

|   |
|---|
| Curriculum Structure and Curriculum Content for the Academic year-2019-23 |
|---|

|                           |
|---------------------------|
| Department: Biotechnology |
|---------------------------|

|                             |
|-----------------------------|
| Program: B.E. Biotechnology |
|-----------------------------|



## Table of Contents

|   |                   |
|---|-------------------|
| <b><i>Vision and Mission of KLE Technological University .....</i></b>                              | <b><i>3</i></b>   |
| <b><i>Vision and Mission Statements of the School / Department .....</i></b>                        | <b><i>4</i></b>   |
| <b><i>Program Educational Objectives/Program Outcomes and Program-Specific Objectives .....</i></b> | <b><i>5</i></b>   |
| <b><i>Curriculum Structure-Overall .....</i></b>  | <b><i>7</i></b>   |
| <b><i>Curriculum Structure-Semester wise .....</i></b>  | <b><i>8</i></b>   |
| <b><i>Semester - I .....</i></b>  | <b><i>19</i></b>  |
| <b><i>Semester - II .....</i></b>   | <b><i>35</i></b>  |
| <b><i>Semester- III .....</i></b>   | <b><i>54</i></b>  |
| <b><i>Semester- IV .....</i></b>  | <b><i>69</i></b>  |
| <b><i>Semester- V .....</i></b>   | <b><i>84</i></b>  |
| <b><i>Semester- VI .....</i></b>  | <b><i>98</i></b>  |
| <b><i>Semester- VII .....</i></b>   | <b><i>110</i></b> |
| <b><i>Semester- VIII .....</i></b>  | <b><i>133</i></b> |
| <b><i>List of Open Electives .....</i></b>  | <b><i>17</i></b>  |
| <b><i>List of Program Electives .....</i></b>   | <b><i>18</i></b>  |
| <b><i>Curriculum Content- Course wise .....</i></b>   | <b><i>19</i></b>  |

### Vision

KLE Technological University will be a national leader in Higher Education—recognised globally for innovative culture, outstanding student experience, research excellence and social impact.

### Mission

KLE Technological University is dedicated to teaching that meets highest standards of excellence, generation and application of new knowledge through research and creative endeavors.

The three-fold mission of the University is:

- To offer undergraduate and post-graduate programs with engaged and experiential learning environment enriched by high quality instruction that prepares students to succeed in their lives and professional careers.
- To enable and grow disciplinary and inter-disciplinary areas of research that build on present strengths and future opportunities aligning with areas of national strategic importance and priority.
- To actively engage in the Socio-economic development of the region by contributing our expertise, experience and leadership, to enhance competitiveness and quality of life.

As a unified community of faculty, staff and students, we work together with the spirit of collaboration and partnership to accomplish our mission.

## Vision and Mission Statements of the School / Department

### Vision

The KLE Tech – Department of Biotechnology will excel and lead in education, research and innovation in Biotechnology contributing to the evolving needs of the society.

### Mission

- To provide an excellent educational experience to undergraduate students of Biotechnology through quality teaching, relevant curriculum and effective research experience that enables students to become leaders in their chosen field.
- To provide scholarly, vibrant learning and research environment that enables to achieve personal and professional development.
- To cater to the societal needs and serve the communities at local, national and international levels combined with a deep awareness of ethical responsibilities to profession and society.

## Program Educational Objectives/Program Outcomes and Program-Specific Objectives

| <b>Program Educational Objectives -PEO's</b>  |
|---|
| Graduates will demonstrate peer- recognized technical competency in the analysis, design and development of solutions for Molecular Biotechnology and Bioprocess Engineering.   |
| Graduates will demonstrate leadership and initiative to advance professional and organizational goals with commitment to ethical standards of profession, teamwork and respect for diverse cultural background  |
| Graduates will be engaged in ongoing learning and professional development through pursuing higher education, and self-study  |
| Graduates will be committed to creative practice of engineering and other professions in a responsible manner contributing to the socio-economic development of the society   |
| <b>Program Outcomes-PO's</b>  |
| Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.  |
| Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.  |
| Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations. |
| Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.  |
| Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations  |
| Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.  |
| Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development  |
| Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.  |
| Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.   |
| Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and                        |



receive clear instructions.

Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

***Program Specific Objectives -PSO's***

Demonstrate adequate proficiency of good laboratory practices in terms of accuracy & precision, safety, ethics and reproducibility and able to follow standard operating procedures (SOP).

Demonstrate proficiency of Bioprocess Technology towards development of processes and products in global context.

Apply the knowledge of engineering & applied science to demonstrate research aptitude/skills in frontier areas of biotechnology.

