the biochemical basis of health and disease.

**COURSE OUTCOMES (COS):**

**CO1:** Students will be able to explain the origin of life and basic concepts of biomolecules and biochemistry.

**CO2:** Students will learn to describe the structure, properties, and biological importance of water.

**CO3:** Students will know classify amino acids and proteins and relate their structure to functions and disorders.

**CO4:** Students will understand enzyme structure, mechanism of action, and factors affecting enzyme activity.

**CO5:** Students will be able to study nucleic acids and classify carbohydrates and lipids and describe their functions and applications.

**CO6:** Students will summarize the roles of vitamins and plant secondary metabolites.

| Sr. No. | Topic Details | No. of Lectures |
|---|---|---|
| | **CREDIT I** | **15 L** |
| **1.** | **Foundation of Biochemistry**<br>1.1 From molecules to the first cell (origin of a cell)<br>1.2 Miller and Urey experiment<br>1.3 Biomolecules of a cell<br>1.4 Functional groups in biomolecules<br>1.5 Conformations and configurations of biomolecules<br>1.6 Scope and importance of Biochemistry in - agriculture, medicine, and biotechnology. | **03** |
| **2.** | **Water - The solvent of life**<br>2.1 Physical properties of water<br>2.2 Structure of water molecule,<br>2.3 Polarity of water molecule,<br>2.4 Weak interactions in aqueous solutions | **02** |
| **3.** | **Amino acids and Proteins**<br>3.1 Structure, classification, properties and functions of amino acids.<br>3.2 Structure (primary, secondary, tertiary and quaternary), properties | **05** |

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|---|---|---|
| | and functions of proteins<br>3.3 Biological disorders of amino acid metabolism<br>3.4 Commercial applications | |
| **4.** | **Carbohydrates**<br>4.1 Definition, classification and properties of carbohydrates.<br>4.2 **Monosaccharides:** Aldoses and Ketoses, basic structure, D and L configuration, and linear and cyclic (ring) forms.<br>4.3 **Oligosaccharides:** Formation of glycosidic bonds, reducing and non-reducing sugars with examples such as sucrose, lactose and maltose.<br>4.4 **Polysaccharides:** Homopolysaccharides (starch, glycogen, cellulose) and heteropolysaccharides, their basic structures, distribution and biological roles.<br>4.5 Biological functions and major commercial applications of carbohydrates. | **05** |
| | **CREDIT II** | **15 L** |
| **5.** | **Nucleic Acids**<br>5.1 Definition and importance of nucleic acids,<br>5.2 Structure of nucleotides - nitrogenous base, pentose sugar, phosphate group),<br>5.3 Types of nucleic acids: DNA and RNA,<br>5.4 Structure of DNA as per the Watson and Crick,<br>5.5 Biological functions of nucleic acids. | **02** |
| **6.** | **Enzymes**<br>6.1 Definition, nature of enzymes and co-factors,<br>6.2 Classification and properties of enzymes, active site.<br>6.3 Mechanism of enzyme action: free energy, activation energy, binding energy, transition state, lock and key hypothesis, induced fit theory.<br>6.4 Factors affecting enzyme activity: pH, temperature, substrate concentration, enzyme concentration.<br>6.5 Enzyme inhibition: Competitive, uncompetitive, non-competitive, Reversible and irreversible inhibition, feedback inhibition.<br>6.6 Enzyme Kinetics: Definition and importance of enzyme kinetics, basic concept of the Michaelis–Menten equation. | **06** |
| **7.** | **Lipids**<br>7.1 Definition and classification of lipids: simple, conjugate and derived lipids,<br>7.2 Properties and functions of lipids.<br>7.3 Biological disorders of lipid metabolism.<br>7.4 Commercial applications. | **04** |
| **8.** | **Vitamins**<br>8.1 Definition, classification of vitamins<br>8.2 Source and functions of vitamins<br>8.3 Secondary metabolites in plants: Alkaloids, terpenoids, phenolics, flavonoids,<br>8.4 Biological and ecological significance of secondary metabolites | **03** |

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## T.Y.B.Sc. Botany [Semester - VI]

## Course Category –Major Core Course (MJ)

## Course Code – BOT-355-MJ-P

**Course Title: Practical Based on BOT-351-MJ-T and BOT-352-MJ-T**

**[No. of Credits: 2 C]** **[No. of Lectures: 60 L]**

**COURSE OBJECTIVES:**

1. To understand the fundamental principles of inheritance proposed by Gregor Mendel.
2. To study Mendel's laws – Law of Segregation and Law of Independent Assortment through practical experiments.
3. To perform monohybrid and dihybrid crosses using suitable experimental materials (e.g., pea plant traits or simulated data).
4. To analyse phenotypic and genotypic ratios obtained from experimental crosses.
5. To interpret patterns of dominant and recessive inheritance.
6. To develop skills in recording, tabulating, and interpreting genetic data

**COURSE OUTCOMES (COS):**

**CO1:** Explain the basic concepts of heredity and Mendelian principles.
**CO2:** Perform and analyse monohybrid and dihybrid cross experiments.
**CO3:** Calculate expected ratios and compare them with observed results.
**CO4:** Construct Punnett squares to predict offspring genotypes and phenotypes.
**CO5:** Distinguish between dominant and recessive traits.
**CO6:** Develop analytical and problem-solving skills in classical genetics.

| Sr. No. | Title of the Practical | No. of Practical |
|---|---|---|
| | **CREDIT I – Practical Based on BOT 351-MJ-T** | |
| **1.** | **Preparation and identification of at least Four herbarium specimens** using available resources (Literature, herbaria, e-resources, taxonomic keys) and classify up to family level (according to Bentham and Hooker's System of classification). | **1 P** |
| **2.** | **Study of families** with reference to systematic position (according to Bentham & Hooker System of Classification) Diagnostic characters, floral formula, floral diagram. (Any-04 including all group)<br>Polypetalae: Brassicaceae and Fabaceae (Papilionaceae)<br>Gamopetalae: Asteraceae and Acanthaceae<br>Monochlamydeae: Nyctaginaceae<br>Monocotyledoneae: Liliaceae and Poaceae | **4 P** |
| **3.** | **Study of life cycle of Pinus** - Morphology (Long and Dwarf Shoots, Male and Female Cones), Whole mount of Dwarf Shoot, T.S. of Needle, L.S/ T.S. Male Cone, Whole mount Microsporophyll, Whole mount Microspores, L.S Female Cone (Permanent Slide). | **1 P** |
| **4.** | **Study of life cycle of Gnetum**- Morphology (Long and Dwarf Shoots, Male and Female Cones), T.S. of Stem, L.S/ T.S. Male Cone, Whole mount Microsporophyll, Whole mount Microspores, L.S Female Cone | **1 P** |

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|---|---|---|
| | (Permanent Slide). | |
| **5.** | Botanical excursion; Preparation and submission of visit report and any ten correctly identified digital herbarium. | **1 P** |
| | **CREDIT II – Practical Based on BOT 352-MJ-T** | |
| **6.** | Study of monohybrid and dihybrid crosses with suitable example. | **1 P** |
| **7.** | Study multiple alleles with suitable example. | **1 P** |
| **8.** | Study quantitative inheritance with Cob length in maize. | **1 P** |
| **9.** | Induction of Tetraploidy in Onion Root Tip Cells. | **1 P** |
| **10.** | Study of Multiple Translocation in *Rhoeo*. | **1 P** |
| **11.** | Study two point test cross with suitable example. | **1 P** |
| **12.** | Study three point test cross with suitable example and construct a gene map. | **1 P** |

## T.Y.B.Sc. Botany [Semester - VI]

## Course Category –Major Core Course (MJ)

## Course Code – BOT-356-MJP

## Course Title: Practical Based on BOT-353-MJ-T and BOT-354 MJ-T

**[No. of Credits: 2 C]** **[No. of Lectures: 60 L]**

**COURSE OBJECTIVES:**

1. To introduce students to the principles of plant pathology and microbiological techniques used in identification and study of plant diseases.
2. To develop practical skills in preparation of culture media, microbial isolation, inoculation, and culture techniques used in laboratory investigations.
3. To familiarize students with biochemical analysis methods including qualitative and quantitative estimation of biomolecules and enzyme activities.
4. To provide hands-on experience in laboratory techniques such as chromatography, spectrophotometry, and biochemical assays for plant and microbial studies.
5. To enhance observational and analytical skills through field visits, disease identification, and study of molecular biology concepts such as DNA structure.

**COURSE OUTCOMES (COS):**

**CO1:** Demonstrate knowledge of plant diseases and apply Koch's postulates for identification of pathogenic organisms.
**CO2:** Prepare culture media and perform microbial culture techniques including streak plate, pour plate, spread plate, and serial dilution methods.
**CO3:** Identify and differentiate fungal, bacterial, viral, and non-parasitic plant diseases along with commonly used plant protection chemicals and microbial pesticides.
**CO4:** Perform qualitative and quantitative biochemical experiments for carbohydrates, proteins, amino acids, lipids, reducing sugars, vitamin C, and enzyme activities using standard laboratory methods.
**CO5:** Apply analytical techniques such as spectrophotometry, paper chromatography, and molecular model studies to interpret biological and biochemical data effectively.

| Sr. No. | Title of the Practical | No. of Practical |
|---|---|---|
| | **CREDIT I – Practical Based on BOT-353-MJ-T** | |
| **1.** | Study of Koch's postulates using appropriate material. | **1 P** |
| **2.** | Preparation of PDA culture media and inoculation using serial dilution method. | **1 P** |
| **3.** | Culture Technique- Streak Plate method, Pour plate method and Spread plate method | **1 P** |
| **4.** | Study of any two Fungal and Bacterial plant diseases from the theory. | **1 P** |
| **5.** | Study of any two Viral and Non-Parasitic plant diseases as per theory. | **1 P** |
| **6.** | Demonstration: One popular fungicide, One Popular bactericide and One Microbial pesticide. | **1 P** |
| **7.** | Field visit to nearby locality, collection and submission of any 5-plant disease Photographs observed during visit other than the syllabus. | **1 P** |

| | CREDIT I – Practical Based on BOT-354-MJ-T | |
|---|---|---|
| **8.** | Qualitative tests for Carbohydrates, Proteins, Amino Acids and Lipids using standard solutions. | **1 P** |
| **9.** | Estimation of total free amino acids by spectrophotometry. | **1 P** |
| **10.** | Demonstrate the activity of catalase and study the effect of pH and enzyme concentration. | **1 P** |
| **11.** | Estimation of soluble proteins by Lowery *et. al.* method. | **1 P** |
| **12.** | Separation of amino acids by paper chromatography. | **1 P** |
| **13.** | Estimation of reducing sugars by DNSA method. | **1 P** |
| **14.** | Estimation of Vitamin C (Ascorbic acid) from plants. | **1 P** |
| **15.** | Study of DNA structure (Watson–Crick model) using charts or molecular models. | **1 P** |

# SEMESTER - VI

| COURSE DETAILS | COURSE CODE | COURSE TITLE | CREDITS |
|---|---|---|---|
| Vertical – 1 (V1) | | | |
| Major Elective Courses – (1 T + 1 P) x 2C = 4 C (Any one from basket) | BOT-360-MJ-T | Phyto-clinical Techniques | 2 C |
| | BOT-361-MJ-T | Agricultural Business Management | |
| | BOT-362-MJ-T | Botany in relation to Apiculture and Sericulture | |
| | BOT-363-MJ-P | Practical Based on BOT-360-MJ-T | 2 C |
| | BOT-364-MJ-P | Practical Based on BOT-361-MJ-T | |
| | BOT-365-MJ-P | Practical Based on BOT-362-MJ-T | |

## T.Y.B.Sc. Botany [Semester - VI]

## Course Category –Major Elective Courses

## Course Code –BOT-360-MJ-T

## Course Title: Phyto-Clinical Techniques

**[No. of Credits: 2 C]** **[No. of Lectures: 30 L]**

**COURSE OBJECTIVES:**

1. To introduce students to the fundamental concepts and scope of Phytochemistry and its clinical applications.
2. To familiarize students with the principles and procedures involved in the collection, processing, and preservation of plant materials for analysis.
3. To provide a comprehensive understanding of various solvent systems and extraction techniques used to isolate bioactive compounds from plants.
4. To enable students to learn different chromatographic and spectroscopic methods for the separation, purification, and characterization of phytoconstituents.
5. To impart knowledge on the techniques used for evaluating the quality, safety, and efficacy of herbal drugs, including pharmacopoeia standards.
6. To develop a foundational understanding of clinical trial phases and regulatory guidelines (like AYUSH, WHO) for herbal product development.

**COURSE OUTCOMES (COS):**

**CO1:** Explain the fundamental principles of Phytochemistry and the classification of plant-based drugs.

**CO2:** Demonstrate the correct procedures for the collection, drying, preservation, and authentication of plant material for scientific analysis.

**CO3:** Apply appropriate solvent systems and extraction techniques (conventional and modern) to isolate phytoconstituents from plant matrices.

**CO4:** Perform preliminary phytochemical screening to identify the major classes of secondary metabolites present in a given plant extract.

**CO5:** Utilize basic chromatographic (TLC, Column) and spectroscopic (UV-Vis) techniques for the separation, purification, and preliminary characterization of compounds.

**CO6:** Evaluate the quality and purity of herbal drugs by determining pharmacopoeia parameters.

| Sr. No. | Topic Details | No. of Lectures |
|---|---|---|
| | **CREDIT I** | **15 L** |
| **1.** | **Introduction**<br>1.1 History, scope and importance of medicinal plants in Indian culture.<br>1.2 Classification of crude drugs - Taxonomical, Morphological, Chemical, and Pharmacological<br>1.3 Definition and fundamental principles of the major Indigenous Medical Sciences (IMS): Ayurveda, Siddha, Unani and Ethnobotany | **02** |
| **2.** | **Indigenous Herbal Formulations (Galenicals)**<br>2.1 Definition and significance of Galenicals in IMS | **05** |

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| | 2.2 Extraction processes in traditional medicine:<br>2.2.1 Swarasa (Juice)<br>2.2.2 Kalka (Paste)<br>2.2.3 Kwatha (Decoction)<br>2.2.4 Hima (Cold infusion)<br>2.2.5 Phanta (Hot infusion)<br>2.2.6 Taila (Medicated oil)<br>2.2.7 Asava-Arishta (Fermented formulations) | |
| **3.** | **Collection, Processing, and Preservation of Plant Material**<br>3.1 Good Agricultural and Collection Practices (GACP)<br>3.2 Authentication of plant material – Organoleptic and Microscopic evaluation<br>3.3 Protocols for collection - Season, Age, and Time of day.<br>3.4 Drying methods - Shade drying, Oven drying, and Lyophilisation<br>3.5 Preservation and storage of raw plant materials | **04** |
| **4.** | **Preliminary Phytochemical Screening**<br>4.1 Chemical tests for the identification of major phytoconstituents:<br>4.1.1 Alkaloids - Dragendorff's, Mayer's, and Wagner's tests,<br>4.1.2 Glycosides - Legal's and Baljet's tests<br>4.1.3 Terpenoids and Steroids - Salkowski's, and Lieberman Burchard tests<br>4.1.4 Phenolics and Tannins - Ferric Chloride and Gelatin test<br>4.1.5 Flavonoids - Shinoda test | **04** |
| | **CREDIT II** | **15 L** |
| **5.** | **Quality Control and Standardization of Herbal Drugs**<br>5.1 Importance of standardization<br>5.2 Parameters for quality control as per WHO and Pharmacopoeia guidelines (e.g., Ayurvedic Pharmacopoeia of India)<br>5.3 Determination of ash values, extractive values, moisture content, and heavy metal analysis<br>5.4 Detection of adulteration in herbal drugs | **03** |
| **6.** | **Separation and Purification Techniques**<br>6.2 Chromatography: Principle and applications<br>6.2 Thin Layer Chromatography (TLC): Principle; mobile and stationary phases; preparation of TLC plates; development techniques; detection of spots (Rf value calculation).<br>6.3 Column Chromatography: Principle, packing methods, elution techniques, and fraction collection.<br>6.4 Introduction to Paper Chromatography and HPLC (High-Performance Liquid Chromatography). | **04** |
| **7.** | **Clinical Applications of Herbal Medicines**<br>7.1 Phytomedicine for Gastrointestinal Health: Review of Formulations and their herbal combinations (e.g., Triphala, Hingwashta kchurna).<br>7.2 Phytomedicine for Respiratory Health: Herbal remedies for respiratory diseases (Sitopaladi Churna, Trikatu Churna, Kantakari Avaleha) | **05** |

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| | 7.3 Phytomedicine for Antipyretic (Fever): Herbal remedies for Fever and Inflammation (Giloy – *Tinospora cordifolia* Decoction, Sudarsana Churna / Vati. | |
| **8.** | **Clinical Techniques and Regulatory Activities**<br>8.1 Introduction to clinical trials: Phases of clinical trials - Preclinical, Phase I, II, III, IV.<br>8.2 Overview of regulatory guidelines for herbal drugs (AYUSH, WHO, FDA).<br>8.3 Safety evaluation: Evaluation of safety and efficacy of herbal products. | **03** |

**REFERENCES:**


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## T.Y.B.Sc. Botany [Semester - VI]

## Course Category –Major Elective Course (MJ)

## Course Code –BOT-361-MJ-T

## Course Title: Agricultural Business Management

**[No. of Credits: 2 C]** **[No. of Lectures: 30 L]**

**COURSE OBJECTIVES:**

1. To introduce students to the fundamentals of agribusiness and its role in agriculture.
2. To develop understanding of farm management and agribusiness operations.
3. To familiarize students with marketing, finance, and entrepreneurship in agriculture.
4. To build skills for decision-making in agricultural enterprises.

**COURSE OUTCOMES (COS):**

After completing the course, students will be able to:

**CO1:** Understand the structure and functioning of agribusiness systems.
**CO2:** Apply farm management principles for decision-making.
**CO3:** Analyze agricultural marketing systems and price behavior.
**CO4:** Identify financial sources and manage risks in agriculture.
**CO5:** Develop basic business plans for agribusiness ventures.
**CO6:** Understand supply chain and value addition in agriculture.

| Sr. No. | Topic Details | No. of Lectures |
|---|---|---|
| | **CREDIT I** | **15 L** |
| **1.** | **Introduction to Agribusiness**<br>1.1 Concept, scope, and importance of agribusiness<br>1.2 Components of agribusiness system (input, production, processing, marketing)<br>1.3 Agribusiness in India: structure and status<br>1.4 Role of agribusiness in rural development<br>1.5 Emerging trends in agribusiness | **05** |
| **2.** | **Farm Management Principles**<br>2.1 Meaning, objectives, and scope of farm management<br>2.2 Factors of production (land, labor, capital, management)<br>2.3 Types of farming systems<br>2.4 Cost concepts and farm income measures<br>2.5 Farm planning and budgeting<br>2.6 Decision-making in farm management | **06** |
| **3.** | **Agricultural Marketing**<br>3.1 Concepts and functions of agricultural marketing<br>3.2 Marketing channels and intermediaries<br>3.3 Price determination and market structure<br>3.4 Regulated markets and e-NAM<br>3.5 Storage, grading, and standardization<br>3.6 Problems and reforms in agricultural marketing in India | **04** |

| | CREDIT II | 15 L |
|---|---|---|
| **4.** | **Agribusiness Finance and Risk Management**<br>4.1 Importance of finance in agribusiness<br>4.2 Sources of agricultural finance (institutional and non-institutional)<br>4.3 Credit planning and repayment<br>4.4 Risk and uncertainty in agriculture<br>4.5 Crop insurance and risk management strategies | **05** |
| **5.** | **Agripreneurship and Enterprise Development**<br>5.1 Concept of agripreneurship<br>5.2 Characteristics of successful agripreneurs<br>5.3 Business plan preparation<br>5.4 Government schemes for agribusiness development (e.g., PMFME, Agri-startups) | **05** |
| **6.** | **Supply Chain and Value Addition**<br>6.1 Concept of supply chain management in agriculture<br>6.2 Value chain and value addition<br>6.3 Post-harvest management and processing<br>6.4 Role of cooperatives and Farmer Producer Organizations (FPOs) | **05** |

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7. Government of India – *Economic Survey (Agriculture Chapter)*
8. NABARD Publications – *Agriculture and Rural Development Reports*
9. FAO – *Agribusiness Handbook Series*
10. ICAR – *Handbook of Agriculture.*

## T.Y.B.Sc. Botany [Semester - VI]

## Course Category – Major Elective Courses

## Course Code – BOT-362-MJ-T

## Course Title: Botany in relation to Apiculture and Sericulture

**[No. of Credits: 2 C]** **[No. of Lectures: 30 L]**

**COURSE OBJECTIVES:**

1. To provide knowledge of the botanical basis of apiculture and sericulture.
2. To understand bee flora and pollination biology in relation to crop productivity.
3. To study mulberry cultivation and host plant management for silkworm rearing.
4. To develop awareness about economic importance and entrepreneurship opportunities in apiculture and sericulture.
5. To introduce students to sustainable agricultural practices associated with bee and silk industries.

