Shri Someshwar Shikshan Prasarak Mandal's

SOMESHWAR SCIENCE COLLEGE

Someshwarnagar,Tel. Baramati, Dist: Pune (Pin : 412 306) Maharashtra, India
(Affilliated to Savitribai Phule Pune University, Pune) Estd : 2007

Govt. Rag. No. N.G.C. 2007(189/07) Mashi-3, Dt. 2 July 2007 College Code 827 University Appvl. No. IDNo. PU/PN/S/284/2007

1.3.1 Integration integrates cross-Cutting issues relevant to Gender, Environment and sustainability, Human Values and Professional Ethics have been included in the curriculum by the university Syllabus

Index

Sr.No.	Course Name	Department	Subject Name	Pattern
1	S.Y.B.Sc & S.Y.B.C.S	English	English	2020-2021
2	S.Y.B.Sc	Zoology	Zoology	2020 CBCS
3	S.Y.B.Sc	Botany	Botany	2020 CBCS
4	T.Y.B.Sc	Chemistry	I) Industrial Chemistry II) Environmental Chemistry III) Analytical Chemistry	2021 CBCS
5	S.Y.B.Sc	Electyronics	Electronic Science	2020CBCS
6	F.Y.B.Sc	-	Environmental Education	2024
7	M.Sc	Chemistry	Human Rights and Act	2013

SYBSC & SYBSC (Computer Science)

ENGLISH

(Ability Enhancement Compulsory Course-AECC)

(Choice Based Credit System-35:15-Pattern)

(w. e. f- 2020- 2021)

(02-Credit Course)

Text: ***Horizons: English in Multivalent Contexts*** (Board of Editors- Orient BlackSwan)

Preamble:

This is an ABILITY ENHANCEMENT COURSE. Considering the needs of students and the requirements of professional sectors, the syllabus of this paper is designed to enhance linguistic and professional skills of the students. In the age of technology, it's high time for the students to acquire and exercise the skill and sub-skills of using English in multivalent contexts.

The paper aims at a balanced up-gradation of the students, focussing on their ability enhancement. Hence, to avoid a lopsided professional development, the humane values are also taken care of by accommodating literature section in the syllabus. The other units cater to the needs of enhancing speaking ability, writing ability, the ability to face an interview, the ability of using soft skills effectively while planning one's work and working on the plans. By and large, the present syllabus is an attempt to galvanise the existing competencies of the students and enhancing their abilities for a better performance and better results.

Objectives:

1. To introduce the use of English in multimedia
2. To acquaint the students with the language skills in multivalent contexts
3. To acquaint and enlighten students regarding the speaking skill in various contexts
4. To acquaint and familiarize the students with advanced writing skills in different contexts
5. To acquaint and familiarize the students with soft skills
6. To minimize the gap between the existing communicative skills of the students and the skills they require at professional level
7. To develop competence among the students to appreciate and analyze short stories and poetry

Semester-III

Text: ***Horizons: English in Multivalent Contexts*** (Board of Editors- Orient BlackSwan)

Content-

UNIT-I- LITERATURE **10 Clock Hours**

1. **Short Story:**
   i) 'A Shadow': R. K. Narayan
2. **Poetry:**
   i) La Belle Dame sans Merci: John Keats
   ii) Where the Mind is without Fear: Rabindranath Tagore

UNIT-II-CONVERSATIONAL SKILL **10 Clock Hours**

(Sample Dialogues, Useful Expressions and Exercises)

1. Introducing Yourself and Others
2. Asking, Giving and Refusing Permission
3. Describing Daily Routine
4. Complaining and Apologizing
5.

UNIT-III-INTERVIEW TECHNIQUES **10 Clock Hours**

1. Job Application Letter
2. Resume Writing
3. GDPI
4. Presentations

Semester-IV

Text: ***Horizons: English in Multivalent Context (***Board of Editors- Orient BlackSwan)

UNIT-I-LITERATURE **10 Clock Hours**

1. **Short Story:**

i) My Lost Dollar: Stephen Leacock

2. **Poetry:**

i) The Bird Sanctuary: Sarojini Naidu

ii) Stopping by Woods on a Snowy Evening: Robert Frost

UNIT-II-WRITING SKILLS **10 Clock Hours**

(Sample Passages, Useful Techniques and Exercises)

1. Notices
2. Agenda
3. Minutes
4. Content Writing

UNIT-III-SOFT SKILLS AND PERSONALITY DEVELOPMENT

(Sample Situations, Useful Techniques and Exercises) 10 Clock Hours

1. An Introduction to Soft Skills

2. SWOC Analysis

3. Goal Setting

4. Project Management

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BIBLIOGRAPHY:

1. Adair, John. Effective Communication, London: Pan Macmillan Ltd. 2003.

2. Amos, Julie-Ann. Handling Tough Job Interviews. Mumbai: Jaico Publishing, 2004.

3. Baron, N.S., (2008).Always On: Language in an Online and Mobile World. Oxford University

Press. Oxford.

4. Borg, James.(2010). Body Language: 7 Easy Lessons to Master the Silent Language. FT Press.

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9. Moore, Ninja-Jo, et al. Nonverbal Communication: Studies and Applications. New York: Oxford University Press, 2010.

10. Nelson, Paul E. & Judy C. Pearson, Confidence in Public Speaking.

11. Prasad, H. M. How to Prepare for Group Discussion and Interview. New Delhi: Tata McGraw-Hill Publishing Company Limited, 2001.

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13. Raman, Meenakshi & Sangeeta Sharma. Technical Communication: Principles and Practice. Second Edition. New Delhi: Oxford University Press, 2011.

14. Rutherford, Andrea J. Basic Communication Skills for Technology: Second Edition. Delhi: Pearson Education, 2007.

15. Sharma, R. C. & Krishna Mohan. Business Correspondence and Report Writing: Third Edition. New Delhi: Tata McGraw-Hill Publishing company Limited, 2007.

WEB LINKS:

http://networketiquette.net/

https://public.wsu.edu/~brians/errors/

http://users3.ev1.net/~pamthompson/body_language.htm

http://www.albion.com/netiquette/corerules.html

http://www.bbc.co.uk/worldservice/learningenglish/radio/specials/1535_questionanswer/page15.shtml

http://www.colostate.edu/Depts/Speech/rccs/theory44.html

http://www.dailywritingtips.com/

EVALUATION PATTERN

Considering the choice-based credit system (CBCS) and the semester pattern, both Semesters-III & IV will have a uniform evaluation pattern of **50 marks** each. There will be an **'Internal Examination'** for **15 marks** and **Semester-end Examination** for **35 marks**.

The Internal Examination for **15 marks** will be conducted in two parts.

1) Practical Examination for 05 marks:

(The choices like Group Discussion, Mock Interviews, Seminar, Project Presentation, Role Play, Home Assignment, Library Work, Lecture Notes etc. can be considered.)

2) A Mid-semester Written Test for 10 marks:

The Mid-semester Written Test will be based on the book prescribed for the syllabus. The test aims at assessing students' writing competence in general. Hence, descriptive and essay type questions can be considered while setting the question paper.

Semester-end Examination:

The Semester-end Examination will have a uniform question paper pattern for both semesters. The pattern of the question paper is given below.

SEMESTER-END EXAMINATION

Question Paper Patterns (III & IV)

Marks: 35 **Time: 2 Clock Hours**

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Instructions:

1. All questions are compulsory.

2. Figures to the right indicate full marks.

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Q.1) Long-answer question on Unit-1

(Any 1 out of 2) (15)

Q.2) Short notes on Unit-2

(Any 2 out of 3) (10)

Q.3) Short notes on Unit-3

(Any 2 out of 3) (10)

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SAVITRIBAI PHULE PUNE UNIVERSITY

(Formerly University of Pune)

B. Sc. Degree Course in

MICROBIOLOGY

Choice Based Credit System [CBCS]
2019 Pattern

Syllabus for Third Year

(To be implemented from Academic Year 2021-22)

Board of Studies (Microbiology)
Savitribai Phule Pune University
[SPPU] Pune-411007

GENERAL INFORMATION

Eligibility at third year B. Sc. Microbiology:

Student shall clear all First Year B. Sc. Microbiology courses and satisfactorily keep terms of Second Year of B. Sc. with Microbiology as one of the subjects.

Course Structure: T. Y. B. Sc. Microbiology course includes 12 theory papers (DSEC-Discipline Specific Elective Course), 06 practical courses and 04 skill enhanced courses (SEC). The 06 theory papers, 03 practical courses and 02 skill enhanced courses (SEC) will be taught in semester V and the remaining 06 theory papers, 03 practical courses and 02 skill enhanced courses (SEC) will be taught in semester VI. The examination will be held semester-wise for theory and practical papers.

Note:

i. Each lecture (L) will be of 50 minutes.
ii. Each practical of 4 hours 20 minutes and 12 practical sessions per semester
iii. 12 weeks for teaching 03 weeks for evaluation of students (theory as well as practical).
iv. For details refer UG rules and regulations (CBCS for Science program under Science andTechnology) published on SPPU website.

Evaluation Pattern (As per CBCS rules, SPPU 2019 Pattern)

1. Each theory and practical course carry 50 marks equivalent to 2 credits.
2. Each course will be evaluated with Continuous Assessment (CA) and University Assessment (UA) mechanism.
3. Continuous assessment shall be of 15 marks (30%) while university Evaluation shall be of 35 marks (70%).
4. To pass each course, a student has to secure 40% mark in continuous assessment as well as university assessment i.e. 6 marks in continuous assessment and 14 marks in university assessment for the respective course.
5. For Continuous Assessment (internal assessment) minimum two tests per paper must be organized, of which one must be written test of 10 marks. 6. Method of assessment for internal exams: Viva-Voce, Project, survey, field visits, tutorials, assignments, group discussion, etc.

2.2 Mandatory Credit courses for award of B.Sc. Degree:

In addition to the compulsory credits of 132, the student has to earn additional 8 credits from following groups by taking/participating/conducting respective activities.

Courses in Group I are compulsory.

The student can earn **maximum 04 credits from an individual group from Group 2 to Group -9.**

These extra credits will not be considered for GPA calculation, however these are mandatory for the completion and award of B. Sc. Degree.

Group 1: Physical Education (at F. Y. B. Sc. Sem. I) -01 credit
Physical Education (at F. Y. B. Sc. Sem. II) - 01 credit

(Note: Group I is compulsory for all the students as stated above.)

Group 2: Sport representation at College level - 01 credit
Sport representation at University/Statelevel - 02 credits

Group 3: National Social Service Scheme (participation in Camp): 01 credits
N.C.C.(with participation in annual camp) -01 credit
N. C. C. (with B certificate/C certificate award)- 02 credits
N.S.S./N.C.C. Republic day parade participation - 04 credits

Group 4: Avishkar participation; Extension activity participation, Cultural activity participation -01 credit
Avishkar selection at University level - 02 credits
Avishkar winner at state level - 04 credits

Group 5: Research paper presentation at State/National level - 01credits
Research paper presentation at International level - 02 credits

Group 6: Participation in Summer school/programme; Short term course (not less than 1-week duration) - 03 credit.

Group 7: Scientific Survey, Societal survey, - 02 credits.

Group 8: Field Visits; Study Tours; Industrial Visits; Participation in curricular/ cocurricular competitions- 01 Credit.

Group 9: Online certificate Courses /MOOC Courses/ Career Advancement Course up to 04 credits (Minimum 10 Hrs. / credit)

Equivalences for the New Courses (w. e. f. from 2021-22) with Old Courses (2013 Pattern) in Microbiology

T. Y. B. Sc. Microbiology

Semester - V

Theory/ Practical/ Skill Enhancement	Old Course Semester-III		New Course Semester-V (CBCS 2019 Pattern)	
	Course Number	**Course Title**	**Course Number**	**Course Title**
Discipline Specific Elective Course (DSEC) **Theory**	**MB 331**	Medical Microbiology-I	**MB 351**	Medical Microbiology-I
	MB 334	Immunology-I	**MB 352**	Immunology-I
	MB 333	Enzymology	**MB 353**	Enzymology
	MB 332	Genetics and Molecular Biology-I	**MB 354**	Genetics
	MB 335	Fermentation Technology -I	**MB 355**	Fermentation Technology-I
	MB 346	Agricultural and Environmental Microbiology	**MB 356**	Agricultural Microbiology
Discipline Specific Elective Course (DSEC) **Practical**	**MB 349**	Practical Course-III Diagnostic Microbiology and Immunology	**MB 357**	Practical course-I based on: MB 351 Medical Microbiology-I MB 352 Immunology I
	MB 348	Practical Course-II Biochemistry and Genetics	**MB 358**	Practical course-II based on MB 353 Enzymology MB 354 Genetics
	MB 347	Practical Course I Applied Microbiology	**MB 359**	Practical course-III based on: MB 355 Fermentation Technology-I MB 356Agricultural Microbiology
Skill Enhancement course	-	-	**MB 3510**	Marine Microbiology
	-	-	**MB 3511**	Dairy Microbiology

Equivalences for the New Courses (w. e. f. from 2021-22) with old Courses (2013 Pattern) in Microbiology

T. Y. B. Sc. Microbiology Semester-VI

Theory/ Practical/ Skill Enhancement	Old Course Semester-III		New Course Semester-VI (CBCS 2019 Pattern)	
	Course Number	**Course Title**	**Course Number**	**Course Title**
Discipline Specific Elective Course (DSEC) **Theory**	**MB 341**	Medical Microbiology-II	**MB 361**	Medical Microbiology II
	MB 344	Immunology-II	**MB 362**	Immunology II
	MB 343	Metabolism	**MB 363**	Metabolism
	MB 342	Genetics and Molecular Biology-II	**MB 364**	Molecular Biology
	MB 345	Fermentation Technology-II	**MB 365**	Fermentation Technology II
	MB 336	Food and Dairy Microbiology	**MB 366**	Food Microbiology
Discipline Specific Elective Course (DSEC) **Practical**	**MB 349**	Practical course-III Diagnostic Microbiology and Immunology	**MB 367**	Practical course-I. Based on: MB 361 Medical Microbiology II and MB 362 Immunology II
	MB 348	Practical course-II Biochemistry and Genetics	**MB 368**	Practical course-II. Based on**:** MB 363 Metabolism and MB 364 Molecular Biology
	MB 347	Practical course-I Applied Microbiology	**MB 369**	Practical course III. Based on: MB 365 Fermentation technology-II and MB 366 Food Microbiology
Skill Enhancement course	**-**	**-**	**MB 3610**	Waste management
	-	**-**	**MB 3611**	Nano biotechnology

Evaluation Pattern

T. Y. B. Sc. Microbiology

Courses							
Semester-V				**Semester-VI**			
Paper	**Course Title**	**Internal examination Marks**	**University examination Marks**	**Paper**	**Course Title**	**Internal Exam Marks**	**University examination Marks**
MB 351	Medical Microbiology I	15	35	**MB 361**	Medical Microbiology II	15	35
MB 352	Immunology I	15	35	**MB 362**	Immunology II	15	35
MB 353	Enzymology	15	35	**MB 363**	Metabolism	15	35
MB 354	Genetics	15	35	**MB 364**	Molecular Biology	15	35
MB 355	Fermentation technology I	15	35	**MB 365**	Fermentation Technology II	15	35
MB 356	Agricultural Microbiology	15	35	**MB 366**	Food Microbiology	15	35
MB 357	Practical course-I Based on: MB351 and MB 352	15	35	**MB 367**	Practical course I Based on: MB 361 and MB 362	15	35
MB 358	Practical course-II Based on MB 353 and MB 354	15	35	**MB 368**	Practical course II Based on**:** MB 363 and MB 364	15	35
MB 359	Practical course-III Based on:MB 355 and MB 356	15	35	**MB 369**	Practical course III Based on: MB 365 Fermentation technology II, MB 366 Food Microbiology	15	35
MB 3510	Marine Microbiology	15	35	**MB 3610**	Waste Management	15	35
MB 3511	Dairy Microbiology	15	35	**MB 3611**	Nano biotechnology	15	35

Semester V

DSEC-MB 351: Medical Microbiology- I

[2 Credits; 36 Lectures]

[1 credit=15hrs x 60 mins = 900mins/50mins=18 lectures]

Course Outcomes:

- Understand the human anatomy, pathogens associated with diseases.
- Acquire knowledge of principles underlying establishment of pathogens in human body.
- Comprehend of pathogenesis of specific pathogens causing microbial diseases.
- Assess epidemiological patterns of microbial disease transmission as various modes, intensity at local and global level.
- Gain Knowledge principles of chemotherapy of microbial diseases and development of drug resistance among pathogens and strategies to mitigate.
- Develop identification systems for microbialdisease diagnosis, disease treatment and prevention measures.

Credit No.	Topics	No. of Lectures
Credit I	**Introduction to infectious diseases and Epidemiology**	**18**
	1. Introduction to infectious diseases of following human body systems:(Brief anatomy and Physiology, Diseases, Pathogens, common symptoms)	
	a. Respiratory system	2
	b. Gastrointestinal system and liver	2
	c. Urogenital system	2
	d. Central nervous system	2
	2. Epidemiology:	
	a. Case control and cohort studies – Study design and application	2
	b. Principle and methods – Clinical trials of drugs and vaccines (Randomized control trials Concurrent parallel and cross-over trials)	3
	c. Epidemiology of infectious diseases	
	i. Sources and Reservoirs of Infection	1
	ii. Modes of Transmission of Infections	1
	iii. Disease Prevention and Control Measures, Vaccine-preventable bacterial diseases and nonvaccine-preventable bacterial diseases	3

	Study of bacterial pathogens:	**18**
Credit II	**3. Study of following groups of bacterial pathogens:** (With respect to- Classification and Biochemical characters, Antigenic structure, Viability characteristics, Pathogenicity, Pathogenesis, Symptoms, Laboratory diagnosis, Epidemiology, Prophylaxis and Chemotherapy): *a. Salmonella, Vibrio* *b. Streptococcus pneumoniae, Streptococcus pyogenes, Neisseria meningitidis and Neisseria gonorrhoeae* *c. Pseudomonas aeruginosa* *d. Treponema, Leptospira* *e. Clostridium tetani* *f. Mycobacterium tuberculosis* and *Mycobacterium leprae* g. Rickettsial diseases - Scrub typhus, Spotted fevers	 2 4 2 2 2 4 2

References: MB 351 Medical Microbiology-I

1. Chakraborty P. (2013). A Textbook of Microbiology. 3rd edition. New Central Book Agency. India. ISBN-13: 978-8173818769
2. Champoux J. J., Neidhardt F. C., Drew W. L. and Plorde J. J. (2004). Sherris Medical Microbiology: An Introduction to infectious diseases. 4th edition. Ryan K. J. and Ray C. G. (editors). McGraw-Hill Companies. DOI: 10.1036/0838585299
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16. Mukherjee K. L. and Ghosh S. (2010). Medical Laboratory Technology. Volume III: Procedure Manual for Routine Diagnostic Tests. 2nd edition. McGraw Hill Education (India) Private Limited. ISBN-13: 978-1259061257
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Links:

1. https://www.who.int/travel-advice/disease-information
2. https://Microbenotes.Com/Remdesivir/#Mechanism-Of-Action-Of-Remdesivir
3. *Aspergillus* https://www.cdc.gov/fungal/diseases/aspergillosis/index.html
4. *Histoplasma cap*sulatum https://www.cdc.gov/fungal/diseases/histoplasmosis/
5. *Cryptococcus neoformans* www.cdc.gov/fungal/diseases/cryptococcosis-neoformans/

Semester V

DSEC-MB-352 Immunology- I

[2 Credits; 36 Lectures]

[1 credit=15hrs x 60 mins = 900mins/50mins=18 lectures]

Course Outcomes

- Understand immune system structure, composition, function and comparison of different types of immunity.
- Acquire knowledge about antigens, Recognition of pathogens; antigen processing and presentation; Immunity to infection and pathological consequences of immunodeficiency's.
- To learn the applications of Immunology in monoclonal antibodies, vaccines production and Immunotherapy.
- Understand abnormal working of Immune system in hypersensitivity, auto immune diseases, immune tolerance and transplantation immunology.
- To develop strategies for Diagnosis of diseases based on antigen and antibody reactions with emphasis on prevailing communicable diseases.