## Curriculum Structure-Overall

| Semester :              |  |  |  |   |   |  |   | Total Program Credits:176   |  |
|-------------------------|--|--|--|---|---|--|---|---|--|
| Course with course code | I  | II   | III  | IV  | V   | VI   | VII   | VIII  |  |
|                         | Single Variable Calculus<br>18EMAB101 (4-1-0)          | Multivariable Calculus<br>18EMAB102 (4-1-0)            | NMDE<br>20EMAB205 (4-0-0)                    | Biostatistics<br>20EMAB210 (3-1-0)                | Genetic Engineering & Applications<br>15EBTC301 (4-0-0)         | Bioprocess Engineering<br>15EBTC306 (4-0-0)                          | Downstream Processing Technology<br>22EBTC401 (4-0-0)     | Capstone project<br>20EBTW402 (0-0-11)                            | Internship project<br>20EBTW494 (0-0-11) |
|                         | Engineering Chemistry<br>15ECBH101(3-0-0)              | Engineering Physics<br>15EPHB102 (3-0-0)               | Microbiology<br>15EBTC201 (4-0-0)            | Immunology<br>15EBTC203 (3-0-0)                   | Bioinformatics<br>20EBTC301 (4-0-0)                             | Bioprocess Control & Automation<br>19EBTC302 (4-0-0)                 | Bioprocess Equipment Design<br>15EBTC402 (3-0-0)          | Program Elective - 06<br>XXEBTE4XX (3-0-0)                        | Internship training<br>18EBTI493 (0-0-6) |
|                         | C Programming for problem solving<br>18ECSP101 (0-0-3) | Engineering Mechanics<br>15ECVF102(4-0-0)              | Biochemistry<br>15EBTC202 (4-0-0)            | Enzyme Technology<br>17EBTC201 (4-0-0)            | Reaction Engineering<br>15EBTC303 (4-0-0)                       | Program Elective –01<br>XXEBTE3XX (3-0-0)                            | Program Elective– 03<br>XXEBTE4XX (3-0-0)                 |   |  |
|                         | Engineering Exploration<br>15ECRP101 (0-0-3)           | Computer Aided Engineering Drawing<br>15EMEP101(0-0-3) | Bioprocess Calculations<br>15EBTF201 (4-0-0) | Cell &Molecular Biology<br>15EBTC205 (4-0-0)      | Biological Thermodynamics<br>15EBTC304 (3-0-0)                  | Program Elective – 02<br>XXEBTE3XX (3-0-0)                           | Program Elective - 04<br>XXEBTE4XX (3-0-0)                | Open Elective<br>Industrial Waste Management<br>19EBTO401 (3-0-0) |  |
|                         | Basic Electronics<br>18EECF102 (4-0-0)                 | Basic Electrical Engineering<br>18EEEF102 (3-0-0)      | Unit operations-I<br>17EBTF201 (3-0-0)       | Unit operations-II<br>17EBTF202 (3-0-0)           | Research Methodology<br>15EBTC305 (3-0-0)                       | Humanities – 01 (HSC) (PALR)<br>16EHSC301 (3-0-0)                    | Program Elective - 05<br>XXEBTE4XX (3-0-0)                |   |  |
|                         | Basic Mechanical Engg<br>15EMEF101 (2-1-0)             | Social Innovation<br>15EHSP101 (0-1-1)                 | Microbiology Lab<br>15EBTP201 (0-0-1)        | Enzyme Technology Lab<br>15EBTP204 (0-0-1)        | Mini Project<br>15EBTW301 (0-0-3)                               | Minor Project<br>15EBTW302 (0-0-6)                                   | Humanities -02 (HSC)<br>CIPE & EVS<br>15EHSA401<br>Audit  |   |  |
|                         | Professional Communication<br>15EHS101 (1-1-0)         | Engineering Physics Lab<br>16EPHP102 (0-0-1)           | Biochemistry Lab<br>15EBTP202 (0-0-1)        | Cell & Molecular Biology Lab<br>15EBTP205 (0-0-1) | Genetic Engineering & Immunotechnology Lab<br>15EBTP301 (0-0-1) | Bioprocess Engineering Lab<br>15EBTP303 (0-0-1.5)                    | Senior Design Project<br>20EBTW401 (0-0-6)                |   |  |
|                         |  |  | Unit operations-I Lab<br>17EBTP201 (0-0-1)   | Unit Operations-II Lab<br>17EBTP202 (0-0-1)       | Bioinformatics Lab<br>15EBTP302 (0-0-1)                         | Bioprocess Control & Reaction Engineering Lab<br>19EBTP301 (0-0-1.5) | Downstream Processing Technology Lab<br>15EBTP401 (0-0-1) |   |  |
| Credits                 | 21   | 23   | 22   | 21  | 23  | 26   | 23  | 17  |  |