**COURSE OUTCOMES (COS):**

After successful completion of the course, students will be able to:

**CO1:** Identify important bee flora and host plants used in apiculture and sericulture.
**CO2:** Explain the relationship between plants, pollinators, and crop productivity.
**CO3:** Understand botanical and ecological requirements for beekeeping and silkworm rearing.
**CO4:** Describe cultivation practices of mulberry and other host plants.
**CO5:** Apply basic knowledge for small-scale entrepreneurship in apiculture and sericulture sectors.

| Sr. No. | Topic Details | No. of Lectures |
|---|---|---|
| | **CREDIT I: BOTANY IN RELATION TO APICULTURE** | **15 L** |
| **1.** | **Introduction to Apiculture**<br>1.1 Definition and scope of apiculture<br>1.2 Types of Honey bees and their characteristics<br>1.3 Components and life stages of honeybee colony<br>1.4 Equipment of beekeeping and requirements to start beekeeping<br>1.5 Role of bees in agriculture and biodiversity | **03** |
| **2.** | **Bee Flora and Pollination Biology**<br>2.1 Definition and characteristics of bee flora<br>2.2 Nectar and pollen producing plants<br>2.3 Pollination mechanisms in flowering plants<br>2.4 Role of bees in cross pollination and crop improvement | **03** |
| **3.** | **Botanical Aspects of Honey Production**<br>3.1 Seasonal flowering plants<br>3.2 Medicinal and commercial plants useful for honey production<br>3.3 Honey flow and dearth periods<br>3.4 Factors affecting visit of honeybees to flower<br>3.4.1 Color of the flowers<br>3.4.2 Motion of flowers | **04** |

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|---|---|---|
| | 3.4.3 Quantity and/or quality of pollen and nectar<br>3.4.5 Day Light<br>3.4.6 Climate change<br>3.4.7 Pesticides use<br>3.4.8 Habitat loss<br>3.5 Importance of plant diversity in apiculture | |
| **4.** | **Plant–Bee Interaction and Ecology**<br>4.1 Co-evolution of flowering plants and bees<br>4.2 Floral adaptations for pollination<br>4.3 Ecological significance of pollinators<br>4.4 Conservation of pollinator-friendly plants<br>4.5 Diseases and enemies of Bees:<br>4.5.1 Bee diseases – Protozoan, Bacterial, Viral, Fungal – with two examples.<br>4.5.2 Bee pests – Wax moth (Greater and Lesser), Wax beetle.<br>4.5.3 Bee Enemies – Bee eater, King crow, Wasp, Lizard, Bear, Man. | **03** |
| **5.** | **Bee Products and Economic Botany**<br>5.1 Honey, beeswax, royal jelly, propolis and pollen<br>5.2 Medicinal and commercial applications of bee products<br>5.3 Entrepreneurship opportunities in apiculture<br>5.4 Government schemes and support for beekeeping in agriculture | **02** |
| | **CREDIT II: BOTANY IN RELATION TO SERICULTURE** | **15 L** |
| **6.** | **Introduction to Sericulture**<br>6.1 Definition and scope of sericulture<br>6.2 History and importance of silk industry<br>6.3 Types of silkworms and silk<br>6.4 Life cycle of silkworm (*Bombyx mori*)<br>6.5 Host plants of silkworms - Mulberry and non-mulberry | **03** |
| **7.** | **Mulberry Botany and Cultivation**<br>7.1 Taxonomy and morphology of mulberry (*Morus* spp.)<br>7.2 Climatic and soil requirements<br>7.3 Propagation methods<br>7.4 Major diseases and pests of mulberry<br>7.5 Organic and eco-friendly management practices<br>7.6 Harvesting of mulberry: a) Leaf plucking; b) Branch cutting; c) Whole shoot cutting<br>7.7 Nutritional importance of mulberry leaves for silkworms<br>7.8 Importance of healthy host plants in cocoon quality | **04** |
| **8.** | **Rearing Techniques and Environmental Conditions**<br>8.1 Introduction, Types of rearing<br>8.2 Rearing house and equipment<br>8.3 Temperature, humidity and ventilation requirements<br>8.4 Feeding of silkworms with mulberry leaves<br>8.5 Care during larval stages<br>8.6 Rearing Process:<br>8.6.1 Brushing and early age rearing | **05** |

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|---|---|---|
| | 8.6.2 Late age rearing methods<br>8.6.3 Bed cleaning and spacing<br>8.6.4 Mounting and cocoon formation<br>8.7 Preventive hygiene measures<br>8.8 Disinfection methods | |
| **9.** | **Economic Botany and Entrepreneurship in Sericulture**<br>9.1 Value-added products from sericulture<br>9.2 Rural employment opportunities<br>9.3 Sustainable sericulture practices | **03** |

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4. Ganga, G. & Sulochana Chetty, J. – An Introduction to Sericulture.
5. Shukla, G.S. & Upadhyay, V.B. – Economic Zoology.
6. Pandey, B.P. – Economic Botany.
7. Vashishta, P.C. – Botany for Degree Students.
8. Singh, S. – Bee Keeping in India.
9. Krishnaswami, S. – New Technology of Silkworm Rearing.
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11. Singh, S. (1962). Beekeeping in India. Indian Council of Agricultural Research, New Delhi.
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13. Research journals:

- Journal of Apicultural Research
- Indian Journal of Sericulture

14. Ganga, G. & Sulochana Chetty, J. – An Introduction to Sericulture.
15. Krishnaswami, S. – Silkworm Rearing Manual.
16. Dandin, S.B. et al. – Handbook of Sericulture Technologies.
17. Indian Silk Board Publications.

## T.Y.B.Sc. Botany [Semester - VI]

## Course Category – Major Elective Courses

## Course Code – BOT-363-MJ-P

## Course Title: Practical Based on BOT-360-MJ-T

**[No. of Credits: 2 C]** **[No. of Lectures: 60 L]**

**COURSE OBJECTIVES:**

1. To provide hands-on training in the authentication of crude plant drugs using organoleptic and microscopic methods.
2. To develop skills in the preparation of traditional herbal formulations (Galenicals) as per classical texts.
3. To enable students to perform preliminary phytochemical screening for the identification of major secondary metabolites.
4. To impart practical knowledge of chromatographic techniques (TLC, Column) for the separation and purification of plant constituents.
5. To train students in the determination of pharmacopoeial quality control parameters for the evaluation of herbal drugs.

**Course Outcomes (COs):**

**CO1:** Authenticate and evaluate the quality of crude plant drugs based on organoleptic and physical parameters.

**CO2:** Prepare various traditional herbal formulations and demonstrate an understanding of their significance.

**CO3:** Perform systematic phytochemical analysis to identify the presence of alkaloids, glycosides, flavonoids, and other secondary metabolites in a given plant sample.

**CO4:** Apply thin-layer and column chromatography for the separation and partial purification of phytoconstituents.

**CO5:** Determine key quality control parameters like ash values, extractive values, and Rf values to assess the purity and standard of herbal materials.

| Sr. No. | Title of the Practical | No. of Practical |
|---|---|---|
| 1. | Collection, authentication, and evaluation of crude drugs based on organoleptic characters (color, odor, taste, and texture). | 1 P |
| 2. | Determination of physico-chemical parameters of any two crude drugs – Ash values (Acid-insoluble, Water-soluble ash). | 2 P |
| 3. | Preparation of Swarasa (juice) and Kalka (paste) from fresh plant material (e.g., *Adhatoda vasica*, *Tinospora cordifolia*). | 1 P |
| 4. | Preparation of Kwatha (decoction) and Phanta (hot infusion) from coarse plant powders (e.g., *Zingiber officinale*, *Terminalia chebula*). | 1 P |
| 5. | Demonstration of Soxhlet extraction and Cold Maceration techniques. | 1 P |
| 6. | Preliminary Phytochemical Screening for Alkaloids (Mayer's, Dragendorff's, Wagner's tests); Glycosides (Legal's test); Terpenoids and Steroids (Salkowski's test); Phenolics/Tannins ($FeCl_3$ test); Flavonoids (Shinoda test); and Carbohydrates. | 2 P |

| | | |
|---|---|---|
| **7.** | Histochemical analysis of crude drugs. | **1 P** |
| **8.** | Determination of extractive values (Alcohol-soluble, Water-soluble) and loss on drying (moisture content). | **1 P** |
| **9.** | Study of powder microscopy of a crude drug (e.g., Senna leaf, Cinnamon bark) to detect adulterants/characters. | **1 P** |
| **10.** | Study of the behaviour of crude drug powders (e.g., *Curcuma longa*, *Withania somnifera*) under UV and ordinary light after treatment with different reagents. | **2 P** |
| **11.** | Botanical Excursion / Field Report: Collection, identification, and submission of a brief report on 5 locally available medicinal plants with details on their clinical uses and submission of botanical excursion report. | **2 P** |

## T.Y.B.Sc. Botany [Semester - VI]

## Course Category – Major Elective Courses

## Course Code – BOT-364-MJ-P

## Course Title: Practical Based on BOT-361-MJ-T

**[No. of Credits: 2 C]** **[No. of Lectures: 60 L]**

**COURSE OBJECTIVES:**

1. To understand the different components of the agribusiness system.
2. To study farm management, cost of cultivation and farm income measures.
3. To learn basic budgeting and farm planning techniques.
4. To understand agricultural marketing, grading, and standardization practices.
5. To develop knowledge of agricultural finance, insurance, and agribusiness planning.

**Course Outcomes (COs):**

**CO1:** Students will identify and classify different agribusiness enterprises.
**CO2:** Students will calculate cost of cultivation and farm income measures.
**CO3:** Students will prepare simple farm plans and partial budgets.
**CO4:** Students will analyse agricultural marketing channels and price spread.
**CO5:** Students will prepare basic business plans for agribusiness enterprises.

| Sr. No. | Title of the Practical | No. of Practical |
|---|---|---|
| 1. | To study different components of agribusiness system (input, production, processing, marketing). | 1 P |
| 2. | To identify various agribusiness enterprises in the local area and classify them. | 1 P |
| 3. | To study the structure and functioning of an agribusiness firm (case study method). | 1 P |
| 4. | To study factors of production in a farm (land, labor, capital, management). | 1 P |
| 5. | To calculate cost of cultivation of a selected crop. | 1 P |
| 6. | To estimate different farm income measures (gross income, net income, family labor income). | 1 P |
| 7. | To prepare a simple farm plan for a small farm. | 1 P |
| 8. | To perform partial budgeting for farm decision-making. | 1 P |
| 9. | To study marketing channels for major agricultural commodities. | 1 P |
| 10. | To analyze price spread of a selected commodity. | 1 P |
| 11. | To visit a regulated market / APMC and study its functioning… | 1P |
| 12. | To study grading and standardization practices of agricultural produce. | 1 P |
| 13. | To identify sources of agricultural finance in the locality (banks, cooperatives, SHGs). | 1 P |
| 14. | To study crop insurance schemes and calculate premium/claims (case example). | 1 P |
| 15. | To prepare a simple business plan for an agribusiness enterprise (e.g., nursery, dairy, food processing unit). | 1 P |

## T.Y.B.Sc. Botany [Semester - VI]

## Course Category – Major Elective Courses

## Course Code – BOT-365-MJ-P

## Course Title: Practical Based on BOT-362-MJ-T

**[No. of Credits: 2 C]** **[No. of Lectures: 60 L]**

**COURSE OBJECTIVES:**

1. To provide hands-on knowledge of important bee flora and silkworm host plants.
2. To develop practical skills in identification of nectar, pollen and mulberry plants.
3. To understand basic techniques used in apiculture and sericulture practices.
4. To familiarize students with pollination biology and plant–insect interactions.
5. To impart knowledge about cultivation and management of host plants used in sericulture.
6. To encourage field-based learning and entrepreneurship awareness in apiculture and sericulture sectors.

**COURSE OUTCOMES (COS):**

After successful completion of the practical course, students will be able to:

**CO1:** Identify economically important bee forage plants and silkworm host plants.
**CO2:** Demonstrate basic practical skills related to beekeeping and silkworm rearing.
**CO3:** Examine floral characteristics associated with pollination by bees.
**CO4:** Perform basic cultivation and propagation techniques of mulberry plants.
**CO5:** Recognize common pests and diseases affecting bee flora and mulberry plants.
**CO6:** Prepare herbarium specimens and maintain field observation records.
**CO7:** Understand the role of plants in enhancing honey and silk production.
**CO8:** Apply practical knowledge for small-scale income generation and sustainable agricultural practices.

| Sr. No. | Title of the Practical | No. of Practical |
|---|---|---|
| | **CREDIT I: PRACTICAL'S BASED ON APICULTURE** | |
| **1.** | To visit botanical garden and enlist the flowering plants with distinguishing characters. | **1 P** |
| **2.** | To survey honey bee colonies in the college campus and create geo-tag photo album. | **1 P** |
| **3.** | To study external morphology of worker bee. | **1 P** |
| **4.** | To study equipment used in beekeeping. | **1 P** |
| **5.** | To study bee products - Honey, Wax, Royal jelly, Propolis, Venom. | **1 P** |
| **6.** | To estimate the protein concentration in the pollen grain by Lowry's method. | **1 P** |
| **7.** | Observation of the natural honey under microscope. | **1 P** |
| **8.** | Awareness rally in any one village regarding importance of Honeybees. | **1 P** |
| **9.** | Visit to the local commercial apiary. | **1 P** |

| | CREDIT II: PRACTICAL BASED ON SERICULTURE | |
|---|---|---|
| **10.** | Study of morphology of mulberry plant (*Morus* spp.). | **1 P** |
| **11.** | Propagation of mulberry by stem cutting method. | **1 P** |
| **12.** | Observation of life cycle stages of silkworm (*Bombyx mori*). | **1 P** |
| **13.** | Demonstration of mulberry leaf harvesting techniques. | **1 P** |
| **14.** | Study of common pests and diseases of mulberry plants. | **1 P** |
| **15.** | Visit to a sericulture farm or silk rearing unit and preparation of field report. | **1 P** |

# SEMESTER - VI

| COURSE DETAILS | COURSE CODE | COURSE TITLE | CREDITS |
|---|---|---|---|
| Vertical – 4 (V4) | | | |
| Vocational Skill Courses (VSC) – (1 T/ P = 2 C) (Any one from basket) | VSC-371-BOT-P | Advances in Fermentation Technology | 2 C |
| | VSC-372-BOT-P | Commercial Mushroom and SCP Production Technology | |
| | VSC-373-BOT-P | Millets for Sustainable Human Welfare | |

## T.Y.B.Sc. Botany [Semester - VI]

## Course Category –Vocational Skill Courses (VSC)

## Course Code –VSC-371-BOT–P

## Course Title: Advances in Fermentation Technology

**[No. of Credits: 2 C]** **[No. of Lectures: 60 L]**

**COURSE OBJECTIVES:**

1. To Understand the Concept and Steps in Fermentation Technology
2. To Inculcate the techniques used for the preparation of Culture Media
3. To prepare the fermented products like Fruit wine, Vinegar, Malt, Citric Acid etc.
4. To identify soil micro-flora and the beneficial microorganisms existing in the soil.
5. Nurture the Students to Boost confidence regarding handling of microorganisms

**COURSE OUTCOMES (COS):**

**CO1:** Students will be able to understand the importance of precautions and safety aids to be taken during performing the fermentation practical.

**CO2:** Students will gain the practical knowledge of the use of starter cultures related to fermentation.

**CO3:** Students will demonstrate competence in microbial processes involved in Fermentation.

**CO4:** Students will understand concepts of Wine, Malt, Vinegar and Citric Acid production.

**CO5:** Students will analyze the actual microbial processes involved in fermentation.

**CO6:** Students will be capable of preparing an Industrial Visit Report in order to understand Scaling up, Hygiene safety and principle of Large Bioreactors.

| Sr. No | Title of the Practical | No. of Practical |
|---|---|---|
| 1. | Laboratory Safety precautions during handling of various instruments and chemicals related to fermentation – Any Five (Autoclave, Laminar Air Flow, Hot Air Oven, Microwave Oven, Fumigation, Sterilization) | 1 P |
| 2. | Preparation of any one Culture medium (Potato Dextrose Agar for – Fungi and Nutrient Agar Medium for Bacteria) and inoculation of any one suitable microorganism. | 1 P |
| 3. | Preparation of Starter Yeast (Baker's/Brewer's Yeast) medium for the fermentation of Wine and Bread. | 1 P |
| 4. | Preparation of Fermented Product - Fruit Wine / Arishta / Kanji / Bread / Idli) from the suitable material. | 1 P |
| 5. | Demonstration of Fermented products with respect to Microorganism, and its industrial Applications - Bread, Idli, Vinegar, Fruit Wine, Penicillin, Citric Acid, Rectified Spirit, Asava, and Arishta | 1 P |
| 6. | Preparation of Malt using suitable plant material – Wheat / Barley / Oats grains. | 2 P |
| 7. | Preparation of Vinegar from any one available fruit – Apple / Plums / Pineapple / Mango / Oranges and Paper chromatographic study of acetic acid formed during the fermentation process. | 2 P |
| 8. | Qualitative chemical tests for detection of Organic Acids, Tannins, Flavanoids, | 1 P |

| | | |
|---|---|---|
| | Lactic Acid and Carbon dioxide present in the fermented products - Citric Acid, Drakshasava, Butter Milk, Idli Base and Vinegar. | |
| **9.** | Isolation of Soil-micro flora from the soil sample using serial dilution technique for development of cultures (Use Potato Dextrose Agar and obtain culture of any five microorganisms). | **1 P** |
| **10.** | Preparation of Effective Microorganisms Starter from the standard EM-1 solution. | **1 P** |
| **11.** | Demonstration Practical – Identify the microorganisms with the help of permanent slides with respect to its industrial applications - Any Five (*Saccharomyces cervisiae, Aspergillus niger, Penicillum notatum, Lactobacillus sps, Streptococcus sps, Trichoderma sps*) | **1 P** |
| **12.** | Visit to Wine Industry / Sugarcane Industry Alcohol Plant / Any Relevant Fermentation Industry in nearby area. | **2 P** |

**REFERENCES:**


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13. John Mallett 2014 – A Practical Guide From Field to Brew House. Brewers Publications ISBN-13: 978-1938469121.
14. Robert Miguel Rodriguez 2023 How to Make Fruit Wines. ISBN-13: 979-8223196105

## T.Y.B.Sc. Botany [Semester - VI]

## Course Category – Vocational Skill Courses (VSC)

## Course Code – VSC-372-BOT-P

## Course Title: Commercial Mushroom and SCP Production Technology

**[No. of Credits: 2 C]** **[No. of Lectures: 60 L]**

**COURSE OBJECTIVES:**

1. To understand the basic biology, cultivation methods, and economic importance of commercial mushrooms.
2. To develop practical skills in pure culture preparation, spawn production, and crop management of mushrooms.
3. To study processing, preservation, value addition, and marketing of mushroom products.
4. To learn the principles and laboratory cultivation of microorganisms used for Single Cell Protein (SCP) production.
5. To understand the nutritional, environmental, and economic significance of SCP in food and feed industries.

**COURSE OUTCOMES (COS):**

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

**CO1:** Explain the biology, cultivation techniques, and importance of commercial mushrooms.
**CO2:** Perform laboratory techniques such as media preparation, pure culture maintenance, and spawn production.
**CO3:** Apply methods of mushroom cultivation, harvesting, processing, and value addition.
**CO4:** Demonstrate laboratory-scale production and harvesting of Single Cell Protein.
**CO5:** Evaluate the nutritional value and economic potential of mushroom and SCP production.

| Sr No. | Title of the Practical | No. of Practical |
|---|---|---|
| | **CREDIT- I: Commercial Mushroom Technology** | |
| **1.** | Study of types of mushrooms- Edible, medicinal, and poisonous mushroom with two suitable examples. | **1 P** |
| **2.** | Study of infrastructure required for commercial mushroom cultivation and cost assessment for mushroom project. | **1 P** |
| **3.** | Preparation of Potato Dextrose Agar (PDA) medium and production, incubation of master culture of Button/ Milky mushroom. | **2 P** |
| **4.** | Preparation of Grain spawn for button /Milky Mushroom and identification of spoilage. | **1 P** |
| **5.** | Demonstration of *Agaricus bisporus* (Button Mushroom) cultivation. | **1 P** |
| **6.** | Cultivation of *Calocybe indica* (Milky Mushroom) mushroom - Preparation of bed from suitable agriculture waste (cleaning, sterilization, bagging etc.) and inoculation of spawn on to the bed | **2 P** |
| | **CREDIT II: Single Cell Protein (SCP) Production** | |
| **7.** | Study of requirements for commercial *Yeast* / *Spirulina* production. | **1 P** |
| **8.** | Isolation of *Yeast* / *Spirulina* for SCP production. | **1 P** |
| **9.** | Laboratory-scale production and growth monitoring of Yeast / Spirulina | **2 P** |

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|---|---|---|
| **10.** | SCP biomass harvesting and drying techniques. | **1 P** |
| **11.** | Economic assessment of commercial SCP production and value-added product from spirulina and yeast | **1 P** |
| **12.** | Educational visit to mushroom farm /SCP production unit with report submission. | **1 P** |

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1. Singh, S.K. & Jha, P.K. – Mushroom Production and Utilization — Covers cultivation steps, substrates, spawn, spawn run, harvesting, preservation and marketing of mushrooms at commercial level.
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## T.Y.B.Sc. Botany [Semester - VI]

## Course Category – Vocational Skill Courses (VSC)

## Course Code – VSC-373-BOT-P

## Course Title: Millets for Sustainable Human Welfare

**[No. of Credits: 2 C]** **[No. of Lectures: 60 L]**

**COURSE OBJECTIVES:**

1. To understand the nutritional importance and health benefits of millets.
2. To develop practical skills in preparation of millet-based food products.
3. To learn value addition techniques using different millet grains.
4. To promote the use of multigrain and millet foods for healthy diets.
5. To develop knowledge of identification and collection of different millet samples.

**COURSE OUTCOMES (COS):**

**CO1:** Students will identify major millets and explain their nutritional value.
**CO2:** Students will prepare different millet-based food products successfully.
**CO3:** Students will apply value addition techniques in millet processing.
**CO4:** Students will understand the role of millets in nutrition and health promotion.
**CO5:** Students will collect, preserve, and submit different millet samples properly.

| Sr. No. | Title of the Practical | No. of Practical |
|---|---|---|
| 1. | To Demonstrate major millets, nutritive values and benefits. | 1 P |
| 2. | Hands on training on preparation of millet bread. | 1 P |
| 3. | Hands on training on preparation of millet cookies. | 1 P |
| 4. | Hands on training on preparation of flaked jowar. | 1 P |
| 5. | Hands on training on preparation of germinated ragi/multigrain drink. | 1 P |
| 6. | Hands on training on preparation of multigrain pasta. | 1 P |
| 7. | Hands on training on preparation of multigrain halwa. | 1 P |
| 8. | Hands on training on preparation of millet based upma. | 1 P |
| 9. | Hands on training on preparation of millet pappad. | 1 P |
| 10. | Hands on training on preparation of Rajgira ladoo. | 1 P |
| 11. | Hands on training on preparation of millet (Ragi) roti. | 1 P |
| 12. | Hands on training on preparation of millet muffins. | 1 P |
| 13. | Hands on training on preparation of millet noodles. | 1 P |
| 14. | Hands on training on preparation of millet Shankarpali (Sweet Diamond Cuts). | 1 P |
| 15. | Collection and submission of millet samples 50 grams each (Any Ten). | 1 P |

# SEMESTER - VI

| COURSE DETAILS | COURSE CODE | COURSE TITLE | CREDITS |
|---|---|---|---|
| Vertical – 6 (V6) | | | |
| OJT – (4 C) | BOT-381-OJT | On Job Training (OJT) in Botany | 4 C |

# T.Y.B.Sc. Botany [Semester - VI]

## Course Category – On Job Training (OJT)

## Course Code – BOT-381-OJT

## Course Title: On Jon Training (OJT) in Botany

**[No. of Credits: 4 C]** **[No. of Lectures: 120 L]**

## Guidelines for On-Job Training (OJT) in Botany

**A. Purpose of On-Job Training:**

On-Job Training (OJT) provides students with practical exposure to real working environments related to botany, plant sciences, agriculture, biotechnology, horticulture, forestry, environmental science, seed technology, apiculture, sericulture and allied industries. It helps students develop technical skills, professional ethics and employability.