Credit No.	Topics	No. of Lectures
Credit I	**Organs of immune system, Innate immunity, Antigen and Immunoglobulin**	**18**
	1. Organs of immune system: a. Primary lymphoid organs (Thymus and Bone Marrow): Thymus – structure, thymic education (positive and negative selection) Bone marrow –Structure and Negative selection b. Secondary lymphoid organs – structure and functions of spleen and lymph node, mucous associated lymphoid tissue, lymphatic system and lymph circulation	2 2
	2. Innate immunity: Non-specific mechanisms of defense: Second line of defense: a. Humoral components: Defensins, pattern recognition proteins (PRP) and pathogen associated molecular patterns (PAMPs), complement, kinins, and acute phase reactants. b. Cellular components: Phagocytic cells – PMNL, macrophages (reticulo-endothelial cell system) and dendritic cells c. Phagocytosis (oxygen dependent and independent systems), Complement activation (Classical, Alternative and lectin pathway), Inflammation (cardinal signs, mediators, vascular and cellular changes, role of Toll-like receptors)	1 1 5

	3. Antigen: a. Factors affecting immunogenecity b. Antigenic determinants, haptens and cross-reactivity, Carrier, Adjuvants c. Types ofantigens: Thymus-dependent and thymus-independent antigens, Synthetic antigens, Soluble and particulate antigens, Autoantigens, Isoantigens	1 1 1
	4. Immunoglobulins: a. Characteristic of domain structure, functions of light and heavy chain domains and antigenic nature of immunoglobulin molecules b. Molecular basis of antibody diversity (kappa, lambda and heavy chain)	2 2
Credit II	**Antigen- Antibody Interactions, Major Histocompatibility Complex, Transplantation and Immunity and Hybridoma Technology and Monoclonal Antibodies**	**18**
	5. Antigen- Antibody Interactions: **A. Principles of interactions:** Antibody affinity and avidity, ratio of antigen antibody, lattice hypothesis and two stage theory, antigen-antibody reactionkinetics (dialysis equilibrium experiment) **B. Visualization of antigen antibody complexes:** a. Precipitation reactions: in fluid and in gel, immunoelectrophoresis b. Agglutination reactions: hemagglutination, bacterial agglutination, passive agglutination and agglutination-inhibition c. Immunofluorescence techniques: direct and indirect, fluorescence-activated cell sorting (FACS) d. Enzyme-linked immunosorbent assay (ELISA), biotin-avidin system and enzyme-linked immune absorbent spot (ELISpot) assay e. Radioimmunoassay RIA	2 1 1 2 2 1
	6. Major Histocompatibility Complex: a. Structure of MHC in man and mouse b. Structure and functions of MHC class–I and class–II molecules c. MHC antigen typing (microcytotoxicity and mixed lymphocyte reaction)	 1 1 1
	7. Transplantation and Immunity; a. Types of Grafts, Allograft rejection mechanisms b. Prevention of allograft rejection	 2 1

	8. Hybridoma Technology and Monoclonal Antibodies;	
	a. Preparation, HAT selection and propagation of hybridomas secreting monoclonal antibodies	2
	b. Applications of monoclonal antibodies	1

References: MB-352 Immunology- I

1. Abbas A. K. and Lichtman A. H. (2004). Basic Immunology- Functions and Disorders of Immune System. 2nd Ed. Saunders. Elsevier Inc. PA. USA.
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Semester V

DSEC-MB 353: Enzymology

[2 Credits; 36 Lectures]

[1 credit=15hrs x 60 mins = 900mins/50mins=18 lectures]

Course Outcomes

- To understand methods of active site determination, role of enzymes and its cofactors in microbial physiology.
- To learn to perform enzyme assay, purification and quantification of enzymes activity, enzyme kinetics in terms of initial, final velocity, mathematical expression of enzyme kinetic parameters.
- To correlate regulation of metabolism at enzymatic levels and apply, methodology for commercial applications of enzymes
- To learn mechanisms of transport of solutes across the membrane
- To get acquainted with mechanism of biosynthesis and degradation of bio molecules
- To comprehend basic concept of autotrophic mode of metabolism of prokaryotes

Credit No.	Topics	No. of lectures
Credit I	**Enzymes:**	**18**
	1. Structure of enzymes: a. Methods to determine amino acid residues at active site (Physical method e.g. x-ray crystallography and chemical methods such as trapping of ES complex, use of inhibitors, use of pseudo- substrate change of pH) b. Role of vitamins in metabolism: Occurrence, Structure and Biochemical functions of the following: i. Thiamine (Vitamin B1) and Thiamine Pyrophosphate ii. Vitamin D	3 2
	2. Enzyme assays: a. Principles of enzyme assays and calculation of enzyme unit, specific activity b. Enzymes assays with examples by: i. Spectrophotometric methods ii. Radioisotope assay	1 2

	3. Principles and Methods of Enzyme purification: a. Methods of cell fractionation b. Principles and methods of enzyme purification: i. Based on molecular size ii. Based on charge iii. Based on solubility differences iv. Based on specific binding property and selective adsorption c. Construction of enzyme purification chart	 2 2 2 2 1 1
Credit II	**Enzyme Kinetics, metabolic regulation and Immobilized Enzymes:**	**18**
	4. Enzyme Kinetics: a. Concept and use of initial velocity b. Michaelis-Menton equation for the initial velocity of single substrate enzyme catalyzed reaction. Brigg's Haldane modification of Michaelis Menton equation. Michaelis Mentonplot, Lineweaver and Burk plot. Definition with significance of Km, Ks, Vmax	 2 5
	5. Metabolic Regulations: a. Enzyme compartmentalization at cellular level b. Allosteric enzymes c. Feedback mechanisms d. Covalently modified regulatory enzymes (Glycogenphosphorylase) e. Proteolytic activation of zymogens f. Isozymes - concept and examples g. Multienzyme complex e.g. Pyruvate dehydrogenase complex (PDH)	 1 1 2 1 1 1 1
	6. Immobilization of enzymes: Concept, methods of immobilization and applications	3

References: MB 353 Enzymology

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Semester V

DSEC -MB 354: Genetics

[2 Credits; 36 Lectures]

[1 credit=15hrs x 60 mins = 900mins/50mins=18

lectures] Course Outcomes

- To exhibit a knowledge base in Genetics and Molecular Biology
- To understand the central dogma of Molecular Biology
- To construct genetic map of bacteria and fungi
- To get introduced to concept of recombination and bacteriophage Genetics
- To understand the concept cloning in bacteria
- To demonstrate the knowledge of common and advanced laboratory practices in Molecular Biology

Credit No.	Topics	No. of lectures
	DNA Replication and Gene Expression	**18**
	1. Process of prokaryotic DNA replication a. Single replicon b. Bidirectional movement of replication fork c. Ori C d. Pre-priming and Priming reaction. e. DNA polymerases, DNA synthesis of leading, lagging strand Okazaki fragments. f. Termination- Ter sequence, Tusprotein	4

Credit I	**2. Prokaryotic and Eukaryotic Transcription**	3
	i. Transcription in Prokaryotes	
	a. Structure of promoter	
	b. Structure and function of RNA polymerase	
	c. Steps of transcription: Initiation, Elongation and termination	
	ii. Transcription in eukaryotes with respect to protein coding Gene:	4
	a. Promoter, promoter proximal elements and enhancers	
	b. Transcription regulatory proteins	
	c. RNA polymerases	
	d. Steps in transcription: Initiation, Elongation, Termination	
	e. Post transcriptional modifications: 5' capping, 3' polyadenylation and introduction to RNA splicing	

	3. Regulation of transcription: Concept and components of operon: Lac operon: Inducible operon	2
	4. Translation in prokaryotes and eukaryotes a. Structure and role of m-RNA, t-RNA and Ribosomes in Translation b. Role of Aminoacyl t-RNAsynthetase in translation c. Steps in translation: Initiation, elongation, translocation and termination of protein synthesis d. Salient features of Eukaryotic translation	5
Credit II	**Gene transfer and mapping techniques**	**18**
	5. Gene transfer by Transformation a. Discovery of Transformation b. Natural transformation Systems- *Streptococcus pneumoniae* and *Haemophilus influenzae.* c. Factors affecting transformation i. Competence development ii. Size of DNA iii. Concentration of DNA	4
	6. Gene transfer by Conjugation a. Discovery of Conjugation, b. Properties of F plasmid, F^+, F^-, Hfr and F′ strains c. Process of conjugation between F^+ and F^-, Hfr and F^-, F ’and F-	4
	7. Gene transfer by Transduction a. Discovery of Transduction b. Generalized transduction mediated by P22 c. Specialized transduction mediated by lambda phage	4
	8. An introduction to Gene mapping a. Gene linkage and concept of genetic recombination b. Recombination mapping: Map unit, recombination frequency c. Mapping of genes by co-transformation d. Mapping of genes by co-transduction e. Mapping by interrupted mating experiment f. Numerical problems based on co-transformation, co-transduction and interrupted mating	6

References: MB 354 Genetics

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Reference-Links:

1. Potential biohazards of recombinant DNA molecules: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC388511/?page=1
2. National Academies Press: Introduction of Recombinant DNA-Engineered Organisms Into theEnvironment: Key Issues: https://www.nap.edu/download/18907#
3. Guidelines and Handbook for Institutional Biosafety Committees (DBT, Govt. of India and BCIL):https://thsti.res.in/pdf/IBG.pdf
4. University of North Carolina's Biosafety Guidelines (Principles, Risk assessment, Biosafety levels, Guidelines):
   https://ehs.unca.edu/laboratory-safety/biological-safety/
   http://www.informatics.jax.org/silver/chapters/7-1.shtml

Semester V

DSEC -MB 355 Fermentation Technology– I

[2 Credits; 36 Lectures]

[1 credit=15hrs x 60 mins = 900mins/50mins=18 lectures]

Course Outcomes

- To impart technical understanding of commercial fermentations.
- To apply classical, advanced strain improvement and isolation techniques for fermentation processes.
- To optimize and sterilize media used in fermentation industry for commercially economical and efficient fermentations.
- To recover the product using suitable methods and ensuring quality of the finished product by quality assurance tests.
- To acquaint fermentation economics, process patentability, process validation.
- To comprehend the large-scale productions of commercially significant fermentation products of classical and recent significance.

Credit No.	Topics	No. of lectures
Credit I	**Upstream processes of fermentations**	**18**
	1. Strain Improvement: a. Objectives of strainimprovement b. Methods for strain improvement: i. Types of mutants used in strain improvement (altered cell permeability mutants, auxotrophs, analogue resistant mutants, revertants) ii. Selection of different types of mutants (replica plate method, filtration enrichment, penicillin enrichment method, gradient plate technique) iii. Application of rDNA technology (significance, technique for commercial recombinant products like insulin)	 1 1 2 1
	2. Media optimization a. Objectives of media optimization b. Methods of media optimization: i. Classical approach – One factor at a time, Full factorial design ii. Plackett and Burman Design (with example) (Numerical problems of PBD can be discussed using software) iii. Response Surface Methodology (RSM)	 1 1 2 1

	3. Sterilization of Media:	
	a. Methods of sterilization	1
	b. Batch sterilization and Continuous sterilization (direct and indirect methods)	1
	c. Concept and derivation of Del factor	1
	d. Filter sterilization of liquid media	1
	4. Scale-up and Scale-down:	
	a. Objectives of scale-up	1
	b. Levels of fermentation (laboratory, pilot-plant and production level – flow sheet to explain scale up)	1
	c. Criteria of scale-up for critical parameters [Aeration (kLa Volumetric Mass transfer coefficient), Agitation (P/V ratio, N_{Re} Reynolds number, N_p Power number, N_{Fr} Froudes number), Sterilization and broth rheology (Newtonian and non Newtonian fluids - bacterial and mycelia fungal fermentations)]	1
	d. Scale-down (example of anyone commercial fermentation)	1
Credit II	**Downstream processing and Quality assurance of fermentation products**	**18**
	5. Downstream processing of fermentation products: (method, principle, types, examples of fermentations, factors affecting, merits and demerits at large scale operation)	
	a. Cell disruption methods	1
	b. Filtration	1
	c. Centrifugation	1
	d. Liquid-liquid extraction	1
	e. Distillation	1
	f. Drying	1
	6. Quality assurance of fermentation products (as per IP, USP)	
	a. Methods of detection and Quantification of the fermentation product: physicochemical, biological and enzymatic methods	2
	b. Sterility testing (direct inoculation method, membrane filtration method)	1
	c. Bioburden test	1

	d. Microbial limit test	1
	e. Pyrogen testing: Endotoxin detection (LAL test)	1
	f. Ames test and modified Ames test	1
	g. Toxicity testing (Acute toxicity)	1
	h. Shelf life determination	1
	7. Fermentation economics:	
	a. Contribution of various expense heads to a process (Recurring and nonrecurring expenditures) citing any suitable example.	1
	b. Introduction to Intellectual Property Rights – Types of IPR (patenting in fermentation industry)	1
	c. Concept of validation (significance of SOPs)	1

References: MB 355 Fermentation Technology- I

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Reference links:

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    https://academic.oup.com/jimb/article-pdf/18/5/340/34773995/jimb0340.pdf.
25. Large scale production of rabies vaccine:
26. Large scale production of tetanus vaccine:
    http://nopr.niscair.res.in/bitstream/123456789/26533/1/JSIR%2060%2810%29%20773-778.pdf.
27. USA Clinical Laboratory Standards Institute(CLSI) Guidelines 2021: https://clsi.org/

Semester V

DSEC - MB 356: Agricultural Microbiology

[2 Credits; 36 Lectures]

[1 credit=15hrs x 60 mins = 900mins/50mins=18 lectures] Course Outcomes

- To understand plant growth improvement with respect to disease resistance, environment tolerance.
- To correlate stages of plant disease development, epidemiology, symptom based classification, control methods.
- To understand the importance of microorganisms in sustainable agriculture, biotechnological application of bio films, edible vaccines.
- To correlate Soil Micro biome and Role of microorganisms in soil health
- To determine the use of Microorganisms as tools in plant genetic engineering.

Credit No.	Topics	No. of lectures
Credit I	**Plant Pathology**	**18**
	1. Plant growth improvement and Stages in development of a disease a. Plant growth improvement with respect to disease resistance b. Stages in development of a disease: Infection, invasion, colonization, dissemination of pathogensand perennation	3
	2. Classification of disease based on symptoms (with one example of the following): Canker, Downy mildew, Mosaic	3
	3. Plant disease epidemiology Concepts of monocyclic, polycyclic and polyetic diseases with one example of each, disease triangle and forecasting of plant diseases.	6
	4. Methods of plant disease control i. Eradication ii. Chemical control iii. Biological control (employing bacterial and fungalcultures) iv. Integrated pest management v. Genetic engineering for disease resistant plants	6

Credit II	**Microorganisms in sustainable Agriculture and tools in plant genetic engineering**	**18**
	5. Microorganisms in sustainable Agriculture a. Soil Micro biome (plant Micro biome) b. Concept, Composition, functioning and methods to study: i. Conservation of soil health: Role of microorganisms in soil health ii. Phytonutrient availability by soil microorganisms Mechanism of diazotrophy, Phosphate solubilization, Potassium mobilization, micronutrient availability iii. Biofilm in plant surfaces, Biofilm formation; Biofilm in Phyllosphere and rhizosphere, Examples of plant- microbe interactions in biofilms, Biotechnological applications of plant biofilms	 2 1 4 3
	6 Microorganisms in plant genetic engineering: a. Concept of GM crops (Transgenic crops) w.r.t. to edible vaccines, insecticide resistance, herbicide resistance, improved varieties, new variants, disease resistance b. Tools and techniques: i. Microorganisms as tools in plant genetic engineering (Shuttle vectors) ii Technology of BT resistant crops iii. Concept of edible vaccines iv Technique of use of plant viruses in genetic engineering c. RNAi Technology and antisense RNA technology in disease resistant plant varieties	 2 1 1 1 1 2

References: MB 356 Agricultural Microbiology

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Semester V

Practical Course-I

DSEC-MB – 357: Diagnostic Microbiology and Immunology [2 Credits; 78 Lectures]

[1 credit=15hrs x 130 mins = 1950 mins/50 mins=39 lectures]

78 L distributed as 60 L for performing practicals and 18 L for internal evaluation

12 Practicals x 5 lectures = 60 Lectures

Sr. No	Title of the Practical	No. of Practicals
1.	**Clinical microbiology:** **Physical, Chemical and Microscopic examination of Clinical samples -** Urine, stool and pus	2
2.	**Isolation, identification of following pathogens from clinicalsamples:** i. *Klebsiella* spp. ii. *Salmonella* spp. *iii. Pseudomonas* spp iv.*Streptococcus* spp. **and** *Enterococcus spp* (for identification use of keys as well as Bergey's Manual is recommended)	4
3.	**Agglutination tests:** Widal test (Slide test and Tube Test) and Rapid Plasma Reagin (RPR) test	1
4.	**Epidemiological survey:** Development of hypothesis, Data collection, organization, statistical analysis, graphical representation using computers and interpretation, Preparation of report	2
5.	**Hemogram:** a. Estimation of hemoglobin (Acid hematin and Cyan-methemoglobin method) b. ESR and PCV determination, c. White blood cell differential count from peripheral blood d. Counting of RBCs and WBCs using counting chamber e. Calculation of hematological indices	3

References: MB 357: Diagnostic Microbiology and Immunology

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Practical Course – II

MB 358: Enzymology and Genetics [2 Credits; 78 Lectures]

[1 credit=15hrs x 130 mins = 1950 mins/50 mins=39 lectures] 78 L distributed as 60 L for performing practicals and 18 L for internal evaluation **12 Practicals x 5 lectures = 60 Lectures**

Sr. No.	Title of the Practical	No. of Practical
1.	Determination of absorption spectra and molar extinction co-efficient of two different dyes (by colorimetry /spectrophotometry)	**1**
2.	Qualitative analytical tests using flow charts for i. Proteins (tests for aromatic amino acids, sulfur containing amino acids, different amino acids) ii. Carbohydrates (tests for monosaccharides, disaccharides, and polysaccharides)	**2**
3.	Preparation of buffers and calibration of pH meter	**1**
4.	Paper Chromatography i. Separation and Identification of amino acids from mixture by paper chromatography ii. Separation and Identification of sugars from mixture by paper chromatography	**1**
5.	Extraction and quantitative estimation of total carbohydrate /proteins from natural sample: i. Estimation of total carbohydrates from natural sources by Phenol Sulphuric acid method ii. Estimation of reducing sugar from natural sources by DNSA method ii. Estimation of proteins from natural sources by Folin Lowry method	**3**
6.	Isolation of genomic DNA from bacteria	**1**
7.	Determination purity of DNA and its quantification: a. Estimation of DNA by UV- spectrophotometric method, 260/280 ratio b. Estimation of DNA by the diphenylamine	**1**
8.	Bacterial Conjugation	**1**

9.	Chromosome Staining (G-banding) Giemsa staining of chromosome from eukaryotic cell extract	**1**

Semester V

Practical course-III

DSEC-MB 359 Fermentation Technology- I and Agricultural Microbiology [2 Credits; 78 Lectures]

[1 credit=15hrs x 130 mins = 1950 mins/50 mins=39 lectures]

78 L distributed as 60 L for performing practicals and 18 L for internal evaluation

12 Practicals x 5 lectures = 60 Lectures

Sr. No	Title of the Practical	No. of Practical
1.	Sterility Testing of pharmaceuticals (non-biocidal injectables): Direct inoculation method, membrane filtration method, using control test cultures as per IP guidelines (availability at the center).	**2**
2.	Minimum inhibitory concentration and minimum bactericidal concentration of antibacterial compounds (MIC and MBC)	**2**
3.	Antibiotic and growth factor assay (agar gel diffusion technique)	**2**
4.	Isolation and identification of *Xanthomonas* spp. from Citrus canker	**1**
5.	Isolation of ***Plasmopara viticola*** from grapes (Downy Mildew)	**1**
6.	Collection of plant disease specimens and study of symptoms/ Project based on digital record of plant diseases (Group Activity)	**1**
7.	Isolation of PGPR with phosphate solubilization potential/Vesicular-Arbuscular Mycorrhiza (VAM), Preparation of liquid bioinoculants	**2**
8.	Validation of commercial formulations of bioinoculants based on BIS standards, Pot studies to check effect of bioinoculants on plant growth	**1**

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   - Manual - https://law.resource.org/pub/in/bis/S06/is.6092.3.2.2004.pdf
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   - https://www.ijnpnd.com/article.asp?issn=2231-0738;year=2013;volume=3;issue=1;spage=29;epage=33;aulast=Ranjan.
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SEM V

Skilled Base Elective MB 3510 Marine Microbiology

2 Credit Course: 1.5 credit theory+0.5 credit Practical

Course Outcome:

- To impart the awareness of unseen and unexplored niche of marine ecosystem of microbes.
- To acquire advances in the knowledge of marine microbes and marine ecology.
- To learn the field research on marine processes and laboratory research on microorganisms.
- To comprehend the role of marine microbes in bioremediation and bioprospecting.
- To avail career opportunities in marine education, industry and research.

Theory Total Lectures: 21

Credit	Theory	No. of lectures
Credit 1.5	**1. Marine ecology and sampling** a. Marine Habitats – estuaries, mangroves, coralreefs, salt marshes, coastal ecosystems, deep sea, hydrothermal vents, Polar habitat – Arctic, Antarctica, Southern Ocean b. Physiology of marine microorganisms – metabolic diversity, marine loop, marine snow, Role of marine microorganisms in biogeochemical cycles, nutrient cycling and hydrocarbon degradation c. Sampling methods– water sampling (Niskin sampler) and sediment sampling (Grab sampler, box corer, gravity corer), Culturing methods – VBNC, biofilm, mats from vents and estuarine sample.	3 4 4
	2. Marine microbes, role in bioremediation and bioprospecting a. Extremophilic microorganisms – econiches, different typeswith examples and significance b. Archaea –biodiversity, stress response, adaptation and significance c. Marine mycology– econiche, types of marine fungi and	2 3 2

	significance d. Bioremediation – heavy metals, hydrocarbon pollutants – tar ball and oil spills	3

Skilled Based Elective MB 3510:

Marine Microbiology Practical

Total Lectures: 15 Practical 03 x 05 lectures=15 lectures

Credit	Practical	No. of Practicals
Credit 0.5	**1.** Physico-chemical analysis of sea water	1
	2. Isolation of marine bacteria/ fungi from different econiches – coastal waters, deep sea, estuarine waters, sediments	1
	3. Isolation of extremophilic bacteria – halophiles, thermophiles, acidophiles, alkalophiles, psychrophiles, osmophiles (any two of these)	1

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Semester V

Skilled Base Elective MB 3511 Dairy Microbiology

2 Credit Course: Total lectures: 36: Theory-21 L; Practical-15L

Course Outcome:

- To understand prospects of dairying at commercial marketing.
- To acquire skills of processing of milk and dairy products.
- To assess quality control in dairyindustry.
- To comprehend production of dairy products of commercial significance with emphasis tolocal and global market demand.

Skilled Base Elective MB 3511 Dairy Microbiology Theory Total Lectures: 21

Credit No.	Theory	No of Lectures
Credit 1.5	**1. Definition, types, microflora and pathogens:** i. Definition of milk, Composition and physicochemical propertiesof Milk of different animals. Difference between colostrum and milk. ii. Types of milk: whole, toned, double toned, homogenized, and skimmed milk, dehydrated milk iii. Microflora associated with milk and its importance. iv. Sources of contamination of raw milk and relative importance in influencing quality of milk during production, collection, transportation, and storage, milk borne diseases.	8
	2. Processing Techniques and naturally occurring preservatives i. Bacteriological aspects of processing techniques like bactofugation, thermisation, pasteurization (in detail process is expected), sterilization and boiling. ii. Naturally occurring preservative systems in milk like LP system, immunoglobulins, Lysozyme, Lactoferrin etc.	4

	3. Spoilage of Milk i. Spoilage of Milk ii. Succession of microorganisms in milk leading to spoilage iii. Stormy fermentation, ropiness, sweet curdling iv. Color and flavor defects v. Preservation of Milk and Milk products by physical (irradiation) and Chemical agents, food grade bio preservatives (GRAS), Bacteriocins of LAB	5

	4. Microbiological aspects of quality control and qualityassurance in production of milk and milk products. i. Good Manufacturing Practices, ii. Sanitary standard operating procedures, iii. Total quality management and application of HACCP program in dairy industry. iv. Safety concern of biofilm formation on equipment surfaces and their control measures	4

Skilled Base Elective MB 3511 Dairy Microbiology Practical

Total Lectures: 15Total Practical 05 x 05 lectures=15 Lectures

Credit	Practicals	Number of Practicals
Credit 0.5	**1. Microbiological analysis of milk:** Enumeration of bacteria. (Standard Plate Count (SPC) and Direct Microscopic Count) – raw milk and pasteurized milk	1
	2. Microbiological quality control tests for milk: i. Dye reduction tests (MBRT/Resazurin) ii. Mastitis test iii. Somatic cell count iv. Phosphatase test	1
	3. Microbiological quality of indigenous dairy products: i. Khoa ii. Kulfi iii. Shrikhand iv. Paneer v. Curd/ Buttermilk	1

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Semester VI

DSEC-MB 361: Medical Microbiology II

[2 Credits; 36 Lectures]

[1 credit=15hrs x 60 mins = 900mins/50mins=18 lectures]

Credit No.	Topics	No. of lectures
Credit I	**Chemotherapy**	**18**
	1. Routes of drug administration.	1
	2. Mode of action of antimicrobial agents on:	
	a. Bacteria:	
	i. Cell wall: Beta lactams:1st to 6th Generation- e.g. Meropenem, Imipenem, Piperacillin, Tazobactam	2
	ii. Cell membrane: Polymyxin	1
	iii. Protein synthesis: Streptomycin, Tetracycline	1
	iv. Nucleic acids: Fluroquinolones, Rifamycin	1
	v. Enzyme inhibitors: Trimethoprim, Sulfomethaxazole	1
	b. Fungi: Griseofulvin, Amphotericin B, Anidulafungin, Vericonazole	3
	c. Viruses: Acyclovir, Oseltamivir, Remdecivir	1
	d. Protozoa: Metronidazole, Chloroquine	1
	3. Mechanisms of drug resistance on:	
	a. Genetic basis:	3
	i. Mutations in gene(s)	
	ii. Acquisition of foreign DNA coding for resistance determinants through horizontal gene transfer.	
	b. Mechanisms of drug resistance by:	3
	i. Limiting uptake of a drug.	
	ii. Modification of a drug target.	
	iii. Inactivation of a drug.	
	iv. Active efflux of a drug.	