## Curriculum Structure-Semester wise

### Semester - I

| No           | Code      | Course  | Category | L-T-P         | Credits   | Contact Hours | ISA | ESA | Total | Exam Duration (in hrs) |
|--------------|-----------|---|----------|---------------|-----------|---------------|-----|-----|-------|------------------------|
| 1            | 18EMAB101 | <a href="#">Single Variable Calculus</a>          | BS       | 4-1-0         | 5         | 6             | 50  | 50  | 100   | 3 Hours                |
| 2            | 15ECHB101 | <a href="#">Engineering Chemistry</a>             | BS       | 3-0-0         | 3         | 3             | 50  | 50  | 100   | 3 Hours                |
| 3            | 18ECSP101 | <a href="#">C Programming for Problem solving</a> | ES       | 0-0-3         | 3         | 6             | 80  | 20  | 100   | 3 Hours                |
| 4            | 15ECRP101 | <a href="#">Engineering Exploration</a>           | ES       | 0-0-3         | 3         | 6             | 80  | 20  | 100   | 3 Hours                |
| 5            | 18EECF102 | <a href="#">Basic Electronics</a>                 | ES       | 4-0-0         | 4         | 4             | 50  | 50  | 100   | 3 Hours                |
| 6            | 15EMEF101 | <a href="#">Basic Mechanical Engg.</a>            | ES       | 2-1-0         | 3         | 4             | 50  | 50  | 100   | 3 Hours                |
| 7            | 15EHSH101 | <a href="#">Professional Communication</a>        | HSS      | 1-1-0         | 2         | 3             | 50  | 50  | 100   | 3 Hours                |
| <b>TOTAL</b> |           |   |          | <b>15-2-6</b> | <b>23</b> | <b>32</b>     |     |     |       |                        |



### Semester - II

| No           | Code      | Course   | Category | L-T-P         | Credits   | Contact Hours | ISA | ESA | Total | Exam Duration (in hrs) |
|--------------|-----------|--|----------|---------------|-----------|---------------|-----|-----|-------|------------------------|
| 1            | 18EMAB102 | <a href="#">Multivariable Calculus</a>             | BS       | 4-1-0         | 5         | 6             | 50  | 50  | 100   | 3 Hours                |
| 2            | 15EPHB102 | <a href="#">Engineering Physics</a>                | BS       | 3-0-0         | 3         | 3             | 50  | 50  | 100   | 3 Hours                |
| 3            | 15ECVF102 | <a href="#">Engineering Mechanics</a>              | ES       | 4-0-0         | 4         | 4             | 50  | 50  | 100   | 3 Hours                |
| 4            | 15EMEP101 | <a href="#">Computer Aided Engineering Drawing</a> | ES       | 0-0-3         | 3         | 6             | 80  | 20  | 100   | 3 Hours                |
| 5            | 18EEEF102 | <a href="#">Basic Electrical Engineering</a>       | ES       | 3-0-0         | 3         | 3             | 50  | 50  | 100   | 3 Hours                |
| 6            | 15EHSP101 | <a href="#">Social Innovation</a>                  | HSS      | 0-1-1         | 2         | 3             | 80  | 20  | 100   | 3Hours                 |
| 7            | 16EPHP102 | <a href="#">Engineering Physics Lab</a>            | BS       | 0-0-1         | 1         | 2             | 80  | 20  | 100   | 3 Hours                |
| <b>TOTAL</b> |           |  |          | <b>14-2-5</b> | <b>21</b> | <b>27</b>     |     |     |       |                        |

### Semester- III

| No           | Code      | Course  | Category | L-T-P         | Credits   | Contact Hours | ISA | ESA | Total | Exam Duration (in hrs) |
|--------------|-----------|---|----------|---------------|-----------|---------------|-----|-----|-------|------------------------|
| 1            | 20EMAB205 | <u>Numerical Methods and Differential Equations</u> | BS       | 4-0-0         | 4         | 4             | 50  | 50  | 100   | 03 Hours               |
| 2            | 15EBTC201 | <u>Microbiology</u>                                 | PSC      | 4-0-0         | 4         | 4             | 50  | 50  | 100   | 03 Hours               |
| 3            | 15EBTC202 | <u>Biochemistry</u>                                 | PSC      | 4-0-0         | 4         | 4             | 50  | 50  | 100   | 03 Hours               |
| 4            | 15EBTF201 | <u>Bioprocess Calculations</u>                      | ES       | 4-0-0         | 4         | 4             | 50  | 50  | 100   | 03 Hours               |
| 5            | 17EBTF201 | <u>Unit Operations-I</u>                            | ES       | 3-0-0         | 3         | 3             | 50  | 50  | 100   | 03 Hours               |
| 6            | 15EBTP201 | <u>Microbiology Lab</u>                             | PSC      | 0-0-1         | 1         | 2             | 80  | 20  | 100   | 03 Hours               |
| 7            | 15EBTP202 | <u>Biochemistry Lab</u>                             | PSC      | 0-0-1         | 1         | 2             | 80  | 20  | 100   | 03 Hours               |
| 8            | 17EBTP201 | <u>Unit Operations-I Lab</u>                        | ES       | 0-0-1         | 1         | 2             | 80  | 20  | 100   | 03 Hours               |
| <b>TOTAL</b> |           |   |          | <b>19-0-3</b> | <b>22</b> | <b>25</b>     |     |     |       |                        |