**B. Objectives of OJT:**

1. To provide practical exposure in botanical and plant science fields.
2. To bridge the gap between theoretical knowledge and practical application.
3. To develop technical, analytical and communication skills.
4. To familiarize students with laboratory, field and industrial practices.
5. To encourage problem-solving ability and professional work culture.
6. To create awareness about entrepreneurship and career opportunities in botany.

**C. Expected Learning Outcomes:**

After completion of OJT, students will be able to:

1. Apply botanical knowledge in practical situations.
2. Demonstrate basic laboratory and field skills.
3. Identify plants, pests and diseases effectively.
4. Maintain scientific records and reports.
5. Work independently and in teams.
6. Understand industrial and research practices in botany.
7. Explore employment and entrepreneurship opportunities in plant sciences.

**D. Duration of Training:**

- Minimum duration: **4–6 weeks** (as per institutional guidelines)
- Recommended hours: **120 hours**

**E. Areas for OJT in Botany:** Students may undergo training in:

- Botanical gardens
- Plant nurseries
- Seed industries
- Agricultural farms
- Tissue culture laboratories
- Herbal gardens
- Forestry departments
- Environmental consultancy units

- Sericulture and apiculture centers
- Plant pathology laboratories
- Floriculture units
- Biotechnology industries
- Research institutions and universities
- NGOs working in biodiversity conservation

**F. Activities to be performed during OJT:**

**1. Laboratory-Based Activities:**

- Preparation of slides and specimens
- Herbarium techniques
- Plant tissue culture practices
- Seed testing and germination analysis
- Plant disease identification
- Soil and water analysis

**2. Field-Based Activities:**

- Plant identification and classification
- Nursery management
- Plantation techniques
- Biodiversity surveys
- Pollination studies
- Pest and disease monitoring
- Organic farming
- Biological control

**3. Industry/Extension Activities:**

- Production and processing practices
- Quality control procedures
- Packaging and storage
- Farmer interaction and extension activities
- Documentation and record maintenance

**G. Student Responsibilities**

1. Maintain regular attendance and punctuality.
2. Follow institutional and workplace discipline.
3. Wear proper safety gear wherever necessary.
4. Maintain daily work diary/logbook.
5. Follow safety and ethical guidelines.
6. Respect confidentiality of the organization.
7. Submit training report and presentation after completion.

**H. Role of Training Supervisor:**

1. Provide orientation and guidance to students.
2. Assign suitable practical tasks.
3. Monitor student performance and attendance.
4. Evaluate technical skills and work ethics.
5. Certify successful completion of training.

**I. Evaluation Criteria:**

| Component | Marks (%) |
|---|---|
| Attendance and Discipline | 20% |
| Practical Skills | 30% |
| Logbook/Record Maintenance | 20% |
| Training Report | 20% |
| Viva Voce/Presentation | 10% |

**J. Suggested Documentation:**

Students should submit:

- Daily logbook
- Attendance certificate
- Training completion certificate
- Final training report
- Photographs of activities (if permitted)
- Presentation/Seminar report

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# Savitribai Phule Pune University

*(FormerlyUniversityofPune)*

## Third Year B.Sc. Program in Physics

## (Faculty of Science & Technology)

## T.Y.B.Sc. (Physics)

**To be implemented from Academic Year 2026-2027**

# Table of Contents



## Abbreviations Used

- PO : Programme Outcomes
- PS : Programme Structure
- TLP : Teaching-Learning Process
- AM : Assessment Method
- DSC : Discipline Specific Core
- DSE : Discipline Specific Elective
- OE : Generic Electives
- OP : Open Electives
- VSC : Vocational Skill Courses
- SEC : Skill Enhancement Courses
- VSC* : Vocational Skill Courses(Can be given as advanced practical course related to major)
- AEC : Ability Enhancement Courses
- IKS : Indian Knowledge System

- VEC : Value Education Courses
- OJT : On Job Training (Internship/ Apprenticeship)
- FP : Field projects
- CEP : Community engagement program
- CC : Co-curricular Courses
- RM : Research Methodology
- RP : Research Project

## 1) Introduction to Undergraduate Degree Course in Physics:

As per the recommendations of UGC-F-2022, the undergraduate (UG) degree course in Physics is a 6-semester course spread over 3-academic years **OR** 8-semester course spread over 4-academic years. The Teaching Learning Process (TLP) is students' centric. It involves both theory and practical components. It offers a flexibility of programme structure while ensuring that the student gets a strong foundation in the subject and gains in-depth knowledge. Besides the DSCs (Major Core), a student has options courses from the syllabus comprising of DSEs (Electives), Minor, OE/GEs, SECs, AECs, RPs, RMs, OJT, FP, CEP, IKSs, VECs, CCs and VSCs. Hence, this will be bring out the interdisciplinary as well as multidisciplinary approach and adherence to innovative ways within the curriculum framework. It also allow a students' maximum flexibility in pursuing his/her studies at the undergraduate (UG) level to the extent of having the liberty to eventually design the degree with multiple exit options. Students have these exits options depending upon the needs and aspirations of the student in terms of his/her goals of life, without compromising on the teaching learning, both in qualitative and quantitative terms. This will suit the present day needs of students in terms of securing their paths towards higher studies or employment.

## 2) Programme Duration and Exit Options:

The minimum credit to be earned by a student per semester is 18-credits and the maximum is 26 credits. However, students are advised to earn 22-credits per semester. This provision is meant to provide students the comfort of the flexibility of semester-wise academic load and to learn at his/her own pace. However, the mandatory number of credits which have to be secured for the purpose of award of Undergraduate Certificate/Undergraduate Diploma/Appropriate Bachelor's Degree in Physics are listed in Table-1.

**Table-1: List of award of Undergraduate Certificate/ Undergraduate Diploma/Appropriate Bachelor's Degree in Physics**

| S. No. | Type of Award | Stage of Exit | Mandatory Credits to be Secured for the Award |
|---|---|---|---|
| **1** | Undergraduate Certificate in Physics | After successful completion of Semester II | **44** and an additional 4 credits core NSQF Course/Internship |
| **2** | Undergraduate Diploma in Physics | After successful completion of Semester IV | **88** and an additional 4 credits core NSQF Course/Internship |
| **3** | Bachelor of Science Physics | After successful completion of Semester VI | **132** |
| **4** | Bachelor of Science Physics (Honours) | After successful completion of Semester VIII | **176** |
| **5** | Bachelor of Science Physics (Honours with Research) | After successful completion of Semester VIII with minimum 28 GE credits in Discipline-2 (Minor) | **176** |

**a) Major Discipline (Physics) :**A student pursuing four-year undergraduate programme in Physics (Core course) shall be awarded B.Sc. Honours degree with Major in Physics on completion of VIII Semester, if he/she secures in Physics at least 50% of the total credits i.e., at least 88 credits in Physics out of the total of 176 credits. He/she shall study 20 DSCs and at least 2 DSEs of Physics in eight semesters.

**b) Minor Discipline (Discipline-2):**A student of B.Sc. (Hons.) Physics may be awarded Minor in a discipline, other than Physics, on completion of VIII Semester, if he/she earns minimum 28 credits from seven GE courses of that discipline

## 3) Programme Objectives :

The undergraduate (UG) degree course in Physics aims to provide:

a) Knowledge and skills to undertake higher studies/research in physics and related interdisciplinary areas thereby enabling students' employment/entrepreneurship.
b) Critical and analytical thinking, scientific reasoning, problem-solving skills, communication skills and teamwork.
c) Competence and skill in solving both theoretical and applied physics problems.
d) In-depth knowledge in physics through understanding of key physical concepts, principles, theories and their manifestations.
e) Exposure to the latest advances in physics, allied disciplines and research.
f) A conducive learning environment to ensure cognitive development of students.
**g)** Sufficient subject matter competence and enable students to prepare for various competitive examinations such as UGC-CSIR NET/JRF, GATE, GRE, IIT-JAM, and Civil Services Examinations.
h) Moral and ethical awareness, leadership qualities, innovation and life-long learning.
i) Multicultural competence and multilinguism.

## 4) Program Outcomes :

The learning outcomes of the undergraduate degree course in physics are as follows:

**a) Role of Physics:**

The students will develop awareness and appreciation for the significant role played by physics in current societal and global issues. They will be able to address and contribute to such issues through the skills and knowledge acquired during the programme. They will be able identify/mobilize appropriate resources required for a project, and managing a project through to completion, while observing responsible and ethical scientific conduct, safety and laboratory hygiene regulations and practices.

**b) Research skills:**

The course provides an opportunity to students to hone their research and innovation skills through internship/apprenticeship/project/community-outreach/dissertation/Entrepreneurship/Academic-Project. It will enable the students to demonstrate mature skills in literature survey, information management skills, and data analysis and research ethics.

**c) Hands-on/ Laboratory Skills:**

Comprehensive hands-on/ laboratory exercises will impart analytical, computational and instrumentation skills. The students will be able to demonstrate mature skills for the collation, evaluation, analysis and presentation of information, ideas, concepts as well as quantitative and/or qualitative data.

**d) In-depth disciplinary knowledge:**

The student will acquire comprehensive knowledge and understanding of the fundamental concepts, theoretical principles and processes in the main and allied branches of physics. The core papers will provide in-depth understanding of the subject. A wide choice of elective courses offered to the student will provide specialized understanding rooted in the core and interdisciplinary areas.

**e) Communication and IT Skills:**

Various DSCs, DSEs, SECs, GEs and AECs have been designed to enhance student's ability to write methodical, logical and precise reports. The courses will, in addition, guide the student to communicate effectively through oral/poster presentations, writing laboratory/ project reports and dissertations. Several IT based papers in DSCs, DSEs, SECs and AECs will enable students to develop expertise in general and subject specific computational skills.

**f) Critical and Lateral Thinking:**

The programme will develop the ability to apply the underlying concepts and principles of physics and allied fields beyond the classrooms to real life applications, innovation and creativity. A student will be able to distinguish between relevant and irrelevant facts and information, discriminate between objective and biased information, apply logic to arrive at definitive conclusions, find out if conclusions are based upon sufficient evidence, derive correct quantitative results, make rational evaluations, and arrive at qualitative judgments according to established rules.

## 5) Programme Structure :

The detailed Credit framework of undergraduate degree programme in Physics is provided in Table 2.

**Table-2: Credit framework of undergraduate degree programme in Physics.**

| Level /Difficulty | Sem | Subject-1 | | | | Subject-2 | Subject-3 | GE/ OE | SEC | IKS | AEC | VEC | CC | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4.5/100 | I | 2(T)+2(P) | | | | 2(T)+2(P) | 2(T)+2(P) | 2(T) | 2(T/P) | 2(T) Generic | 2(T) | 2 | - | 22 |
| | II | 2(T)+2(P) | | | | 2(T)+2(P) | 2(T)+2(P) | 2(P) | 2(T/P) | - | 2(T) | 2 | 2 | 22 |
| **Exit Option:** Award of UG Certificate in Major with 44 credits **and** an additional 4 credits core NSQF Course/Internship **OR** Continue with Major and Minor.<br>**Continue Option:** Student will select one subject among the (Subject-1, Subject-2, and Subject-3) as major and another as minor **and** third subject will be dropped. | | | | | | | | | | | | | | |
| **Level /Difficulty** | **Sem** | **Credits related to major** | | | | **Minor** | | **GE/ OE** | **SEC** | **IKS** | **AEC** | **VEC** | **CC** | **Total** |
| | | Discipline Specific Core (DSC) **Major Core** | Discipline Specific Elective (DSE) **Major Elective** | **VSC** | **FP/ OJT /CEP** | | | | | | | | | |
| 5.0/200 | III | 4(T)+2(P) | - | 2(T/P) | 2 (FP) | 2(T)+2(P) | - | 2(T) | - | 2(T) Major Subject Specific | 2(T) | - | 2 | 22 |
| | IV | 4(T)+2(P) | - | 2(T/P) | 2(CEP) | 2(T)+2(P) | - | 2(P) | 2(T/P) | - | 2(T) | - | 2 | 22 |
| **Exit Option:** Award of UG Diploma in Major and Minor with 88 credits **and** an additional 4 credits core NSQF Course/Internship **OR** Continue with Major and Minor. | | | | | | | | | | | | | | |
| 5.5/300 | V | 8(T)+4(P) | 2(T)+2(P) | 2(T/P) | 2 (FP/ CEP) | 2(T) | - | - | - | - | - | - | - | 22 |
| | VI | 8(T)+4(P) | 2(T)+2(P) | 2(T/P) | 4(OJT) | - | - | - | - | - | - | - | - | 22 |
| Total 3 Years | | 44 | 8 | 8 | 10 | 18 | 8 | 8 | 6 | 4 | 8 | 4 | 6 | 132 |
| **Exit Option:** Award of UG degree in Major with 132 credits **OR** Continue with Major and Minor. | | | | | | | | | | | | | | |
| 6.0/400 | VII | 6(T)+4(P) | 2(T)+2(P) | - | 4(RP) | 4(T)(RM) | - | - | - | - | - | - | - | 22 |
| | VIII | 6(T)+4(P) | 2(T)+2(P) | - | 8(RP) | - | - | - | - | - | - | - | - | 22 |
| Total 4 Years | | 64 | 16 | 8 | 22 | 22 | 8 | 8 | 6 | 4 | 8 | 4 | 6 | 176 |
| **Exit Option:** Award of UG Honours with Research Degree in Major and Minor with 176 credits.<br>**-OR-** | | | | | | | | | | | | | | |
| 6.0/400 | VII | 10(T)+4(P) | 2(T)+2(P) | - | - | 4(T)(RM) | - | - | - | - | - | - | - | 22 |
| | VIII | 10(T)+4(P) | 2(T)+2(P) | - | 4(OJT) | - | - | - | - | - | - | - | - | 22 |
| Total 4 Years | | 72 | 16 | 8 | 14 | 22 | 8 | 8 | 6 | 4 | 8 | 4 | 6 | 176 |
| **Exit Option:** Award of UG Honours Degree in Major and Minor with 176 credits. | | | | | | | | | | | | | | |

## 6) Teaching-Learning Process :

a) The undergraduate programme in Physics is designed to provide students with a sound theoretical background, practical training in all aspects of physics and research.
b) It will help them develop an appreciation of the importance of physics in different contexts.
c) The programme includes foundational as well as in-depth courses that span the traditional sub disciplines of physics.
d) Along with the DSCs there are DSEs, GEs, SECs, AECs and VACs which address the need of the hour.
e) Physics courses will be delivered through the conventional chalk and talk method, laboratory work, projects, case studies, field work, seminars, hands-on training/workshops in a challenging, engaging, and inclusive manner that accommodates a variety of learning styles and ICT enabled teaching-learning tools (PowerPoint presentations, audio visual resources, e-resources, models, software, simulations, virtual labs, etc.).
f) Students will be encouraged to carry out short term projects and participate in industrial and institutional visits and outreach programmes.
g) Students will be introduced to scientific reasoning and discovery, innovative problem-solving methodologies, online quizzes, surveys, critical analysis etc. to develop convergent and divergent thinking abilities.
h) The laboratory training complements the theoretical principles learned in the classroom and includes hands-on experience with modern instruments, computational data analysis, modelling, error estimation and laboratory safety procedures.
i) Different pedagogies such as experiential learning, participative learning, project-based learning, inquiry-based learning and ICT pedagogy integration instruction (blended and flipped learning) will be adopted wherever possible.
j) Students will be encouraged to work in groups to develop their interpersonal skills like communication and team work.
k) Students' diligent and active participation/ engagement in industrial visits/ internships/ academic projects/ dissertations will lay a strong foundation for a successful career in academics, industry, research, entrepreneurship and community outreach.

## 7) Assessment Methods :

The primary objective of assessment will be to assess the learning outcomes of the course in tune with the broad outcomes of strengthening core theoretical knowledge base, practical laboratory skills, and research. Assessment will be based on continuous evaluation (MCQs, Short Questions (SQ), Class Test (CT), Seminar, Presentation (PPT), Group Discussion (GD), Quiz, Assignment, Tutorials, etc.) and end of semester examination of Savitribai Phule Pune University, Pune.

### (i) Internal Assessment or Continuous Evaluation:

During a semester, students' mastery of the various learning outcomes as described in the syllabus will be assessed through MCQs, Short Questions (SQ), Class Test (CT), Seminar, Presentation (PPT), Group Discussion (GD), Quiz, Assignment, Tutorials, etc. Each theory paper and practical paper will

have 20marks for internal assessment. The critical analysis of internal assessment or continuous evaluation outcomes will provide opportunities to improve the teaching-learning process by focusing on the areas that need conceptual strengthening, laboratory exposure or design of new experiments, and research.

**(ii) End of Semester University Examinations:**

The summative end-semester university examinations will be conducted for both theory and practical courses. Besides internal assessment, each theory paper and each practical paper will be of 50 marks for end of semester examination of the university.

## 8) Scheme of Examination :

The total marks for a 2-credits course is 50.

- Theory Paper of 02 Credits:
    - Internal Exam (20 M) + University Theory Exam (30 M) = Total 50 M
    - Duration: For Internal exam = 45 Min. and for University Exam = 02 hours.
- Practical Paper of 2 Credits:
    - Internal Exam (20 M) + University Practical Exam (30 M) = Total 50 M
    - Duration: For Internal exam = 45 Min. and for University Exam = More than 04 hours.

Internal exam will be conducted by particular college/institutes at the end of each semester.

External exam will be conducted by Savitribai Phule Pune University, Pune at the end of each semester.

**Note:**

a) Each semester comprises of 15 weeks.
(12 weeks Actual Teaching + 3 weeks for Continuous Internal Evaluation)

b) One Credit of the Theory is equal to15 clock hours (Teaching 1 hour per week for each credit).
(12 hours Actual Teaching + 3 hours Continuous Internal Evaluation – Assignments, Tutorials, Practice, Problem solving sessions, Group discussion, Seminars and Unit Tests.)

c) One Credit of Practical = 30 clock hours(2 Contact hours per credit per week)
(24 hours' Actual Table work + 6 hours for journal completion, and Continuous Internal Evaluation of each practical)

d) Practical for each course comprises of 02 Credits = 60 clock hours.
    - Minimum 12 laboratory/ Field sessions of 04 clock hours must be conducted in one (1) semester.
    - In case of short practical, two practical should be conducted in one session.
    - Each practical of 04 clock hours in the laboratory should consist of table performance for concerned practical, careful observations, calculation, writing results and conclusion, and submission of practical in written form.
    - Pre-laboratory reading and post laboratory assignments should be given on each practical as a part of continuous internal evaluation.