Credit II	**Human and Animal Viruses, Fungal and Protozoal Pathogens**	**18**
	4. Introduction to cultivation of viruses	2
	5. Study of following groups of viral pathogens:	
	a. **Human viruses** (with respect to – Virion, Characteristics, Viability characteristics, Pathogenicity, Pathogenesis, Symptoms, Laboratory diagnosis including serological diagnosis, Epidemiology, Prophylaxis and Chemotherapy):	
	i. Respiratory Viruses: Influenza Virus, Corona Virus	2
	ii. Hemorrhagic Virus: Dengue	2
	iii. Hepatic Virus: Hepatitis A Virus	1
	iv. Gastrointestinal Virus: Rotavirus	1
	v. Cutaneous Viruses: Human papillomavirus	1
	vi. Neurological Viruses: Japanese Encephalitis Virus	1
	b. **Animal Viruses:** FMD Virus and Rinderpest Virus	2
	6. Study of following groups of parasites (with respect to Classification, Lifecycle, Morphological characteristics, Viability characteristics, Pathogenicity, Pathogenesis, Symptoms, Laboratory diagnosis (Serological diagnosis wherever applicable), Epidemiology, Prophylaxis and Chemotherapy):	
	a. Plasmodium	2
	b. Entamoeba	1
	7. Study of following groups of yeast and fungal pathogens (With respect to – Morphological and cultural characteristics, Classification, Pathogenicity, Pathogenesis, Symptoms, Laboratory diagnosis, Epidemiology, Prophylaxis and Chemotherapy)	
	a) *Aspergillus* species (Pathogenic)	1
	b) Cryptococcus neoformans	1
	c) Histoplasma capsulatum	1

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Links:

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9. *Histoplasma caps*ulatum https://www.cdc.gov/fungal/diseases/histoplasmosis/
10. *Cryptococcus neoformans* www.cdc.gov/fungal/diseases/cryptococcosis-neoformans/

Semester VI

DSEC-MB 362 Immunology– II

[2 Credits; 36 Lectures]

[1 credit=15hrs x 60 mins = 900mins/50mins=18 lectures]

Credits	Topics	No. of Lectures
Credit I	**Cytokines, Adaptive / Acquired Immunity, Hypersensitivity, Autoimmunity and Autoimmune diseases and Immunodeficiency**	**18**
	1. Cytokines: a. Concept- Cytokines, lymphokines, monokines, interleukines, chemokines, interferons and tumor necrosis factor b. Properties, Attributes and biological functions of cytokines	 1 2
	2. Adaptive / Acquired Immunity (Third line of defense): **A. Humoral Immune Response** i. Primary and secondary response kinetics, significance in vaccination programs ii. Response of secondary lymphoid organs to antigen iii. Antigen processing and presentation (Major Histocompability class I and class II restriction pathways), cell-cell interactions and adhesion molecules, response to super-antigens, role of cytokines in activation and differentiation of B-cells **B. Cell Mediated Immune Response** i. Activation and differentiation of T cells, role of cytokines in activation ii. Mechanism of Cytotoxic T lymphocytes (CTL) mediated cytotoxicity, Antibody-dependent cellular cytotoxicity (ADCC) iii. Significance of Cell Mediated Immune Response (CMI) iv. Immune response against tumors and foreign transplanted cells	 2 1 5 2 3 1 1

Credit II	**Hypersensitivity, Autoimmunity and Autoimmune diseases and Immunodeficiency**	**18**
	3. Hypersensitivity a. General principles of different types of hypersensitivity reactions b. Gell and Coomb's classification of hypersensitivity – mechanism with examples for type I (Immediate), II, III and IV (delayed)	 2 5
	4. Autoimmunity and Autoimmune diseases: a. Immunological tolerance b. Types of autoimmune diseases c. Factors contributing development of autoimmune diseases d. Immunopathological mechanisms e. Diagnosis and treatment of autoimmune diseases: Myasthenia gravis and Rheumatoid arthritis f. Therapeutic immunosuppression for autoimmunity	 1 1 1 1 2 1
	5. Immunodeficiency: i. Complement deficiencies ii. Introduction to congenital immunodeficiency disorders: Common Variable Immune Deficiency (CVID) and acquired immunodeficiency: Immune mechanisms in AIDS	 2 2

References: MB 362- Immunology-II

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Semester VI

DSEC-MB 363: Metabolism

[2 Credits; 36 Lectures]

[1 credit=15hrs x 60 mins = 900mins/50mins=18 lectures]

Credit No.	Topics	No of lectures
Credit I	**Membrane transport and Bioenergetics**	**18**
	1. Membrane transport mechanisms: i. Passive transport - Diffusion, Osmosis, Facilitated transport ii. Active transport - Active transport systems in bacteria iii. Group translocation of sugars inbacteria iv. Ionophores: Mechanism and examples	6
	2. Bioenergetics: i. Laws of thermodynamics- first and second law ii. Concepts of free energy, entropy, high energy compounds: Pyrophosphate, enolic phosphates, acyl phosphates, thioester compounds, and guanidinium compounds iii. Mitochondrial electron transport chain: components, arrangement of different components in the inner membrane, structure and function of ATP synthatase, inhibitors and uncouplers of ETC and oxidative phosphorylation, energetics of mitochondrial electron transport chain	1 4 7
Credit II	**Metabolic pathways and Autotrophy**	**18**
	3. Biosynthesis and Degradation: a. Chemistry, concept of polymerization of macromolecules: Polysaccharides. (Starch, and peptidoglycan) and Lipids (Fatty acids, triglycerides and phospholipids) b. Degradation of macromolecules – Polysaccharides (starch), Lipids (fatty acids oxidation e.g. β oxidation), Proteins (urea cycle)	6 6
	4. Bacterial Photosynthesis: Photosynthetic bacteria with reference to photosynthetic apparatus, energy generation, and CO_2 fixation a. Cyanobacteria, b. Purple bacteria	2 2
	5 Chemolithotrophy: Concept and one example, Iron oxidizing bacteria	2

References: MB 363 Metabolism

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Semester VI

DSEC -MB-364: Molecular Biology

[2 Credits; 36 Lectures]

[1 credit=15hrs x 60 mins = 900mins/50mins=18 lectures]

Credit No	Topics	No. of lectures
Credit I	**Genetic Recombination and Bacteriophage Genetics.**	**18**
	1. Gene linkage and crossing over a. Mendel's laws: Eukaryotic Cell cycle, Mitosis, Meiosis b. Holliday model for Homologous recombination, Role of Rec and Ruvproteins c. Genetic mapping by Tetrad analysis in *N. crassa* (Numerical Calculations using PD, TT and NPD) *d.* Genetic Mapping by Parasexual cycle in *A. nidulans*	9
	2. Bacteriophage Genetics a. Lytic cycle: Virulent phages, T-series phages, Concept and formation ofplaque, Lysogenic cycle: Temperate phage (λphage) b. Bacteriophage mutants: Plaque morphology (r type), Host range, Conditional lethal mutants (Ts and Am) c. Concept of Genetic Complementation and Cis-trans test of genetic function. (Intergenic- rII locus of T4 phage, Mechanism of Intragenic complementation.) d. Fine structure mapping of rII locus of T4 phage using Benzer's spot tests and deletion mapping	9
Credit II	**DNA damage and repair mechanisms, Recombinant DNA technology**	**18**
	3. DNA damage and Repair mechanisms a. DNA damage by hydrolysis, deamination, alkylation, oxidation, Radiation (X rays and UV rays) b. DNA repair by Photo reactivation c. DNA repair by Mismatch repair mechanism d. DNA repair by Excision repair mechanisms (BER/NER)	5

	4. Recombinant DNA Technology Tools and basics of recombinant DNA technology a. Introduction to recombinant DNA technology b. Restriction enzymes: Concept, Nomenclature, properties and types with examples (Eco R1, Sma I, Pst I). c. Vectors: Features of an ideal vector i. Plasmids: pBR322 ii. Bacteriophage vectors: Lambda iii. Cosmids iv. High capacity vectors: YACs, BACs v. Expression vectors d. Joining of DNA molecules- DNA Ligases (*E. coli* and T4 phage), Use of Linker / Adaptor / Homopolymer tailing e. Methods to transfer recombinant DNA into bacterial host cells (Physical – Electroporation, Gene gun, Chemical –$CaCl_2$ mediated, liposome mediated) f. Methods of screening recombinants using selective markers and Blue-White screening	10
	5. Molecular techniques used in RDT a. Isolation of genomic DNA b. Principle and methodology of Agarose gel electrophoresis and its applications c. Concept, Methodology and applications of Southern, Northern and Western blotting	3

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Reference-Links:

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6. National Academies Press: Introduction of Recombinant DNA-Engineered Organisms Into theEnvironment: Key Issues: https://www.nap.edu/download/18907#
7. Guidelines and Handbook for Institutional Biosafety Committees (DBT, Govt. of India and BCIL):https://thsti.res.in/pdf/IBG.pdf
8. University of North Carolina's Biosafety Guidelines (Principles, Risk assessment, Biosafety levels, Guidelines): https://ehs.unca.edu/laboratory-safety/biological-safety/ http://www.informatics.jax.org/silver/chapters/7-1.shtml

Semester VI

DSEC - MB 365 Fermentation Technology – II

[2 Credits; 36 Lectures]

[1 credit=15hrs x 60 mins = 900mins/50mins=18 lectures]

Credit No.	Topics	No. of lectures
Credit I	**Solid state and Submerged state fermentations and Large scale fermentations**	**18**
	1. Introduction to Solid State Fermentation and Submerged Fermentation: Process, production strains, media, fermentor design, fermentation conditions, applications, merits and demerits	1
	2. Large scale production of (process with flow sheet, nature of the product, production pathway, applications, production strains, media, fermentation process, parameters, product recovery) **a. Primary Metabolites:** i. Vitamins (B12 and B2) ii. Amino acids - Glutamic acid, Lysine iii. Organic acids (Citric acid, Vinegar and Lactic acid) **b. Secondary metabolites:** i. Bioethanol ii. Alcoholic Beverages - a. Beer (Lagering, Maturation, Types of beer) b. Wine (Aging, Malo-lactic acid fermentation, types of wine, wine defects, comparison of white and red wine) iii. Antibiotics [Penicillin (natural and semi synthetic) and Streptomycin]	3 3 4 1 3 3

Credit II	**Large scale production of enzymes, steroids, biomass-based products, milk products, vaccines, immune sera and Modern trends in microbial production**	**18**
	3. Enzymes i. Amylase ii. Esterases iii. Proteases	 1 1 1
	4. Microbial transformation of steroids	2
	5. Biomass based products: i. Yeast: Baker's and Distiller's yeast *ii.* Probiotics: *Lactobacillus sporogenes*	 2 1
	6. Milk products: i. Cheese (Processed, soft, semi-hard, hard ripened types- bacterialand mold) ii. Yogurt (plain, flavoured, fruit, sundae style. Stirred type, set type, probiotic yoghurt)	 2 2
	7. Vaccines i. Polio – Inactivated Polio Vaccine, Oral Polio Vaccine ii. Tetanus – Tetanus toxoid (TT) iii. Rabies – HDCC, Chick embryo cell line, Vero cell line	 1 1 1
	8. Immune sera i. Anti tetanus serum (ATS) ii. Anti rabitic serum (ARS)	 1 1
	9. Modern trends in microbial production: Biosurfactant and bioemulsifier	 1

References: MB 365 Fermentation Technology- II

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https://www.who.int/biologicals/vaccines/Tetanus_Recommendations_TRS_980_Annex_5
https://academic.oup.com/jimb/article-pdf/18/5/340/34773995/jimb0340.pdf.
52. Large scale production of rabies vaccine:
53. Large scale production of tetanus vaccine:
http://nopr.niscair.res.in/bitstream/123456789/26533/1/JSIR%2060%2810%29%2077 3- 778.pdf.
54. USA Clinical Laboratory Standards Institute(CLSI) Guidelines 2021: https://clsi.org/

Semester VI

DSEC - MB 366: Food Microbiology

[2 Credits; 36 Lectures]

[1 credit=15hrs x 60 mins = 900mins/50mins=18 lectures]

Course Outcome

- To describe food safety problems and solutions in India and global scale.
- Identify and classify types of microorganisms in food processing and compare their Characteristics and behaviour
- To learn food classification based on their perishability, intrinsic and extrinsic factors affecting the growth of microbes in foods, role of microorganisms in food fermentation.
- To acquire knowledge about food spoilage, food borne diseases, predisposition and preventive and control measures.
- To apply principles of sanitation, heat treatment, irradiation, modified atmosphere, antimicrobial preservatives and combination of method (hurdle concept) to control microbial growth with emphasis on HACCP guidelines.

Credit No	Topics	No. of lectures
Credit I	**Introduction to properties of food and spoilage of food**	**18**
	1. Classification of food- Perishable, non-perishable, and stable. **Sensory characters of food-** a. Definition of food b. Sensory or organoleptic factors- appearance factors (size,shape, color, gloss, consistency, wholeness) c. Textural factors-texture changes d. Flavor factors (taste, smell, mouthfeel, temperature	4
	2. Factors affecting Microbial growth in food a. Intrinsic factors- pH, water activity, O-R potential, nutrient content, biological structure of food, inhibitory substances in food. b. Extrinsic factors-Temperature of storage, Relative humidity, concentration of gases.	5
	3. Sources of food spoilage microorganisms a. Contamination and spoilage of perishable foods- vegetables and fruits, Meat and meat products, Fish and other sea food, Egg and poultry products. b. Contamination and spoilage of canned foods c. Contamination and spoilage of- cereals and cereal products, sugar and sugar products, salad dressings, spices and condiments.	9

Credit II	**Food Preservation and food in relation to disease**	**18**
	a. Principles of food preservation a. Importance of TDP, TDT, D, F, Z values b. Use of low and high temperature for food preservation. c. Use of chemicals and antibiotics in food preservation, d. Canning e. Dehydration f. Use of radiation g. Tetra pack technology h. Food grade bio preservatives	10
	5. Microbial food poisoning and food infection *a.* Food poisoning -*Clostridium botulinum, Aspergillus flavus* *b.* Food infection-*Salmonella typhimurium, Vibrio parahaemolyticus*	4
	6. Concept of Prebiotic and Probiotic and fermented food- definition, Health effects, Quality assurance, Safety, side effects and risk. Potential applications of Prebiotic, Probiotic and fermented food	2
	7. Food sanitation and regulatory authorities (ISO, FDA, WHO)	2

References: MB 366 Food Microbiology

1. Alias A K., Paliyath G. and Bhat R. (2012). Progress in Food Preservation. United Kingdom: Wiley. ISBN: 9780470655856
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Semester VI

Practical Course-I

DSEC-MB – 367: Diagnostic Microbiology and Immunology

[2 Credits: 78 Lectures]

[1 credit=15hrs x 130 mins = 1950 mins/50 mins=39 lectures]

78 L distributed as 60 L for performing practicals and 18 L for internal evaluation

12 Practicals x 5 lectures = 60 Lectures

Sr. No.	Title of the Practical	No. of Practicals
1.	**Study of permanent slides/ of following microbial pathogens:** a) *Entamoeba histolytica* b) *Giardia* spp. c) *Plasmodium* spp. d) *Mycobacterium* (tuberculosis and leprae) e) *Epidermophyton* spp.	1
2.	**Isolation and identification of following:** Isolation and identification of *Candida* from skin/mouth. (Slide Culture Technique) a. i. Isolation and identification of *Aspergillus niger* ii. Determination of Koch's Postulates using *Aspergillus niger*. iii. Total fungal spore count by Neubauer's chamber	4
3.	**Antibiotic sensitivity testing of the bacterial pathogens (for Gram negative and Gram Positive)**	1
4.	**Immunohematology:** a. Determination of titre of Anti-A and Anti-B in human serum b. Cross-matching (Major and Minor) and Coomb's test (Direct and Indirect)	2
5.	Qualitative detection of Rheumatoid factor (RA factor) and Streptolysin O using Slide test.	1
6.	**Immunoprecipitation:** Double diffusion (Ouchterlony) technique	1
7.	**Demonstrations of:** a. ELISA (Antigen/ Antibody detection) b. Egg inoculation technique	1
8.	**Visit to blood bank and preparation of visit report**	1

References: MB 367: Diagnostic Microbiology and Immunology

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23. Maheshwari N. (2017). Clinical Pathology Hematology and Blood Banking (For Dmlt Students). 3rd edition. Jaypee Brothers Medical Publishers. ISBN-13: 978- 9386261182
24. Mukherjee K. L. and Ghosh S. (2010). Medical Laboratory Technology, Volume I: Procedure Manual for Routine Diagnostic Tests. 2nd edition. McGraw Hill Education (India) Private Limited. ISBN-13: 978-1259061233
25. Mukherjee K. L. and Ghosh S. (2010). Medical Laboratory Technology, Volume II: Procedure Manual for Routine Diagnostic Tests. 2nd edition. McGraw Hill Education (India) Private Limited. ISBN-13: 978-1259061240

26. Mukherjee K. L. and Ghosh S. (2010). Medical Laboratory Technology, Volume III: Procedure Manual for Routine Diagnostic Tests. 2nd edition. McGraw Hill Education (India) Private Limited. ISBN-13: 978-1259061257

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28. Talib V. H. (2019). Handbook Medical Laboratory Technology. 2nd edition. CBS Publishers and Distributors Pvt. Ltd. ISBN-13: 978-8123906775

Semester VI Practical Course – II

SEC-MB 368: Metabolism and Molecular Biology [2 Credits: 78 Lectures]

[1 credit=15hrs x 130 mins = 1950 mins/50 mins=39 lectures]

78 L distributed as 60 L for performing practicals and 18 L for internal evaluation

12 Practicals x 5 lectures = 60 Lectures

Sr. No.	Title of the Practical	No. of Practical
1.	Clinical Biochemistry - Estimations of i. Blood sugar ii. Blood urea iii. Serum cholesterol iv. Serum proteins and albumin	**3**
2.	Enzyme production, purification, quantification and Immobilization: i. Lab scale production of amylase using isolates ii. Precipitation of amylase fromfermentation broth (salt/solvent) iii. Determination of specific activity ofcrude and purified amylase iv. Immobilization of Amylase using calciumalginate	**4**
3.	Enrichment, Isolation and Enumeration of Bacteriophages (Principle, Methodology and Calculations of phage titer in PFU/ml)	**2**
4.	Isolation of Plasmid DNA and Agarose Gel Electrophoresis (Demonstration/hands on as per infrastructure availability)	**1**
5.	Study of Mitotic cell division from onion root tips	**1**
6.	Visit to a Biotechnology/ Biochemistry institute	**1**

References: MB 368 Metabolism and Molecular Biology

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9. Wilson K. and Walker J. (Editors). (2010). Principles and Techniques of Biochemistryand Molecular Biology. 7th edition. Cambridge University Press, New York. ISBN-13: 978-0521731676

Semester VI Practical Course-3

DSEC-MB 369 Fermentation Technology- II and Food Microbiology [2 Credits; 78 Lectures]

[1 credit=15hrs x 130 mins = 1950 mins/50 mins=39 lectures]

78 L distributed as 60 L for performing practicals and 18 L for internal evaluation

12 Practicals x 5 lectures = 60 Lectures

Sr. No	Title of the practical	No. of Practicals
1.	Lab Scale production of the fermentation products: a. Ethanol (fermentation, recovery by simple distillation, estimation of end product by CAN method and fermentation efficiency) **or** b. Citric acid (fermentation, recovery by acid base precipitation and estimation of product bytitrometry)	**2**
2.	Solid state fermentation for production of any one fermentation product (*Trichoderma sp.* / mushrooms / enzymes)	**1**
3.	Isolation and identification of Probiotic microflora from natural sources or any commercial formulation.	**2**
4.	Study of SOPs for pharmaceutical industry a. disinfectant efficacy testing b. Physical monitoring of microbiologysection c. Handling of biological indicators d. Microbiological testing of vials e. Identification of contaminant in sterile area	**1**
5.	Detection of aflatoxin	**1**
6.	Determination of TDP and TDT value	**2**
7.	Determination of TDR and D value	**1**
8.	HACCP guidelines for food industry (activity based)	**1**
9.	Visit to any food industry or a fermentation industry	**1**

References: MB 369 Fermentation Technology- II and Food Microbiology

1. Lab scale fermentations:
   - Casida L. E., Jr. (2019). Industrial Microbiology, New Age International

- Patel A. H. (2016). Industrial Microbiology. Trinity Press (Publisher). ISBN-13-9789385750267

https://onlinelibrary.wiley.com/doi/pdf/10.1111/j.1541-4329.2005.tb00060.x

2. Solid state fermentation:
   - https://iopscience.iop.org/article/10.1088/1757-899X/612/2/022111/pdf.
   - https://www.scielo.br/j/babt/a/vDHdsFscjRYsW6jkRfKQCDM/?lang=en.
   - Meshram S. U. and Shinde G. B. (2009). Applied Biotechnology. I.K. International Publishing House Pvt. Ltd., New Delhi.
3. Isolation of Probiotic bacteria:
   - https://www.frontiersin.org/articles/10.3389/fmicb.2019.01382/full.
   - https://www.hindawi.com/journals/ijmicro/2020/8865456/.
4. Study of SOPs:
   - https://www.pharmaguideline.com/2012/01/sop-for-physical-monitoring-of.html
   - http://biomanufacturing.org/uploads/files/989767618742858542-sop-visual-inspection-process.pdf.
5. Detection of aflatoxin:
   - https://old.fssai.gov.in/Portals/0/Pdf/Draft_Manuals/MYCOTOXIN.pdf.
   - https://journals.sagepub.com/doi/pdf/10.1177/156482659902000411.
   - https://www.diva-portal.org/smash/get/diva2:799266/FULLTEXT01.pdf.
6. Determination of TDT, TDP, TDR, D value.
   - Frazier W. C., Westhoff D. C. and Vanitha N. M. (2013). Food Microbiology. 5th edition. McGraw Hill education, India.
   - Jay J. M. and Loessner M. J. (2005). Modern Food Microbiology. 7th edition. Springer. ISBN 978-0-387-23413-7.
7. HACCP:

   https://www.fsai.ie/food_businesses/haccp/principles_of_haccp.html.