### Semester- IV

| No           | Code      | Course   | Category | L-T-P         | Credits   | Contact Hours | ISA | ESA | Total | Exam Duration (in hrs) |
|--------------|-----------|--|----------|---------------|-----------|---------------|-----|-----|-------|------------------------|
| 1            | 20EMAB210 | <a href="#">Biostatistics</a>                    | BS       | 3-1-0         | 4         | 5             | 50  | 50  | 100   | 03 Hours               |
| 2            | 15EBTC203 | <a href="#">Immunology</a>                       | PSC      | 3-0-0         | 3         | 3             | 50  | 50  | 100   | 03 Hours               |
| 3            | 17EBTC201 | <a href="#">Enzyme Technology</a>                | PSC      | 4-0-0         | 4         | 4             | 50  | 50  | 100   | 03 Hours               |
| 4            | 15EBTC205 | <a href="#">Cell &amp; Molecular Biology</a>     | PSC      | 4-0-0         | 4         | 4             | 50  | 50  | 100   | 03 Hours               |
| 5            | 17EBTF202 | <a href="#">Unit Operations-II</a>               | ES       | 3-0-0         | 3         | 3             | 50  | 50  | 100   | 03 Hours               |
| 6            | 15EBTP204 | <a href="#">Enzyme Technology Lab</a>            | PSC      | 0-0-1         | 1         | 2             | 80  | 20  | 100   | 03 Hours               |
| 7            | 15EBTP205 | <a href="#">Cell &amp; Molecular Biology Lab</a> | PSC      | 0-0-1         | 1         | 2             | 80  | 20  | 100   | 03 Hours               |
| 8            | 17EBTP202 | <a href="#">Unit Operations-II Lab</a>           | PSC      | 0-0-1         | 1         | 2             | 80  | 20  | 100   | 03 Hours               |
| <b>TOTAL</b> |           |  |          | <b>17-1-3</b> | <b>21</b> | <b>25</b>     |     |     |       |                        |

### Semester- V

| No           | Code      | Course   | Category | L-T-P         | Credits   | Contact Hours | ISA | ESA | Total | Exam Duration (in hrs) |
|--------------|-----------|--|----------|---------------|-----------|---------------|-----|-----|-------|------------------------|
| 1            | 15EBTC301 | <a href="#">Genetic Engineering &amp; Applications</a>         | PSC      | 4-0-0         | 4         | 4             | 50  | 50  | 100   | 03 Hours               |
| 2            | 22EBTC301 | <a href="#">Bioinformatics</a>                                 | PSC      | 4-0-0         | 4         | 4             | 50  | 50  | 100   | 03 Hours               |
| 3            | 15EBTC303 | <a href="#">Reaction Engineering</a>                           | PSC      | 4-0-0         | 4         | 4             | 50  | 50  | 100   | 03 Hours               |
| 4            | 15EBTC304 | <a href="#">Biological Thermodynamics</a>                      | PSC      | 3-0-0         | 3         | 3             | 50  | 50  | 100   | 03 Hours               |
| 5            | 15EBTC305 | <a href="#">Research Methodology</a>                           | PSC      | 3-0-0         | 3         | 3             | 50  | 50  | 100   | 03 Hours               |
| 6            | 15EBTW301 | Mini Project   | PRJ      | 0-0-3         | 3         | 9             | 50  | 50  | 100   | 03 Hours               |
| 7            | 15EBTP301 | <a href="#">Genetic Engineering &amp; Immunotechnology Lab</a> | PSC      | 0-0-1         | 1         | 2             | 80  | 20  | 100   | 03 Hours               |
| 8            | 15EBTP302 | <a href="#">Bioinformatics Lab</a>                             | PSC      | 0-0-1         | 1         | 2             | 80  | 20  | 100   | 03 Hours               |
| <b>TOTAL</b> |           |  |          | <b>18-0-5</b> | <b>23</b> | <b>31</b>     |     |     |       |                        |

### Semester- VI

| No           | Code      | Course  | Category | L-T-P         | Credits   | Contact Hours | ISA | ESA | Total | Exam Duration (in hrs) |
|--------------|-----------|---|----------|---------------|-----------|---------------|-----|-----|-------|------------------------|
| 1            | 15EBTC306 | <a href="#">Bioprocess Engineering</a>                            | PSC      | 4-0-0         | 4         | 4             | 50  | 50  | 100   | 03 Hours               |
| 2            | 19EBTC302 | <a href="#">Bioprocess Control &amp; Automation</a>               | PSC      | 4-0-0         | 4         | 4             | 50  | 50  | 100   | 03 Hours               |
| 3            | XXEBTE3XX | Program Elective - 01   | PE       | 3-0-0         | 3         | 3             | 50  | 50  | 100   | 03 Hours               |
| 4            | XXEBTE3XX | Program Elective - 02   | PE       | 3-0-0         | 3         | 3             | 50  | 50  | 100   | 03 Hours               |
| 5            | 16EHSC301 | Humanities – 01 (PALR)  | HSC      | 3-0-0         | 3         | 3             | 50  | 50  | 100   | 03 Hours               |
| 6            | 15EBTW302 | Minor Project   | PRJ      | 0-0-6         | 6         | 18            | 50  | 50  | 100   | 03 Hours               |
| 7            | 15EBTP303 | <a href="#">Bioprocess Engineering Lab</a>                        | PSC      | 0-0-1.5       | 1.5       | 3             | 80  | 20  | 100   | 03 Hours               |
| 8            | 19EBTP304 | <a href="#">Bioprocess Control &amp; Reaction Engineering Lab</a> | PSC      | 0-0-1.5       | 1.5       | 3             | 80  | 20  | 100   | 03 Hours               |
| <b>TOTAL</b> |           |   |          | <b>17-0-9</b> | <b>26</b> | <b>41</b>     |     |     |       |                        |