**Pattern for Internal Theory Assessment: (20 Marks)**

Que-1: Choose correct option (MCQs) (5-MCQs with Multiple Options) – 5 marks

Que-2: True or False (MCQs) (5-MCQs with Multiple Options) – 5 marks

Que-3: Answer the following questions (Short answer questions) (any 5 out of 7) – 5 marks

Que-4: Answer the following questions (Short answer Definition/Problems/Diagram)(any 5 out of 7)–5marks

**Pattern for External Theory Assessment: (30 Marks)**

Que-1: Answer the following questions (Short answer/Definition/Problems/Diagram, etc.) (any 5 out of 7)–**5 marks**

Que-2: A) Answer the following questions (Long answer questions) – **5 marks**

i) ----------

ii) ----------

B) Answer the following questions (Long answer questions/Problems) – **3 marks**

i) ----------

ii) ----------

Que-3: A) Answer the following questions (Long answer questions) – **5 marks**

i) ----------

ii) ----------

B) Answer the following questions (Long answer questions/Problems) – **3 marks**

i) ----------

ii) ----------

Que-4: Write a short note on following. (any 3 out of 5) –**9 marks**

a) ----------

b) ----------

c) ----------

d) ----------

e) ----------

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# List of Courses

**Note: Every subject has 2 credits.**

## 9) List of Discipline Specific Core (DSC) Courses (Major Core)

**Major Core (Semester-I) (4 Credits) (2T+2P)**

**Semester I**

PHY-101-T : Fundamental of Physics-I
PHY 102-P : General Physics Lab-I

**Major Core (Semester-II) (4 Credits) (2T+2P)**

**Semester II**

PHY-151-T : Fundamental of Physics-II
PHY-152-P : General Physics Lab-II

**Major Core (Semester-III) (6 Credits) (4T+2P)**

**Semester III**

PHY 201 MJ : Mathematical Physics-I
PHY 202(A) MJ : Electronics
PHY 202(B) MJ : Instrumentation
PHY 203 MJP : General Physics Lab-III

**Major Core (Semester-IV) (6 Credits) (4T+2P)**

**Semester IV**

PHY 251 MJ : Oscillation, Waves and Sound
PHY 252 MJ : Optics
PHY 253 MJP : General Physics Lab-IV

**Major Core (Semester-V) (12 Credits) (8T+4P)**

**Semester V**

PHY 301 MJ : Mathematical Physics-II
PHY 302 MJ : Solid State Physics-I
PHY 303 MJ : Electrodynamics-I
PHY 304 MJ : Classical Mechanics
PHY 305 MJP : General Physics Lab-V
PHY 306 MJP : General Physics Lab-VI

**Major Core (Semester-VI) (12 Credits) (8T+4P)**

**Semester VI**

PHY 351 MJ : Atomic and Molecular Physics-I
PHY 352 MJ : Quantum Mechanics-I
PHY 353 MJ : Statistical Mechanics-I
PHY 354 MJ : Nuclear Physics-I
PHY 355 MJP : General Physics Lab-VII
PHY 356 MJP : Physics Lab-VIII (Project-I)

## Major Core (Semester-VII) (10 Credits) (6T+4P)

**Semester VII**

PHY 401 MJ : Atomic and Molecular Physics-II
PHY 402 MJ : Solid State Physics-II
PHY 403 MJ : Electrodynamics-II
PHY 404 MJP : General Physics Lab-IX
PHY 405 MJP: General Physics Lab-X

## Major Core (Semester-VIII) (10 Credits)(6T+4P)

**Semester VIII**

PHY 451 MJ : Quantum Mechanics-II
PHY 452 MJ : Statistical Mechanics-II
PHY 453 MJ : Nuclear Physics-II
PHY 454 MJP : General Physics Lab-XI
PHY 455 MJP : Physics Lab-XII (Project-II)

## 10) List of Discipline Specific Electives (DSE) Courses (Major Electives)

**Semester V :4 Credits. (2T+2P)**

PHY 310(A) MJ : Thin films Technology
PHY 310(B) MJ : Functional Nanomaterials
PHY 310(C) MJ : Advanced Electronics (only for Instrumentation subject students)
PHY 311 MJP : Special Physics Lab-I

**Semester VI :4 Credits. (2T+2P)**

PHY 360(A) MJ : Lasers Technology
PHY 360(B) MJ : Medical Electronics
PHY 361 MJP : Special Physics Lab-II

**Semester VII :4 Credits. (2T+2T/P)**

PHY 410(A) MJ : Radiation Physics
PHY 410(B) MJ : Remote Sensing
PHY 411 MJP : Special Physics Lab-III

**Semester VIII :4 Credits. (2T+2T/P)**

PHY 460(A) MJ : Energy Studies
PHY 460(B) MJ : Astronomy and Astrophysics
PHY 461 MJP : Special Physics Lab-IV

## 11) List of Vocational Skill Courses (VSC):(Each semester: 2 Credits)(P)

**Semester-III :**

PHY 221 VSC P : Introduction to Computational Physics-I

**Semester-IV :**

PHY 271 VSC P : Introduction to Computational Physics-II

**Semester-V :**

PHY 321 VSC P : Solar PV System: Design, and Maintenance

**Semester-VI :**

PHY 371 VSC P : Modern Electric Vehicle Technology

## 12) List of Indian Knowledge System (IKS) Courses :( Each semester: 2 Credits)(T)

**Semester-I :**

As per university circular

**Semester-III :**

PHY 201 IKS : India's Contribution to Physics

## 13) List of Minor (MN) Courses :

**Semester-III :(4 Credits)(2T+2P)**

PHY 241 MN : Applied Physics-I

PHY 242 MNP : Applied Physics Lab-I

**Semester-IV :(4 Credits)(2T+2P)**

PHY 291 MN : Applied Physics-II

PHY 292 MNP : Applied Physics Lab-II

**Semester-V : (2 Credits)(T)**

PHY 341 MN : Modern Physics: Concept and Applications

**Semester-VII :(4 Credits)(T)**

PHY 441 MN : Research Methodology

## 14) List of Generic Elective (GE)/Open Elective (OE) Courses :

As per University Circular (see basket)

**Semester-I :** Select any **one** subject for**2-credits (T)**

OE-101-PHY : Physics of Daily Life

OE-102-PHY : Biological Physics

**Semester-II** : Select any **one** subject for**2-credits (P)**

OE-151-PHY : LED Light - Repairing and Maintenance

OE-152-PHY : Maintenance and Repairing of Physics Lab equipment

**Semester-III :2-credits (T)**

OE-221-PHY : Eco-friendly Energy for Modern Living

**Semester-IV : 2-credits (P)**

OE-271-PHY: Li-Battery -Repairing and Maintenance

## 15) List of Skill Enhancement Courses (SECs) :

**Note** : **Each semester** for **2(P)**-credits

**Semester-I :** Select any **one (P)**

SEC-101-PHY : Experimental Skills in Physics

SEC-102-PHY : Physics of Water Filtration Systems

SEC-103-PHY : Renewable Energy and Energy Harvesting

SEC-104-PHY : Programming for Physical Applications (C++ / Python)

**Semester-II :** Select any **one (P)**

SEC-151-PHY : Numerical Techniques in Physics

SEC-152-PHY : Introduction to Laser and Fibre Optics

SEC-153-PHY : Radiation Safety

SEC-154-PHY : Basic Lab Electric devices and Circuits

**Semester-IV:** Select any **one (P)**

SEC-251-PHY : Basic Instrumentation Skills

SEC-252-PHY : Sensors and Detection Technology

SEC-253-PHY : Introduction to Physics of Devices

SEC-254-PHY : Technical Design and Drawing of Electronic Circuit

## 16) List of Value Education Courses (VEC): 2-Credits (T)

**Semester-I**

As per University Circular (see basket)

**Semester-II**

As per University Circular (see basket)

## 17) List of Ability Enhance Courses (AEC): 2-Credits (T)

**Semester-I:** Select any **one**

AEC-101-ENG : English

**Semester-II:** Select any **one**

AEC-151-ENG : English

**Semester-III:** Select any **one**

As per University Circular

AEC-231-HIN : Hindi

AEC-232-MAR : Marathi

**Semester-IV:** Select any **one**

As per University Circular

AEC-281-HIN : Hindi

AEC-282-MAR : Marathi

## 18) List of Co-Curricular Courses (CC): 2-Credits

**Semester-II:** Select any **one**

As per University Circular (see basket)

**Semester-III:** Select any **one**

As per University Circular (see basket)

**Semester-IV:** Select any **one**

As per University Circular (see basket)

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# Syllabus of Courses

## 19) Syllabus of Discipline Specific Core (DSC) Courses (Major Core)

**Major Core (Semester V) (12 Credits) (8T+4P)**

**Note: Every subject has 2 credits**

## Semester-V

**T.Y.B.Sc. (Physics) (Sem-V)**

## PHY-301-MJ : Mathematical Physics-II

**Lectures: 30 hrs** **(Credits-02)**

**A) Course Objectives:** This course aims to introduce

1) To study the basic concepts regarding Mathematical tools to analyse and solve problems in Physics.
2) To impart knowledge about Curvilinear Co-ordinates, theory of relativity, partial differential equations, special functions and Fourier series.

**B) Learning Course Outcomes (CO) :** Upon completion of the course, the student will be able to,

1) Understand Curvilinear Co-ordinates.
2) Identify applications of partial differential equations and to understand various physical quantities.
3) To understand the concept of special theory of relativity and their significance
4) Perform the calculations in special functions
5) Understand Basic concepts of Fourier Series, Fourier coefficients & its use to solve basic problems.
6) Apply the knowledge of these mathematical techniques applicable to theoretical and practical physics.

**C) Instructional design:**

**1)** Lecture method **2)** Tutorial method**3)** Seminars 4) Use of Multimedia
5) Creation of online resources

**D) Evaluation Strategies :**

**1)** Descriptive written examinations **2)** Assignments **3)** Seminars, Orals, and Viva

**E) Course Contents : Theory**

| Module-1 | Co-ordinate Systems and Partial Differential Equations | Lectures = 12H |
|---|---|---|
| | 1.1 Review of Cartesian, spherical and cylindrical co-ordinates<br>1.2 Transformation equation<br>1.3 General Curvilinear co-ordinate system: Co-ordinate surface, co-ordinate lines, length, surfaces.<br>1.4 Expressions for gradient, divergence, Laplacian, and curl. | **Lectures = 9** |

| | | |
|---|---|---|
| | 1.5 General methods for solving second order PDE<br>1.6 Method of separation of variables in Cartesian, Spherical polar and cylindrical co-ordinate system (2D Laplace's equation, 1D Wave equation)<br>1.7 Singular points ($x = x_0$, $x = \infty$)<br>1.8 Solution of differential equation-Statement of Fuch's theorem, Frobenius method of series solution (Legendre's Equation).<br>**Problem Solving** | **Lectures = 3H** |
| **Module-2** | **Special Theory of Relativity** | **Lectures = 8H** |
| | 2.1 Introduction<br>2.2 Newtonian relativity<br>2.3 Galilean transformation equation<br>2.4 Michelson-Morley experiment<br>2.5 Postulates of special theory of relativity<br>2.6 Lorentz transformations<br>2.7 Kinematic effects of Lorentz transformation, Length contraction, Proper time<br>**Problem Solving** | **Lectures = 6H**<br>**Lectures = 2H** |
| **Module-3** | **Special Functions and Fourier Series** | **Lectures = 10H** |
| | **Part A: Special Functions**<br>3.1 Introduction<br>3.2 generating function for Legendre Polynomials: Pn(x), Properties of Legendre Polynomials<br>3.3 Generating function for Hermite Polynomials: Hn(x), Properties of Hermite Polynomials<br>3.4 Bessel function of first kind: Jn (x), Properties of Bessel function of first kind<br>**Problem Solving**<br>**Part B: Fourier Series**<br>3.6 Introduction to Fourier Series<br>3.7 Dirichlet's Conditions for a Fourier Series<br>3.8Determination of Fourier coefficients $a_0, a_n \& b_n$<br>3.9 Simple problems (Odd function, even function, $x, x^2, e^{+x}, e^{-x}$) on finding a Fourier Series with continuous interval only<br>3.10 Advantages or applications of Fourier Series<br>**Problem Solving** | **Lectures = 3H**<br>**Lectures = 2H**<br>**Lectures = 3H**<br>**Lectures = 2H** |

**Activities:** Conduct **any one** classroom activity during class lecture for each module.

**Module 1: Curvilinear Co-ordinates and Partial Differential Equations:**

Activity 1: Practice to solve problems on Curvilinear Coordinate system

Activity 2: Practice to solve problems on **Partial Differential Equations**

**Module 2: The Special Theory of Relativity:**

Activity 1: Practice to solve problems on **Special Theory of Relativity**

Activity 2: Use the **Special Theory of Relativity to solve**

**Module 3: Special Functions & Fourier Series**

Activity 1: Solving problems on Practical Harmonic Analysis

Activity 2: Study and calculate Fourier coefficients for different functions.

**Reference books:**


1. Mathematical methods for physicists, Arfken and Weber, Academic press Newyork, 7th Edition.
2. Mathematical physics, Rajput, Pragati prakashan-1997.
3. Mathematical methods in the physical sciences – Marry L. Boas, John Willy & Sons publication, 3rd Edition-2005.
4. Introduction to special relativity, Robert Resnick, John Wiley & Sons, Inc.-1968.
5. Mathematical physics, B. D. Gupta, Vikas publishing house Pvt. Ltd., 4th edition-2010.
6. Mathematical physics, H. K. Dass, Dr. Rama Varma, S. Chand & Company Pvt. Ltd.,7th Edition-2014
7. The Special Theory of Relativity: A Mathematical Approach-Farook Rahaman, Springer Publication - 2014.


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T.Y.B.Sc. (Physics) (Sem-V)

# PHY-302-MJ : Solid State Physics-I

**Lectures: 30 hrs** **(Credits-02)**

**A) Course Objectives:** This course aims to

1) Develop Conceptual Understanding of Crystal structures in Physics.
2) Understand Structure Determination Techniques
3) Understand Band Theory, Electronic and Magnetic Properties of solids.

**B) Learning Course Outcomes (CO) :** Upon completion of the course, the student will be able to,

1) To understand crystal structures and concepts like Miller indices, interplanar spacing, packing fraction, and reciprocal lattice.
2) To understand the principles of experimental techniques X-ray diffraction and to analyze crystal structures using diffraction.
3) To understand Ewald construction and diffraction conditions in direct and reciprocal lattice.
4) To understand origin of bands and concept of density of states and Fermi energy in solids.
5) To understand electrical and magnetic properties of solids.
6) To apply concepts to numerical and analytical problems in solid state Physics.

**C) Instructional design:**

**1)** Lecture method **2)** Tutorial method **3)** Seminars 4) Use of multimedia and online resources

**D) Evaluation Strategies :**

**1)** Descriptive or subjective written examinations **2)** Assignments **3)** Tutorials **4)** Seminar or Oral or Viva

**E) Course Contents : Theory**

| **Module-1** | **Crystalline Solids** | **Lectures = 09** |
|---|---|---|
| | Lattice, Basis, Translational Vectors, Primitive Unit Cell, Symmetry Operations, Different types of lattices, Miller indices, Inter Planer spacing, SC, BCC and FCC structures, Packing Fraction, Crystal structures : NaCl, CsCl, KCl, Diamond, ZnS, HCP, Concept of Reciprocal Lattice and its properties,<br>**Problem Solving** | **Lectures = 07**<br>**Lectures = 02** |
| **Module-2** | **Crystal Structure Determination** | **Lectures = 09** |
| | Bragg's Diffraction, Bragg's Law, Experimental X-ray diffraction Methods: The Laue Method, Bragg's Spectrometer, Powder Method (Debye Scherrer method), Analysis of cubic structure by powder method, Ewald's Construction, Bragg's Diffraction condition in direct and reciprocal lattice,<br>**Problem Solving** | **Lectures = 07**<br>**Lectures = 02** |

| Module-3 | Band Theory, Electronic and Magnetism Properties of Solids | Lectures = 12 |
|---|---|---|
| | **Electronic Properties of Solids :** Free Electron model, Energy levels and Density of States, Nearly free electron model, Fermi energy, Fermi level, Hall Effect, Mobility, Hall Angle, Numericals<br>**Band Theory of Solids:** Origin of energy gap, Energy bands in Solids, Distinction between metal, semiconductor and insulator, Numericals<br>**Magnetism :** Diamagnetism, Paramagnetism, Ferromagnetism, Hysteresis, Variation of magnetic susceptibility with temperature, Curie Wiess Law, Superconductor as example of perfect diamagnet,<br>**Problem Solving** | **Lectures = 10**<br><br>**Lectures = 02** |

**F) REFERENCES:**


1. Solid State Physics - S.O.Pillai, 6thEdition, New Age International (P) Ltd, Publisher, (2010).
2. Solid State Physics – Kakani S.L. and Hemrajani C., 4th Edition, S. Chand Publication, (2005).
3. Fundamentals of SolidState Physics – B.S.Saxena, R.C.Gupta and P.N.Saxena, Pragati Prakashan,Meerut, Uttar Pradesh
4. Introduction to Solid State Physics- Charles Kittel, John Wiley and Sons, 7th Edition.
5. Solid State Physics- A.J.Dekker, Macmillan India Ltd, (1998).
6. Solid State Physics- R.K. Puri, V.K. Babbar, S. Chand Publication.
7. Elementary Solid State Physics Principles and Applications - M. Ali Omar, Pearson Education, Inc. and Dorling Kindersley Publishing, (2006)
8. Problems and Solution in Solid State Physics-S.O. Pillai, New Age International (P) Ltd.
9. Solid State Physics - P.K. Palanisamy, Scitech Publications(India) Pvt Ltd, Chennei, 1st Edition, (2004)
10. Solid State Physics: Essential Concepts - David W. Snoke, 2nd Edition, Cambridge University Press
11. Concepts of Modern Physics - Beiser, Arthur
12. Concepts of Modern Physics - 6th ed., McGraw-Hill, (2003)


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T.Y.B.Sc. (Physics) (Sem-V)

# PHY-303-MJ : Electrodynamics-I

**Lectures: 30 hrs** **(Credits-02)**

**A) Course Objectives:** This course aims to introduce the foundational aspects of classical electrodynamics, focusing on electric and magnetic field theory, material response, and the qualitative understanding of Maxwell's equations

1) To introduce advanced concepts of electric and magnetic fields beyond the basic level studied in the first year.
2) To study the behaviour of electromagnetic fields in material media.
3) To develop understanding of Maxwell's equations and electromagnetic wave propagation.
4) To build a foundation for higher studies in electrodynamics.

**B) Learning Course Outcomes (CO) :** Upon completion of the course, the student will be able to,

1) Understand the fundamental concepts of electric and magnetic fields.
2) Identify the behavior of fields in dielectric and magnetic materials.
3) Explain Maxwell's equations and their physical significance.
4) Describe the basic properties of electromagnetic waves.
5) Apply the knowledge of electrodynamics to simple physical systems.

**C) Instructional design:**

1) Lecture method using board teaching 2) Tutorial method for problem solving
3) Seminars by students 4) Use of multimedia (animations/simulations)
5) Creation of online learning resources

**D) Evaluation Strategies :**

1) Descriptive written examinations 2) Assignments and problem-solving tasks
3) Seminars, oral presentations, and viva

**E) Course Contents : Theory**

| **Module-1** | **Electric Fields in Matter & Potential Theory** | **Lectures = 10** |
|---|---|---|
| | 1.1 Brief revision of Coloumb,s Law, electric field, electrostatic potential & Gauss's law (statement and significance)<br>1.2 Potential energy of system of charges<br>1.3 Poisson's and Laplace equations (conceptual)<br>1.4 Motion of charge particle moving with uniform velocity in constant electric field<br>1.5 Polarization (**P**), Electric Displacement (**D**), Electric dipole, Electric susceptibility and Dielectric Constant and bound charges<br>1.6 Bound Volume and Surface Charge densities<br>1.7 Energy stored in electric field<br>1.8 Applications: Capacitors with dielectric | **Lectures = 08** |
| | **Problem Solving** | **Lectures = 02** |

| Module-2 | Magnetic Fields in Matter & Electrodynamics Basics | Lectures = 12 |
|---|---|---|
| | 2.1 Brief revision of Magnetic field, Magnetic flux<br>2.2 Biot–Savart law (statement)<br>2.3 Magnetic field due to steady current<br>2.4 Motion of charge particle moving with uniform velocity in constant magnetic field.<br>2.5 Lorentz Force & Ampere's circuital law (Statement)<br>2.6 Force between two current-carrying conductors<br>2.7 Magnetic dipole moment and its interaction with magnetic field<br>2.8 Magnetic vector potential (statement)<br>2.9 Magnetization (**M**) of matter and Relation between **B**, **H**, and **M**<br>2.10 Types of magnetic materials (concept)<br>2.11 Concept of electromagnetic induction, Faradays law, Lenz law (Statement& concept)<br>2.12Applications : Solenoid & Toroid<br>**Problem Solving** | **Lectures = 9**<br><br>**Lectures = 03** |
| **Module-3** | **Maxwell's Equations & Electromagnetic Waves** | **Lectures = 08** |
| | 3.1 Equation of continuity<br>3.2 Displacement current and Generalization of Ampere's law<br>3.3 Maxwell's equations (Differential and Integral form) and their physical interpretation<br>3.4 Electromagnetic wave equation (qualitative)<br>3.5 Plane electromagnetic waves<br>3.6 Transverse nature of EM waves<br>3.7 Poynting Theorem and Poynting vector<br>3.8 Applications: Electromagnetic spectrum and communication systems<br>**Problem Solving** | **Lectures = 06**<br><br>**Lectures = 02** |

**F) REFERENCES:**


1) Introduction to Electrodynamics, David J. Griffiths, Pearson Education.
2) Engineering Electromagnetics, William H. Hayt and John A. Buck, McGraw-Hill Education.
3) Electricity and Magnetism, D. C. Tayal, Himalaya Publishing House.
4) Electricity and Magnetism, Brijlal and N. Subrahmanyam, S. Chand & Company Ltd.
5) Electricity and Magnetism, Edward M. Purcell, McGraw-Hill Education.


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T.Y.B.Sc. (Physics) (Sem-V)

# PHY-304-MJ : Classical Mechanics

**Lectures: 30 hrs** **(Credits-02)**

**A) Course Objectives:** This course aims to introduce the **fundamental principles of classical mechanics** and their applications in understanding the motion of particles and systems of particles.

1. To study the **basic concepts of motion, force, energy, and momentum**.
2. To impart knowledge about the **dynamics of particles in central force fields**.
3. To understand the **motion of charged particles in electric and magnetic fields**.
4. To introduce the **Lagrangian and Hamiltonian formulations** of mechanics.
5. To develop the ability to solve **numerical and conceptual problems** in classical mechanics.

**B) Learning Course Outcomes (CO) :** Upon completion of the course, the student will be able to,

1. Understand the **basic laws and concepts of classical mechanics**.
2. Identify the **physical significance of centre of mass, momentum, and energy conservation**.
3. Explain the **motion of particles under electric, magnetic, and central force fields**.
4. Describe **Kepler's laws and the motion of artificial satellites**.
5. Understand **fundamental concepts of elastic and inelastic scattering**
6. Apply the knowledge of **Lagrangian and Hamiltonian mechanics** to physical systems.
7. Solve **numerical problems related to particle dynamics and constrained systems**.

**C) Instructional design:**

1. Lecture method for explaining theoretical concepts and derivations.
2. Tutorial method for problem solving and numerical practice.
3. Seminars for student participation and conceptual understanding.
4. Use of Multimedia such as PPTs, animations, and simulations for effective teaching.
5. Creation of online resources like notes, assignments, and reference material for self-learning.

**D) Evaluation Strategies :**

1. Descriptive written examinations to assess theoretical understanding.
2. Assignments to strengthen conceptual clarity and numerical problem-solving ability.
3. Seminars, Orals, and Viva to evaluate communication skills and depth of subject knowledge.