Semester VI

Semester VI Skilled Base Elective MB 3610 Waste Management

2 Credit Course: Total lectures: 36: Theory-21 L; Practical-15L

Course Outcome:

- To understand waste management and it practicable applicability.
- To assess the magnitude and influence of hazardous content of waste, pollution of waters and waste water treatment technologies.
- To learn the design and working of treatment plants and methods used for liquid and solid waste treatment.
- To impart the understanding ofkinetics of biological systems used in waste treatment.
- To learn the standards of waste management and competent authorities involved at National and international level.

Skilled Base Elective MB 3610 Waste Management Theory Total Lectures 21

Credit	Theory	No. of Lectures

Credit	A. Liquid Waste Management	
1.5	**1. Principles of Wastewater Treatment** i. The need for treatment of wastewater ii. General characteristics of liquid waste - pH, Color Turbidity, Odor, Electrical conductivity, COD, BOD, Total Solids, Total Dissolved Solids, Total Suspended Solids, Total Volatile Solids, Chlorides, Sulphates, Oil and Grease.	4
	2. Microbiology of Wastewater Role of microorganisms in wastewater treatment i. Aerobic and Anaerobic digestion models; attached / anchored and suspended growth. ii. Removal of pathogenic microbes, indicator microbes, enumeration of different types of microbes	4
	3. Unit operations in wastewater treatment plant i. Collection system - Methods of collection, conservancy systems, water carriage system, sewerage system. ii. Screen chamber, Grit chamber, Oil and grease removal iii. Stabilization pond, Aerated lagoon iv. Activated sludge process, Trickling filter v. Rotating biological contactors, anaerobic digestion processes, fluidized bed reactor.	4

	Topic	No. of lectures
	B. Solid Waste Management and hazardous waste	
	4. Characterization of solid wastes: Dairy and e-waste	2
	5. Biomedical waste: Definition, Types, Processing	2
	6. Solid biodegradable waste processing: Composting, Vermicomposting, Biogas production	2
	7. Post-processing by-products of municipal solid waste treatment:leachate refused-derived fuel (RDF)	3

Skilled Base Elective MB 3610 Waste Management Practicals Total Lectures 15 Total Practicals 05 x 05 lectures= 15 lectures

Credit	Practicals	No. of Practicals
Credit 0.5	**1.** Determination of Solids in wastewater: Total Solids, Suspended Solids, Dissolved Solids, Volatile Solids, Fixed Solids, Settleable Solids	1
	2. Determination of Dissolved Oxygen, BOD and COD of waste water (before and after treatment) (MPCB Standards)	1
	3. Preparation of Project report based on a case study (Hotel/ Industry-Dairy, Food processing) Study of the source, generation rates and characteristics of hazardous wastes and their regulation, handling, treatment, and disposal. Special emphasis is placed on process design of waste handling, treatment and disposal systems.	1

References: Skilled Base Elective MB 3610 Waste Management

1. Chandrappa R. and Das D. B. (2012). Solid Waste Management-Principles and Practice. In Environmental Science and Engineering. Springer (Firm).
2. Dutta S., Neela Priya D., Chakradhar B. and Sasi Jyothsna T.S. (2019) Value Added By-products Recovery from Municipal Solid Waste in Waste Valorisation and Recycling. Springer, Singapore.
3. Masters G. M. (1994). Introduction to Environmental Engineering and Science. Prentice Hall of India (Private) Ltd., New Delhi.
4. Metcalf and Eddy (Eds.) 2003. Wastewater Engineering – Treatment and Reuse.

5. Pichtel J. (2014). Waste Management Practices- Municipal, Hazardous and Industrial.2nd edition. CRC Press.
6. Prakash S. (2009). Biotechnology for Water and Wastewater Treatment. Navyug Publishers and Distributors, New Delhi.
7. Rajaram V., Siddiqui F. Z., Agrawal S. and Khan M. E. (2016). Solid and liquid waste management- Waste to wealth. PHI Learning Private Limited, New Delhi, India
8. Ramachandran T. V. (2009). Management of Municipal Solid Waste. Centre for Ecological Sciences, IISc Karnataka Research Foundation. India
9. Rangwala S. C. (2005). Water supply and sanitary engineering. Charotar Publishing House, India
10. Standard Methods for the Examination of Water and Wastewater. (2017). 23rd Edition. American Public Health Association, American Water Works Association, and Water Environment Federation
11. Tchobanoglous G. and Kreith F. (2002). Handbook of solid waste management. 2nd edition. McGraw-Hills Professional.
12. Tchobanoglous G., Burton F. L. and Stensel H. D. (2003). Wastewater Engineering, Treatment, Disposal and Reuse. 4th Ed., Metcalf and Eddy (Editors). Mc Graw Hill Companies.Inc.
13. Wesley Eckenfelder W. Jr. (2000). Industrial Water Pollution Control. 3rd Edition. McGraw Hill.

Semester VI

Skilled Base Elective MB 3611 Nano-biotechnology 2 Credit Course: 1.5 credit theory+0.5 credit Practical Theory-21 L; Practical-15L

Course Outcome

- To understand design, development and application of Nanomaterials and their application in Nanodevices.
- To learn fundamentals of nanotechnology as to Synthesis and characterization techniques of nanoparticles.
- To acquire knowledge of applications of nanomaterials in different disciplines of human life.
- To compare the merits of using nanotechnology with existing technologies.

Skilled Base Elective MB 3611 Nano-biotechnology Theory [total lectures 21]

Sr. No.	Topic	No. of Lectures
Credit 1.5	**1. Introduction to Nano-biotechnology:** a. Introduction to nanoscale, nanomaterials, nanoscience and nanotechnology b. Nanoscale bioassemblies c. Liposomes, viruses, DNA, polysaccharides and proteins (Protein nanotubes, nanofibers, peptide nanoparticles). d. Biomedical applications of bioassemblies e. Cell targeting, drug delivery, bioimaging and vaccine development.	**6**
	2. Microbial mediated metallic nanoparticles synthesis: a. Gold nanoparticles (AuNPs) b. Silver nanoparticles (AgNPs) c. Au-Ag alloy nanoparticles d. Oxide nanoparticles e. Magnetic nanoparticles f. Non-magnetic oxide nanoparticles g. Sulfide nanoparticles etc.	**5**
	3. Characterization techniques for nanomaterials: UV-visual spectroscopy, Fourier transform infrared (FTIR), X-ray diffraction	**6**

	(XRD), X-ray photoelectron spectroscopy (XPS), Scanning electron microscopy (SEM), Transmission electron microscopy (TEM) and dynamic light scattering (DLS).	**4**

	4. Applications of nanoparticles: Antibacterial agent, drug delivery, biosensor, animal industry and nanotechnology in wastewater treatment.	

Skilled Base Elective: MB 3611 Nano-biotechnology. Practicals [total lectures 15]

Credit	Practical	No. of Practicals
Credit 0.5	**1.** Microbial synthesis of metallic nanoparticle synthesis (any two): silver, chromium, cobalt)	**1**
	2. Detection and Characterization of metallic nanoparticlesin colloidal solutions by: a. UV-Spectrophotometer b. FTIR analysis	**1**
	3. Application of nanoparticles- checking antimicrobial activities against the microbial synthesized metallic nanoparticles (any two)	**1**

References: Skilled Base Elective: MB 3611 Nano-biotechnology.

1. Bujold K. E., Lacroix A., and Sleiman H. F. (2018). DNA Nanostructures at the Interface with Biology. Chem. 4: 495–521. Elsevier Inc.
2. Chokriwal A., Sharma M. M. and Singh A. (2014). Biological synthesis of nanoparticles using bacteria and their applications. American Journal of PharmTechResearch. 4(6):38-61.
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6. Fariq A., Khan T. and Yasmin, A. (2017). Microbial synthesis of nanoparticles and their potential applications in biomedicine. J. Appl. Biomed. 15: 241–248
7. Li X., Xu H., Chen Z. S. and Chen G. (2011). Biosynthesis of nanoparticles b microorganisms and their applications. Journal of Nanomaterials. 2011.

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10. Rajput N. and Bankar A. (2017). Bio-inspired gold nanoparticles synthesis and their anti-biofilm efficacy. J. Pharm. Investig. 47: 521–530.
11. Rattan R., Shukla S., Sharma B. and Bhat M. (2021). A mini review on lichen-based nanoparticles and their applications as antimicrobial agents. Front. Microbiol. https://doi: 10.3389/fmicb.2021.633090
12. Salame P. H., Pawade V. B. and Bhanvase B. A. (2018). Characterization tools and techniques for nanomaterials. Nanomaterials for Green Energy: 83–111. doi:10.1016/b978- 0-12-813731-4.00003-5
13. Shukla M. and Shukla P. (2020) Microbial nanotechnology for bioremediation of industrial wastewater. Front. Microbiol. 590631. https://doi.org/10.3389/fmicb.2020.
14. Tiquia-Arashiro S. and Rodrigues D. (2016). Nanoparticles Synthesized by Microorganisms. In Extremophiles: Applications in Nanotechnology. 1-51. Springer,Cham.
15. Xiangqian Li, Huizhong Xu, Zhe-Sheng Chen, and Guofang Chen. (2011). Biosynthesis of nanoparticles by microorganisms and their applications nanostructures for medicine and pharmaceuticals Volume 2011 |Article ID 270974 | https://doi.org/10.1155/2011/270974
16. Yan S., He W., Sun C., Zhang X., Zhao H., Li Z., Zhou W., Tian X., Sun X., Han X. (2009). The biomimetic synthesis of zinc phosphate nanoparticles. Dyes and Pigments. 80(2): 254–258.

SavitribaiPhule Pune University

(Formerly University of Pune)

Three Year B.Sc. Degree Program in Zoology

(Faculty of Science & Technology)

S.Y.B.Sc. Zoology

(w.e.f. June 2020)

As per

Choice Based Credit System

Syllabus implemented from

Academic Year 2020-2021

Preamble:

Zoology is one of the major subjects of Basic Sciences and deals with all aspects of animal biology. It includes an interesting range of highly diverse topics. A zoology student needs to gain understanding of many areas of the subject to keep pace with advancements in Life Sciences.

This under-graduate degree program has been designed by the Board of Studies in Zoology of SavitribaiPhule Pune University with a substantial component of what is needed from zoologists as a skilled career and what zoologists need to pursue for post-graduation and further academic studies. It follows the guidelines laid down by the University Grants Commission, New Delhi. This newly designed curriculum is a perfect blend of the classical aspects in Zoology and the advanced and more specialized areas.

This degree offers Discipline Specific Core Courses **[CC]** in Animal Systematics, Animal Ecology, Animal Cell biology, Applied Zoology, Pest Management, Histology, Biological Chemistry, Genetics, Developmental Biology, Parasitology, Medical & Forensic Zoology, Animal Physiology, Molecular Biology, Entomology, Techniques in Biology and Evolutionary Biology.

In addition to the Core Courses, Ability Enhancement Compulsory Courses **[AECC]** have been added in the second year i.e. Semester III and Semester IV of the undergraduate course. In the third year i.e. Semester V and Semester VI, Discipline specific Elective Courses **[DSEC]** and Skill Enhancement Courses **[SEC]** have been offered. The students, therefore, have an opportunity to take courses in Environment Awareness, Language communication: English/Marathi, Aquarium Management, Poultry Management and Environmental Impact Assessment. In Semester VI the students also have a course dedicated to Project work.

The syllabus has been framed in such a way that the student gains each year, a broader perspective of the subject as he progresses towards completion of the degree program. Field trips, Educational visits and the Project work have been included for the student to experience the applications of the theory learnt in the classroom.

After completion of the program, it is expected that students will understand and appreciate: animal diversity, few applications of Zoology, the structure, functions and life processes at cellular, tissue, organ and system level, significance of evolution, and basic concepts of human health. The students would also gain an insight into laboratory and field work through the practical course, field work and the project.

While presenting this new syllabus to the teachers and students of F. Y. B. Sc. Zoology, I am extremely happy to state that efforts have been made to seek inputs of all the stake holders to make it more relevant.

The new course that will be effective from the academic year 2019- 2020 and will follow the Choice Based Credit System in a Semester mode. It has been primed keeping in view the distinctive requirements of B. Sc. Zoology students. The contents have been drawn-up to accommodate the widening prospects of the discipline of Life Sciences. They reflect the changing prerequisites of the students. This program has been introduced with 132 credits for the subject group while 08 credits to earn from any of the 08 groups offering a range of curricular, cocuricular and extracurricular activities. This pattern has been specially aimed towards the overall development of the students'. The calculation of credits and CGPA will be as per the guidelines of the University. The B. Sc. Zoology program provides an appropriate blend of classical and applied aspects of the subject. This newly designed curriculum will allow students to acquire the skill in handling scientific instruments planning and performing in the laboratory and exercising critical judgement, independent thinking and problem solving skills.

The Syllabus has been revised with the following aims

- To foster curiosity in the students for Zoology
- To create awareness amongst students for the basic and applied areas of Zoology
- To orient students about the importance of abiotic and biotic factors of environment and their conservation.
- To provide an insight to the aspects of animal diversity.
- To inculcate good laboratory practices in students and to train them about proper • handling of lab instruments.

Course Structure:

Course Structure with Credit Distribution of the Undergraduate Science Program in Zoology

Course	Course Code and Name of the Course		Credits
F. Y. B. Sc.	**SEMESTER I**	**SEMESTER II**	
CC	ZO - 111 Animal Diversity I	ZO-121 Animal Diversity II	2 + 2
CC	ZO - 112 Animal Ecology	ZO-122 Cell Biology	2 + 2
CC	ZO - 113 Zoology Practical Paper	ZO-123 Zoology Practical Paper	1.5 +1.5
S. Y. B. Sc.	**SEMESTER III**	**SEMESTER IV**	
CC	ZO - 231 Animal Diversity III	ZO - 241 Animal Diversity IV	2 + 2
CC	ZO - 232 Applied Zoology I	ZO - 242 Applied Zoology II	2 + 2
CC	ZO - 233 Zoology Practical Paper	ZO - 243 Zoology Practical Paper	2 + 2
AECC	EVS 231- Environment Awareness	EVA 241- Environment Awareness	2 + 2
AECC	LA 231 - English/Marathi	LA 241 - English /Marathi	2 + 2
T. Y. B. Sc.	**SEMESTER V**	**SEMESTER VI**	
DSEC	ZO - 351 Pest Management	ZO - 361 Medical & Forensic Zoology	2 + 2
DSEC	ZO - 352 Histology	ZO - 362 Animal Physiology	2 + 2
DSEC	ZO - 353 Biological Chemistry	ZO - 363 Molecular Biology	2 + 2
DSEC	ZO - 354 Genetics	ZO - 364 Entomology	2 + 2
DSEC	ZO - 355 Developmental Biology	ZO - 365 Techniques in Biology	2 + 2
DSEC	ZO - 356 Parasitology	ZO - 366 Evolutionary Biology	2 + 2
DSEC	ZO- 357 Zoology Practical Paper 1	ZO - 367 Zoology Practical Paper 1	2 + 2
DSEC	ZO- 358 Zoology Practical Paper 2	ZO - 368 Zoology Practical Paper 2	2 + 2
DSEC	ZO- 359 Zoology Practical Paper 3	ZO - 369 Zoology Practical Paper 3	2 + 2
SEC	ZO - 3510 Aquarium Management	ZO- 3610 Environmental Impact Assessment	2 + 2
SEC	ZO - 3511 Poultry Management	ZO - 3611 Project	2 + 2

Detailed Syllabus of S. Y. B. Sc.

Paper	Semester III Course Code & Course	Credits	No of Hours	Marks (Internal + University)		Semester IV Course Code & Course	Credits	No of Hours	Marks (Internal + University)
I	ZO - 231 Animal Diversity III	02	30	15+ 35= 50		ZO - 241 Animal Diversity IV	02	30	15+ 35 = 50
II	ZO - 232 Applied Zoology I	02	30	15+ 35 = 50		ZO - 242 Applied Zoology II	02	30	15+ 35 = 50
III	ZO - 233 Zoology Practical Paper	02	14 Practicals	15+ 35 = 50		ZO - 243 Zoology Practical Paper	02	14 Practicals	15+ 35 = 50
AECC	EVS 231- Environment Awareness	02	30	15+ 35 = 50		EVA 241- Environment Awareness	02	30	15+ 35 = 50
AECC	LA 231- English/ Marathi	02	30	15+ 35 = 50		LA 241- English/ Marathi	02	30	15+ 35 = 50

Animal Diversity III & IV

Objectives –

1. To understand the origin and advancement of higher vertebrates (tetrapoda).
2. To understand general characters of different groups of higher vertebrates.
3. To classify vertebrates and to become able to understand the possible group of vertebrates observed in nature.
4. To understand different behaviors and adaptations in higher vertebrates
5. To understand affinities among different groups of higher vertebrates.

Learning Outcomes for the course -

1. The students will be able to understand, classify and identify the diversity of higher vertebrates.
2. The students will able to understand the complexity of higher vertebrates
3. The students will be able to understand different life functions of higher vertebrates.
4. The students will be able to understand the linkage among different groups of higher vertebrates.
5. The student will become aware regarding his role and responsibility towards nature as a protector, to understand his role as a trustee and conservator of life which he has achieved by learning, observing and understanding life.

Course Title: Animal Diversity - III

Course Code: ZO – 231,

Semester - III **(2 credits – 30 Hours)**

No. Title & Contents **Number of Lectures**

1. Introduction to Phylum Chordata – **(03)**

1.1 Origin & Ancestry of Chordates.

1.2 Comparative account of fundamental characters of Chordates with Non Chordates.

1.3 Salient features of Phylum Chordata.

1.4 Classification of Phylum Chordata up to classes – Pisces, Amphibia, Reptilia, Aves, Mammalia.

2. Introduction to Group – Protochordata. **(03)**

2.1 Salient features of Protochordata.

2.2 Salient features of subphylumswith two example each - Names only.

Hemichordata – *Balanoglossus*and*Rhabdopleura*, Urochordata - *Herdmania*and*Salpa*, Cephalochordata –*Branchiostoma*(Amphioxus) and*Asymmetron*.

3. Introduction to subphylum – Vertebrata **(02)**

3.1 Salient features of Vertebrata.

3.2 Introduction and General characters of sections with two examples - Names only.

Agnatha–*Petromyzon*&*Myxine*&Gnathostomata–Frog&*Labeo*.

4. Introduction to Class – Pisces **(04)**

4.1 Salient features of Class – Pisces.

4.2 Introductaionand Salient features of sections with two examples - Names only.

Class – Chondrichthyes–*Scoliodon*and *Chimaera*&Osteichthyes – *Labeo*and*Catla*

4.3 Types of Scales in Fishes.

4.4 Types of Fins in Fishes.

5. Introduction to Class – Amphibia (03)

5.1 Salient features of Class – Amphibia.

5.2 Introduction to order – Apoda–*Ichthyophis,*Urodela–*Salamandra*(Salamander) and& Annura - *Rana*.

5.3 Parental care in Amphibia.

6. Study of *Scoliodon* (15)

Scoliodon – 6.1 - Systematic position, Geographical distribution, Habit, Habitat 01

6.2 - External characters 01

6.3 - Digestive System, Food and feeding mechanism. 02

6.4 - Respiratory System – Structure of Holobranch only. 02

6.5- External & Internal Structure of heart, Working of heart. 02

6.6 - Nervous System – Brain only. 03

6.7 - Male urinogenital system & Female reproductive System. 03

6.8- Yolk sac placenta. 01

Applied Zoology I and II

Objectives :

1. To understand the basic life cycle of the honeybees, beekeeping tools and equipments.
2. To learnfor managing beehives for honey production and pollination.
3. To understand the basic information about fishery, cultural and harvesting methods of fishes.
4. To understand fish preservation techniques.
5. To understand the biology, varieties of silkworms and the basic techniques of silk production and harvesting of cocoons.
6. To learn the different silkworm species and their host plants.
7. To study types of agricultural pests and Major insect pests of agricultural importance.
8. To study Pest control practices.

Learning Outcomes of the course:

1. The learner understands the basics about beekeeping tools, equipment, and managing beehives.
2. The learner understands the basic information about fishery, cultural and harvesting methods of fishes and fish preservation techniques.
3. The learner understands the biology, varieties of silkworms and the basic techniques of silk production.
4. The learner understands the types of agricultural pests, Major insect pests of agricultural importance and Pest control practices.

Course Title - Applied Zoology I

Course Code - ZO - 232

Semester III **2 Credits - 30 lectures**

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1) Sericulture: **16**

1.1 An introduction to Sericulture, Study of different types of silk moths, their distribution, Taxonomic position and varieties of silk produced in India : Mulberry, Tassar, Eri and Muga silk moths. 02

1.2 ExternalMorphology and life cycle of *Bombyxmori.* 02

1.3 Cultivation of mulberry :

a) Varieties for cultivation,

b) Rain fed and irrigated mulberry cultivation- Fertilizer schedule, Pruning methods and leaf yield. 02

1.4 Harvesting of mulberry : **a)** Leaf plucking, **b)** Branch cutting,

c) Whole shoot cutting. 01

1.5 Silk worm rearing :

a) Varieties for rearing,

b) Rearing house,

c) Rearing techniques,

d) Important diseases and pests. 03

1.6 Preparation of cocoons for marketing. 01

1.7 Post harvest processing of cocoons :

a) Stiffling, sorting, storage, deflossing and riddling,

b) Cocoon cooking, reeling equipment and rereeling, washing and polishing. 03

1.8 Biotechnological and biomedical applications of silk. 02

2) Agricultural Pests and their control: **14**

2.1 An introduction to Agricultural Pests, types of pests (agricultural, store grain, veterinary). 01

2.1 Major insect pests of agricultural importance (Marks of identification, life cycle, nature of damage and control measures). 06

a) Jowar stem borer,

b) Red cotton bug,

c) Brinjal fruit borer,

d) Mango stem borer,

e) Blister beetle, f)Rice weevil,

f) Pulse beetle,

g) Tick.