## Semester- VII

| No           | Code      | Course   | Category | L-T-P         | Credits   | Contact Hours | ISA | ESA | Total | Exam Duration (in hrs) |
|--------------|-----------|--|----------|---------------|-----------|---------------|-----|-----|-------|------------------------|
| 1            | 22EBTC401 | <a href="#">Downstream Processing Technology</a>     | PSC      | 4-0-0         | 4         | 4             | 50  | 50  | 100   | 03 Hours               |
| 2            | 15EBTC402 | <a href="#">Bioprocess Equipment Design</a>          | PSC      | 3-0-0         | 3         | 3             | 50  | 50  | 100   | 03 Hours               |
| 3            | XXEBTE4XX | Program Elective - 03                                | PE       | 3-0-0         | 3         | 3             | 50  | 50  | 100   | 03 Hours               |
| 4            | XXEBTE4XX | Program Elective - 04                                | PE       | 3-0-0         | 3         | 3             | 50  | 50  | 100   | 03 Hours               |
| 5            | XXEBTE4XX | Program Elective - 05                                | PE       | 3-0-0         | 3         | 3             | 50  | 50  | 100   | 03 Hours               |
| 6            | 15EHSA401 | Humanities – 02 (CIPE & EVS)                         | HSA      | <i>Audit</i>  |           |               |     |     |       |                        |
| 7            | 20EBTW401 | Senior Design Project                                | PRJ      | 0-0-6         | 6         | 18            | 50  | 50  | 100   | 03 Hours               |
| 8            | 15EBTP401 | <a href="#">Downstream Processing Technology Lab</a> | PSC      | 0-0-1         | 1         | 2             | 80  | 20  | 100   | 03 Hours               |
| <b>TOTAL</b> |           |  |          | <b>16-0-7</b> | <b>23</b> | <b>36</b>     |     |     |       |                        |
| 9            | 17EBTE490 | Research Experience for Undergraduates (REU)         | PE       | 0-0-6         | 6         | 18            | 50  | 50  | 100   | 03 Hours               |
| <b>TOTAL</b> |           |  |          | <b>0-0-6</b>  | <b>6</b>  | <b>18</b>     |     |     |       |                        |

### Semester- VIII

| No           | Code      | Course               | Category | L-T-P         | Credits   | Contact Hours | ISA | ESA | Total | Exam Duration (in hrs) |
|--------------|-----------|----------------------|----------|---------------|-----------|---------------|-----|-----|-------|------------------------|
| 1            | XXEBTE4XX | Program Elective -06 | PE       | 3-0-0         | 3         | 3             | 50  | 50  | 100   | 03 Hours               |
| 2            | 19EBTO401 | <u>Open Elective</u> | OE       | 3-0-0         | 3         | 3             | 50  | 50  | 100   | 03 Hours               |
| 3            | 20EBTW402 | Capstone Project     | PRJ      | 0-0-11        | 11        | 33            | 50  | 50  | 100   | 03 Hours               |
| <b>TOTAL</b> |           |                      |          | <b>6-0-11</b> | <b>17</b> | <b>39</b>     |     |     |       |                        |
| 4            | 18EBTI493 | Internship-Training  | --       | 0-0-6         | 6         | --            | 50  | 50  | 100   | 03 Hours               |
| 5            | 20EBTW494 | Internship-Project   | PRJ      | 0-0-11        | 11        | <b>33</b>     | 50  | 50  | 100   | 03 Hours               |
| <b>TOTAL</b> |           |                      |          | <b>0-0-17</b> | <b>17</b> |               |     |     |       |                        |

| Semester | I  | II | III | IV | V  | VI | VII | VIII | Total |
|----------|----|----|-----|----|----|----|-----|------|-------|
| Credits  | 21 | 23 | 22  | 21 | 23 | 26 | 23  | 17   | 176   |



### List of Open Electives

| Sr.No | Name of the Course                 | Course Code |
|-------|------------------------------------|-------------|
| 1     | <u>Industrial waste management</u> | 19EBTO401   |