**E) Course Contents : Theory**

| **Module-1** | **Motion of Particles** | **Lectures = 10H** |
|---|---|---|
| | 1.1 Charged Particles: Motion of a charged particle in constant electric, magnetic and electromagnetic field,<br>1.2 System of particles: Concept of Centre of mass, Conservation of linear momentum, angular momentum, energy of system of | **Lectures = 7** |

| | | |
|---|---|---|
| | particles.(statements only)<br>1.3 Day to day applications of Classical mechanics,<br>**Problem Solving** | <br><br>**Lectures = 3** |
| **Module-2** | **Central force Field** | **Lectures= 10H** |
| | 2.1 Central force Field: Definition and Properties of central force field.<br>2.2 Reduction of two body problem to an equivalent one body problem<br>2.3 Motion in central force field,<br>2.4 Kepler's laws of planetary motion and Artificial Satellite<br>2.5 Elastic and inelastic scattering: Elastic scattering - Laboratory and centre of mass system (2L)<br>**Problem Solving** | **Lectures = 7**<br><br><br><br><br><br>**Lectures = 3** |
| **Module-3** | **Langrangian and Hamiltonian formulation** | **Lectures= 10H** |
| | 3.1 Limitations of Newton's Law of Motion,<br>3.2 Constraints and Their Classification, Example of Constrains, degrees of freedom, generalized coordinate, configuration space,<br>3.3 Principle of Virtual work done,<br>3.4 D'Almeberts Principle of virtual work,<br>3.5 Langrangian and Hamiltonian equations, (4L)<br>3.6 Cyclic coordinates, Phase space<br>**Problem Solving** | **Lectures = 7**<br><br><br><br><br><br>**Lectures = 3** |

**F) REFERENCES:**


1) **Classical Mechanics** by J.C. Upadhyaya, Himalaya publishing Houses, 2nd Edition, (2005).
2) **Introduction to Classical Mechanics**byR. G. Takawale, P. S. Puranik, Tata McGraw Hill publishing Company Ltd., New Delhi, (2017).
3) **Classical Mechanics**byNC Rana and PS Joag, Tata McGraw Hill Education Private Limited, New Delhi, (1991).
4) **Classical Mechanics** by P.V.Panat, Alpha Science International Ltd., (2005).
5) **Classical Mechanics**byHerbert Goldstein, Narosa Publishing House, (2018).
6) **Introduction to Classical Mechanics with Problems and Solutions** by David Morin, Cambridge University Press (2009)


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T.Y.B.Sc. (Physics) (Sem-V)

# PHY-305-MJP : Basic Physics Lab-V

**Lectures: 60 hrs** **(Credits-02)**

**Section-I:General Physics (any 12)**

1. Moment of Inertia by Bifilar suspension
3. Young's modulus by Koeing method
4. Surface tension of mercury by Ripple method
5. Surface tension liquid by Fergusson method
6. Surface tension of mercury by Quincke's method
7. 'Y' by vibration of wooden scale
8. Determination of wavelength of light by Michelson's interferometer
9. Surface Tension of Mercury by method of Ripples.
10. Viscosity of Liquid by rotating cylinder method.
11. Coefficient of sound absorption
12. 'Y' by Cornu's Method
13. Hall Effect: To measure the Hall coefficient
14. Energy gap of a semiconductor
15. Study of XRD spectrum of any material.
16. Resistivity by Four probe method
17. Platinum resistance thermometer

**Section II: Additional Activities to be conducted during the semester (Any-1):**

1. Demonstrations: Any 2 demonstrations equivalent to 3 experiments
2. Study tour / Industrial visit / Field visit with report equivalent to 3 experiments
3. Mini project equivalent to 3 experiments
4. Computer aided demonstrations (simulations or animations) (Any 2 demonstrations equivalent to 3 experiments)

**Study tour:** Student have to participate in study tour organized by department to study about physics in Industry / Company / Organization / Research Institute / Research organization / Small scale industry / University Department and compulsory submitted study tour report equivalent to 3 experiments signed by study tour co-ordinator and HOD of Department.

**Note:** Students have to perform total 15-experiments (12-experiments from Section-I and 1-activity from Section-II)

**OR**

Participated in Additional any **one** activity equivalent to **3-experiments** with 15-experiments (12 experiments from Section-I and 3-experiments from Section-II) mentioned above. Total laboratory work with additional one activity should be 15-experiments.

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T.Y.B.Sc. (Physics) (Sem-V)

# PHY-306-MJP : Basic Physics Lab-VI

**Lectures: 60 hrs** **(Credits-02)**

**Section-I: Basic Physics Laboratory ( any 12)**

**GROUP-I: Electronics / Advanced Electronics (any 9)**

1. Characteristics of J-FET
2. Design and built astable multivibrator using IC-555/IC-741
3. Half adder /Full adder
4. Integrator and differentiator using IC-741
5. IC 723 as regulated power supply
6. Instrumental amplifier using three OP-AMPs
7. Temperature controller using PT 100 / thermocouple /thermistor temperature sensors
8. Object counter (two digit)
9. Schmitt trigger
10. Study of LVDT
11. Study of R-S flip flop
12. Study of DAC: R-2R ladder type
13. Analog Multiplexer and De-Multiplexer using Ic-4051
14. Characteristics of MOS-FET

**GROUP-II: Electrodynamics (any 3)**

1. Study of forced oscillations by electromagnetically driven simple pendulum
2. Self-Inductance by Anderson's bridge
3. Core losses in transformers
4. Electromagnetic pendulum
5. Self-Inductance by Maxwell's bridge

**Section II: Additional Activities to be conducted during the semester (Any-1):**

1. Demonstrations: Any 2 demonstrations equivalent to 3 experiments
2. Study tour / Industrial visit / Field visit with report equivalent to 3 experiments
3. Mini project equivalent to 3 experiments
4. Computer aided demonstrations (simulations or animations) (Any 2 demonstrations equivalent to 3 experiments)

**Study tour:** Student have to participate in study tour organized by department to study about physics in Industry / Company / Organization / Research Institute / Research organization / Small scale industry / University Department and compulsory submitted study tour report equivalent to 3 experiments signed by study tour co-ordinator and HOD of Department.

**Note:** Students have to perform total 15-experiments (12-experiments from Section-I and 1-activity from Section-II)

**OR**

Participated in Additional any **one** activity equivalent to **3-experiments** with 15-experiments (12 experiments from Section-I and 3-experiments from Section-II) mentioned above. Total laboratory work with additional one activity should be 15-experiments.

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T.Y.B.Sc. (Physics) (Sem-VI)

# PHY-351-MJ : Atomic and Molecular Physics-I

**Lectures: 30 hrs** **(Credits-02)**

**A) Course Objectives:** This course aims to introduce Atomic and molecular spectroscopy.

1) To study the basic concepts regarding Atomic models and atomic spectra.
2) To impart knowledge about Molecular and Raman spectroscopy.

**B) Learning Course Outcomes (CO) :** Upon completion of the course, the student will be able to,

1) Understand basic concepts of spectroscopy.
2) Identify the various types of spectra.
3) explain various spectroscopic terms and their significance.
4) able to solve problems in spectroscopy.
5) Apply the knowledge of spectroscopy in various fields like biology, medicine, chemistry, etc.

**C) Instructional design:**

**1)** Lecture method. **2)** Tutorial method. **3)** Seminars/Group discussion.
4) Use of Multimedia 5) Creation of online resources

**D) Evaluation Strategies :**

**1)** Descriptive written examinations **2)** Assignments **3)** Seminars, Orals, and Viva

**E) Course Contents : Theory**

| **Module-1** | **Atomic structure** | **Lectures = 05H** |
|---|---|---|
| | 1. Revision of Bohr's atomic models<br>2. Vector atom model (Concepts of space quantization and electron spin)<br>3. Four quantum numbers, Pauli Exclusion Principle, Hund's rule, Aufbau principle<br>4. Electron configuration, Quantum states, Spectral notations of quantum states.<br>**Problem Solving** | **Lectures = 3**<br><br>**Lectures = 2** |
| **Module-2** | **One and two valence electron systems** | **Lectures = 10H** |
| | 1. Spin-Orbit Interaction Energy, (Single valence electron atom), Energy levels of Na-atom, Selection rules, Spectra of sodium atom.<br>2. Spectral terms of two electron atoms, terms for equivalent electrons, LS and JJ-coupling schemes (pd configuration only).<br>3. Singlet-Triplet separations for interaction energy of LS coupling (pd configuration only), Lande's interval rule (Graphical representation of $^3D$ term only).<br>**Problem Solving** | **Lectures = 7**<br><br>**Lectures = 3** |
| **Module-3** | **Spectroscopy** | **Lectures = 15H** |
| | **Part 1 - Molecular spectroscopy**<br>1. Introduction of molecular spectra and its types<br>2. Rotational energy levels, Rotational spectra of rigid diatomic molecule<br>3. Vibrational energy levels<br>4. PE vs interatomic distance curve, Electronic spectra of molecules, Frank-Condon principle (Concepts only)<br>**Problem Solving** | **Lectures = 3**<br><br>**Lectures = 2** |

| | | |
|---|---|---|
| | **Part 2 - Raman spectroscopy**<br>1. Introduction of Raman effect, Molecular polarizability<br>2. Classical theory and Quantum theory of Raman Effect<br>3. Applications of Raman spectroscopy<br>**Problem Solving**<br><br>**Part 3 - X-ray Spectroscopy**<br>1. Nature of X rays<br>2. Discrete and Continuous X ray spectra, Duane and Hunt's Rule<br>3. X ray emission spectra<br>4. Mosley's law and its applications<br>**Problem Solving** | **Lectures = 3**<br><br>**Lectures = 2**<br><br>**Lectures = 3**<br><br>**Lectures = 2** |

**Activities:**

**1) Spectroscopy simulation**

https://phet.colorado.edu/sims/html/molecules-and-light/latest/molecules-and-light_all.html

**2) Rutherford's Scattering**

https://phet.colorado.edu/sims/html/rutherford-scattering/latest/rutherford-scattering_all.html

**3) Hydrogen spectra study**

https://phet.colorado.edu/sims/html/models-of-the-hydrogen-atom/latest/models-of-the-hydrogen-atom_all.html

**4) Perform various physics experiments virtually using website**

https://www.vlab.co.in/broad-area-physical-sciences

**F) REFERENCES:**


1) Modern Physics by R. Murugeshan, Er. K. Sivaprasath, S. Chand, 2014, Revised edition
2) Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles by Robert Eiseberg, Robert Resnik, Wiley, 2016, 2nd edition
3) Molecular structure and Spectroscopy by G. Aruldhas, PHI, 2015, 2nd edition
4) Fundamentals of Molecular Spectroscopy by Colin Banwell, Elaine McCash, TMH, 4th ed
5) Concepts of Modern Physics by Arthur Baiser, McGraw Hill International, 4th edition
6) Introduction to Atomic spectra by White H. E, McGraw Hill International


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T.Y.B.Sc. (Physics) (Sem-VI)

# PHY-352-MJ : Quantum Mechanics-I

**Lectures: 30 hrs** **(Credits-02)**

**A) Course Objectives:**

1. To introduce the fundamental principles and experimental foundations of quantum mechanics.
2. To develop the ability to apply the Schrödinger equation to analyse simple quantum systems and understand their physical behaviour.
3. To familiarize students with operator methods and the mathematical framework used to describe quantum mechanical observables.

**B) Learning Course Outcomes (CO):** Upon successful completion of the course, students will be able to:

1. Understand the core concepts and experimental basis of quantum mechanics, including wave-particle duality and uncertainty principle.
2. Apply the Schrödinger equation to analyse basic quantum systems such as particle in a deep potential well, step potential and tunnelling phenomena.
3. Interpret the physical significance of wave functions, probability densities and expectation values in quantum systems.
4. Utilize operator formalism, including commutation relations and Hermitian operators to describe measurable physical quantities in quantum mechanics.

**C) Instructional design:**

1) **Lecture Method:** Concept-based teaching using chalk and board supported by ICT.
2) **Tutorial Method:** Problem-solving sessions and doubt-clearing activities to reinforce understanding of quantum systems.
3) **Seminars:** Student-led presentations on selected topics.
4) **Use of Multimedia:** Use of animations, simulations and visual demonstrations (e.g. wave functions, potential wells, tunnelling) to improve conceptual clarity and student engagement.

**D) Evaluation Strategies :**

1) Theoretical assessments through college and university examinations focusing on conceptual understanding, derivations, and numerical problem-solving skills.
2) Regular assignments comprising numerical problems and short conceptual questions.
   Evaluation through student presentations, oral examinations, and viva voce to assess conceptual clarity, communication skills, and depth of understanding

**E) Course Contents : Theory**

| **Module-1** | **Foundations of Quantum Mechanics** | **Lecture = 08** |
|---|---|---|
| | 1. Historical Background: Black body radiation, photoelectric effect.<br>2. De Broglie Hypothesis: Matter Waves & the de Broglie Wavelength Relation<br>3. Davisson and Germer experiment.<br>4. Wave particle duality.<br>5. Concept of wave function, wave packet, phase velocity ($V_p$), group velocity ($V_g$) and relation between $V_p$ & $V_g$.<br>6. Heisenberg's uncertainty principle: statement & physical significance, position-momentum, energy-time and angular forms of uncertainty.<br>7. Applications of quantum mechanics: semiconductor physics, quantum computing and spectroscopy (In brief).<br>**Problem Solving** | **Lectures = 5**<br><br>**Lectures = 3** |
| **Module-2** | **Schrödinger Formalism &Applications of Schrodinger's Steady state equation** | **Lecture = 15** |

| | | |
|---|---|---|
| | **Schrödinger Formalism**<br>1. Physical interpretation of wave function.<br>2. Requirements of wave function.<br>3. Schrodinger time dependent equation.<br>4. Schrodinger time independent equation. (Steady state equation).<br>5. Probability current density, equation of continuity & its physical significance.<br>6. Eigen function & Eigen values.<br>7. Expectation value.<br>8. Ehrenfest's theorem (Statement Only).<br>**Applications Schrodinger's Steady state equation**<br>1. Free particle.<br>2. Step potential.<br>3. Potential barrier (Qualitative discussion), Barrier penetration & tunnelling effect.<br>4. Particle in infinitely deep potential well (1D only).<br>**Problem Solving** | **Lectures= 12**<br><br>**Lectures = 3** |
| **Module-3** | **Quantum Mechanical Operators and its Algebra** | **Lecture = 07** |
| | 1. Fundamental operators in quantum mechanics: Position operator, momentum operator, angular momentum and Hamiltonian (total energy) operators.<br>2. Hermitian operator.<br>3. Commutator algebra: commutator bracket, properties and identities<br>4. Commutation relations for position, linear and angular momentum operators, Simultaneous eigen functions.<br>5. Parity in quantum mechanics: concept of parity, parity operator and its eigenvalue.<br>**Problem Solving** | **Lectures = 4**<br><br>**Lectures = 3** |

**F) References:**


1. N. Zettili, *Quantum Mechanics - Concepts and applications*, Wiley publication, ISBN: 978-0-470-02679-3
2. Griffiths, David J. *Introduction to Quantum Mechanics*. Upper Saddle River, Pearson Prentice Hall, 2005. ISBN: 9780131118928.
3. Ajoy Ghatak, S. Lokanathan, *Quantum Mechanics: Theory and Applications*, Springer Publication, ISBN 978-1-4020-2130-5
4. G Aruldhas, *Quantum Mechanics*, Phi Learning Private Ltd., ISBN : 97881203363
5. R. Shankar, Ramamurti. *Principles of Quantum Mechanics*. Springer, 2008. ISBN: 9780306447907.
6. Eisberg, Robert M., and Robert Resnick. *Quantum Physics of Atoms, Molecules, Solids, Nuclei, and Particles*. Wiley, 1985. ISBN: 9780471873730.
7. Liboff, Richard L. *Introductory Quantum Mechanics*. Addison Wesley, 2002. ISBN: 9780805387148.
8. Feynman, Richard P., Robert B. Leighton, and Matthew L. Sands. T*he Feynman Lectures on Physics*. Addison Wesley, 1989. ISBN: 9780201500646.
9. P M Mathews and K Venkatesan, *A Textbook of Quantum Mechanics*, Tata McGraw Hill publication, ISBN. : 9780070146174.
10. Gupta, Kumar & Sharma, *Quantum Mechanics*, Jai Prakash Nath Publications.


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T.Y.B.Sc. (Physics) (Sem-VI)

# PHY-353-MJ : Statistical Mechanics -I

**Lectures: 30 hrs** **(Credits-02)**

**A) Course Objectives:** This course aims to introduce the fundamental concepts of classical statistical mechanics.

1. To understand the connection between microscopic states and macroscopic properties.
2. To develop knowledge of ensembles and thermodynamic probability.

**B) Learning Course Outcomes (CO) :** Upon completion of the course, the student will be able to,

1. Understand the foundations of statistical mechanics.
2. Identify the connection between microscopic states and macroscopic properties.
3. Explain Maxwell-Boltzmann statistics and its significance.
4. Compute partition functions and derive thermodynamic quantities.
5. Apply ensemble theory to physical systems.

**C) Instructional design:**

1) Lecture method 2) Tutorial method 3) Seminars 4) Use of Multimedia

**D) Evaluation Strategies :**

1) Descriptive written examinations 2) Assignments 3) Seminars

**E) Course Contents : Theory**

| **Module-1** | **Basic Concepts of Thermodynamics & Statistics** | **Lectures = 12** |
|---|---|---|
| | Mean free path, Definition of Transport phenomenon, Thermodynamic functions: Internal Energy, Enthalpy, Helmholtz function, Gibb's function, Maxwell Relations, Specific heat and latent heat equations, Probability, distribution functions, Random Walk in 1D, Binomial distribution, Calculation of mean values, Probability distribution for large-scale N, Gaussian probability distributions,<br>**Problem Solving** | **Lectures = 9**<br>**Lectures = 3** |
| **Module-2** | **Statistical Ensembles** | **Lectures = 12** |
| | Specification of state of system, Statistical ensembles, Basic Postulates, Probability calculations, Behaviors of density of states, Thermal, Mechanical and general interactions Micro canonical Ensemble (Isolated System), Canonical ensembles, simple application of canonical ensemble (Molecule in an Ideal Gas),<br>**Problem Solving** | **Lectures = 9**<br>**Lectures = 3** |
| **Module-3** | **Introduction to Quantum Statistics** | **Lectures = 6** |
| | Quantum distribution function,<br>Maxwell-Boltzmann's statistics, Bose-Einstein Statistics, Fermi-Dirac | |

| | | |
|---|---|---|
| | Statistics,<br>Comparison of the distributions. | |

**F) REFERENCES:**


1. Fundamentals of Statistical and Thermal Physics: F. Reif, McGraw-Hill International Edition (1985).
2. Fundamentals of Statistical Mechanics: B. B. Laud, New Age International Publication (2003).
3. Statistical Mechanics: R. K. Pathria, Butterworth Heinemann (2nd Edition).
4. Statistical Mechanics: K. Huang, John Willey and Sons (2nd Edition).
5. Statistical Mechanics: Satya Prakash and KedarNath Ram, Nath Publication (2008).
6. Statistical Mechanics: Loknathan and Gambhir.
7. Thermodynamics, Kinetic Theory, and Statistical Thermodynamics: Sears and Salinger.


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T.Y.B.Sc. (Physics) (Sem-VI)

# PHY-354-MJ : Nuclear Physics -I

**Lectures: 30 hrs** **(Credits-02)**

**A) Course Objectives:** This course aims to introduce fundamental concepts of nuclear physics, structure, radioactivity, forces, reactions and their technological applications as per NEP 2020 guidelines.

- To study the basic concepts regarding nuclear structure, properties, radioactivity, accelerators and detectors.
- To impart knowledge about nuclear forces, reactions, fission, fusion and nuclear reactor theory.

**B) Learning Course Outcomes (CO):** Upon completion of the course, the student will be able to,

- Understand the structure and properties of the nucleus, radioactivity and its applications.
- Identify the principles and working of particle accelerators and nuclear radiation detectors.
- Explain nuclear forces, elementary particles and quark model along with their significance.
- Analyze nuclear reactions, Q-value, fission, fusion, chain reaction and the working of nuclear reactors.
- Apply the knowledge of nuclear physics to solve numerical problems based on binding energy, radioactive decay, half-life and semi-empirical mass formula.

**C) Instructional design:**

- Lecture method using chalk-board and PowerPoint presentations
- Tutorial method for problem-solving sessions
- Seminars on applications of radioactivity and nuclear energy
- Use of Multimedia (animations of accelerators, reactors and nuclear processes)
- Creation of online resources (e-notes, short video lectures on selected topics)

**D) Evaluation Strategies:**

- Descriptive written examinations (University theory paper + Internal tests)
- Assignments (numerical problems and application-based)
- Seminars, Orals, and Viva

**E) Course Contents: Theory**

| Module-1 | Nuclear Structure, Properties of nuclei and Radioactivity | Lectures-12 |
|---|---|---|
| | **Basic concept of nucleus:** Composition, Charge, Size, Density (Revision); Nuclear mass, Mass defect, Binding energy, Packing fraction, Systematics of nuclear binding energy, Classification of nuclei, Nuclear stability curve;<br>**Properties:** Nuclear spin, Parity, Statistics of nuclei, Magnetic dipole moment, Electric quadrupole moment;<br>**Radioactivity:** Properties of α, β, γ-rays; Laws of radioactive decay, Half-life, Mean life, Units of activity, Specific activity, Successive disintegration; Radiocarbon dating; Applications of radioactivity (Agricultural, Medical, Industrial, | **Lectures-10** |

| | | |
|---|---|---|
| | Archaeological);<br>**Problem Solving** | <br>**Lecture-2** |
| **Module-2** | **Accelerators, Detectors, Nuclear Forces and Nuclear Models** | **Lectures-10** |
| | **Accelerators:** Introduction, Classification, Linear accelerator, Cyclic accelerator (Cyclotron), Accelerators in India (Discussion only);<br>**Radiation Detectors:** Classification, Geiger-Muller counter, NaI(Tl) Scintillation detector;<br>**Nuclear Forces:** Properties, Meson theory of nuclear forces; Elementary particles and Quark model;<br>**Nuclear Models:** Shell model: Evidences, Theory of single particle shell model, Liquid drop model: Weizsacher's semi-empirical mass formula,<br>**Problem Solving** | **Lectures-8**<br><br>**Lecture-2** |
| **Module-3** | **Nuclear Reactions and Reactor Theory** | **Lectures-10** |
| | **Nuclear reactions:** Introduction, Conservation laws, Q-value equation, Exoergic and endoergic reactions, Threshold energy, Compound nucleus hypothesis, Nuclear fission & fusion, Stellar energy: Proton-proton cycle and Carbon cycle, Fission Chain reaction;<br>**Nuclear reactor:** Basic components, Critical mass and critical size, Homogeneous and heterogeneous reactors, power reactor, fast breeders, Reactors in India (Discussion only),<br>**Problem Solving** | **Lectures-8**<br><br>**Lecture-2** |

**Reference Books:**


1. Dr. S. N. Ghoshal, Nuclear Physics, Revised Edition, S. Chand Publication, 2014.
2. D. C. Tayal, Nuclear Physics, Revised Enlarged Edition, Himalaya Publishing House.
3. K.S. Krane, Introductory Nuclear Physics, Wiley India, 1988.
4. B. L. Cohen, Concepts of Nuclear Physics, Tata McGraw Hill.
5. I. Kaplan, Nuclear Physics, 2nd Edition, Narosa, New Delhi, 1989.
6. S.B. Patel, Nuclear Physics: An Introduction, New Age International, 1991.
7. Glenn F.Knoll, Radiation Detection and Measurement: 4th Edition, John Wiley & sons.
8. S.S. Kapoaor and V.S. Ramamurthy, Nuclear Radiation Detectors: New Age International Publishers.