2.3 Non insect pests: Rats, Crabs, Snails, and Squirrels 01

2.4 Pest control practices in brief: Cultural control, Physical control, Mechanical control, Chemical control, Biological control, Pheromonal control, Autocidal control and Concept of IPM in brief. 04

2.5 Plant protection appliances: Shoulder type Rotary duster, Knapsack sprayer, Cynogas Pump. 02

Course Title: Zoology Practical Paper

Course Code: ZO – 233

Semester - III **(2 credits – 60 Hours)**

Animal Diversity - III

1. Museum study of Group Protochordata : *Balanoglossus, Herdmania, Petromyzon*. (D)
2. Museum study of Class Pisces: Labeo, *Scoliodon, Hippocampus.* (D)
3. Museum study of Class Amphibia :*Salamandra, Rana, Ichthyophis*. (D)
4. Study of types of scales in fishes: Placoid scale, Cycloid scale, Ctenoid scale & Ganoid scale. (D)
5. Study of types of tail fins in fishes: Homocercal, Heterocercal &Diphycercal. (D)
6. Study of external characters & digestive system of locally available fish. (E) - Compulsory
7. Study of brain of locally available fish. (D)
8. Temporary preparation of scales & its identification from locally available fish. - (E) Compulsory
9. Compulsory field visit to study pond ecosystem with reference to Pisces and amphibians, report writing and submission. (**2 P**)

Sericulture –

1. Study of external morphology and life-cycle of *Bombyx mori.* (D)
2. Study of five equipments in Sericulture. (E) - Compulsory
3. Preparation of a map showing distribution of silk moth and rearing/ sericulture practices in India. (E)
4. Compulsory submission of Photographs/ sketches of Mulberry, Tassar, Eri and Muga silkmoths. (E)

Agricultural Pests and their control -

1. Study of following insect pests with respect to marks of identification, nature of damage, economic importance and control measures. (D)
    a) Jowar stem borer,
    b) Red cotton bug,
    c) Brinjal fruit borer,
    d) Mango stem borer.
2. Study of following pests with respect to marks of identification, nature of damage, economic

a) Rice weevil,

b) Pulse beetle,

c) Tick.

3. Study of any two non insect pests corresponding to theory course. (D)
4. Compulsory submission of at least five Insect Pests/ Photographs/ Sketches. (E)
5. Study of pest control appliances (as per theory course). (D)
6. Compulsory field visit to Sericulture farm/ Agricultural farm, report writing and submission. **(2 P).**

Minimum 14 practical's must be conducted with at least Seven practical's from each paper.

Course Title: Animal Diversity - IV

Course Code: ZO – 241

Semester - IV (2 credits – 30 Hours)

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1. Introduction to class –Reptilia (04)

1.1 Salient features of class Reptilia with one example (name only) – *Chelone*, *Calotes*.

1.2 Venomous and Non-venomous snakes – Cobra, Russell's viper, and Rat snake, Grass snake.

1.3 Snake venom, symptoms, effect and cure of snake bite, first aid treatment of snakebite.

1.4 Desert adaptations in reptiles in brief.

2. Introduction to class –Aves (05)

2.1 Salient features of class Aves with two examples (names only) – Sparrow, Parrot.

2.2 Flight adaptations in birds.

2.3 Types of Beaks and feet in birds.

2.4 Migration in birds – Altitudinal, Latitudinal.

3. Introduction to class - Mammalia. (04)

3.1 Salient features of class Mammalia with two examples (names only) – Rat, Rabbit.

3.2 Egg laying mammals.

3.3 Aquatic adaptations in mammals.

3.4 Flying adaptations in mammals.

3.5 Cursorial and fossorial adaptation in mammals

4. Study of Rat (17)

4.1 Systematic position, habit and habitat.	01
4.2 External characters.	01
4.3 Digestive system, food and feeding.	02
4.4 Respiratory system.	02
4.5 Blood vascular system – Structure of Heart.	02
4.6 Nervous system – Central Nervous system only.	03
4.7 Sense organs – Structure and functions of Eye & Ear.	03

Course Title - Applied Zoology II

Course Code - ZO-242

Semester IV **2 Credits- 30 lectures**

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1. Apiculture: **16**

1.1 An introduction to Apiculture, Systematic position, Study of habit, habitat and nesting behavior of *Apisdorsata*, *Apisindica*, *Apis florae* and *Apismellifera*. 02

1.2 Life cycle, Colony organization and Division of labour. 02

1.3 Bee behaviour and communication (Round Dance and Wag-Tail Dance). 02

1.4 Bee keeping equipments :

a) Bee box (Langstroth type),

b) Honey extractor,

c) Smoker,

d) Bee-veil,

e) Gloves,

f) Hive tool,

g) Bee Brush,

h) Queen excluder. 02

1.5 Bee keeping and seasonal management. 02

1.6 Bee products (composition and uses) :

a) Honey,

b) Wax,

c) Bee Venom,

d) Propolis,

e) Royal jelly,

f) Pollen. 02

1.7 Diseases and enemies of Bees :

a) Bee diseases - Protozoan (Nosema), Bacterial (American foul brood), Viral (Sac brood), Fungal (Chalk brood).

b) Bee pests - Wax moth (Greater and Lesser), Wax beetle.

c) Bee predators - Green Bee eater, King crow, Wasp, Lizard. 02

1.8 Bee pollination and management of bee colonies for pollination. 02

2. Fisheries : **14**

2.2 An introduction to fisheries and its types (in brief) : Freshwater fisheries, Marine fisheries,

2.3 Habit, habitat and culture methods of following freshwater forms : 03

a) Rohu (*Labeo rohita*) ,

b) Catla (*Catla catla*) ,

c) Mrigal (*Cirrhinus mrigala*).

2.3 Harvesting methods of following marine forms: 03

a) *Harpodon*,

b) Mackerel,

c) Pearl oyster.

2.4 Crafts and Gears in Indian Fishery: 02

a) Crafts – Catamaran, Machwa, Dinghi.

b) Gears – Gill net, Dol net, Rampani net, Cast net.

2.5 Fishery byproducts: 02

a) Fish meal,

b) Fish flour,

c) Fish Liver oil,

d) Fish manure,

e) Fish fin soup.

2.6 Fish preservation technique: 02

a) Chilling,

b) Freezing,

c) Salting,

d) Drying,

e) Canning.

Course Title: Zoology Practical Paper

Course Code: ZO – 243

Semester - IV **(2 credits – 60 Hours)**

Animal Diversity - IV

1. Museum study of Class Reptilia: Venomous & Non-venomous snake – Two each. (D)
2. Identification of Venomous & Non-venomous snakes with the help of pictorial taxonomic keys. – (D) -Compulsory
3. Museum study of Class Aves: Crow, *Kingfisher*& Duck. (D)
4. Study of types of beaks &feet's in birds – Any two each. (D)
5. Museum study of Class Mammalia: Rat, Shrew & Bat. (D)
6. Study of external characters & digestive system of Rat. (D)
7. Study of Heart of Rat. - (D) -Compulsory
8. Study of brain of Rat. (D)
9. Study of reptilian / avian diversity in and around the campus (**2 P**) - (E) -Compulsory
10. Compulsory visit to Zoo / Wildlife sanctuary / Bird sanctuary, report writing and submission. (**2 P**)

Apiculture –

1. Study of external morphology, life cycle and polymorphism in Honey Bee. (D)
2. Temporary mounting of mouth parts, legs, wings and sting apparatus of worker bee. (E)
3. Study of Bee keeping Equipment: Bee box, Honey extractor, Smoker**,** Bee-veil, queen excluder. (D)- Compulsory
4. Study of Bee products: Honey, Wax, Venom, Royal jelly, Pollen. (D)
5. Estimation of carbohydrates from Honey in different samples. (D)- Compulsory
6. Study of Bee enemies: Wax moth, Bee eater, ant. (D)

Fisheries –

1. Identification, Classification and study of habit, habitat and economic importance of **a)** Rohu (*Labeo rohita*), **b)** Catla (*Catla catla*), **c)** Mrigal (*Cirrhinus mrigala*). (D)
2. Identification, Classification and study of habit, habitat and economic importance of **a)** Prawn, **b)** Crab, **c)** Lobster, **d)** Pearl Oyster. - Compulsory

3. Study of crafts: **a)** Catamaran, **b)** Machwa, **c)** Dinghi (Photographs/models/line drawings). (D)

4. Study of gears in fishing: **a)** Gill net, **b)** Dol net, **c)** Rampani net, **d)** Cast net. (Photographs/models/line drawings). (D)

7. Study of nutritional value of fish: Biochemical estimation of fish muscle proteins by using Biuret method. (E) - Compulsory

7. Compulsory study tour/field visit to Apiculture institute / Fish farm/ Aquarium. (E) **(2 P)**.

Minimum 14 practical's must be conducted with at least Seven practical's from each paper.

Recommended Reference Books

Animal Diversity – III & IV

1. Text Books of Zoology, Invertebrates Vol- II, 1992, T.J.Parker and W.A. Haswel, Edited by Marshall and Williams,CBS publications and distribution, New Delhi.
2. Integrated Principles of Zoology, Eleventh Edition, Hickman CP, Roberts LS & Larson A. International Edition ISBN 0–07–118077–X, The McGraw-Hill Companies, Inc.,
3. Modern Text Book of Zoology, Vertebrates. R. L. Kotpal, 3rd edn. Rastogi Publications, Meerut.
4. Chordate Zoology, 1982, P.S.Dhami and J.K.Dhami, R. Chand and Co., New Delhi.
5. Biology, Campbell nand Reece. 7th Edn. Pearson Education in South Asia, Delhi.
6. Young, J. Z. (2004). The Life of Vertebrates. III Edition. Oxford university press.
7. Pough H. Vertebrate life, VIII Edition, Pearson International.
8. Integrated Principles of Zoology, Eleventh Edition, Hickman C. P., Roberts L. S.& Larson A. International Edition ISBN 0–07–118077–X, The McGraw-Hill Companies, Inc.,
9. Arora M.P. Chordates I. Himalya Publications.
10. Organic Evolution. R.S. Lull. Light & Life Publishers.
11. Jordan E. L. &Verma P. S. 2003. Chordates Zoology. S. Chand & Company Ltd. New Delhi.
12. Biology, Campbell Nand Reece. 7th Edn. Pearson Education in South Asia, Delhi.

Applied Zoology I & II

1. Principal of Sericulture, 1994. HisaoArguo, Oxford & Co.
2. An Introduction of Sericulture, 1995. G.Ganga, J. Sulochana, Oxford & IBH Publication Co. Bambay.
3. FAQ Manual of Sericulture. Vol I - Mulberry Cultivation, Vol II - Silkworm Rearing. Central Silk Board, Bangalore.
4. Mane, P.C., Chaudhari R. D. et al. Highly sensitive label-free bio-interfacial colorimetric sensor based on silk fibroin-gold nanocomposite for facile detection of chlorpyrifos pesticide. Scientific Reports2020,10, 4198. https://doi.org/10.1038/s41598-020-61130-y
5. Entomology & Pest Management. Pedigo L. P. Prentice Hall, India 1996.
6. General & Applied Entomology, Nayar K. K. & T. N. Ananthkrishnan& B. V. Davis, Tata McGraw Hill Publication, New Delhi.
7. Insects. M. S. Mani, National Book Trust, India, 2006.
8. Insects & Mites of Crops in India. M. R. G. K. Nair – by ICAR, New Delhi.
9. The Science of Entomology. W. S. Romosor and J. G. Stoffolano, McGraw Hill Publication, 1988.

10. Agricultural Insect Pests of India and their Control, Dennis S. Hill, Cambridge University Press.
11. Applied Entomology. Vol. I & II. K. P. Srivastava. Kalyani Publication, Ludhiana, New Delhi.
12. Principles of Insect Pest Management. G. S. Dhaliwal and Ramesh Arora, Kalyani Publications, Ludhiana.
13. Pest Management and Pesticides: Indian Scenario. Editor- B. Vasantaraj David, Namrutha Publications, Madras (Chennai).
14. Concepts of Insect Control. Ghosh M. R. Wiley Eastern Ltd. New Delhi.
15. Destructive and useful Insects, their habit and Control, 1973. C.L. Metcalf and W. P. Flint, Tata McGraw Hill Publications, New Delhi.
16. A Text Book of Entomology, 1974. V. K. Mathur and K. D. Upadhayay, Goel Printing Press, Barani.
17. Imm's general Text Book of Entomology, Vol I & II, Richard and Davis Owen.
18. Biology of Insects, 1992. S. C. Saxena. Oxford and IBH Publishing Co., New Delhi, Bombay, Calcutta.
19. Bee and Bee Keeping, 1978, Roger A. Morse, Conell University Press, London.
20. The Behaviour& Social Life of Honey Bees, C. R. Ribbandas, Dover Publication inc. New York.
21. Fishes. Mary Chandy. National Book Trust India, 2005.
22. Economic Zoology, Shukla Upadhyay, Rastogi Publication, Meerut, India, 1998.
23. Fisheries Developments, K. K. Trivedi, Oxford and IBH Pub. Co.
24. Marine Fishes in India, 1990, D.V. Bal & K. Virabhdra, Tata McGraw Hill Publication.
25. Fishery Management, 1990, S. C. Agarwal, Avinash Publication House, New Delhi.

Note – Use latest editions of the books.

Savitribai Phule Pune University

(Formerly University of Pune)

Three Year B.Sc. Degree Program in Botany

(Faculty of Science & Technology)

S.Y.B.Sc Botany

Choice Based Credit System Syllabus

To be implemented from Academic Year 2020-2021

Title of the Course: B. Sc Botany

1. **Structure of Course:**

Structure B.Sc. Botany syllabus					
Year	Semester	Course Type	Course code	Course Name	Credits
1	1	Compulsory Course	BO 111	Plant life and utilization I	2
			BO 112	Plant morphology and Anatomy	2
			BO 113	Practical based on BO 111 & BO 112	1.5
	2	Compulsory Course	BO 121	Plant life and utilization II	2
			BO 122	Principles of plant science	2
			BO 123	Practical based on BO 121 & BO 122	1.5
2	**3**	**Compulsory Course**	**BO 231**	**Taxonomy of Angiosperms and Plant Ecology**	**2**
			BO 232	**Plant Physiology**	**2**
			BO 233	**Practical based on BO 231 & BO 232**	**2**
	4	**Compulsory Course**	**BO 241**	**Plant Anatomy and Embryology**	**2**
			BO 242	**Plant Biotechnology**	**2**
			BO 243	**Practical based on BO 241 & BO 242**	**2**
3	5	Discipline Specific Elective Course	BO 351	Botany Theory Paper 1	2
			BO 352	Botany Theory Paper 2	2
			BO 353	Botany Theory Paper 3	2
			BO 354	Botany Theory Paper 4	2
			BO 355	Botany Theory Paper 5	2
			BO 356	Botany Theory Paper 6	2
			BO 357	Botany Practical Paper 1	2
			BO 358	Botany Practical Paper 2	2
			BO 359	Botany Practical Paper 3	2
		Skill Enhancement course	BO 3510	Botany Theory Paper 7	2
			BO 3511	Botany Theory Paper 8	2
3	6	Discipline Specific Elective Course	BO 361	Botany Theory Paper 1	2
			BO 361	Botany Theory Paper 2	2
			BO 362	Botany Theory Paper 3	2
			BO 363	Botany Theory Paper 4	2
			BO 364	Botany Theory Paper 5	2
			BO 365	Botany Theory Paper 6	2
			BO 366	Botany Practical Paper 1	2
			BO 367	Botany Practical Paper 2	2
			BO 368	Botany Practical Paper 3	2
		Skill Enhancement course	BO 3610	Botany Theory Paper 7	2
			BO 3611	Botany Theory Paper 8	2

2. Equivalence of Previous Syllabus:

Old Course (2014 Pattern)	**New Course (2020 CBCS Pattern)**
BO-211: Taxonomy of Angiosperms and Plant community	BO 231: Taxonomy of Angiosperms and Plant Ecology
BO-212:Plant Physiology	BO 232: Plant Physiology
BO-221: Plant Anatomy and Embryology	BO 241: Plant Anatomy and Embryology
BO-222: Plant Biotechnology	BO 242: Plant Biotechnology
Practical based on theory courses (Paper I and Paper II)	Semester III: Practical based on BO 231 & BO 232 Semester IV: Practical based on BO 241 & BO 242

S.Y.B.Sc. Botany CBCS
Pattern (Semester III, Paper I)
2020-2021

BO 231: Taxonomy of Angiosperms and Plant Ecology - 2 Credits (30 Lectures)

Sr. No.	Topic Details	No. of Lectures
	Credit-I	**15**
1.	**Introduction to Angiosperms Taxonomy** Definition, scope, objectives and importance of taxonomy Exploration, Description, Identification, Nomenclature and classification Concept of Systematics with brief historical background	**02**
2.	**Systems of classification** Comparative account of various systems of classification Artificial system- Carl Linnaeus Natural system- Bentham and Hooker Phylogenetic system- Engler and Prantl APG system- A brief review	**05**
3.	**Study of Plant Families** Study of following families with reference to systematic position (As per Bentham and Hooker's system of classification), salient features, floral formula, floral diagram and any five examples with their economic importance – Annonaceae, Brassicaceae, Myrtaceaee, Rubiaceae, Solanaceae, Apocynaceae, Nyctaginaceae and Amaryllidaceae	**08**
	Credit-II	**15**
4.	**Botanical Nomenclature** Concept of nomenclature, brief history, Binomial nomenclature International Code for Nomenclature of Algae, Fungi and Plants (ICN)- Principles, Rules and Recommendations; 'Type' specimen and its types (Holotype, Paratype, Isotype, Lectotype, Neotype). Concept of Typification. Ranks and endings of taxa names, Coining of Genus and Species names Single, double and multiple authority citations	**05**
5.	**Introduction to ecology** Definition, concept, scope, and interdisciplinary approach, autecology and synecology. Species diversity: definition, concept, scope, and types: Alpha, Beta and Gamma diversity. Methods of vegetation sampling: quadrat method, transect method, plot less method Genetic Diversity: definition, nature and origin of genetic variations Species Diversity: definition, origin of species diversity, diversity indices, species abundance Ecosystem Diversity: definition, major ecosystem types of the world, Hotspots in India – concept and basis of 'hotspot' identification.	**06**

6.	**Ecological grouping of the plants** Ecological grouping of the plants with reference to their significance of adaptive external and internal features: a) Hydrophytes, b) Mesophytes c) Xerophytes d) Halophytes with examples.	**04**

References-

1. Balfour Austin (2016). Plant Taxonomy. Syrawood Publishing House
2. Chapman, J.L. and Reiss, M.J. (1998). Ecology: Principles and applications. Cambridge, University Press.
3. Chopra G.L. (1984). Angiosperms: Systematics and Life-Cycle., Pradeep Publications
4. Cooke, Theodore (1903-8). The Flora of the Presidency of the Bombay Vol. I, II, III (Repr. ed), Botanical Survey of India.
5. Cronquist, A. (1968). The Evolution and Classification of Flowering Plants. Thomas Nel and Sons Ltd. London.
6. Datta S.C. (1988). Systematic Botany. New Age Publ.
7. Davis P.H and V.H Heywood (1963). Principles of Angiosperm Taxonomy. Oliver and Boyd, London.
8. Heywood V.H. (1967). Plant Taxonomy, Hodder & Stoughton Educational, London.
9. Judd Walter S., Campbell, C. S., Kellogg, E. A., Stevens, P.F. and M. J. Donoghue. (2008). Plant Systematics- A Phylogenetic Approach. Sinauer Associates, INC, Publishers.Sunderland, Massachusetts, USA.
10. Kormondy Edward (1995). Concepts of Ecology, Pearson Publ.
11. Lawrence G.H.M. (1955). An Introduction to Plant Taxonomy. McMillan, New York.
12. Lawrence, G.H.M. (1951). Taxonomy of Vascular Plants. McMillan, New York.
13. Michael P. (1984). Ecological Methods for field and Laboratory investigations TMH Co. ltd. Bombay.
14. Mondol A.K. (2016) Advanced Plant Taxonomy, New Central Book Agency (NCBA)
15. Naik V.N. (1988) Taxonomy of Angiosperms. Oxford and IBH
16. Odum E.P., (2004). Fundamentals of Ecology, Publ. Cengage Learning, Australia
17. Pande B.P. (1997). Taxonomy of Angiosperms. S. Chand.
18. Pande B.P. (2001) Taxonomy of Angiosperms. S. Chand.
19. Radford A.E. 1986. Fundamentals of Plant Systematics, Harper and Row N Y.
20. Santapau H. (1953). The Flora of Khandala on the Western Ghats of India. BSI
21. Sharma O.P. (2011), Plant Taxonomy, Tata Mc grow Hill
22. Shivrajan V.V. & N.K.P. Robson (1991). Introduction to Principles of Plant Taxonomy. Cambridge Univ. Press
23. Shukla Priti and Shital Mishra (1982). An introduction to Taxonomy of angiosperms. Vikas Publ.
24. Simpson, M.G. (2010). Plant Systematics. Elsevier, Amsterdam.
25. Singh Gurucharan (2005). Systematics: Theory and Practice. Oxford IBH.
26. Singh J.S., S.P. Singh, and S.R. Gupta (2006). Ecology, Environment and Resource Conservation. Anamaya Publ. New Delhi.
27. Singh N.P. (2001) Flora of Maharashtra Volume-II BSI, Kolkatta
28. Singh N.P. (2003) Flora of Maharashtra Volume-III BSI, Kolkatta
29. Singh N.P., S. Karthikeyan (1996) Flora of Maharashtra Volume-I, BSI, Kolkatta
30. Singh V. and D.K. Jain, (1981). Taxonomy of Angiosperms. Rastogi Publication, Meerut.
31. Singh, Gurcharan. (2012). Plant Systematics: Theory and Practice. Completely revised and enlarged 3rd edition. Oxford & IBH, New Delhi.
32. Stuessy, Tod F. (2009). Plant Taxonomy: The Systematic Evaluation of Comparative Data, second edition. Columbia University Press.

33. Swingle D.B. (1946). A Text book of Systematic Botany. McGraw Hill Book Co. New York.
34. Takhtajan A. (1969). Flowering Plants: Origin and Disposal.