### List of Program Electives

| Sr.No | Name of the Course  | Course Code |
|-------|---|-------------|
| 1     | <a href="#"><u>Insilco Modeling and Drug Design</u></a>                               | 15EBTE302   |
| 2     | <a href="#"><u>Bioanalytical Techniques</u></a>                                       | 19EBTE301   |
| 3     | <a href="#"><u>Industrial Biotechnology</u></a>                                       | 20EBTE401   |
| 4     | <a href="#"><u>Food Processing Technology</u></a>                                     | 15EBTE402   |
| 5     | <a href="#"><u>Environmental Biotechnology</u></a>                                    | 22EBTE401   |
| 6     | <a href="#"><u>Quality Assurance and regulations</u></a>                              | 18EBTE403   |
| 7     | <a href="#"><u>Process Safety and Risk Assessment in industrial biotechnology</u></a> | 22EBTE402   |
| 8     | <a href="#"><u>Plant and Animal Biotechnology</u></a>                                 | 15EBTE403   |
| 9     | <a href="#"><u>Biopharmaceuticals</u></a>   | 15EBTE404   |
| 10    | <a href="#"><u>Genomics and Proteomics</u></a>  | 15EBTE405   |
| 11    | <a href="#"><u>Bioethics, safety and IPR</u></a>                                      | 20EBTE403   |
| 12    | <a href="#"><u>Vaccine Technology</u></a>   | 21EBTE401   |
| 13    | <a href="#"><u>Biological Data Analysis</u></a>                                       | 18EBTE402   |
| 14    | <a href="#"><u>Genomic data analysis</u></a>  | 21EBTE402   |
| 15    | <a href="#"><u>Bio-business and entrepreneurship</u></a>                              | 20EBTE402   |
| 16    | <a href="#"><u>Phytochemicals and Herbal products</u></a>                             | 22EBTE403   |



## Curriculum Content- Course wise

|   |                                     |                              |
|---|-------------------------------------|------------------------------|
| <b>Program: Biotechnology</b>   |                                     | <b>Semester: I</b>           |
| <b>Course Title: Single variable Calculus</b>   |                                     | <b>Course Code:18EMAB101</b> |
| <b>L-T-P:4-1-0</b>  | <b>Credits:05</b>                   | <b>Contact Hours:50</b>      |
| <b>ISA Marks:50</b>   | <b>ESA Marks:50</b>                 | <b>Total Marks:100</b>       |
| <b>Teaching Hours:04</b>  | <b>Examination Duration:3 Hours</b> |                              |
| <b>Unit I</b>   |                                     |                              |
| <b>1.Functions, Graphs and Models</b>   |                                     |                              |
| Functions, types of functions, transformations and models (Linear, exponential, trigonometric).   |                                     |                              |
| <b>07 Hours</b>   |                                     |                              |
| <b>MATLAB:</b> Graphing functions, Domain-Range and Interpreting the models   |                                     |                              |
| <b>2. Calculus of functions and models</b>  |                                     |                              |
| Limit of a function, Infinite limits- graph, Continuity and discontinuity, Intermediate value theorem statement, Roots of the equation using Bisection Method and Newton- Raphson Method. Interpretation of derivative as a rate of change, All the rules of derivatives (List only), Maxima, Minima and optimization problems. Curvature and Radius of Curvature, Indeterminate forms, L- Hospital's rule-Examples |                                     |                              |
| <b>13 Hours</b>   |                                     |                              |
| <b>MATLAB:</b> optimization problems. Curvature problems  |                                     |                              |
| <b>Unit II</b>  |                                     |                              |
| <b>3. Infinite Series</b>   |                                     |                              |
| Definition, Convergence of series, Tests of convergence – p-series, Alternating series. Power series, radius of convergence, Taylor's and Maclaurin's series, Applications of Taylor's and Maclaurin's series   |                                     |                              |
| <b>06 Hours</b>   |                                     |                              |
| <b>MATLAB:</b> Convergence of series  |                                     |                              |
| <b>4. Integral calculus</b>   |                                     |                              |
| Tracing of standard curves in Cartesian form ,Parametric form and Polar form; Beta and gamma function, relation between them, evaluation of integrals using Beta and gamma functions; Applications to find arc length, Area, Volume and surface area (Cartesian, parametric and polar curves). Approximate integration- Trapezoidal rule, Simpson's 1/3 rule  |                                     |                              |
| <b>14 Hours</b>   |                                     |                              |
| <b>MATLAB:</b> problems on arc length, area, volume and surface area  |                                     |                              |



### Unit III

#### 5. Ordinary differential equations of first order

(a) Introduction to Initial Value problems. Linear and Bernoulli's equations, Exact equations and reducible to exact form, Numerical solution to Initial Value problems-Euler's method, Modified Euler's method and Runge-Kutta method

(b) Applications of first order differential equations-Orthogonal trajectories growth and decay problems, mixture problems, Electrical circuits, falling bodies.