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T.Y.B.Sc. (Physics) (Sem-VI)

# PHY-355-MJP : Basic Physics Lab-VII

**Lectures: 60 hrs** **(Credits-02)**

**Section I: Basic Physics Laboratory (any 12)**

**GROUP-I: Atomic and Molecular Physics (any 4)**

1. Determination of Rydberg's constant
2. Zeeman Effect
3. Llyod's mirror
4. Determination of Resolving Power of grating
5. Determination of wavelength by Constant deviation spectrometer

**GROUP-II: Statistical Physics (any 4)**

1. Determination of pressure coefficient of air by constant volume thermometer.
2. Verification of Stefan's fourth power law by bulb filament
3. Thermal conductivity by Forbes Method.
4. Thermal conductivity of rubber tube.
5. Thermal diffusivity of Brass.
6. Thermal and Electrical conductivity of Cu.

**GROUP-III: Nuclear Physics and Quantum Mechanics (any 4)**

1. Characteristics of G.M. tube
2. Inverse square law (γ-rays)
3. e/m by Thomson method
4. Determination of Planck's constant
5. Study of Gaussian distribution by G. M. tube.

**Section II: Additional Activities to be conducted during the semester (Any-1):**

1. Demonstrations: Any 2 demonstrations equivalent to 3 experiments
2. Study tour / Industrial visit / Field visit with report equivalent to 3 experiments
3. Mini project equivalent to 3 experiments
4. Computer aided demonstrations (simulations or animations) (Any 2 demonstrations equivalent to 3 experiments)

**Study tour:** Student have to participate in study tour organized by department to study about physics in Industry / Company / Organization / Research Institute / Research organization / Small scale industry / University Department and compulsory submitted study tour report equivalent to 3 experiments signed by study tour co-ordinator and HOD of Department.

**Note:** Students have to perform total 15-experiments (12-experiments from Section-I and 1-activity from Section-II)

**OR**

Participated in Additional any **one** activity equivalent to **3-experiments** with 15-experiments (12 experiments from Section-I and 3-experiments from Section-II) mentioned above. Total laboratory work with additional one activity should be 15-experiments.

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T.Y.B.Sc. (Physics) (Sem-VI)

# PHY-356-MJP : Physics Lab-VIII (Project-I)

**Lectures: 60 hrs** **(Credits-02)**

**Guidelines:**

It is expected that,

1. The student does work equivalent to about ten (15) laboratory experiments throughout the semester in the third year.
2. One bears in mind that the project work is a practical course and it is intended to develop a set of skills pertaining to the laboratory work apart from the cognition of students. Therefore, the guides should not permit projects that involve no contribution on part of student.
3. The project must have a clear and strong link with the principles of basic physics and/or their applications.
4. The theme chosen should be such that it promotes better understanding of physics concepts and brings out the creativity in the students.
5. The evaluation of the project work must give due credit to the amount of the project work actually done by a student, skills shown by the student, understanding of the physics concepts involved and the final presentation at the time of viva voce.
6. It is also recommended that a teacher will look after Four (4) projects at one time.
7. The student can perform an Experimental/Theoretical related with Physical science / Electronics / Computational project in Physics or interdisciplinary areas under the supervision of guides.
8. The student can learn the basics of the topic chosen for project, to learn how to do literature survey and set up the basic experimental/theoretical and computational techniques needed for the project.
9. The department encourage to students for projects both in experimental and theoretical areas of Physics in collaboration with other institutes and industry.

**The Project work shall consist of the following Criterions.**

1. Project work is mandatory for all the T.Y.B.Sc. students.
2. All the T.Y.B.Sc. students will have to complete the Project work prescribed by the Board of Studies in Physics of Savitribai Phule Pune University during the VI$^{th}$ Semester.
3. It is expected that the Project work shall consist of Title of Project, Abstract, Objectives, Introduction, Literature survey, Materials and Methods, Experimental, Result and Discussion, Conclusion, and Application, References, etc.

**Evaluation weightage:**

- University Examination: 30 Marks
- Internal Examination: 20 Marks

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## 20) Syllabus of Discipline Specific Elective (DSE) Courses (Major Elective)

**Major Elective (Semester V) (4 Credits) (2T+2P)**

**T.Y.B.Sc. (Physics) (Sem-V)**

# PHY-310(A)-MJ : Thin Film Technology

**Lectures: 30 hrs** **(Credits-02)**

**A) Course Objectives:** This course aims to develop scientific research approach among the students and prepare them for higher studies and career opportunities in Physics and related fields by introducing them with

1. Fundamental concepts of thin films such as definition, difference from bulk materials, nucleation and growth mechanisms, the stages of film formation and the optical, electrical, properties of thin film.
2. Various thin film deposition techniques, including physical and chemical.
3. Various characterization techniques to analyse thin film properties for different applications.
4. Importance and applications of thin films in electronics, optics, magnetic devices, energy systems, biomedical coatings, and industrial sectors.

**B) Learning Course Outcomes (CO) :** Upon completion of the course, the student will be able to,

1. Understand the thin films, differentiate them from bulk and thick films, and explain nucleation, growth processes, stages of film formation and properties of thin films.
2. Explain and compare various thin film deposition techniques, including physical and chemical methods.
3. Gain knowledge of characterization methods and analyse thin film properties for their applications.
4. Gain problems solving skills related to real-world applications in electronics, optics, energy devices, biomedical fields, and industry, and suggest suitable materials and techniques for specific applications.

**C) Instructional design:**

**1)** Lecture method **2)** Tutorial method **3)** Seminars4) Use of Multimedia

5) Creation of online resources

**D) Evaluation Strategies :**

**1)** Descriptive written examinations **2)** Assignments **3)** Seminars, Orals, and Viva

**E) Course Contents : Theory**

| Module-1 | Fundamentals of Thin Films | Lectures= 8h |
|---|---|---|
| | 1. Introduction of thin films<br>2. Difference between bulk, thick and thin film materials<br>3. Nucleation theory (homogeneous & heterogeneous)<br>4. Growth mechanisms (island, layer, Stranski–Krastanov) | |

| | | |
|---|---|---|
| | 5. Stages of film growth<br>6. Surface energy and interface energy (overview),<br>7. Adhesion of thin films<br>8. Grain size and microstructure of thin films,<br>9. Epitaxy (homoepitaxy and heteroepitaxy)<br>10. Properties of thin films (electrical, optical, mechanical, magnetic) | |
| **Module-2** | **Thin film deposition Methods** | **Lectures = 8h** |
| | • Thin film deposition methods and their classification<br>• Physical deposition methods :<br>a) Sputtering<br>b) Thermal evaporation<br>c) Chemical Vapour Deposition<br>• Chemical deposition methods:<br>a) Sol-gel<br>b) Electrochemical deposition<br>c) SILAR<br>d) Chemical Bath Deposition | |
| **Module-3** | **Thin film Characterizations** | **Lectures= 8h** |
| | 1. Structural characterization: XRD and EDAX,<br>2. Surface morphology: SEM and TEM,<br>3. Spectroscopic Characterization: UV-Vis and IR<br>4. Electrical properties: Four Probe Method,<br>**5.** Functional groups study: FTIR | |
| **Module-4** | **Thin film Applications** | **Lectures= 6h** |
| | 1. Thin film - Thermistor, Strain gauge and Capacitor,<br>2. Electronics (ICs, sensors)<br>3. Optical coatings (anti-reflection, mirrors)<br>4. Magnetic Applications (Audio, video and computer memories, Magnetic read/write heads)<br>5. Thin film solar cells<br>6. Energy storage devices<br>7. Photocatalytic devices<br>8. Medical and biomedical coatings<br>9. Industrial applications (automobile, defence) | |

**F) REFERENCES:**

1. Chopra, K.L. (1969) Thin Films Phenomena. McGraw-Hill, New York.

2. Ohring, M. (2002). Materials science of thin films: deposition and structure. Academic press.
3. Goswami, A. (1996). Thin film fundamentals. New age international.
4. Vossen, J. L., & Kern, W. (Eds.). (1991). Thin film processes II (Vol. 2). Gulf Professional Publishing.
5. Maissel, L. I., & Glang, R. (1995). Handbook of thin film technology.
6. Martin, P. M. (2009). Handbook of deposition technologies for films and coatings: science, applications and technology. William Andrew.
7. Pierson, H. O. (1999). Handbook of chemical vapour deposition: principles, technology and applications. William Andrew.
8. Brinker, C. J., & Scherer, G. W. (1990). Sol-gel science: the physics and chemistry of sol-gel processing. Gulf Professional Publishing.
9. Chopra, K. (2012). Thin film device applications. Springer Science & Business Media.
10. Moorthy, S. B. K. (Ed.). (2015). Thin film structures in energy applications. Cham, Switzerland: Springer International Publishing.

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T.Y.B.Sc. (Physics) (Sem-V)

# PHY-310(B)-MJ : Functional Nanomaterials

**Lectures: 30 hrs** **(Credits-02)**

**A) Course Objectives:** This course aims to develop scientific research approach among the students and prepare them for higher studies and career opportunities in Physics and related fields by introducing them with

1) Fundamental concepts of nanomaterials
2) Methods of synthesis.
3) Various characterization techniques to analyse properties prepared samples for different applications.
4) Applications of nanomaterials in electronics, optics, magnetic devices, energy systems, biomedical coatings, and industrial sectors.

**B) Learning Course Outcomes (CO) :** Upon completion of the course, the student will be able to,

1) Understand the nanomaterials.
2) Gain knowledge of characterization methods and analyse properties for their applications.
3) Gain problems solving skills related to real-world applications in electronics, optics, energy devices, biomedical fields, and industry, and suggest suitable materials and techniques for specific applications.

**C) Instructional design:**

**1)** Lecture method**2)** Tutorial method**3)** Seminars4) Use of Multimedia

5) Creation of online resources

**D) Evaluation Strategies :**

**1)** Descriptive written examinations**2)** Assignments**3)** Seminars, Orals, and Viva

**E) Course Contents : Theory**

| | | |
|---|---|---|
| **Module-1** | **Introduction to nanomaterials:** | **Lectures = 7H** |
| | • Introduction to Nano-sized materials and Structures<br>• Classification of nanostructured materials<br>• Properties of Nanomaterials: Mechanical, Electrical, Thermal and Optical properties | |
| **Module-2** | **Methods for Synthesis of Nanomaterials:** | **Lectures = 8H** |
| | • Bottom-up and Top-down approaches<br>• Synthesis Methods:<br>a) Thermal Evaporation,<br>b) Sputter deposition,<br>c) Colloidal method,<br>d) Sol-gel Method, | |

| | | |
|---|---|---|
| | e) Chemical Vapour deposition,<br>f) Electrochemical Deposition. | |
| **Module-3** | **Characterization Techniques:** | **Lectures= 10H** |
| | • **Structural characterization :** XRD, EDAX<br>• **Morphological Characterization:** SEM, TEM<br>• **Optical characterization:** UV-Vis, IR<br>• **Magnetic characterization:** VSM | |
| **Module-4** | **Applications of nanomaterials** | **Lectures = 5H** |
| | Nano-electronics, Cosmetics, Medical, Biosensors, Automobiles, Space, Sports, Cloth industry, etc. | |

**Reference books :**


1) Nanotechnology: Principles and Practices by Sulbha Kulkarni, Capital Publishing Co. New Delhi.
2) Introduction to nanotechnology, by C. P. Poole Jr. and F. J. Ownes, Willey Publications.
3) Origin and development of nanotechnology by P. K. Sharma, Vista International publishing house.
4) Nanostructure and nanomaterials synthesis, Properties and applications, by G. Cao, Imperials College Press, London.
5) The chemistry of nanomaterials: Synthesis, properties and applications, C. N. R. Rao, A. Muller, A. K. Cheetham (Eds) Wiley VCH Verlag Gmbh& Co, Weinheim, 2004.


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T.Y.B.Sc. (Physics) (Sem-V)

# PHY-310(C)-MJ : Advanced Electronics

**Lectures: 30 hrs** **(Credits-02)**

**A) Course Objectives:** - This course aims to introduce basic electronics.

1) To study the basic concepts regarding Analog and Digital electronics and their usefulness.

2) To impart knowledge about the importance of day-to-day electronics.

B) Learning Outcomes (CO): - Upon completion of the course, the student will be able to,

1) Understand the parameters, characteristics, and workings of transistors.

2) Identify and use various electronic devices like transistors, FET, and op-amp.

3) To understand the electronic circuits and their significance.

4) Define performance parameters Logic gates and its families.

5) Apply the knowledge of analog and digital electronics.

C) Instructional Design: -

1) Lecture method 2) Tutorial method 3) Seminars/ Demo kits. 4) Use of Multimedia

5) Creation of online resources.

D) Evaluation Strategies:-

1) Descriptive written examinations 2) MCQ's based examination 3) Assignments

4) Experiential Learning based activity. 5) Seminars, Orals, and Viva

**E) Course Contents : Theory**

| | | |
|---|---|---|
| **Module-1** | **Applications of Semiconductor Devices** | **Lectures = 10** |
| | **Field Effect Transistor :**<br>1. JFET :Classification, Principle, Working and IV-characteristics<br>2.MOSFETs : DE-MOSFET and E-MOSFET<br>3. Applications of FET<br>**Timer IC-555:**<br>1. Block diagram, working and design<br>2. Applications of IC-555<br>**OP-AMP :**<br>1. Applications as Integrator, Differentiator, Comparator<br><br>Solving Problems on FET, IC-555, OP-AMP | **Lectures = 8**<br><br>**Lectures=2** |
| **Module-2** | **Flip Flop and Counters** | **Lectures = 8** |
| | 1. Introduction to Flip Flop and Counters<br>2. RS, D, JK and T-flip flops.<br>3. Application of FF in Sequential Circuits as Counters and Registers.<br>4. Asynchronous and Synchronous Counters. (3-bit Counter),<br>5. Shift Registers and their types of operation -SISO, SIPO, PISO, PIPO (Concepts only). | |
| **Module-3** | **Analog and Digital Signal Conditioning** | **Lectures = 12** |

| | | |
|---|---|---|
| | **Analog Signal Conditioning:**<br>1. Analog Multiplexer and De-Multiplexer using Ic-4051,<br>2. Ideal & Practical characteristics of Low Pass, High Pass, band pass and band reject filters<br>3. Instrumentation amplifier using 3-OP-AMP,<br>4. Application of Instrumentation Amplifier as thermocouple signal conditioning<br>**Digital Signal Conditioning:**<br>1. Digital Multiplexer and De-Multiplexer using NAND gate,<br>2. Priority encoder using Ic-74148,<br>3. Decoders: 2 to 4 decoder and 3 to 8 Decoder.<br>4. Signal Converters:<br>• DAC: R-2R ladder type DAC, Binary weighted DAC.<br>• ADC: Single slope ADC, Successive Approximation ADC, Flash ADC.<br>5. Applications of Analog and Digital Signal Conditioning | **Lectures = 6**<br><br>**Lectures = 6** |

**F) REFERENCES:**


1. Malvino, Electronic Principles (6th Ed.), Tata McGraw Hill, New Delhi
2. R. P. Jain, Modern Digital Electronics (3rd Ed.), Tata McGraw Hill, New Delhi
3. B. L. Theraja, Basic Electronics - Solid State, S. Chand and Company, New Delhi
4. K. R. Botkar, Integrated Circuits, Khanna Publishers, Delhi
5. C.D. Johnson, Process Control Instrumentation Technology, Pearson Education, 8th edition.
6. Krishna Kant, Computer Based Industrial Control, Eastern Economic Edition
7. Rangan, Mani, Sharma, Instrument of Device System
8. B. C. Nakra, K. K. Chaudhari, Instrument measurement and analysis


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T.Y.B.Sc. (Physics) (Sem-V)

# PHY-311-MJP : Special Physics Lab-I

**Lectures: 60 hrs** **(Credits-02)**

**A) Course Objectives:** This course aims to enhance the skill-based capabilities in thin film technology on

1. Hands-on experience in the preparation and deposition of thin films (oxide, semiconductor, and metal) using various physical and chemical thin film deposition techniques
2. To familiarize students with modern thin film characterization methods.
3. To develop the ability to analyze experimental results and correlate thin film properties with applications, such as solar cells, Energy storage devices, magnetic devices, sensors, and electronic components.

**B) Learning Course Outcomes (CO) :** Upon completion of the course, the student will be able to,

1. Understand how prepare and deposit thin films using various deposition techniques
2. Characterize thin films using techniques like XRD, SEM, AFM, UV-Vis spectroscopy, four-point probe, FTIR, ellipsometry, and profilometer.
3. Analyze and interpret experimental data of thin films from the various applications such as solar cells, sensors, magnetic devices, and electronic components.

**C) Instructional design:**

1) Experimental methods
2) Field Visit / Survey
3) Seminars
4) Use of Multimedia for Demonstration.
5) Creation of online resources google classroom, Simulation software.
6) Journal writing.

**D) Evaluation Strategies :**

1) Practical Exam.
2) Assignments/ Mini Projects
3) Industrial / research centre/ university department visit report
4) report based on published article
5) Seminars, Orals, and Viva.

**E) Course Contents : Thin Film Technology Practical**

| Expt. No. | Name of Experiment |
|---|---|
| **Section – I: Preparation of Thin Films (Any – 6)** | |
| **1** | Prepare semiconductor thin film using sol-gel. |
| **2** | Deposit thin film using dip coating and study thickness vs withdrawal speed. |
| **3** | Prepare semiconductor thin film using spin coater and study thickness vs spin speed. |
| **4** | Deposit semiconductor thin film using chemical bath deposition (CBD). |

| | |
|---|---|
| **5** | Deposit metal film using electrodeposition method. |
| **6** | Prepare semiconductor thin film using SILAR. |
| **7** | Prepare semiconductor thin film using spray pyrolysis. |
| **8** | Prepare semiconductor thin film / powder using hydrothermal method. |
| **9** | Prepare semiconducting powder using Co-precipitation method. |
| **10** | Deposit metal thin film under vacuum by Thermal Evaporation (use online demonstration/video). |
| **11** | Study sputtering process (use online demonstration/video). |
| **12** | Study CVD process and reaction mechanism. |
| **Section – II: Characterization and Application of Thin Films(Any – 6)** | |
| **1** | Measure thickness using Ellipsometry/ Profilometer / weight difference method |
| **2** | Determination of Crystal Structure of given XRD pattern |
| **3** | To calculate crystallite size by Scherrer Equation of given XRD pattern |
| **4** | To study surface morphology of given SEM image |
| **5** | To study surface roughness of given AFM 2D and 3D images |
| **6** | To calculate band gap of thin film using UV-Vis spectroscopy |
| **7** | To measure resistivity of thin film using Four-point probe method |
| **8** | To identify chemical bonds in thin films using FTIR |
| **9** | To observe hysteresis loop (using data/software/demo) |
| **10** | Study working of magnetic read/write heads (model/video/demo) |
| **11** | Measure I–V characteristics of solar cell under light |
| **12** | Determine efficiency of given output I-V characteristics graphs of Solar Cell |
| **13** | To study the chemical state of any material/compound using X-ray photoelectron spectroscopy (XPS) data. |

**Activities: (Any one)**

1. Prepare report on any thin film applicationbased on published report of current academic year.
2. Visit coating/solar/batteryetc. industry.
3. Visit characterization centre / research centre/ institute/ University department etc.
4. Watch thin film fabrication/characterization videos and make report on it.
5. Prepare report on review article on thin film Applications, synthesis, characterization etc. published in current academic year.
6. Prepare report on Future of Thin Film Technology based on published report of current academic year.

**Section III: Additional Activities to be conducted during the semester (Any-1):**

1. Study tour / Industrial visit / Field visit with report.
2. Minor projects Industry-Specific Projects (Minimum 15 pages)
3. Demonstrations – Any one demonstrations of other experiments.

**Study tour:** Student have to participate in study tour organized by department to study about physics in Industry / Company / Organization / Research Institute / Research organization / Small scale industry /

University Department and compulsory submitted study tour report equivalent to 3 experiments signed by study tour co-ordinator and HOD of Department.

**Note:** Students have to perform total 15-experiments (12-experiments from Section-I& II and 1activity)

**OR**

Participated in Additional any **one** activity equivalent to **3-experiments** with 15-experiments (12 experiments from Section-I and II and 1-activity from Section-III) mentioned above. Total laboratory work with additional one activity should be 15-experiments.