IMPORTANT WEBSITES

THE FAMILIES OF FLOWERING PLANTS- L. Watson and M.J. Dallwitz
https://www.delta-intkey.com/angio/index.htm

ANGIOSPERM PHYLOGENY WEBSITE, version 14.
http://www.mobot.org/MOBOT/research/APweb/

THE PLANTS OF THE WORLD ONLINE PORTAL
http://www.plantsoftheworldonline.org/

INTERNATIONAL PLANT NAME INDEX (IPNI)
https://www.ipni.org/

TROPICOS
https://www.tropicos.org/home

BIODIVERSITY HERITAGE LIBRARY
https://www.biodiversitylibrary.org/

BOTANICUS DIGITAL LIBRARY
https://www.botanicus.org/

INTERNET ARCHIVE- DIGITAL LIBRARY
https://archive.org/

DATABASE OF PLANTS OF INDIAN SUBCONTINENT
https://sites.google.com/site/efloraofindia/

BOTANICAL SURVEY OF INDIA
https://bsi.gov.in/content/1416_1_FloraofIndia.aspx

FLOWERS OF INDIA
http://www.flowersofindia.net/

eFLORAS OF WORLD
http://www.efloras.org/

S.Y.B.Sc. Botany CBCS
Pattern (Semester III, Paper II)
2020-2021

Credit I:

BO 232: Plant Physiology - 2 Credits (30 Lectures)

1. Introduction to Plant Physiology **2L**
Scope and applications of plant physiology

2. Absorption of water **3L**
2.1 Role of water in plants
2.2 Mechanisms of water absorption with respect to crop plants
2.3 Factors affecting rate of water absorption

3. Ascent of sap **3L**
3.1 Introduction and definition.
3.2 Transpiration pull or cohesion-tension theory, evidences and objections
3.3 Factors affecting ascent of sap

4. Transpiration **7L**
4.1 Definition
4.2 Types of transpiration – cuticular, lenticular and stomatal
4.3 Structure of stomata
4.4 Mechanism of opening and closing of stomata –Steward's hypothesis, active K+ transport mechanism
4.5 Factors affecting the rate of transpiration
4.6 Significance of transpiration
4.7 Antitranspirants
4.8 Guttation
4.9 Exudation

Credit II:

5. Nitrogen metabolism **7L**
5.1 Introduction and role of nitrogen in plants
5.2 Nitrogen fixation by *Rhizobium* and BGA
5.2.1 Symbiotic nitrogen fixation, nitrogenase enzyme- structure and function
5.2.2 Non-symbiotic nitrogen fixation
5.3 Importance and production technique of BGA
5.4 Denitrification, ammonification and nitrification
5.5 Reductive amination and transamination

6. Seed dormancy and germination **4L**
6.1 Definition, types of seed dormancy and germination
6.2 Methods to break seed dormancy
6.3 Metabolic changes during seed germination
6.4 Role of phytohormones to improve seed germination
6.5 Vigor Index**Physiology of flowering 4L**
6.6 Photoperiodism – Concept, definition, short day plants, long day plants and day plants.

6.7 Phytochrome theory, role of phytohormones in induction and inhibition of flowering
6.8 Applications of photoperiodism
6.9 Vernalization–concept and definition, mechanism of vernalisation, applications of vernalisation and devernalization

References:

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4. Helgi OPik, Stephen A. Rolfe, Arthur J. Willis. 2005. The Physiology of Flowering Plants, Cambridge University Press, UK
5. Kirkham, M.B. 2004. Principles of Soil and Plant Water Relations. Elsevier, Amsterdam, Netherlands.
6. Dennis, D.T., Turpin, D.H., Lefebvre, D.D. and Layzell, D.B. 1997. Plant Metabolism. 2nd Edition. Longman Group, U.K.
7. Fitter, A. and Hay, R.K.M. 2001. Environmental Physiology of Plants. Academic Press, UK.
8. Press, M.C., Barker, M.G., and Scholes, J.D. 2000. Physiological Plant Ecology, British Ecological Society Symposium, Volume 39, Blackwell Science, UK.
9. Sayyed Iliyas, 2020. Steps in Plant Physiology, Lambert Academic Publishing, Mauritius.
10. Devlin, R.M. and F.H. Witham. 1983. Plant Physiology. Willard Grant Press. U.S.A.
11. Hans-Walter Heldt. 1997. Plant Biochemistry and Molecular Biology. Oxford University Press, New York.
12. Moore, T.C. 1979. Biochemistry and Physiology of Plant Hormones. SpringerVerlag. Berlin.
13. Raman, K. 1997. Transport Phenomena in Plants. Narosa Publishing House. New Delhi.
14. Jain, V.K. 2000: Fundamentals of Plant Physiology. S. Chand & Co, New Delhi.
15. Pandey, S.N. 1991: Plant Physiology, Vikas Publishing House (P) Ltd., New Delhi, India.
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17. Nobel, P.S. 2009. Physicochemical and Environmental Plant Physiology.4th edition Academic Press, UK.

S.Y.B.Sc. Botany CBCS Pattern
Practical (Semester III Paper III) 2020-2021
BO 233: Practical based on BO 231 & BO 232

Practical based on Taxonomy of Angiosperms and Plant Ecology, and Plant Physiology

Sr. No.	Title	No. of Practical
	Taxonomy of Angiosperms and Plant Ecology	
1	Study of tools of taxonomy and ecological instruments (any four each)	1
2	Description of flowering plant in botanical terms	1
3	Study of plant families (any four)	3
4	Study of ecological adaptations in Hydrophytes with any two examples	1
5	Study of ecological adaptations in Xerophytes with any two examples	1
6	Study of vegetation by list count quadrat method.	1
	Plant Physiology	
7	Perform phytochemical test for starch and protein in germinating and non germinating seeds	1
8	Isolation of Leaf Protein Concentration (LPC) from suitable plant material.	1
9	Determination of Diffusion Pressure Deficit (DPD)	1
10	Determine rate of transpiration under different conditions of Sunlight, Shade and Wind	1
11	Demonstration of the following **a.** Commercial biofertilizers **b.** Imbibition in seeds **c.** Ringing experiment **d.** Arc Auxanometer **e.** Spectrophotometer **f.** Nitrogen fixing bacteria / BGA (specimen/ slide)	1
12	Calculate seed germination percentage and vigor index	1
13	Botanical excursion tour and visit to Floriculture industry / Soil testing center / Seed testing center	1

N.B. Botanical excursion tour and submission of report along with herbarium of any five weeds of the following (List of Weeds attached).

List of weeds

Acanthospermun hispidum DC.Asteraceae

Aerva javanica (Burm.f.) Juss. Ex Schult.

Amaranthaceae Aeschynomene americana

L.Fabaceae Tropical America Ageratum conyzoides

L.Asteraceae America

SEMESTER IV

S.Y.B.Sc. Botany CBCS Pattern (Semester IV, Paper I) 2020-2021

BO 241: Plant Anatomy and Embryology- 2 Credits (30 Lectures)

Credit-I Plant anatomy: (15 Lectures)

1. Introduction **2L**

1.1 Definition

1.2 Scope of plant anatomy

2. Epidermal tissue system **3L**

2.1 Structure, types and functions of epidermis

2.2 Structure, types and functions of Stomata

2.3 Epidermal outgrowths- non-glandular and glandular

2.4 Motor cells

3. Mechanical tissue system **3L**

3.1 Principles involved in distribution of mechanical tissues with one example each

a) Inflexibility,

b) Incompressibility,

c) Inextensibility and

d) Shearing stress

3.2 Vascular tissue system: Structure and function of xylem, phloem and cambium

4. Normal secondary growth **3L**

4.1 Introduction

4.2 Normal secondary growth in dicotyledonous stem

4.3 Development of annual rings, periderm, bark, tyloses and lenticel

5. Anomalous secondary growth **4L**

5.1 Introduction

5.2 Causes of anomalous secondary growth

5.3 Anomalous secondary growth in:

a) Dicotyledonous stem (*Bignonia*),

b) Dicotyledonous root (*Raphanus*),

c) Monocotyledonous stem (*Dracaena*)

Credit-II Plant Embryology (15 Lectures)

7. Introduction **1L**

7.1 Definition and scope of plant embryology

8. Microsporangium and male gametophyte **4L**

8.1 Structure of tetrasporangiate anther

8.2 Types of tapetum

8.3 Sporogenous tissue

8.4 Microsporogenesis: process and its types
8.5 Types of microspore tetrad
8.6 Male gametophyte: structure and development of male gametophyte

9 Megasporangium and female gametophyte **4L**

9.1 Structure
9.2 Types of ovules
9.3 Types of megaspore tetrads
9.4 Female gametophyte: structure of typical embryo sac
9.5 Types of embryo sacs – monosporic, bisporic and tetrasporic

10. Pollination and Fertilization: **3L**

10.1 Introduction and definition
10.2 Types of pollination
10.3 Germination of pollen grain
10.4 Entry of pollen tube- porogamy, mesogamy and chalazogamy
10.5 Double fertilization and its significance.

11. Endosperm and embryo **3L**

11.1 Endosperm: Types – nuclear, helobial and cellular.
11.2 Structure of Dicotyledonous and Monocotyledonous embryo.

References:

1. Plant Anatomy, Chandurkar P J, Plant Anatomy Oxford and IBH publication Co. New Delhi 1971
2. B P Pandey, Plant Anatomy. S Chand and Co. Ltd, New Delhi 1978
3. Greulach V A and Adams J E Plant- An introduction to Modern Biology, Toppen Co. Ltd, Tokyo,
4. Eams and Mc Daniel,An Introduction to Plant Anatomy, McGraw –Hill Book Co. Ltd and Kogakusha Co, Tokyo, Japan
5. Adriance S Foster Practical Plant Anatomy, D Van Nostrand Co. INC, New York
6. Esau, Plant Anatomy, Wiley Toppan Co. California, USA
7. Pijush Roy, Plant Anatomy. New Central Book Agency Ltd, Kolkata
8. Pandey S N and Ajanta Chadha, Plant Anatomy and Embryology, Vikas Publishing House, Pvt, Ltd, New Delhi
9. Bhojwani S S and Bhatnagar S P, An Embryology of Angiosperms
10. Maheshwari P, An introduction to Embryology of Angiosperm
11. Nair P K K Essentials of Palynology.

S.Y.B.Sc. Botany CBCS
Pattern (Semester IV, Paper II)
2020-2021

Credit I: **BO 242: Plant Biotechnology (2 Cr- 30 Lectures)**

Chapter 1 Introduction to Plant Biotechnology 3L

1.1 History and definition
1.2 Scope and importance of plant biotechnology
1.3 Current status of biotechnology in India.

Chapter 2 Plant Tissue Culture 8L

2.1 Concept of plant tissue culture and cellular totipotency
2.2 Basic techniques: Types of culture, Media preparation, sterilization, inoculation, incubation, hardening
2.3 Applications with reference to: Micropropagation, Somaclonal variation, Haploid production, Protoplast fusion & Somatic hybrids, Embryo rescue, Production of secondary metabolites.
2.4 Commercial Plant Tissue culture laboratories in Maharashtra and India.

Chapter 3 Single Cell Protein (SCP) 4L

3.1 Concept and definition
3.2 Importance of proteins in diet
3.3 Production of SCP from *Spirulina* and Yeast
3.4 Importance & acceptability of SCP

Credit II:

Chapter 4 Plant Genetic Engineering 5L

4.1 Introduction, concept
4.2 Tools of genetic engineering (restriction enzymes, ligases, plasmid vectors)
4.3 Gene cloning Technique
4.4 Applications of plant genetic engineering: insect pest resistance, abiotic stress tolerance, herbicide resistance

Chapter 5 Genomics, Proteomics and Bioinformatics 5L

5.1 Genomics- concept, types, methods used for whole genome sequencing
5.2 Proteomics-concept, types, methods used in proteome analysis
5.3 Bioinformatics-concept, database and its classification, data retrieval tools.

Chapter 6 Bioremediation 2L

6.1 Introduction and concept
6.2 Microbial remediation
6.3 Phytoremediation

Chapter 7 Biofuel technology 3L

7.1 Definition, Concept and types of Renewable and nonrenewable energy sources
7.2 Definition and concept of Biogas, Bioethanol, Biobutanol, Biodiesel & Biohydroge

S.Y.B.Sc. Botany CBCS Pattern Practical
(Semester IV Paper III) 2020-2021 BO 243:
Practical based on BO 241 & BO 242

Sr. No.	Title	No. of Practical
	Plant Anatomy and Embryology	
1	Study of epidermal tissue system – non-glandular and glandular trichomes, multilayered epidermis, typical stomata (Dicotyledonous and Monocotyledonous).	2
2	Study of mechanical tissues and their distribution in root, stem and leaves.	1
3	Study of normal secondary growth in dicot stem – *Annona* /*Moringa* (Double stained temporary preparation).	1
4	Study of anomalous secondary growth in *Bignonia* and *Dracaena* stem (Double stained temporary preparation).	1
5	Study of tetrasporangiate anther and types of ovules with the help of permanent slides	1
6	Study of dicot and monocot embryo.	1
	Plant Biotechnology	
7	Instruments/equipments used in plant tissue culture laboratory: Principle and working of Autoclave, oven, laminar air flow cabinet, micropipette, culture bottles/tubes with cotton plug	1
8	Preparation & sterilization of MS medium	1
9	Surface sterilization and Inoculation of nodal sector, leaf, anther and maize embryo	2
10	Laboratory cultivation of *Spirulina*	1
11	Demonstration practical on transgenic crops viz; Bt-Cotton, Golden rice	1
12	Demonstration of principle and working of agarose gel electrophoresis, centrifuge, spectrophotometer	1
13	Visit to plant tissue culture laboratory	1

DSEC-II: CH-505: Industrial Chemistry - I [Credit -2, 36 L]

Chapter No.	Title of Topic/Chapter	No. of lecture
1	Modern Approach to Chemical Industry	06
2	Manufacture of Basic Chemicals	07
3	Sugar and Fermentation Industry	07
4	Soap and Detergents Industry	08
5	Dyes and Pigments	08
	Total	**36**

1. Modern Approach to Chemical Industry (6 L)

Introduction, basic requirements of chemical industries, chemical production, unit process and unit operations, Quality control and quality assurance, process control, research and development, human resource, safety measures, classification of chemical reactions, batch and continuous process, Conversion, selectivity and yield, copy-right act, patent act, trademarks.

Ref. No.-7, Relent pages, Ref. - 10: www.wikipedia.org/wiki/copyright_act_of1976/patent act/ trademark

Aims and Learning objectives: The students are expected to learn;

i. Importance of chemical industry,

ii. Meaning of the terms involved,

iii. Comparison between batch and continuous process,

iv. Knowledge of various industrial aspects

2 Manufacture of Basic Chemicals (7 L)

a) Ammonia: Manufacture of ammonia by modified Haber-Bosch process, Physico-chemical principles involved and uses of ammonia.

b) Nitric acid: Manufacture of nitric acid by Ostwald's process, Physico-chemical principles involved and uses of nitric acid.

c) Sulphuric acid: Manufacture of sulphuric acid by contact process, Physico-chemical principles involved and uses of sulphuric acid.

Reference No.-1: Page No. 731 to 761, 809 to 844, Reference-3: 1128-1175, 1253-1263

Aims and Learning objectives: The students are expected to learn

i. Concept of basic chemicals,

ii. Their uses and manufacturing process.

iii. They should also know the physico-chemical principals involved in manufacturing process

3. Sugar and Fermentation Industry (7 L)

a. Sugar: Introduction, manufacture of cane sugar, extraction of juice, purification of juice, sulfitation and carbonation, evaporation, crystallization, separations of crystals, drying refining, grades, recovery of sugar from molasses, by-product of sugar industry,

Reference No.-1: Page No.1208- 1218

b. Fermentation Industry: Introduction, importance, conditions favorable for fermentation, Characteristics of enzymes, short account of some fermentation processes, Alcohol beverages, Manufacture of beer, manufacture of sprit, manufacture of wines, manufacture of vinegar, manufacture of power alcohol, ethyl alcohol from molasses.

Reference No.-1: Page No. 1176-1184

Aims and Learning objectives: The students are expected to learn Sugar Industry: The students are expected to learn

i. Importance of sugar industry,

ii. Manufacture of direct iii. Consumption (plantation white) sugar with flow diagram.

iii. Cane juice extraction by various methods,

iv. Clarification by processes like carbonation, vi. Sulphitation, vii. Phosphatation, etc.

v. Concentration of juice by using multiple effect evaporator system,

vi. Crystallization of sucrose by using vacuum pan.

Fermentation Industry- The students are expected to learn

i. Importance,

ii. Basic requirement of fermentation process,

iii. Manufacturing of ethyl alcohol by using molasses and fruit juice.

4. Soap and detergents (8 L)

(a) Soap: Soap and Fatty Acids: Introduction, Chemistry, Manufacturing Technology, Raw Materials, Functional Properties of Soap, Manufacturing Processes, Saponification Reactor, Cooling, Soap Separator, Soap Extraction, Centrifugation, Neutralization, Direct Neutralization, Carbonate Neutralization, Partial Neutralizing with Soda Ash, Carbon Dioxide Separation, Raw Material Dosing, Caustic Soda, Completion of Neutralizing with Caustic Soda, Neutralization Soap Viscosity,

Reference-5: 980-997, Reference-1: 1243 -1250

(b) Detergents: Synthetic Detergents: Introduction, Characteristic Features of Surfactants, Raw Materials for Surfactant Production, intermediates for Surfactant Production, Anionic Surfactants, Non-ionic Surfactants, Amphoteric Surfactants, Cationic Surfactants, Detergent Additives, Production of Synthetic Detergents, and Washing action of soap and detergents.

Reference-5: 1006-1029, Reference-1: 252 – 1279

Aims and Learning objectives: The students are expected to learn

i. Different types of soap products,

ii. Chemistry of soap.

iii. Raw materials required for soap manufacture

iv. Meaning of the term's Surfactants, Types of surfactants

v. Raw materials for detergents

vi. Detergent builders, additives

vi. Washing action of soap and detergents

5. Dyes and Pigments (8 L)

(a) Dyes: Introduction, qualities of good dye, Colour constituents (Chromophore, auxochrome), classification of dyes according to their application, Synthesis and uses of following dyes: Nitroso dye-martius yellow, Azo dyes-Methyl orange and aniline yellow, Triphenylmethane dye-Crystal violet, Phthalein dye - Phenolphthalein, Xanthane-Fluorescein, Antha-quinnoe-Alizarin and Indigo dyes - Indigo.

Reference -1: pp 1545-1595

(b) Pigments: Introduction, classification and general properties of pigments.

Inorganic pigments:

i) Zinc oxide pigments (Fundamentals and properties, Raw materials, Direct process (American process), Precipitation process)

ii) Iron oxide pigments (Fundamentals and properties, Production of iron oxide pigment by precipitation process),

Reference-9: 80-87, 97 to 109.

Aims and Learning objectives: The students are expected to learn Dyes - Students should know about

i. Dyes: introduction,

ii. Dye intermediates,

iii. Structural features of a dye;

iv. Classification of dyes,

v. Synthesis, Structures, properties and applications of dyes

Pigments: Students should know about

i. Introduction,

ii. Classification and general properties of pigment

iii. Production processes of zinc oxide and iron oxide

References:

1. Industrial Chemistry, B. K. Sharma, Goel publishing House, 18th Ed. (2014)
2. Riegeal's Hand book of industrial chemistry, James A. kent. 9th Ed. CBS publishers
3. Advanced Inorganic Chemistry, Satyaprakash, Tuli, Basu pages 458-463.
4. Advanced Inorganic Chemistry, Satyaprakash, Tuli, Basu pages 830-849
5. Handbook of Industrial Chemistry and Biotechnology, James A. Kent, Tilak V. Bommaraju, Scott D. Barnicki, Thirteenth Edition, Springer.
6. Inorganic Pigments by Gerhard Pfaff, Publisher-De Gruyter, 1st Ed.
7. Shreeve's chemical process industries 5th Edition, G.T. Austin, TATA McGraw-Hill Edition, chemical engineering series
8. Industrial Chemistry, Part-II, R. K. Das, Kalyani Publisher, Second Ed.
9. Inorganic Pigments by Gerhard Pfaff, Publisher-De Gruyter, 1st Ed.

www.wikipedia.org/wiki/copyright_act_of1976 , www.wikipedia.org/wiki/patentact and www.wikipedia.org/wiki/trademark

Industrial visit:

Visit to any one of the Chemical / Pharmaceutical / Polymer / Research Institutes / Sugar Factories / waste water treatment plant, etc. is essential and a systematic report is to be submitted by the student to the Department of Chemistry.

SEC-II: CH-511: Skills Enhancing Course-II [Credit -2, 36 L]

Choose one out of the two options, A and B.

CH-511 (A) : Environmental Chemistry

Chapter No.	Title of Topic/Chapter	No. of lecture
1	Concepts and Scope of Environmental Chemistry	06
2	Hydrosphere and Water Pollution	10
3	Analytical Techniques in water Analysis	10
4	Water pollution and treatment methods	10
	Total	**36**

1: Concepts and Scope of Environmental Chemistry (06L)

Introduction, Environmental Pollution and Classification, Units of concentration, Segments of Environment, Biogeochemical cycles of C, N, P, S and O system

Reference: 1, 2, 3

Aims and objectives: -Students should know:

i. Importance and conservation of environment.

ii. Importance of biogeochemical cycles

2: Hydrosphere and Water Pollution (10L)

Water resources, Hydrological Cycle: stages of hydrological cycle and chemical composition of water bodies, Microbially mediated aquatic reactions, Classification of water pollutants

Organic and Inorganic pollutants, Sewage and Domestic waste, Sediments, Detergents, Pesticides, Eutrophication, Sampling and monitoring water quality parameters: pH, D.O. (Winkler Method), COD, TOC, Total hardness, free chlorine.

Reference: 1 Page no -47-62,

Aims and Objectives:- Students should know:

i. Water resources

ii. Hydrological Cycle

iii. Organic and inorganic pollutants

iv. Water quality parameters

1. Analytical Techniques in water Analysis (10 L)

Water quality parameters and standards, domestic water quality parameters, surface water, sampling, preservation, Monitoring techniques and methodology (pH, conductance, DO, ammonia, nitrate and nitrite, Cl, F, CN, Sulfide, sulphate, phosphate, total hardness, boron, metals and metalloids- As, Cd,

Cr, Cu, Fe, Pb, Mn, Hg (Exclude polarographic and AAS methods), COD, BOD, TOC, phenols, pesticides, surfactants, tannis and lignins, E. Coli, Case studies of water pollution.