**10 Hours**

**MATLAB:** Solve differential equations

#### Text Books

1. Early Transcendentals Calculus- James Stewart, Thomson Books, 7ed 2010

#### Reference Books:

1. Calculus Single and Multivariable, Hughes-Hallett Gleason, Wiley India Ed, 4ed, 2009.
2. Thomas Calculus, George B Thomas, Pearson India, 12ed, 2010

*(Use this template for all courses, semester wise)*

[BACK](#)



|  |                                     |                              |
|--|-------------------------------------|------------------------------|
| <b>Program: Biotechnology</b>              |                                     | <b>Semester: I</b>           |
| <b>Course Title: Engineering Chemistry</b> |                                     | <b>Course Code:15ECHB101</b> |
| <b>L-T-P:3-0-0</b>                         | <b>Credits:03</b>                   | <b>Contact Hours:40</b>      |
| <b>ISA Marks:50</b>                        | <b>ESA Marks:50</b>                 | <b>Total Marks:100</b>       |
| <b>Teaching Hours:03</b>                   | <b>Examination Duration:3 Hours</b> |                              |

### Unit I

#### 1. Pure substances

Properties of pure substance (Steam), two property rule, T-H diagram, formation of steam at constant pressure. Different states of steam: Wet steam-dryness fraction, determination by separating-throttling calorimeter, Dry saturated steam, Superheated steam, thermodynamic parameters of steam, steam table, numerical problems.

T-V, P-V & P-T diagram of pure substance taking water as example. Triple point & critical point, sub-cooled point, Sub-cooled liquid, saturated liquid, mixture of saturated liquid & vapor, saturated vapor & superheated vapor states.

**08 Hours**

#### 2. Real and ideal gases

Properties of Real and Ideal gases. Vander Waal's equation, Vander Waal's constant in terms of critical properties –numerical problems. Compressibility factor, compressibility chart and Law of corresponding state. Ideal gas: equation of state, internal energy and enthalpy as functions of temperature. Ideal gas mixture: Dalton's law of additive pressures and Amagat's law of additive volumes. Terms used in the analysis of mixture of gases - numerical problems.

**05 Hours**

#### 3. Engineering Materials

Ferrous metals – properties and applications of Iron and Steel. Ferrous metal s – properties and applications of copper and aluminium. Cement- properties, mechanism of setting & hardening of cement and applications. Lubricants- Properties –viscosity, flash point, fire point, cloud point and pour point, mechanism- hydrodynamic and boundary lubrication and applications.

**03 Hours**

### Unit II

#### 4. Fuel Chemistry

Fuels, classification, determination of calorific value of a fuel (solid / liquid fuel by Bomb calorimeter), coal analysis- Numerical problems. Petroleum - cracking, Octane number, Cetane number, reforming, and mechanism of knocking in Petrol and Diesel engines. Renewable energy

sources – power alcohol and bio diesel.

**06 Hours**

### **5. Energy Storage and Conversion Systems**

Electrode potential, Nernst equation, Formation of a cell; Reference electrodes – Calomel electrode and Determination of electrode potential using calomel electrode, numerical problems on  $E$ ,  $E_{\text{cell}}$ ,  $E^0_{\text{cell}}$ .

Batteries: Classification, characteristics, Lead-acid and Li ion batteries.

Fuel cells: Methanol- $\text{O}_2$  fuel cell.

**06 Hours**

### **6. Surface Chemistry**

Corrosion: Electrochemical theory of corrosion taking iron as an example; corrosion control – galvanization and tinning.

Metal Finishing: Technological importance of metal finishing, Electroplating, factors affecting nature of electrodeposition- Throwing power of plating bath solution- numerical problems. Electroless plating – advantages over electroplating, electroless plating of copper and its applications in the manufacture of printed circuit board.

**04 Hours**

## **Unit III**

### **7. Polymers**

Introduction, free radical mechanism of addition polymerization taking Ethylene as an example; commercial polymers - Plexi glass, polyurethane and polystyrene. Adhesives – synthesis, properties as applications of Epoxy resins; Polymer Composites - structure, properties and applications of Kevlar and carbon fiber.

**04 Hours**

### **8. Environmental Chemistry:**

Water: Sources and ill effects of water pollutants- fluoride and nitrate; Determination of total hardness of water by EDTS method – numerical problems. Sewage: Determination of biological oxygen demand by Winkler's method – numerical problems and determination of chemical oxygen demand - numerical problems,

**0 Hours**



**Text Books:**

1. A text Book of Engineering Chemistry, 1st edition, Dara. S. S, S. Chand & Co. Ltd., 2009, New Delhi.
2. A text Book of Engineering Chemistry, 16th edition, Jain P.C and Jain M, DhanpatRai Publications, 2006, New Delhi.