**F) REFERENCES:**


1) Elements of X-ray Diffraction: B. D. Cullity and S. R. Stock, Pearson, (2014).
2) Thin Films Technology, Practical Manual for the Laboratory Works, World Scientific Publishing (2022) by Alex Axelevitch
3) Handbook of Thin film Technology, McGraw Hill- 1970 by Leaon I. Maissel and Reinhard Glang,
4) Chemical Solution Deposition of Semiconductor Films, Marcel Dekker (2002), by Gary Hodes


**OR**

**E) Course Contents : Physics of NanomaterialsPractical**

**Section-I: Experiments**

| Expt. No. | Name of Experiment (any 12) |
|---|---|
| 1 | Synthesis of metallic nanoparticles by any chemical method. |
| 2 | Synthesis of Metal Oxide Nanoparticle using different techniques. |
| 3 | Synthesis of silver nanoparticles from silver nitrate by colloidal solution method |
| 4 | Study of optical absorption of nanoparticles. |
| 5 | Determination of crystallite size from X-ray diffraction spectra. |
| 6 | Study of optical band gap of nanoparticles from UV-Vis spectra. |
| 7 | Determination of grain size from X-ray diffraction spectra. |
| 8 | To observe hysteresis loop (using data/software/demo) |
| 9 | Synthesis of metallic nanoparticles by any physical method. |
| 10 | Determination of absorptance and transmittance from IR spectra. |
| 11 | Study surface morphology from SEM image. |
| 12 | Study surface morphology from TEM image. |
| 13 | Study structural behavior from EDAX spectra. |
| 14 | To identify chemical bonds in thin films using FTIR |
| 15 | To calculate crystallite size by Scherrer Equation of given XRD pattern |
| 16 | To study magnetic behaviour of synthesized materials using VSM |

**Activities: (Any one)**

1. Prepare report on any nanomaterials applicationbased on published report of current academic year.
2. Watch synthesis of nanomaterials /characterization videos and make report on it.
3. Prepare report on review article on nanomaterials Applications, synthesis, characterization etc. published paper.

**Section II: Additional Activities to be conducted during the semester (Any-1):**

1. Study tour / Industrial visit / Field visit with report.
2. Minor projects Industry-Specific Projects (Minimum 15 pages)
3. Demonstrations – Any one demonstration of other experiments.

**Study tour:** Student have to participate in study tour organized by department to study about physics in Industry / Company / Organization / Research Institute / Research organization / Small scale industry / University Department and compulsory submitted study tour report equivalent to 3 experiments signed by study tour co-ordinator and HOD of Department.

**Note:** Students have to perform total 15-experiments (12-experiments from Section-I and 1-activity equivalent with 3 experiments)

**F) REFERENCES:**


1) Nanotechnology: Principles and Practices by Sulbha Kulkarni, Capital Publishing Co. New Delhi.
2) Introduction to nanotechnology, by C. P. Poole Jr. and F. J. Ownes, Willey Publications.
3) Origin and development of nanotechnology by P. K. Sharma, Vista International publishing house.
4) Nanostructure and nanomaterials synthesis, Properties and applications, by G. Cao, Imperials College Press, London.
5) The chemistry of nanomaterials: Synthesis, properties and applications, C. N. R. Rao, A. Muller, A. K. Cheetham (Eds) Wiley VCH Verlag Gmbh & Co, Weinheim, 2004.


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T.Y.B.Sc. (Physics) (Sem-VI)

# PHY-360(A)-MJ : LASER Technology

**Lectures: 30 hrs** **(Credits-02)**

**A) Course Objectives:** This course aims to introduce laser technology to solve problems in industry.

1. To acquire a thorough understanding of the theory of modern Laser Physics
2. To understand different types of modern lasers and their applications

**B) Learning Course Outcomes (CO) :** After learning the course the students will be able to

1. Understand to describe and explain fundamental concepts in laser physics.
2. Compare the function and properties of a number of common lasers.
3. Verify properties of material used for laser production.
4. Apply the knowledge of laser in various applications.

**C) Instructional design:**

**1)** Lecture method **2)** Tutorial method **3)** Seminars 4) Use of Multimedia

5) Creation of online resources

**D) Evaluation Strategies :**

**1)** Descriptive written examinations **2)** Assignments **3)** Seminars, Orals, and Viva

**E) Course Contents : Theory**

| **Module-1** | **Basics of laser operation and working** | **Lectures = 10** |
|---|---|---|
| | Introduction to LASERS: Interaction of radiation with matter, Spontaneous and stimulated emission - Population inversion – metastable state, Threshold condition – Gain profile – super-radiance Laser - Rate equation for 3 level and 4 level systems - conditions for CW and pulsed laser action. Black body radiation - Modes of oscillation - Einstein coefficients - relation between the absorption coefficients and Einstein coefficients - Lifetime of excited state- Line Broadening mechanisms. | |
| **Module-2** | **Types of LASERS** | **Lectures =10** |
| | Liquid lasers: Principle and main components of laser, levels of laser action, continuous wave lasers, construction and working of dye laser. Gas Laser: Principle, working and usefulness of gas laser, He-Ne laser, lasing action in Ion lasers, construction and operation of ion lasers<br>Solid state laser: Ruby Laser (3- level system example), ND: YAG laser (4- level system example).<br>Semiconductor Laser: Principle of semiconductor laser diode, threshold frequency, difference between a diode and laser diode, | |

| | | |
|---|---|---|
| | Characteristics of semiconductor lasers, Semiconductor diode lasers, LED versus Laser diode. | |
| **Module-3** | **LASER Applications** | **Lectures = 10** |
| | Laser applications: Material processing with lasers, interaction mechanism, Lattice heating, Material processing mechanism (Laser Cutting, Laser Welding, Laser Surface Modification)<br>Elementary ideas on application of Laser in Medical Science - Medical lasers, Laser diagnostic, Laser for general surgery, Laser Dentistry.<br>Elementary ideas on -Laser in Optical Communication: Optical source for fiber optical communication, Essential characteristics of Laser in fibre optic communication, Holography | |

**F) REFERENCES:**


1. Laser Principles, Types and Application by KR Nambiar, New Age International.
2. Modern Spectroscopy by J Michael Hollas, Fourth Edition, John Wiley and Sons.
3. Lasers Theory and Applications by K. Thyagarajan and A.K. Ghatak, Mcmillan (1981)
4. Laser Fundamentals, by William T. Silfvast, Cambridge University Press, 2008.
5. Principles of Lasers, by Orazio Svelto; Springer, 2009.
6. Laser Spectroscopy and Instrumentation by W. Demtroder.
7. Industrial Applications of Lasers, by K. Koebner (ed.), Wiley (1984).
8. https://www.me.iitb.ac.in/~ramesh/courses/ME677/me677.html


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T.Y.B.Sc. (Physics) (Sem-VI)

# PHY-360(B)-MJ : Medical Electronics

**Lectures: 30 hrs** **(Credits-02)**

**A) Course Objectives:** This course aims to introduce medical electronics;

1. to acquire a thorough understanding of the theory of medical Physics
2. to understand different types of medical instruments and their applications

**B) Learning Course Outcomes (CO) :** After learning the course the students will be able to

1. to understand the fundamental concepts in medical physics.
2. to study the function and properties of a medical instruments.
3. to verify properties of material used for medical instruments production.
4. to apply the knowledge of medical instruments in various applications.

**C) Instructional design:**

**1)** Lecture method **2)** Tutorial method **3)** Seminars 4) Use of Multimedia

5) Creation of online resources

**D) Evaluation Strategies :**

**1)** Descriptive written examinations **2)** Assignments **3)** Seminars, Orals, and Viva

**E) Course Contents : Theory**

| **Module-1** | **Introduction to medical instrumentation** | **Lectures = 6** |
|---|---|---|
| | 1. Terminology of medical instrumentation,<br>2. Physiological system of body<br>3. Sources of bioelectric signals,<br>4. Origin of bioelectric signals,<br>5. Nernst equation,<br>6. Various types of bioelectric signals, | |
| **Module-2** | **Biopotential Electrodes and Sensors** | **Lectures = 12** |
| | **Electrodes:**<br>1. Electrode-electrolyte interface,<br>2. Polarizable and non-polarizable electrodes,<br>3. Electrodes for ECG, EEG, EMG,<br>**Sensors:**<br>1. Resistive sensor,<br>2. Capacitive sensor,<br>3. Inductive sensor,<br>4. Piezoelectric sensor,<br>5. Temperature sensor | |

| Module-3 | Measurements of Pressure and Volume Flow of Blood | Lectures = 12 |
|---|---|---|
| | 1. Direct measurements of blood pressure,<br>2. Heart sounds,<br>3. Phonocardiography,<br>4. Ultrasonic blood flow meter<br>5. Laser Doppler blood flow meter<br>6. Cardiac monitor | |

**F) REFERENCES:**


1. Handbook of Biomedical Instrumentation, R.S. Khandpur
2. Medical Instrumentation application design, John G Webster, Houghon Mifflin Co.
3. Introduction to Medical Electronics, Mahi Publication, Ahmadabad
4. Introduction to biomedical equipment technology J. Carr and John M. Brown
5. Introduction to Biomedical Electronics, Joseph DfuBovy, Mc Graw Hill.
6. Clinical Biophysics, P. Narayanan


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T.Y.B.Sc. (Physics) (Sem-VI)

# PHY-361-MJP : Special Physics Lab-II

**Lectures: 60 hrs** **(Credits-02)**

**A) Course Objectives:** This course aims to introduce laser technology or medical electronics;

1. to acquire a thorough understanding of the theory of modern Laser Physics or medical electronics
2. to understand different types of modern instruments and their applications

**B) Learning Course Outcomes (CO) :** After learning the course the students will be able;

1. to understand to describe and explain fundamental concepts of instruments
2. to compare the function and properties of instruments.
3. to verify properties of material used for instruments production
4. to apply the knowledge of laser and medical electronics in various applications.

**C) Instructional design:**

**1)** Lecture method **2)** Tutorial method **3)** Seminars 4) Use of Multimedia

5) Creation of online resources

**D) Evaluation Strategies :**

**1)** Descriptive written examinations **2)** Assignments **3)** Seminars, Orals, and Viva

**E) Course Contents : LASER Technology Practical**

**Section I: (12 expt. Compulsory and 1 Activity)**

| Expt. No. | Title of Experiment (any 12) |
|---|---|
| **1.** | Measurement of beam divergence of laser. |
| **2.** | Study refractive index of glass using Snell's law |
| **3.** | Measurement of wavelength of Laser beam using Michelson Interferometer. |
| **4.** | Study of Interference in using a Thin Film air wedge |
| **5.** | Study refractive index of liquids using Snell's law |
| **6.** | Study the Refraction of Index of homogeneous and non-homogeneous Liquids. |
| **7.** | Determination of wavelength using Diffraction Grating |
| **8.** | Determination of grating element (number of lines per cm) |
| **9.** | Thin Film in Interference Using an Air Wedge |
| **10.** | Determination of particle size of dust/powder using Laser |
| **11.** | Study of scattering of Light with different particles (chalk dust/milk particles) |
| **12.** | Study of the interference of light using optical fibers |
| **13.** | Determine the focal length of lens using a laser. |
| **14.** | Study of Lissajous figures using diode Laser and mirrors |
| **15.** | Determination of Planck's constant using LED and laser comparison method |
| **16.** | Analyse multiple beam interference and finesse by Fabry–Pérot Interferometer |

| | |
|---|---|
| | study |
| **17.** | Study of Newton's Rings with Laser Source determine radius of curvature of a lens. |
| **18.** | Study surface roughness using speckle patterns using LASER. |
| **19.** | Study the Laser Power of various lasers(Solid/Gas/Liquid) |
| **20.** | Demonstrate reflection-based detection using Barcode Scanner |
| **21.** | Study of holography using laser source |

**Section II : Additional Activities to be conducted during the semester (Any-1):**

1. Study tour / Industrial visit / Field visit with report.
2. Minor projects Industry-Specific Projects (Minimum 15 pages)
3. Demonstrations – Any one demonstration of other experiments.

**References:**


1. "Optical electronics" by Ajoy Ghatak and K. Thyagarajan, Cambridge University Press, 1st Edition (2009)
2. "Laser Physics" by Milonni & Eberly, Wiley publication, 1st edition (2010)
3. "Principles of Lasers" by Svelto and Orazio, Springer publication, 4th edition (1998)
4. A Reference Manual and Experiment Guide for use with Industrial Fiber Optics Helium-Neon Lasers and Optics Education Sets, 13th Edition, New York State, Department of Education.
5. Fiber Optics and Laser Instrumentation (EIC18201), Lab Manual, IIT, Dhanbad.


**OR**

**Course Contents : Medical Electronics Practical**

**Section I: (12 Compulsory and 1 Activities)**

| Expt. No. | Title of Experiment (any 12) |
|---|---|
| 1 | Measurement of BP using Mercury sphygmomanometer and digital BP monitor |
| 2 | Study of ECG machine: Gain, chart speed arrangements and positioning electrodes |
| 3 | Recording of ECG and its analysis. |
| 4 | Absorbance using calorimeter/ Absorption spectra using Spectrophotometer. |
| 5 | Pulse oxymetry: Measurement of SpO2 |
| 6 | Use of thermal scanner/Thermal gun to measure body temperature |
| 7 | Study of glucometer as a sensor and measurement of BSL |
| 8 | Study of EEG machine: Gain, chart speed arrangements and positioning electrodes |
| 9 | Study of EMG machine: Gain, chart speed arrangements and positioning electrodes |

| | |
|---|---|
| 10 | Recording of EEG and its analysis. |
| 11 | Recording of EMG and its analysis. |
| 12 | Study of Resistive sensor and measurement of resistivity, |
| 13 | Study of Capacitive sensor and measurement of capacitance, |
| 14 | Study of Inductive sensor and measurement of inductance |
| 15 | Study of Piezoelectric sensor and measurement of biopotential |
| 16 | Study of Temperature sensor and measurement of temperature |
| 17 | Measure Heart sounds and heart rate |
| 18 | To study of Phonocardiography |
| 19 | Study of Cardiac monitor |

**Section II : Additional Activities to be conducted during the semester (Any-1):**

1. Study tour / Industrial visit / Field visit with report.
2. Minor projects Industry-Specific Projects (Minimum 15 pages)
3. Demonstrations – Any one demonstration of other experiments.

**Study tour:** Student have to participate in study tour organized by department to study about physics in Industry / Company / Organization / Research Institute / Research organization / Small scale industry / University Department and compulsory submitted study tour report equivalent to 3 experiments signed by study tour co-ordinator and HOD of Department.

**Note:** Students have to perform total 15-experiments (12-experiments from Section-I and 1 activity from Section-II equivalent to 3-experiments)

**References:**


1. Handbook of Biomedical Instrumentation, R.S. Khandpur
2. Medical Instrumentation application design, John G Webster, Houghon Mifflin Co.
3. Introduction to Medical Electronics, Mahi Publication, Ahmadabad
4. Introduction to biomedical equipment technology J. Carr and John M. Brown
5. Introduction to Biomedical Electronics, Joseph DfuBovy, Mc Graw Hill.
6. Clinical Biophysics, P. Narayanan


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## 21) List of Vocational Skill Courses (VSC):(Each semester: 2 Credits)(P)

**T.Y.B.Sc. (Physics) (Sem-V)**

# PHY-321-VSC-P : Solar PV System: Design, and Maintenance

**Lectures: 60 hrs** **(Credits-02)**

**A) Course Objectives:** This course aims to enhance the skill-based capabilities in physics

1) To understand the basics of solar energy and solar PV technology.
2) To learn the components of rooftop solar PV systems.
3) To understand basic system design and installation practices.
4) To study maintenance and troubleshooting methods

**B) Learning Course Outcomes (CO):** Upon completion of the course, the student will be able to,

1. Explain the working principle of solar PV systems.
2. Identify major components of rooftop solar installations.
3. Perform basic sizing and design calculations.
4. Describe installation and safety procedures.
5. Understand maintenance and fault detection methods

**C) Instructional design:**

**1)** Experimental methods **2)** Field Visit / Survey **3)** Use of Multimedia for Demonstration

4) Seminars 5) Creation of online resources Google classroom, Simulation software

6) Journal writing.

**D) Evaluation Strategies:**

**1)** Practical Exam. **2)** Assignments/ Mini Projects **3)** Seminars, Orals, and Viva.

**E) Course Contents: Practical**

| Expt. No. | Name of Experiment ( any 12) |
|---|---|
| 1. | To Study of On Grid Solar PV System Components. |
| 2. | To Study of Off Grid Solar PV System Components. |
| 3. | To Study of Types of Solar Panels in PV System. |
| 4. | To Study I-V Characteristics and Efficiency of Solar PV Module. |
| 5. | To Study Series and Parallel Connection of PV Modules. |
| 6. | To Study Performance Testing Under Different Conditions Solar Module. (Cloudy, Rainy, Sunny, Hot, Cold Etc.). |
| 7. | To Study Effect of Tilt Angle/Intensity Variation on Output Power. |
| 8. | To Study Shading Effect on PV Modules. |
| 9. | To Study PWM/ MPPT Charge Controllers for Charging Battery in PV System. |
| 10. | To Design/ Assemble & Install Solar Street Light. |
| 11. | To Design DC/AC Box Component's Connections in on Grid PV System. |

| | |
|---|---|
| 12. | To Study Earthling and Lighting Protection in PV System. |
| 13. | To Study Different Mounting Structure of PV System. |
| 14. | To Study the Proper Cable Wire, Connectors & Protection Devices in PV System. |
| 15. | To Site Analysis for Proper PV System. |
| 16. | To Design Roof Top Grid Connected PV System for Home/Office for Sectioned Load. |
| 17. | To Design Roof Top Off Grid PV System for Home/Office for Sectioned Load. |
| 18. | To Study the Specification of Solar Panel, Solar Inverter, Charge Controller from Catalogue Data. |
| 19. | To Study the Specification of NET Meter/ Bidirectional Meter/ Generation Meter/Data Loggers Used in PV System. |
| 20. | To Study the Standard Procedures and Norms for Grid Connected Solar PV System Installation. |

**Activities: Any 3 activities conducted.**

1. Cleaning and Preventive Maintenance of Panels
2. Solar PV Monitoring using Arduino/ESP32
3. Design PWM charge controller using IC 555 / Arduino.
4. Earthling Resistance Measurement & Insulation Resistance Testing in PV System
5. Study and analyze the grid connected electricity bill of rooftop PV system.
6. Field visit and make report on your nearest Solar Park.
7. Compare different Solar product such as charge controller, Inverter, Solar Module available in market.
8. List the different Solar energy product funding/ subsidy from government of India/ State government (MH). And make aware at least 20 peoples in your society.

**F) REFERENCES:**


1. Photovoltaic Systems Engineering, Roger A. Messenger & Jerry Ventre, CRC Press (2005)
2. Solar PV System: Design, Installation, Operation and Maintenance: L. Ashok Kumar and K. Mohana Sundaram, Nova Science Pub Inc **(2021).**
3. Solar Photovoltaic Technology and Systems: A Manual for Technicians, Trainers and Engineers, C.S. Solanki, Prentice Hall India Learning Private Limited **(2013).**


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T.Y.B.Sc. (Physics) (Sem-VI)

# PHY-371-VSC-P : Modern Electric Vehicle Technology

**Lectures: 60 hrs** **(Credits-02)**

**A) Course Objectives:** This course is designed to provide students with an understanding of the basic concepts and practical aspects of electric vehicles, while helping them develop skills related to EV systems, components and their applications.

1) To introduce the basic concepts and different types of electric vehicles.
2) To develop understanding of major EV components such as battery, motor, controller, charger and BMS.
3) To explain basic electrical systems, wiring, and safety practices used in EVs.
4) To apply fundamental physics concepts in analyzing EV performance.
5) To develop practical skills related to testing, measurement and basic maintenance of EV systems.
6) To provide exposure to real-world EV technology through field visits and interaction with technicians.
7) To create awareness about recent developments and future trends in EV technology.

**B) Learning Course Outcomes (CO) :** After completing this course, students will be able to:

1) Explain different types of electric vehicles and their applications.
2) Identify major EV components and describe their functions.
3) Understand basic wiring and electrical connections used in EVs.
4) Perform simple electrical measurements using standard instruments.
5) Apply basic calculations to estimate EV parameters such as range, energy consumption and charging time.
6) Describe the working of systems such as BLDC motor, controller and throttle.
7) Identify common faults and suggest simple troubleshooting methods.
   Understand practical aspects of EV maintenance through field exposure.
8) Compare different battery technologies used in EVs.
9) Develop basic technical and problem-solving skills related to EV systems.

**The course is designed to provide basic employability skills in the field of electric vehicle technology.**

**C) Instructional design:**

1) Experimental method. 2) Case Studies / Survey / Industrial Visit.
3) Seminars & Case study. 4) Use of Multimedia for demonstrations.
5) Creation of Online Resources / Virtual Lab Practicals.6) Journal Writing

**D) Evaluation Strategies :**

1) Practical Examination.2) Assignments / Case Studies / Showroom Visit.

3) Seminars, Orals and Viva.

**E) Course Contents : Practical**

**NB:** Students shall perform ;

- any 4 practical from sections A,
- any 4 practical from sections B,
- any 3 practical from sections C,
- any 1 practical from sections D,

Total =12 practical

Furthermore, students are required to complete any 3 activities from Section F.