Ref-1: 225-278

2. Water pollution and treatment methods **(10 L)**

Water pollutants, Eutrophication, Waste water treatment (domestic waste water, aerobic treatment, anaerobic treatment, upflow aerobic sludge bed, industrial waste water treatment, drinking water supplies, Trace elements in water, chemical speciation (Cu, Pb, Hg, As, Se, Cr)

Ref-1: 167-225

Reference-1: Environmental Chemistry – A. K. De, Third Edition (Wiley)

Additional References:

1. Environmental Chemistry – A. K. De, 5th Edition (New age international publishers)
2. Environmental Chemistry – A. K. Bhagi and C. R. Chatwal (Himalaya Publishing House)
3. Environmental Chemistry – H. Kaur 2nd Edition 2007, Pragati Prakashan, Meerut, India
4. Environmental Chemistry – J. W. Moore and E. A. Moore (Academic Press, New York)
5. Basic Concepts of Analytical Chemistry: S. M. Khopkar, Wiley Eastern (1995

Analytical Chemistry-II

Chapter No.	Title of Topic/Chapter	No. of lecture
1	Solvent extraction	08
2	Instrumental Methods of Chromatographic Analysis	04
3	High Performance Liquid Chromatography	06
4	Gas Chromatography	06
5	Atomic Absorption Spectroscopy	08
6	Flame Emission Spectroscopy	04
	Total	**36**

Solvent extraction (8 L

Introduction to solvent extraction, organic phase, Partition the theory of extraction (distribution coefficient, Distribution ratio, solute remaining unextracted, Separation coefficient), Factors favoring solvent extraction, Quantitative treatment to solvent extraction equilibrium, Ion association complexes, synergic extraction, some extraction reagent specifically used for inorganic ions (Acetylacetone, 8-Hydroxyquinoline, Diphenylthiocarbazone, Sodium diethyldithiocarbamate, Ammonium pyrrolidine dithiocarbamate), some practical aspects, Applications: determination of copper as the diethyldithiocarbamate complex, Determination of Fe(III) with 8-hydroxyquinoline, determination of nickel by synergistic extraction. Solid phase extraction (Ref-3) Numericals; **Key Reference-2**: 242- 253, [Supplementary Ref-3: 579-593]

1. Instrumental Methods of Chromatographic Analysis (4 L)

Principles of Chromatographic Separations, classification, Theory of Column Efficiency in Chromatography, (theoretical plate, rate theory of chromatography - the Van Deemter equation, efficiency and particle size in HPLC, retention factor efficiency and resolution,

Key Reference -4: 603-617, Supplementary reference-3: 547-556.

2. High Performance Liquid Chromatography (6 L)

Introduction, Types of liquid chromatography (liquid-solid, liquid-liquid, bonded phases), Choice of mode of separation, Equipment for HPLC: mobile phase, sample injection and column design (mobile phase, optimization of mobile phase, gradient elution, solvent delivery and sample injection, sample injection system, the column (effect of column length and column diameter), Choosing the Detector, Ultraviolet detector, Luminescence detector, RI detector, electrochemical detector, Column efficiency, HPLC chromatogram and its characteristics (retention time, peak height, peak area), method of quantitative analysis by HPLC, Example: determination of aspirin, phenacetin and caffeine in a mixture, numerical, **Key Reference -2:** 289-315, [Supplementary reference - Ref-3: 649 – 724, Ref-6: 1-325 -relevant part

3. Gas Chromatography (6 L)

Introduction, Apparatus: A supply of carrier gas from a high-pressure cylinder, Sample injection system and derivatization, the column (Packed columns, Open tubular columns), the detector (properties, hot wire detector or TCD, FID, ECD), Quantitative analysis by GC (Area normalization method and internal standard addition method), Elemental analysis, numerical **Key Reference-2: 317- 337, [**Supplementary reference - 7: 1-209 (relevant part)]

4. Atomic Absorption Spectroscopy (8 L)

Introduction, Elementary theory, Instrumentation, flames, the nebulizer-burner system, non- flame techniques, (graphite furnace, cold vapour technique), resonance line sources,monochromator,

detectors, interferences, chemical interferences, background correction

Methods, Atomic absorption spectrophotometers, Experimental preliminaries (calibration curve methods, standard addition method) Preparation of sample (wet ashing, fusion, Dry ashing, microwave dissolution, concentration procedures), Detection limits, Estimation of Ca and Mg in water.

Key Ref-2: 612 – 643

5. Flame Emission Spectroscopy (4 L)

Introduction, emission spectra, flame emission spectroscopy, flame photometers. Evaluation methods, calibration curve procedure, the standard addition technique, Applications: determination of alkali metals by flame photometry, determination of trace elements in contaminated soil by AAS. Numerical,

Key Reference-2: 645-649, 655-656

References:

Ref-1: Vogel's textbook of Inorganic Quantitative Analysis, Jeffery, Basset, Mendham Deney, 5th Ed, Longman Scientific Technical, and USA (copublished with John Wiley Sons)

Ref-2: Vogel's textbook of Inorganic Quantitative Analysis, Mendham, Deney Barnes, 6th Ed, Pearson education

Ref-3: Analytical Chemistry by G. D. Christian, et al, Wiley, 6th Ed.

Ref-4: Principles of Instrumental Analysis: Holler, Skoog, Crouch 6th Ed. Thomson Publication

Ref-5: Modern Analytical Chemistry, David Harvey, Mc-Graw Hill Higher education

Ref-6: High performance Liquid Chromatography, (Analytical Chemistry through open learning series) Second Ed, Sandie Lindsay, Wiley

Ref-7: Gas Chromatography, (Analytical Chemistry through open learning series) 2nd Ed, Ian A. Fowlis, Wiley

Course outcome: After completion of the course student should able to

1. Define basic terms in solvent extraction, basics of chromatography, HPLC, GC, and AAS and AES. Some important terms are: solvent extraction, aqueous and organic phase, distribution ratio and coefficient, solute remain unextracted, percent extraction, ion association complex, theoretical plate, HETP, retention time, selectivity, resolution, stationary phase, normal and reverse phase, ion exchange, column efficiency, carrier gas, split and spitless injection, packed column, tubular column, atomic absorption and emission spectroscopy, electronic excitation in atoms, nebulization, atomization, reduction of metal ions in flame, absorbance by atoms in flame, flame atomizers, furnace atomizers, interference in AES and FES, HCL, hydride generator, etc.

2. Identify important parameters in analytical processes or estimations. Example: minimum analyte concentration in particular method, reagent concentration for particular analysis, reagent for particular analysis, reaction condition to convert analyte into measurable form, wavelength selection in HPLC with spectrophotometric and fluorometric detector, solvent or carrier gas in HPLC and GC, choice method for the sample preparation in atomic spectroscopic methods, choice of filter and HCL in atomic spectroscopic methods, etc.

3. Explain different principles involved in the analyses using solvent extraction, basics of instrumental chromatography, HPLC, GC, and atomic spectroscopic techniques.

4. Perform quantitative calculations depending upon equations students has studied in the theory. Furthermore, student should able to solve problems on the basis of theory.

5. Discuss / Describe procedure for different types analyses included in the syllabus.

6. Select particular method of analysis if analyte sample is given to him.

7. Differentiate / distinguish / compare among the different analytical terms, process and analytical methods.

8. Demonstrate / explain theoretical principles with help of practical.

9. Design analytical procedure for given sample.

10. Apply whatever theoretical principles he has studied in theory during practical in laboratory.

SAVITRIBAI PHULE PUNE UNIVERSITY, PUNE

Under the Faculty of Science and technology

S. Y. B. Sc. Electronic Science Syllabus To be implemented from June 2020

(CBCS Pattern)

SVITRIBAI PHULE PUNE UNIVERSITY, PUNE

S. Y. B. Sc. Electronic Science Syllabus To be implemented from June 2020

(CBCS Pattern)

Structure of S. Y. B. Sc. Electronic Science

Sem	Paper Code	Paper	Paper title	credits	Periods/week		Evaluation		
					L*	P*	CIE*	UE*	Total
III	EL-231	I	Communication Electronics	2	3		15	35	50
	EL- 232	II	Digital System Design	2	3		15	35	50
	EL-233	III	Practical Course	2		4	15	35	50
IV	EL-241	I	Analog Circuit Design	2	3		15	35	50
	EL-242	II	Microcontroller and Python programming	2	3		15	35	50
	EL-243	III	Practical Course	2		4	15	35	50

**Abbrevations*

L:Lectures/week
P:
Practicals/week

CIE: Continuous Internal Examination
UE: University Examination

SAVITRIBAI PHULE PUNE UNIVERSITY, PUNE CBCS (2020 PATTERN)

S.Y.B.Sc. (Electronic Science)-Semester-

III EL-231: Paper – I: Communication Electronics

Credits	Number of periods/week	Number of lectures of 50 minutes duration	CIE marks	UE marks	Total marks
02	03	36	15	35	50

Course outcomes:

This course provides basic knowledge of analog(continous wave) and digital communication systems . After study through lectures and assignment, student will be able to

CO1	Understand different blocks in communication systems, types of noise in communication systems and its different parameters
CO2	Understand need of modulation, modulation process and amplitude modulation and demodulation methods
CO3	Analyse generation of FM Modulation and demodulation methods and comparison between amplitude and frequency modulation
CO4	Identify different radio receivers and their performance parameters.
CO5	Solve problems based on AM and FM performance parameters
CO6	Compare pulse modulation techniques such as PAM, PPM, PWM and compare TDM and FDM techniques used in communication
CO7	Understand need of sampling and sampling theorem as well as know about performance parameters of digital communication
CO8	Analyze difference between ASK, FSK , PSK as well as PCM and its applications

Unit	Contents	Lectures allotted
1	**Introduction to Electronic Communication**: Introduction to communication- means and modes, Block diagram of an electronic communication system, Electromagnetic spectrum , Brief idea of frequency allocation for radio communication system in India (TRAI) concept of Noise, signal-to-noise (S/N) ratio, Noise figure and noise temperature Need of modulation and demodulation	6

2	**Continuous-wave modulation techniques:** **Amplitude modulation**: AM waveform, mathematical expression of AM, concept of sideband, Definition and problems: modulation index, power distribution. AM using transistor, AM Receiver**:** demodulator circuit using diode and super-heterodyne receiver, characteristics of receiver: selectivity, sensitivity, Image frequency and dynamic range. Block diagram of AM communication system **Frequency modulation**: FM waveform, mathematical representation, frequency spectrum, bandwidth and modulation index. Problems based on modulation index, frequency deviation, average power. FM Modulation using varactor diode. FM Demodulator: Foster-Seeley detector. Block Diagram of FM communication system.	**16**

	Comparison of AM and FM	
3	**Pulse modulation techniques:** Types of analog pulse modulation: concept and generation of PAM, PWM, PPM, Spectra of pulse modulation, concept of time division multiplexing and frequency division multiplexing	**6**
4	**Introduction to digital communication :** Block diagram of digital communication system, advantages of digital communication system, bit rate, baud rate and bandwidth. Serial and parallel communication, concept of sampling, Sampling theorem, PCM concept of keying techniques: ASK, FSK, PSK Block diagram of MODEM	**8**
	Total lectures	**36**

References Books:

1. Communication Electronics :Principles and applications by Louis E Frenzel 3rd edition TMH Publications
2. Electronics Communication Systems by Denis Roddy, John Coolen, PHI publication.
3. Kennedy, George & Davis, Bernard / "Electronic Communication Systems" / Tata McGraw-Hill / 4th Ed.
4. Singh, R.P. & Sapre, S.D. / "Communication Systems: Analog & Digital" / Tata McGraw- Hill.

SAVITRIBAI PHULE PUNE UNIVERSITY,PUNE
CBCS(2020 PATTERN)
S.Y.B.Sc. (Electronic Science)-
Semester III EL-232: Paper- II: Digital Circuit Design

Credits	Number of periods/week	Number of lectures of 50 minutes duration	CIE marks	UE marks	Total marks
02	03	36	15	35	50

Course outcomes:

This course provides basic knowledge about systematic methodology of designing digital systems . After study through lectures and assignment, student will be able to

CO1	Distinguish between different logic families based on their performance parameters
CO2	Analyze basic combinational logic circuits for simple applications
CO3	Design combinational logic circuits using K maps for identified applications
CO4	Design Sequential logic circuits using state diagram, excitation table for identified applications
CO5	Understand and compare different types of ADC and their performance parameters using data sheets/manuals
CO6	Understand and compare different types of DAC and their performance parameters using data sheets/manuals

Unit	Contents	Lectures
1	**Logic families**: Revision of logic gates using diodes, transistors and MOSFETS Introduction to logic families and its performance parameters, Comparative study of TTL, CMOS, ECL with reference to performance parameters	4
2	**Combinational logic circuit design:** OR gate for Event detection, AND gate for Frequency measurement, EX-OR gate for Parity generation and checker, NOT gate for square wave generator, NAND gate for key debouncer circuit Design of code converters using K maps: BCD to Seven segment , Concept of adder using Look ahead carry generator , Keyboard encoder circuits : Priority encoder , Error detection technique : hamming code	12
3	**Sequential logic circuit design:** State table, State diagram, excitation table and transition table, Design of counters using state machines: asynchronous, modulus and up-down counter, Design of sequence generator.	10
4	**Data converters:** Revision of Data converters.: R-2R, binary weighted, counter type, successive approximation ADC: flash, Dual slope Comparative performance analysis of ADC :0808, 0804 and ICL7106 and DACs: 0808, 0804	10
	Total	36

Reference books:

1. Morris Mano, Digital Design, 3rd Edition, Prentice Hall of India.
2. R. P.Jain, Modern Digital Electronics, 4th edition, Tata MacGraw Hill Education India,
3. K. R. Botkar, Integrated Circuits, 3rd Edition, Khanna Publications
4. Thomas Floyd and Jain, Digital Fundamentals, 4th Edition, Pearson Education International
5. Manuals: National semiconductor, EXAR, Intersil, Signetics, Analog Devices

SAVITRIBAI PHULE PUNE UNIVERSITY, PUNE CBCS (2020 PATTERN)
S.Y.B.Sc. Electronic Science -
Semester IV EL-241: Paper - I: Analog Circuit Design

Credits	Number of periods/week	Number of lectures of 50 minutes duration	CIE marks	UE marks	Total marks
02	03	36	15	35	50

Course outcomes:

This course provides basic knowledge about systematic methodology of designing analog systems. After study through lectures and assignment, student will be able to

CO1	Design single/multistage amplifier using transistor and analyze their frequency response base on gain-bandwidth product due to coupling /bypass capacitors
CO2	Classify and compare different power amplifiers
CO3	Understand and design push pull amplifier and need of heat sinks
CO4	Distinguish between Opamp Feedback circuits based on their configurations
CO5	Analyze the effect of negative and positive feedback on characteristics of Opamp
CO6	Understand and analyze the need of positive feedback in oscillator circuits
CO7	Design , develop and build circuits for identified applications

Unit	Contents	Lectures
1	**Amplifiers:** Small signal amplifiers: A.C and D.C. analysis, frequency response, gain Bandwidth product. Design of single stage amplifier, effect of coupling capacitor and bypass capacitor on frequency response (qualitative approach), Design of two stage amplifier	6
2	**Power amplifier:** Classification of power amplifiers on the basis of conduction: class-A, class-B, class-AB, class-C. Class-An amplifier: resistive load/transformer coupled load, efficiency calculation. Concept of harmonic distortion. Class B amplifier: Push-pull amplifier concept, complimentary symmetry class-B push pull amplifier, crossover distortion, Class AB push pull amplifier, Types of heat sinks.	12
3	**Opamp based Systems :** Concept of negative feedback Types of feedback circuits: current shunt, current series, voltage shunt and voltage series, Effect of Negative feedback: on gain ,Bandwidth, input and output impedance, Circuits: Adder, differential amplifier, integrator, differentiator, First order butterworth active filter Concept of Positive Feedback: Barkhousan criterion, Oscillator circuits -Wien bridge , Phase Shift ,astable multivibrator	14
4	**Application Systems:** Design of Audio Amplifier, Design of Public Address System Design of function generator	04
	Total	36

Reference Books:

1. Ramakant Gaikwad, Operational amplifiers and linear Integrated Circuits, 3rd edition, PHP
2. G. B. Clayton, Operational amplifier , ELBS
3. Boylested , Electronic devices and circuits, PHP
4. B.L.Thereja ,Principles of Electronics , S.Chand and Company

SAVITRIBAI PHULE PUNE UNIVERSITY, PUNE CBCS (2020 PATTERN)
S. Y. B. Sc. Electronic Science – Semester IV

EL-242: Paper II: Microcontroller and Python Programming

Credits	Number of periods/week	Number of lectures of 50 minutes duration	CIE marks	UE marks	Total marks
02	03	36	15	35	50

Course outcomes:

This course introduces students with microcontroller using Arduino as well as develops programming ability using python language. After study through lectures and assignment, student will be able to

CO1	Identify the features and architectural details of microcontroller(arduiono)
CO2	Write code/program using open source programming language(ardiuno) for basic identified applications
CO3	Understand programming basics of python programming language
CO4	Understand special features of python programming language such as importing modules, directory, tupules
CO5	Design , build and implement applications using ardiuno and python

Unit	Contents	Lectures
1	**Introduction to Microcontroller** Introduction to Arduino ,: Microcontrollers used in Arduino, Pin configuration And architecture, Concept of digital and analog ports.	4
2	**Building blocks of Arduino programming:** variables and data types**,** Comparison Operators(arithmetic,logical and relational, modulo and assignment) Statements: If-Else Statement, Switch statement Control structures:While and For Loop Writing arduino programs: LED blinking and Push button Serial Port Communication Function blocks: Analogread(), digitalread() functions Intensity control of LED with Pulse Width Modulation using analogWrite()	10
3	**Introduction to Python** Understanding Python variables, Python basic Operators, Understanding python blocks, Declaring and using Numeric data types: int, float, complex, Using string data type and string operations, Defining list and list slicing, Use of Tuple data type, Conditional blocks using if, else and elif, Simple for loops in python, For loop using ranges, string, list and dictionaries, Use of while loops in python, Loop manipulation using pass, continue, break and else Programming using Python conditional and loops block	12
4	**Python Functions , Modules And Packages** Organizing python codes using functions, Organizing python projects into modules, Importing own module as well as external modules, Programming using functions, modules and external packages Building blocks of python programs, Understanding string in built methods, List manipulation using in build methods, Dictionary manipulation, Programming using string, list and dictionary in built functions , tuples	10

	LED blinking using Arduino with python programming	
	Total	**36**

Reference books:

1. Think Python, Allen Downey, O'Reilly, 2012
2. Introduction to Problem Solving with Python, E. Balagurusamy
3. Arduino-Based Embedded Systems: By Rajesh Singh, Anita Gehlot, Bhupendra Singh, and Sushabhan Choudhury.
4. Arduino Made Simple by Ashwin Pajankar

SAVITRIBAI PHULE PUNE UNIVERSITY, PUNE CBCS (2020 PATTERN)

S. Y. B. Sc. Practical Course

Credits/semester	Duration of one practical	CIE marks/semester	UE marks/semester	Total marks/semester
02	4 hours 20 mins	15	35	50

Laboratory requirements: Instruments

1. Power Supply(single and dual)
2. Signal Generator and function generators
3. CRO
4. Digital multimeters
5. Communication training kits/breadboards/tag boards

Software requirements

1. Arduino 10.0 programming enviornment and add on hardware modules
2. Python 3.0 and above

Guidelines for conducting practical:

As the practical in each semester is of 2 credits i.e.duration of 4 hours and 20 minutes. General guidelines for teachers to engage the students are as follows

1. **Utilization of allotted time for hardware practicals**
   a. Understanding the purpose of performing particular expt
   b. Understanding the knowhow of the expt such as circuit diagram, connections, performing the expt, analyzing and verifying the results, plotting the graphs, interpretation of results
   c. Expt can be performed on breadboard/circuit boards/tag boards
   d. Getting familier with datasheets for ICs or components
   e. extension of expt (if possible)
   f. Continuous assessment activity (Viva etc.)
   g. Simulation of experiment using softwares like proteus,pSpice etc
   h. Project like /skill development activity
   i. Poster presentation/project documentation

2. **Utilization of allotted time for software experiment**
   a. Understand the software (Arduino and python) : its features and facilities
   b. Self-learning through small programs *for through understanding
   c. Understand step by step procedure to execute the program
   d. Understand interfacing of various modules to Arduino
   e. Exploring different features of Python programming
   f. Learning algorithms and flowcharts
   g. Building different application programs using arudino and python
   h. Project like/skill development activity

Note: One can extend the activities as per need of the particular experiment

Number of students per batch: 12

Evaluation Process:

- University Examination : 35 marks
- Continuous Internal Examination : 15 marks

Following are different methods of assessing the studies for internal practical examination

1. Oral
2. Journal
3. Mock tests
4. Attendance
5. Performance
6. Project/PLE/Industrial visit

Reference books:

- TTL manuals:National Semiconductor, Signetics
- CMOS manual
- EXAR manual
- Smart Power manual
- National semiconductor manual

SAVITRIBAI PHULE PUNE UNIVERSITY, PUNE CBCS (2020 PATTERN)
S.Y.B.Sc. (Electronic Science)

EL-233: Paper- III: Practical Course: SEMESTER III

Course outcomes:

This course provides hands on experience in communication and digital circuits, which can be conducted by standard circuits. Investigate the operation of several communication circuits and digital circuits (Combinational and sequential). Upon completion of this course student will be able to

CO1	Describe and explain the techniques of generation of AM/ FM and demodulation
CO2	Design FSK generation using standard IC XR 2206 refering data manuals
CO3	Describe and explain the TDM/ FDM generation technique
CO4	Demonstrate PPM/PWM/PAM and PCM techniques using standard circuits in data manuals
CO5	Design and build minimum complexity digital circuits using logic gates
CO6	Design and analyze different combinational and sequential logic circuits using standard ICs in data manuals
CO7	Design ADC/ DAC using data manuals and study its performance parameters

Total experiments: 10

Group B: List of Practicals (Communication Electronics): Any Five

1. Design ,build and test Amplitude Modulator using transistor
2. Design ,build and test FM generation using VCO/IC 8038/varactor diode
3. Design ,build and test Frequency Shift Keying(FSK) using XR 2206
4. Design ,build and test Time division multiplexing/Frequency division multiplexing
5. Design ,build and test Balance modulator and demodulator using IC 1408
6. Design ,build and test PPM/PWM /PAM
7. Demonstration of PCM/delta modulation
8. Design build and test FM Receiver

Group B: List of Practicals (Digital Circuit Design): Any Five

1. Design ,build and test BCD to 7 segment decoder
2. Design ,build and test Event counter/Frequeny counter/square wave generator using logic gates
3. Study of 4- Bit Arithmetic Unit using IC 74181
4. Design ,build and test DAC using R-2R ladder network
5. Design ,build and test ADC using IC 0808/IC 7109/IC 741/IC 324
6. Design ,build and test Sequence generator for stepper motor
7. Design ,build and test Priority keyboard encoder using IC 74148
8. Design ,build and test hamming code error detection circuit

SAVITRIBAI PHULE PUNE UNIVERSITY, PUNE CBCS (2020 PATTERN)
S.Y.B.Sc. (Electronic Science)

EL-243: Paper- III: Practical Course: SEMESTER IV

Course outcomes:

This course provides hands on experience in communication and digital circuits, which can be conducted by standard circuits. Investigate the operation of several communication circuits and digital circuits (Combinational and sequential). Upon completion of this course student will be able to

CO1	Describe and explain the design procedure of different types of active filters and analyze its frequency response
CO2	Demonstrate positive feedback for oscillator circuits using standard ICs
CO3	Describe and explain design procedure for two stage amplifiers and application circuits
CO4	Design practical circuits for identified applications
CO5	Develop working setup and write programs using programming techniques of arduino
CO6	Demonstrate and explain interfacing hardware to arduino microcontroller
CO7	Solve problems using programming techniques of python

Total Expts: 10

Group A: List of Practicals (Analog Circuit Design): Any Five

1. Design,build and test butterworth first order Low Pass Filter and High Pass Filter using OPAMP IC-741
2. Design ,build and test Wein bridge oscillator/Phase shift oscillator
3. Design ,build and test Push pull amplifier
4. Design ,build and test Astable multivibrator using opamp
5. Design ,build and test of two stage amplifier using transistor
6. Design, build and test audio amplifier
7. Liquid level detector
8. Mini project/industrial visit/PLE

Group B: List of Practicals (Arudino and python programming): Any Five arduino programming practicals:

1. To study and understand Interfacing LED array to arduino
2. To study and understand Interfacing keyboard to arduino
3. To study and understand Interfacing sensor to arduino
4. To study and understand interfacing Bluetooth to arguing

Python programming practicals:

5. Enter the number from the user and depending on whether the number is even or odd, print out an appropriate message to the user.
6. Write a program to generate the Fibonacci series.
7. Write a function that reverses the user defined value
8. Write a recursive function to print the factorial for a given number

Environmental Studies (AECC)

Unit 1 : Introduction to environmental studies

- Multidisciplinary nature of environmental studies;
- Scope and importance; Concept of sustainability and sustainable development.