**Total: 15 practical** (12 Practical + 3 Activities)

## Section A. Basic & EV Types Practical

**Description:**

This section introduces students to the basic concepts of electric vehicles. It includes different types of EVs, their main components, battery basics, wiring, and charging systems. It helps students build a strong foundation before moving to advanced topics.

| Expt. No. | Name of Experiment (any 4) |
|---|---|
| 1 | **Study of types of electric vehicles (BEV, HEV, PHEV, FCEV)** (Method: Collect information about different EV types and compare their working principles, energy sources and applications using charts or diagrams.) |
| 2 | **Comparative analysis of EV types (2-wheelers, 3-wheelers & 4-wheelers)** (Method: Compare vehicle types based on parameters such as battery capacity, range, cost and usage. Present the comparison in tabular form.) |
| 3 | **Identification and study of EV components** (Method: Observe actual components or images and identify their function and role in the EV system. Prepare labeled diagrams.) |
| 4 | **Study of Lithium-ion Battery used in Electric Vehicles** (Method: Students will study the basic construction and working of a lithium-ion battery using charts, models, or reference material. Important parameters such as voltage, capacity (Ah), energy (Wh) and applications in EVs will be noted. Students will draw a simple diagram and write their observations.) |
| 5 | **Study of EV wiring diagram (for two-wheeler/3-wheelers/4-wheeler)** (Method: Draw the wiring diagram of a basic EV system and explain the flow of electrical connections.) |
| 6 | **Study of battery management system (BMS)** |

| | |
|---|---|
| | (Method: Study the functions of BMS such as protection, monitoring and balancing using diagrams or case examples.) |
| **7** | **Study of EV charger (AC to DC conversion)**<br>(Method: Draw a block diagram of charger and explain the conversion of AC supply into DC for battery charging.) |
| **8** | **Study of Sensors Used in Electric Vehicles and their Applications**<br>(**Method:** Students will study different sensors such as temperature, speed and Hall sensors using charts or demonstrations and explain their functions in EV systems.) |

## Section B. Physics & Numerical Practicals

**Description:**

This section focuses on simple calculations and case studies related to EV performance. It helps students connect physics concepts with real-life applications.

| Expt. No. | Name of Experiment (any 4) |
|---|---|
| **1** | **Estimation of EV range using battery capacity**<br>(Method: Solve multiple case studies using given data, compare results and represent findings using graphs and conclusions.) |
| **2** | **Calculation of battery backup time under different load conditions**<br>(Method: Use different load conditions to calculate backup time, prepare tables and plot graphs to analyze variation.) |
| **3** | **Measurement of voltage, current and power**<br>(Method: Take readings using a multimeter under different load conditions, calculate power and compare with theoretical values.) |
| **4** | **Analysis of energy consumption per kilometer**<br>(Method: Calculate energy consumption for different vehicles, compare efficiency and present results in tabular form.) |
| **5** | **Estimation of power requirement based on vehicle load**<br>(Method: Calculate power for different load values, plot graphs and analyze the effect of load on performance.) |
| **6** | **Calculation of charging time for different charging methods**<br>(Method: Calculate charging time for different chargers, compare results and include efficiency considerations.) |
| **7** | **Study of regenerative braking system in electric vehicles**<br>(Method: Explain the working using diagrams, perform simple calculations for energy recovery and compare with conventional braking.) |
| **8** | **Study and Analysis of Charge–Discharge Characteristics of EV Battery** |

| | |
|---|---|
| | **(Method:** Charge and discharge data of an EV battery will be observed using given data or demonstration. Students will plot voltage versus time graph and analyze charging and discharging behavior of the battery.) |
| **9** | **Study and Estimation of State of Charge (SOC) and State of Health (SOH) of EV Battery**<br>(**Method:** Students will use given data to calculate SOC and SOH of a battery. They will analyze battery condition and compare values under different conditions.) |
| **10** | **Measurement and Analysis of Battery Capacity and Efficiency of EV Battery**<br>(**Method:** Battery capacity will be calculated using given voltage and current data. Efficiency will be determined by comparing input and output energy and results will be analyzed.) |
| **11** | **Study and Analysis of Torque–Speed Characteristics of EV Motor**<br>(**Method:** Given data for different speeds and torque values will be used. Students will plot torque versus speed graph and analyze motor performance under varying conditions.) |

## Section C. Skill-Based Practicals

**Description:**

This section focuses on developing practical skills related to electric vehicle systems. Students will study the working of important components such as motors, controllers, and control systems. It also includes basic troubleshooting of EV circuits. These practical help students understand how EV systems operate in real conditions and improve their hands-on abilities.

| Expt. No. | Name of Experiment (any 3) |
|---|---|
| **1** | **Study of Induction motor and BLDC Motor used in EVs**<br>(Method: Observe the motor, identify its parts and understand its working with the help of diagram or video.) |
| **2** | **Study of Throttle Control System**<br>(Method: Understand how throttle input controls speed using basic demonstration or explanation.) |
| **3** | **Study of Motor Controller Operation**<br>(Method: Study controller connections and explain its role in controlling motor speed and performance.) |
| **4** | **Study and Diagnosis of Basic Wiring Faults in Electric Vehicles**<br>(Method: Students will observe basic wiring faults such as loose connections, damaged wires, or fuse issues. They will identify the fault using simple tools and suggest corrective actions.) |

| | |
|---|---|
| 5 | **Identification and Troubleshooting of Basic Faults**<br>(Method: Identify simple faults like loose connection or fuse issue and suggest corrective action.) |
| 6 | **Study of Basic EV Safety Precautions and Handling**<br>(Method: Students will study basic safety precautions required while working with electric vehicles. This includes safe handling of batteries, avoiding short circuits, use of proper insulation and precautions during charging. Students will observe safety practices through charts, videos, or demonstration and list important do's and don'ts.) |

## Section D. Showroom / Industry Practicals

**Description:**

This section provides exposure to real electric vehicles through field visits. Students will visit EV showrooms and service centers to observe actual systems, maintenance practices and working conditions. Interaction with technicians helps students understand real-life problems and solutions in EV technology**.**

| Expt. No. | Name of Experiment (any 1) |
|---|---|
| 1 | **Field Study of Electric Vehicles at Showroom**<br>(Method: Visit nearby showroom, observe EV components and note down specifications and working features.) |
| 2 | **Study of EV Maintenance Practices at Service Center**<br>(Method: Observe servicing procedures and discuss common faults and maintenance practices with technician.) |

## Section E. Future-Oriented Practical

**Description:**

This section introduces students to emerging and future technologies in electric vehicles. It focuses on new developments such as advanced battery systems and their comparison with existing technologies. This helps students stay updated with current trends in the EV industry**.**

| Expt. No. | Name of Experiment (any 1) |
|---|---|
| 1 | **Study and Comparison of Solid-State and Lithium-ion Batteries**<br>(Method: Students will study the basic features of lithium-ion and solid-state batteries using charts or reference material. They will compare parameters such as energy density, safety, charging time, and life cycle. The comparison will be presented in tabular form, followed by a short conclusion.) |

## Section F: Activities

**Description:**

This section includes activity-based learning to enhance practical understanding of electric vehicles. Students will perform field-based, analytical, and comparison activities to connect theoretical knowledge with real-world applications.

| Expt. No. | Name of activities (any 3) |
|---|---|
| 1 | **Study of Charging Infrastructure**<br>(Activity: Students will study different types of EV charging infrastructure such as slow and fast charging. They will compare charging time, cost, and applications, and present the differences in tabular form.) |
| 2 | **Comparison of Motors used in EV**<br>(Activity: Compare BLDC motor and induction motor based on performance, efficiency, and application.) |
| 3 | **Study of Power Transmission System in EV**<br>(Activity: Study different transmission mechanisms used in EVs and explain their working.) |
| 4 | **EV Charging Time Survey**<br>(Activity: Study charging time of different EV models and compare slow and fast charging methods.) |
| 5 | **Cost Analysis of Electric Vehicle**<br>(Activity: To compare the running cost of EVs with CNG, petrol and diesel vehicles based on distance and consumption.) |
| 6 | **EV Range Analysis**<br>(Activity: Students will study and analyze the range of an electric vehicle using given battery capacity and energy consumption data. They will calculate the expected range and compare it under different conditions such as load and speed.) |

**F) REFERENCES:**


1) Modern Electric Vehicle Technology: C. C. Chan, Oxford university press, (2001).
2) Fundamentals of Electric Vehicles: Sandeep Dhameja, Newnes, (2001).
3) Electric and Hybrid Electric Vehicles Deign fundamentals: Iqbal Husain, CRC Press, (2011).
4) Electric Vehicle Technology Explained: James Larminie and John Lowry, Wiley, (2012).
5) Battery Technology Handbook: H. A. Kiehne, CRC Press, (2003).


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## 22) Syllabus of Minor (MN) Courses :

### T.Y.B.Sc. (Physics) (Sem-V)

# PHY-341-MN : Modern Physics: Concepts and Applications

**Lectures: 30 hrs** **(Credits-02)**

**A) Course Objectives:** This course aims to introduce basic concepts of modern physics and their applications in daily life

1. To study the limitations of classical physics and the emergence of quantum theory.
2. To impart knowledge of applications of modern physics in science and technology.

**B) Learning Course Outcomes (CO) :** Upon completion of the course, the student will be able to,

1. Understand the need for modern physics and its fundamental concepts.
2. Explain basic quantum phenomena in a conceptual manner.
3. Describe atomic structure and related phenomena.
4. Understand nuclear processes and their applications.
5. Apply concepts of modern physics in interdisciplinary fields.

**C) Instructional design:**

1) Lecture method using board teaching 2) Use of multimedia (animations, simulations)
3) Interactive discussions and examples 4) Student seminars/presentations
5) Creation of online resources

**D) Evaluation Strategies :**

1) Descriptive written examinations 2) Assignments 3) Seminars, Orals, and Viva

**E) Course Contents : Theory**

| **Module-1** | **Origin of Modern Physics and Quantum Concepts** | **Lectures = 10** |
|---|---|---|
| | • Historical background: Classical theory of light<br>• Corpuscular theory of light (Isaac Newton)<br>• Wave theory of light (Christian Huygens)<br>• Basic properties of light: reflection, refraction (concept only)<br>• Limitations of classical physics and emergence of quantum theory<br>• Black body radiation<br>• Photoelectric effect<br>• Compton effect<br>• Planck's quantum theory<br>• Wave particle duality<br>• de Broglie hypothesis<br>• Heisenberg uncertainty principle | **Lectures = 8** |
| | **Problems Solving** | **Lectures = 2** |

| Module-2 | Atomic, Molecular Physics and Spectroscopy | Lectures = 12 |
|---|---|---|
| | • Bohr model of hydrogen atom<br>• Energy levels and atomic spectra<br>• Quantum numbers (basic concept)<br>• Introduction to molecular energy levels (rotational and vibrational levels – qualitative)<br>• Introduction to spectroscopy (concept and types)<br>• Raman effect (concept, stokes and anti-stokes lines)<br>• Zeeman effect (splitting of spectral lines in magnetic field – qualitative)<br>• Stark effect (splitting in electric field – concept only)<br>• Application : Spectroscopy in chemical analysis<br>Determination of molecular structure<br>Fluorescence in biological systems<br>Applications of lasers<br>Study of stars using spectral analysis | |
| **Module-3** | **Nuclear Physics and Applications** | **Lectures = 08** |
| | • Nuclear structure<br>• Concept of mass defect and binding energy<br>• Qualitative idea of binding energy curve<br>• Radioactivity<br>• Half life and mean life<br>• Nuclear reaction: fusion and fission<br>• Applications : Electricity generation using nuclear energy<br>Medical imagine (X-ray, CT Scan)<br>Radiotherapy<br>Food preservation<br>Carbon dating<br>Problem Solving | **Lectures = 6**<br><br>**Lectures = 2** |

**Activities: Conduct any one classroom activity during class lecture for each module.**

**Module 1: Quantum Physics**

**Activity 1:** Demonstration of determination of Planck's constant using LED or simulation.

**Activity 2:** Demonstration to illustrate wave–particle duality using simple light interference and photoelectric effect setup/simulation.

**Module 2: Atomic Physics**

**Activity 1:** Demonstration of atomic spectra using spectroscope/simulation.

**Activity 2:** Demonstration of laser using a laser pointer to observe properties such as directionality and coherence (qualitative).

**Module 3: Nuclear Physics**

**Activity 1:** Demonstration to understand radioactivity using G.M. counter (or simulation/video).

**Activity 2:** Discussion on applications of nuclear energy and radiation safety.

**F) REFERENCES:**


1. Arthur Beiser, Concepts of Modern Physics, 6th ed., Tata McGraw Hill, 2003.
2. S. H. Patil, Elements of Modern Physics, 2nd ed., Tata McGraw Hill, 2007.
3. R. Murugeshan, K. Sivaprasath, Modern Physics, S. Chand Publishing, 2010.
4. B. L. Theraja, Modern Physics, S. Chand Publishing, 2005.
5. H. C. Verma, Concepts of Physics, Part II, Bharati Bhawan, 2012.
6. David J. Griffiths, Introduction to Quantum Mechanics, 2nd ed., Pearson Education, 2005.
7. Eisberg, R., Resnick, R., Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles, 2nd ed., Wiley, 2006.
8. D. Halliday, R. Resnick, J. Walker, Fundamentals of Physics, 10th ed., Wiley, 2014.
9. G. Aruldhas, Engineering Physics, PHI Learning, 2010.
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## 23) Field Project (FP) :

**T.Y.B.Sc. (Physics) (Sem-V)**

# Guidelines for Field Project (FP)

**Lectures: 60 hrs** **(Credits-02)**

Field project work will provide students opportunity to visit and observe situation in rural and urban contexts, students are expected to observe and study actual field situations in socio-economic contexts while doing their field work. It will improve opportunities to understand interconnect between theoretical knowledge and practical applications. Field project is expected to enhance their sensitivity to socio-economic issues and improve their ability of problem solving as well as designing innovative solutions to the existing and emerging problems. Field project component will broaden the possibilities of deeper learning and enhancing research acumen of students. Field project broadens opportunities of social responsibility, environmental sustainability, nation building and peace.

### Objectives:

- Align classroom learnings with awareness about socio-economic conditions.
- Provide students with exposure to socio economic conditions and align their experiences with contemporary problems.
- Integrating theoretical and practical modes blended learning under the guidance of their faculty.
- Enhance research skills including knowledge discovery, analytical tools, methodologies, and ethical conduct.
- Facilitate problem-solving, decision-making, teamwork, and collaboration.
- Foster ability to work in team, develop social awareness and nurture human values among students.
- Encourage collaboration between Higher Education Institutes (HEIs), social organization, Government and non-government institutes for better implementation of Field project.

### Outcomes:

- Apply concepts learned in classrooms to real-world socioeconomic conditions enhancing their understanding and skills.
- Show insights into the challenges, opportunities and culture of socioeconomic diversity, preparing them for future role as responsible citizens.
- Demonstrate evidence of research aptitude and skills of critical thinking, analytical skills, and ethical research conduct in field work.
- Display problem-solving abilities in making informed decisions in complex scenarios through practical situations.
- Work in teams and collaborate to achieve common goals in the work field environments through collaborative efforts.
- Show integrity in their dealings with their work and the people that they interact with by upholding professional; principles and ethical standards.

**Project Report:**

All projects should be typed on A4 sheets, Font Size 12, Times New Roman, one and a half spacing on executive bond paper. The project report shall have appropriate chapter scheme and be presented in minimum of 20 pages.

**Report arrangement :**

1) Title Page
   - Title of the Report
   - Name of the Student
   - Seat number
   - Program Title
   - Name of the Guide
   - Month and year of Submission
2) Certificate by the Institute
3) Certificate by Guide
4) Student's Declaration
5) Acknowledgement
6) Abstract : (200-300 words)
7) Table of contents :
8) List of Figures and Tables :
   - Chapter-1: Introduction
   - Chapter2 : Literature Review
   - Chapter 3: Methodology
   - Chapter 4: Field Work Descriptions, Observations and Analysis
   - Chapter 5: Conclusion and Recommendations
9) References
10) Appendices

**Evaluation Pattern :**

Evaluation during the FP program involves two key components:

a) Internal Evaluation (40%) : by Guide (Marks 20)

Field visit completion, Attendance and interaction = 10 marks
Overall Report quality = 10 marks

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Total = 20 marks

b) External Evaluation (60%) : by External Examiner (Marks 30)

Objectives, Literature Review, Methodology, Data Analysis, Conclusion = 15 marks
Overall Project Report Structure = 05 marks
Presentation Skills = 10 marks

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Total = 30 marks

## Certificate:

**Certificate**

I hereby certify that Mr./Ms. _____ Student of _____ Institute studying in _____ has completed a project titled _____ in the area of _____specialization for the academic year 20xx (semester-V). To the best of my knowledge the work of the student is original and the information included in the project is correct.

Guide Head of the Department

## Declaration :

**Declaration**

I, Mr./Ms. _____ Student of _____ Institute studying in _____ hereby declare that I have completed the field project entitled _____during the academic year 20xx (semester-V). The report work is original and the information/data included in the report is true emerging from the primary and/ secondary data gathered and analyzed as part of this project. Due credit is extended on the work of Literature/Secondary Survey by endorsing it in the Bibliography as per prescribed format.

Signature of the Student with Date
Name of Student

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# OR

## 24) Community Engagement and Service or Programme(CEP) :

**T.Y.B.Sc. (Physics) (Sem-V)**

# Guidelines for Community Engagement Programme (CEP)

**Lectures: 60 hrs** **(Credits-02)**

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### Objectives:

a. To develop an understanding of community needs and challenges.
b. To equip students with skills to identify problem areas within the community.
c. To guide students in creating effective project proposals.
d. To apply classroom knowledge of courses to field realities and thereby improve the quality of learning.

### Field Work:

a. To provide practical experience in implementing community projects.
b. To assess students' ability to apply theoretical knowledge in real-world situations.
c. To develop skills in project management, teamwork, and communication.

### Field Report:

All report should be typed on A4 sheets, Font Size 12, Times New Roman, one and a half spacing on executive bond paper. The report shall have appropriate chapter scheme and be presented in minimum of 20 pages.

### Report arrangement :

1) Title Page
   - Title of the Report
   - Name of the Student
   - Seat number
   - Programme Title
   - Name of the Guide
   - Month and year of Submission
2) Certificate by the Institute
3) Certificate by Guide
4) Student's Declaration
5) Acknowledgement
6) Abstract : (200-300 words)

Chapter-1:
Chapter2:
Chapter 3: y
Chapter 4: Field Work
Chapter 5: Conclusion and Recommendations

7) References
8) Appendices

## Evaluation Pattern :

Evaluation during the CEP programme involves two key components:

a) Internal Evaluation (40%) : by Guide (Marks 20)

Field visit completion, Attendance and interaction = 10 marks

Overall Report quality = 10 marks

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Total = 15 marks

b) External Evaluation (60%) : by External Examiner (Marks 30)

Field visits, Field work Reflection and Analysis, Conclusion = 15 marks

Overall Project Report Structure = 05 marks

Presentation Skills and Community Impact Assessment = 10 marks

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Total = 30 marks

## Certificate:

**Certificate**

I hereby certify that Mr./Ms. _____ Student of _____ Institute studying in _____ has completed a report titled _____ in the area of _____specialization for the academic year 20xx (semester-V). To the best of my knowledge the work of the student is original and the information included in the report is correct.

Guide Head of the Department

## Declaration :

**Declaration**

I, Mr./Ms. _____ Student of _____ Institute studying in _____ hereby declare that I have completed the field report entitled _____during the academic year 20xx (semester-V). The report work is original and the information/data included in the report is true emerging from the primary and/ secondary data gathered and analyzed as part of this project. Due credit is extended on the work of Literature/Secondary Survey by endorsing it in the Bibliography as per prescribed format.

Signature of the Student with Date

Name of Student

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## 25) On Job Training (OJT) :

**T.Y.B.Sc. (Physics) (Sem-VI)**

# Guidelines for On Job Training (OJT)

**Lectures: 120 hrs** **(Credits-02)**

**As per university guidelines:**

The OJT will provide students opportunity to visit and hands-on-training doing their work. It will improve opportunities to understand interconnect between theoretical Physics knowledge and practical applications. The OJT is expected to enhance their sensitivity to socio-economic issues and improve their ability of problem solving as well as designing innovative solutions to the existing and emerging problems. The OJT component will broaden the possibilities of deeper learning and enhancing research acumen of students. The OJT course is designed to provide practical exposure, skill development, and industrial experience to TYBSc Physics students in accordance with NEP 2020 guidelines. The course aims to bridge the gap between theoretical physics knowledge and its real- life applications in industries, laboratories, research institutes, and entrepreneurship sectors. The OJT shall be conducted under the supervision of the Physics department and concerned industry/organization mentor.

### Objectives:

- To provide hands-on training in Physics-related industries, laboratories, and research organizations.
- To develop laboratory skills, analytical abilities, and professional ethics among students.
- To expose students to industrial practices, instrumentation, quality control, and safety procedures.
- To enhance problem-solving, teamwork, communication, and technical skills.
- To familiarize students with modern medical and characterization instruments and industrial processes.
- To create awareness regarding entrepreneurship and employment opportunities in Physics.

### Outcomes:

- Apply concepts learned in classrooms to real-world socioeconomic conditions enhancing their understanding and skills.
- Show insights into the challenges, opportunities and culture of socioeconomic diversity, preparing them for future role as responsible citizens.
- Demonstrate evidence of research aptitude and skills of critical thinking, analytical skills, and ethical research conduct in field work.
- Display problem-solving abilities in making informed decisions in complex scenarios through practical situations.
- Work in teams and collaborate to achieve common goals in the work field environments through collaborative efforts.
- Show integrity in their dealings with their work and the people that they interact with by

upholding professional; principles and ethical standards.

**Project Report:**

All projects should be typed on A4 sheets, Font Size 12, Times New Roman, one and a half spacing on executive bond paper. The project report shall have appropriate chapter scheme and be presented in minimum of 30 pages.

**Report arrangement :**

1) Title Page
   - Title of the Report
   - Name of the Student
   - Seat number
   - Program Title
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   - Chapter 4: Field Work Descriptions, Observations and Analysis
   - Chapter 5: Conclusion and Recommendations
9) References
10) Appendices

**Evaluation Pattern :**

Evaluation during the FP program involves two key components:

a) Internal Evaluation (40%) : by Guide (Marks 40)

Training completion, Attendance and interaction = 30 marks
Overall Report quality = 10 marks
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Total = 40 marks

b) External Evaluation (60%) : by External Examiner (Marks 60)

Objectives, Literature Review, Methodology, Data Analysis, Conclusion = 25 marks
Overall Project Report Structure = 15 marks
Presentation Skills = 20 marks
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Total = 60 marks

## Certificate:

**Certificate**

I hereby certify that Mr./Ms. _____ Student of _____ Institute studying in _____ has completed a project titled _____ in the area of _____specialization for the academic year 20xx (semester-V). To the best of my knowledge the work of the student is original and the information included in the project is correct.

Guide Head of the Department

## Declaration :

**Declaration**

I, Mr./Ms. _____ Student of _____ Institute studying in _____ hereby declare that I have completed the field project entitled _____during the academic year 20xx (semester-V). The report work is original and the information/data included in the report is true emerging from the primary and/ secondary data gathered and analyzed as part of this project. Due credit is extended on the work of Literature/Secondary Survey by endorsing it in the Bibliography as per prescribed format.

Signature of the Student with Date
Name of Student

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