Unit 2 : Ecosystems

- What is an ecosystem? Structure and function of ecosystem; Energy flow in an ecosystem: food chains, food webs and ecological succession. Case studies of the following ecosystems :
  a) Forest ecosystem
  b) Grassland ecosystem
  c) Desert ecosystem
  d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Unit 3 : Natural Resources : Renewable and Non---renewable Resources

- Land resources and land use change; Land degradation, soil erosion and desertification.
- Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations.
- Water: Use and over---exploitation of surface and ground water, floods, droughts, conflicts over water (international & inter---state).
- Energy resources: Renewable and non-renewable energy sources, use of alternate energy sources, growing energy needs, case studies.

Unit 4 : Biodiversity and Conservation

- Levels of biological diversity : genetic, species and ecosystem diversity; Biogeographic zones of India; Biodiversity patterns and global biodiversity hot spots
- India as a mega---biodiversity nation; Endangered and endemic species of India
- Threats to biodiversity: Habitat loss, poaching of wildlife, man---wildlife conflicts, biological invasions; Conservation of biodiversity: In---situ and Ex---situ conservation of biodiversity.
- Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational value.

Unit 5 : Environmental Pollution

- Environmental pollution : types, causes, effects and controls; Air, water, soil and noise pollution
- Nuclear hazards and human health risks
- Solid waste management: Control measures of urban and industrial waste.
- Pollution case studies.

Unit 6 : Environmental Policies & Practices

- Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture

- Environment Laws: Environment Protection Act; Air (Prevention & Control of Pollution) Act; Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act. International agreements: Montreal and Kyoto protocols and Convention on Biological Diversity (CBD).
- Nature reserves, tribal populations and rights, and human wildlife conflicts in Indian context.

Unit 7 : Human Communities and the Environment

- Human population growth: Impacts on environment, human health and welfare.
- Resettlement and rehabilitation of project affected persons; case studies.
- Disaster management: floods, earthquake, cyclones and landslides.
- Environmental movements: Chipko, Silent valley, Bishnois of Rajasthan.
- Environmental ethics: Role of Indian and other religions and cultures in environmental conservation.
- Environmental communication and public awareness, case studies (e.g., CNG vehicles in Delhi).

Unit 8 : Field work

- Visit to an area to document environmental assets: river/ forest/ flora/fauna, etc.
- Visit to a local polluted site---Urban/Rural/Industrial/Agricultural.
- Study of common plants, insects, birds and basic principles of identification.
- Study of simple ecosystems---pond, river, Delhi Ridge, etc.

Savitribai Phule Pune University

(Formerly University of Pune)

Value Education Course (VEC)

Syllabus for F.Y.B.Sc. Students

(As Per National Education Policy-2020)

For Colleges Affiliated to Savitribai Phule Pune University

To be implemented from Academic Year 2024-2025

VEC-101-T: Environment Education-I

Course type: VEC (Theory) **No. of Credits: 2**

Semester : I

Course Outcomes

After the completion of this course, student will be able to- CO-

1: describe how human activities impact the environment.

CO-2: explain principles of sustainable development and resource management.

CO-3: analyze local, regional, and global environmental issues and their effects.

CO-4: evaluate different strategies for conserving biodiversity and ecosystems.

CO-5: apply relevant environmental policies and ethical considerations to real-world scenarios.

CO-6: design and implement action plans for community-based environmental projects**.**

Course Content

Chapter 1: Humans and the Environment [06 hours] The man-environment interaction: Humans as hunter-gatherers; Mastery of fire; Origin of agriculture; Emergence of city-states; Great ancient civilizations and the environment; Middle Ages and Renaissance; Industrial revolution and its impact on the environment; Population growth and natural resource exploitation; Global environmental change.

The emergence of environmentalism: Anthropocentric and eco-centric perspectives (Major thinkers); The Club of Rome- Limits to Growth; UN Conference on Human Environment 1972; World Commission on Environment and Development and the concept of sustainable development; Rio Summit and subsequent international efforts.

Suggested Readings

1. Fisher, Michael H. (2018) An Environmental History of India- From Earliest Times to the Twenty-First Century, Cambridge University Press.
2. Headrick, Daniel R. (2020) Humans versus Nature- A Global Environmental History, Oxford University Press.
3. Hughes, J. Donald (2009) An Environmental History of the World- Humankind's Changing Role in the Community of Life, 2nd Edition. Routledge.
4. Perman, R., Ma, Y., McGilvray, J., and Common, M. (2003) Natural Resource and Environmental Economics. Pearson Education.
5. Simmons, I. G. (2008). Global Environmental History: 10,000 BC to AD 2000. Edinburgh University Press

Chapter 2: Natural Resources and Sustainable Development [08 hours]

Overview of natural resources: Definition of resource; Classification of natural resources- biotic and abiotic, renewable and non-renewable.

Biotic resources: Major type of biotic resources- forests, grasslands, wetlands, wildlife and aquatic (fresh water and marine); Microbes as a resource; Status and challenges.

Water resources: Types of water resources- fresh water and marine resources; Availability and use of water resources; Environmental impact of over-exploitation, issues and challenges; Water scarcity and stress; Conflicts over water.

Soil and mineral resources: Important minerals; Mineral exploitation; Environmental problems due to extraction of minerals and use; Soil as a resource and its degradation.

Energy resources: Sources of energy and their classification, renewable and non-renewable sources of energy; Conventional energy sources- coal, oil, natural gas, nuclear energy; Non-conventional energy sources- solar, wind, tidal, hydro, wave, ocean thermal, geothermal, biomass, hydrogen and fuel cells; Implications of energy use on the environment.

Introduction to sustainable development: Sustainable Development Goals (SDGs)- targets and indicators, challenges and strategies for SDGs.

Suggested Readings

1. Chiras, D. D and Reganold, J. P. (2010). Natural Resource Conservation: Management for a Sustainable Future.10th edition, Upper Saddle River, N. J. Benjamin/Cummins/Pearson.
2. John W. Twidell and Anthony D. (2015). Renewable Energy Sources, 3rd Edition, Weir Publisher (ELBS)
3. William P.Cunningham and Mary A. (2015) Cunningham Environmental Science: A Global Concern, Publisher (Mc-Graw Hill, USA)
4. Gilbert M. Masters and W. P. (2008). An Introduction to Environmental Engineering and Science, Ela Publisher (Pearson)
5. Singh, J.S., Singh, S.P. & Gupta, S.R. 2006. Ecology, Environment and Resource Conservation. Anamaya Publications https://sdgs.un.org/goals

Chapter 3: Environmental Issues: Local, Regional and Global [08 hours]

Environmental issues and scales: Concepts of micro-, meso-, synoptic and planetary scales; Temporal and spatial extents of local, regional, and global phenomena.

Pollution: Impact of sectoral processes on Environment, Types of Pollution- air, noise, water, soil, municipal solid waste, hazardous waste; Transboundary air pollution; Acid rain; Smog.

Land use and Land cover change: land degradation, deforestation, desertification, urbanization. Biodiversity loss: past and current trends, impact.

Global change: Ozone layer depletion; Climate change.

1. Harper, Charles L. (2017) Environment and Society, Human Perspectives on Environmental Issues 6th Edition. Routledge.
2. Harris, Frances (2012) Global Environmental Issues, 2nd Edition. Wiley- Blackwell.
3. William P. Cunningham and Mary A. (2015). Cunningham Environmental Science: A global concern, Publisher (Mc-Graw Hill, USA)
4. Manahan, S.E. (2022). Environmental Chemistry (11th ed.). CRC Press. https://doi.org/10.1201/9781003096238
5. Rajagopalan, R. (2011). Environmental Studies: From Crisis to Cure. India: Oxford University Press.

Chapter 4: Conservation of Biodiversity and Ecosystems [08 hours] **Biodiversity and its distribution**: Biodiversity as a natural resource; Levels and types of biodiversity; Biodiversity in India and the world; Biodiversity hotspots; Species and ecosystem threat categories.

Ecosystems and ecosystem services: Major ecosystem types in India and their basic characteristics- forests, wetlands, grasslands, agriculture, coastal and marine; Ecosystem services- classification and their significance.

Threats to biodiversity and ecosystems: Land use and land cover change; Commercial exploitation of species; Invasive species; Fire, disasters and climate change.

Major conservation policies: in-situ and ex-situ conservation approaches; Major protected areas; National and International Instruments for biodiversity conservation; the role of traditional knowledge, community-based conservation; Gender and conservation.

Suggested Readings

1. Bawa, K.S., Oomen, M.A. and Primack, R. (2011) Conservation Biology: A Primer for South Asia. Universities Press.
2. Sinha, N. (2020) Wild and Wilful. Harper Collins, India.
3. Varghese, Anita, Oommen, Meera Anna, Paul, Mridula Mary, Nath, Snehlata (Editors) (2022) Conservation through Sustainable Use: Lessons from India. Routledge.
4. Bhagwat, Shonil (Editor) (2018) Conservation and Development in India: Reimagining Wilderness, Earthscan Conservation and Development, Routledge.
5. Krishnamurthy, K.V. (2003) Textbook of Biodiversity, Science Publishers, Plymouth, UK

VEC-151-T: Environment Education-II

Course type: VEC (Theory) **No. of Credits: 2**

Semester : II

Course Outcomes

After the completion of this course, student will be able to-

CO-1: identify various types of environmental pollution and their impacts on health.

CO-2: explain the basic concepts of climate change, including its causes and effects.

CO-3: analyze different strategies for adapting to and mitigating the effects of climate change.

CO-4: evaluate various environmental management practices and their effectiveness.

CO-5: apply the principles of key environmental treaties and legislation to case studies.

CO-6: create action plans that address specific environmental issues based on current policies and management practices.

Course Content

Chapter 1: Environmental Pollution and Health [08 hours] **Understanding pollution:** Production processes and generation of wastes; Assimilative capacity of the environment; Definition of pollution; Point sources and non-point sources of pollution.

Air pollution: Sources of air pollution; Primary and secondary pollutants; Criteria pollutants- carbon monoxide, lead, nitrogen oxides, ground-level ozone, particulate matter and sulphur dioxide; Other important air pollutants- Volatile Organic compounds (VOCs), Peroxyacetyl Nitrate (PAN), Polycyclic aromatic hydrocarbons (PAHs) and Persistent organic pollutants (POPs); Indoor air pollution; Adverse health impacts of air pollutants; National Ambient Air Quality Standards.

Water pollution: Sources of water pollution; River, lake and marine pollution, groundwater pollution; water quality Water quality parameters and standards; adverse health impacts of water pollution on human and aquatic life.

Soil pollution and solid waste: Soil pollutants and their sources; Solid and hazardous waste; Impact on human health.

Noise pollution: Definition of noise; Unit of measurement of noise pollution; Sources of noise pollution; Noise standards; adverse impacts of noise on human health.

Thermal and Radioactive pollution: Sources and impact on human health and ecosystems.

Suggested Readings

1. Jackson, A. R., & Jackson, J. M. (2000). Environmental Science: The Natural Environment and Human Impact. Pearson Education.

2. Masters, G. M., & Ela, W. P. (2008). Introduction to environmental engineering and science (No.60457). Englewood Cliffs, NJ: Prentice Hall.
3. Miller, G. T., & Spoolman, S. (2015) Environmental Science. Cengage Learning.
4. Central Pollution Control Board Web page for various pollution standards. https://cpcb.nic.in/ standards/
5. Ahluwalia, V. K. (2015). Environmental Pollution, and Health. The Energy and Resources Institute (TERI).

Chapter 2: Climate Change: Impacts, Adaptation and Mitigation [06 hours] **Understanding climate change:** Natural variations in climate; Structure of atmosphere; Anthropogenic climate change from greenhouse gas emissions– past, present and future; Projections of global climate change with special reference to temperature, rainfall, climate variability and extreme events; Importance of 1.5 °C and 2.0 °C limits to global warming; Climate change projections for the Indian sub-continent.

Impacts, vulnerability and adaptation to climate change: Observed impacts of climate change on ocean and land systems; Sea level rise, changes in marine and coastal ecosystems; Impacts on forests and natural ecosystems; Impacts on animal species, agriculture, health, urban infrastructure; the concept of vulnerability and its assessment; Adaptation vs. resilience; Climate-resilient development; Indigenous knowledge for adaptation to climate change.

Mitigation of climate change: Synergies between adaptation and mitigation measures; Green House Gas (GHG) reduction vs. sink enhancement; Concept of carbon intensity, energy intensity and carbon neutrality; National and international policy instruments for mitigation, decarbonizing pathways and net zero targets for the future; Energy efficiency measures; Renewable energy sources; Carbon capture and storage, National climate action plan and Intended Nationally Determined Contributions (INDCs); Climate justice.

Suggested Readings

1. Pittock, Barrie (2009) Climate Change: The Science, Impacts and Solutions. 2nd Edition. Routledge.
2. www.ipcc.org; https://www.ipcc.ch/report/sixth-assessment-report-cycle/.
3. Adenle A., Azadi H., Arbiol J. (2015). Global assessment of technological innovation for climate change adaptation and mitigation in developing world, Journal of Environmental Management, 161 (15): 261-275.
4. Barnett, J. & S. O'Neill (2010). Maladaptation. Global Environmental Change—Human and Policy Dimensions 20: 211–213.
5. Berrang-Ford, L., J.D. Ford & J. Paterson (2011). Are we adapting to climate change ? Global Environmental Change—Human and Policy Dimensions 21: 25-33.

Chapter 3: Environmental Management [06 hours]

Introduction to environmental laws and regulation: Constitutional provisions- Article 48A, Article 51A (g) and other derived environmental rights; Introduction to environmental legislations on the forest, wildlife and pollution control.

Environmental management system: ISO 14001 Life cycle analysis; Cost-benefit analysis Environmental audit and impact assessment; Environmental risk assessment, Pollution control and management; Waste Management- Concept of 3R (Reduce, Recycle and Reuse) and sustainability; Ecolabeling /Ecomark scheme

Suggested Readings

1. Jørgensen, Sven Marques, Erik João Carlos and Nielsen, Søren Nors (2016) Integrated Environmental Management, A transdisciplinary Approach. CRC Press.
2. Theodore, M. K. and Theodore, Louis (2021) Introduction to Environmental Management, 2nd Edition. CRC Press.
3. Barrow, C. J. (1999). Environmental management: Principles and practice. Routledge.
4. Tiefenbacher, J (ed.) (2022), Environmental Management - Pollution, Habitat, Ecology, and Sustainability, Intech Open, London. 10.5772/
5. Richard A. Marcantonio, Marc Lame (2022). Environmental Management: Concepts and Practical Skills. Cambridge University Press.

Chapter 4: Environmental Treaties and Legislation [10 hours]

An overview of instruments of international cooperation; bilateral and multilateral agreements; conventions and protocols; adoption, signature, ratification and entry into force; binding and non-binding measures; Conference of the Parties (COP)

Major International Environmental Agreements: Convention on Biological Diversity (CBD); Cartagena Protocol on Biosafety; Nagoya Protocol on Access and Benefit-sharing; Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES); Ramsar Convention on Wetlands of International Importance; United Nations Convention to Combat Desertification (UNCCD); Vienna Convention for the Protection of the Ozone Layer; Montreal Protocol on Substances that Deplete the Ozone Layer and the Kigali Amendment; Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal; Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade; Stockholm Convention on Persistent Organic Pollutants; Minamata Convention on Mercury; United Nations Framework Convention on Climate Change (UNFCCC); Kyoto Protocol; Paris Agreement; India's status as a party to major conventions

Major Indian Environmental Legislations: The Wild Life (Protection) Act, 1972; The Water (Prevention and Control of Pollution) Act, 1974; The Forest (Conservation) Act, 1980; The Air

(Prevention and Control of Pollution) Act, 1981; The Environment (Protection) Act, 1986; The Biological Diversity Act, 2002; The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006; Noise Pollution (Regulation and Control) Rules, 2000; Industry-specific environmental standards; Waste management rules; Ramsar sites; Biosphere reserves; Protected Areas; Ecologically Sensitive Areas; Coastal Regulation Zone; Status phase-out of production and consumption of Ozone Depleting Substances by India; National Green Tribunal; Some landmark Supreme Court judgements

Major International organisations and initiatives: United Nations Environment Programme (UNEP), International Union for Conservation of Nature (IUCN),World Commission on Environment and Development (WCED), United Nations Educational, Scientific and Cultural Organization (UNESCO), Intergovernmental Panel on Climate Change (IPCC), and Man and the Biosphere (MAB) programme.

Suggested Readings

1. UNEP (2007) Multilateral Environmental Agreement Negotiator's Handbook, University of Joensuu, ISBN 978-952-458-992-5
2. Ministry of Environment, Forest and Climate Change (2019) A Handbook on International Environment Conventions & Programmes. https://moef.gov.in/wp-content/uploads/2020/02/ convention-V-16-CURVE-web.pdf
3. Kanchi Kohli and Manju Menon (2021) Development of Environment Laws in India, Cambridge University Press.
4. India Code – Digital repository of all Central and State Acts: https://www.indiacode.nic.in/
5. Bohra, Saroj, Judicial Intervention and Evolution of Environmental Principles and Doctrines (January 7, 2019). Available at SSRN: https://ssrn.com/abstract=3311406 or http://dx.doi. org/10.2139/ssrn.3311406

Note: Case Studies and Field Work is compulsory

The students are expected to be engaged in some of the following or similar identified activities:

1. Discussion on one national and one international case study related to the environment and sustainable development.
2. Field visits to identify local/regional environmental issues, make observations

including data collection and prepare a brief report.

3. Documentation of campus biodiversity.
4. Campus environmental management activities such as solid waste disposal, water management, and sewage treatment.

The syllabus

Course I

Introduction to Human Rights and Duties

Credit: 1

I) Basic Concept
   a) Human Values- Dignity , Liberty, Equality , Justice, Unity in Diversity, Ethics and Morals
   b) Meaning and significance of Human Rights Education

II) Perspectives of Rights and Duties
   a) Rights: Inherent-Inalienable-Universal- Individual and Groups
   b) Nature and concept of Duties
   c) Interrelationship of Rights and Duties

III) Introduction to Terminology of Various Legal Instruments
   a) Meaning of Legal Instrument- Binding Nature
   b) Types of Instruments: Covenant-Charter-Declaration-Treaty-Convention-Protocol-Executive Orders and Statutes

IV) United Nations And Human Rights
   a) Brief History of Human Rights- International and National Perspectives
   b) Provision of the charters of United Nations
   c) Universal Declaration of Human Rights- Significance-Preamble
   d) Civil and Political Rights-(Art. 1-21)
   e) Economic, Social and Cultural Rights-(Art.22-28)
   f) Duties and Limitations-(Art. 29)
   g) Final Provision (Art. 30)

Course II

Human rights of vulnerable and disadvantaged groups

Credit: 1

I) General Introduction
   a) Meaning and Concept of Vulnerable and Disadvantaged
   b) Groups, Customary, Socio-Economic and Cultural Problems of
   c) Vulnerable and Disadvantaged Groups

II) Social status of women and children in International and national perspective

   a) Human Rights and Women's Rights –International and National Standards
   b) Human Rights of Children-International and National Standards

III) Status of Social and Economically Disadvantaged people

   a) Status of Indigenous People and the Role of the UN
   b) Status of SC/ST and Other Indigenous People in the Indian Scenario
   c) Human Rights of Aged and Disabled
   d) The Minorities and Human Rights

IV) Human rights of vulnerable groups

   a) Stateless Persons
   b) Sex Workers
   c) Migrant Workers
   d) HIV/AIDS Victims

Course III

Human Rights and Duties in India: Law, Policy, Society and Enforcement Mechanism

Credit: 1

I. Human Rights in Indian Context
   a) Indian Bill of Rights And Sarvodaya
   b) Preamble- Fundamental Rights- Directive Principles-Fundamental Duties

II. Human Rights- Enforcement Mechanism
   a) Human Rights Act, 1993
   b) Judicial Organs- Supreme Court (Art 32) And High Courts(Art 226)
   c) Human Rights Commission- National and State of Maharashtra
   d) Commission of Women, children , Minority, SC/ST
   e) Survey of International Mechanism

III. Human Rights Violations and Indian Polity
   a) Inequalities in society-population-illiteracy-poverty-caster-inaccessibility of legal redress
   b) Abuse of Executive Power-Corruption-Nepotism and favoritism
   c) Human Rights and Good Governance d)

IV. Role of Advocacy Groups
   a) Professional Bodies: Press, Media, Role of Lawyers-Legal Aid
   b) Educational Institutions
   c) Role of Corporate Sector
   d) NGO's