**Reference Books:**

1. An introduction to Thermodynamics, Y V C Rao, Revised Edition, University Press, 2009 Hyderabad.
2. Hand book of batteries, David Linden, Thomas B Reddy, 3rd edition McGraw Hill publications, 2001.
3. Puri B. R., Sharma L.R. and Pathania M. S., Principles of Physical Chemistry, 33rd Edition, S Nagin Chand & Co.,1992.
4. Fontana M G, Corrosion Engineering, 3<sup>rd</sup> Edition, McGraw Hill Publications, 1986.
5. Billmeyer F W, Text Book of Polymer Science, John Wiley &Son's, 1994.
6. Principles of Polymer Chemistry- A. RavvePlelum Press, New York and London.
7. Callister William D, Materials Science and Engineering: An introduction, John Wiley and Sons 2007: 721 pages.

[BACK](#)



|  |                                     |                              |
|--|-------------------------------------|------------------------------|
| <b>Program: Biotechnology</b>                          |                                     | <b>Semester: I</b>           |
| <b>Course Title: C Programming for Problem Solving</b> |                                     | <b>Course Code:18ECSP101</b> |
| <b>L-T-P:0-0-3</b>                                     | <b>Credits:3</b>                    | <b>Contact Hours: 6</b>      |
| <b>ISA Marks:80</b>                                    | <b>ESA Marks:20</b>                 | <b>Total Marks:100</b>       |
| <b>Teaching Hours:78</b>                               | <b>Examination Duration:3 Hours</b> |                              |

### **1.Introduction to Problem solving**

Introduction to algorithms / flowcharts and its notations, top down design, elementary problems.

**03 Hours**

### **2.Basics of C programming language**

Characteristics and uses of C, Structure of C program, C Tokens: Keywords, Identifiers, Variables, Constants, Operators, Data-types, Input and Output statements.

**15 Hours**

### **3.Decision control statements**

Conditional branching statements: if statement, if else statement, else if ladder, switch statement, unconditional branching statements: break, continue.

Introduction to Debugging Skills

Introduction to Test Driven Programming.

**12 Hours**

### **4.Iterative statements**

while, do while, for, nested statements

**10 Hours**

### **5.Functions**

Introduction, Function declaration, definition, call, returns statement, passing parameters to functions, introduction to macros.

Introduction to Coding Standards

**10 Hours**

### **6.Arrays and Strings**

Introduction, Declaration, Accessing elements, Storing values in arrays, Operations on one dimensional array, Operations on two dimensional arrays, Introduction to Code Optimization and refactoring

**15 Hours**





## 7.Pointers

Introduction, declaring pointer, pointer variables, pointer expression and arithmetic, passing arguments to functions using pointers, pointers and arrays, passing an array to a function.

**08 Hours**

## 8.Structures and Unions

Introduction, passing structures to functions, Array of structures, Unions

**05 Hours**

### Text Books:

1. R.G.Dromey, How to Solve it by Computer, 1ed, PHI, 2008.
2. Yashvant Kanetkar, Let us C, 15<sup>th</sup>ed, BPS Publication, 2016.

### Reference Books:

1. B W Kernighan, D M Ritchie, The Programming language C, 2ed, PHI, 2004.
2. B S Gottfried, Programming with C, 2ed, TMH, 2006.
3. B.A. Forouzan, R.F. Gilberg, A Structured Program Approach Using C, 3ed, CENGAGE Learning, 2008.

[BACK](#)



|   |                                     |                              |
|---|-------------------------------------|------------------------------|
| <b>Program: Biotechnology</b>   |                                     | <b>Semester: I</b>           |
| <b>Course Title: Engineering Exploration</b>  |                                     | <b>Course Code:15ECRP101</b> |
| <b>L-T-P:0-0-3</b>  | <b>Credits:3</b>                    | <b>Contact Hours:78</b>      |
| <b>ISA Marks:80</b>   | <b>ESA Marks:20</b>                 | <b>Total Marks:100</b>       |
| <b>Teaching Hours:78</b>  | <b>Examination Duration:3 Hours</b> |                              |
| <b>1.Introduction to Engineering and Engineering Study</b><br><b>01 Hours</b>   |                                     |                              |
| <b>2.Role of Analysis in Engineering, Analysis Methodology</b><br><b>02 Hours</b>   |                                     |                              |
| <b>3.Data Analysis Graphing</b><br><b>02 Hours</b>  |                                     |                              |
| <b>4.Basics of Engineering Design, Multidisciplinary Nature of Engineering Design</b><br><b>05 Hours</b>  |                                     |                              |
| <b>5.Project Management</b><br><b>01 Hours</b>  |                                     |                              |
| <b>6.Sustainability in Engineering</b><br><b>02 Hours</b>   |                                     |                              |
| <b>7.Ethics</b><br><b>01 Hours</b>  |                                     |                              |
| <b>8.Modeling, Simulation and Data Acquisition using Software Tool</b><br><b>01 Hours</b>   |                                     |                              |
| <b>9.Platform based development : Arduino</b><br><b>03 Hours</b>  |                                     |                              |
| <b>10.Course Project</b><br><b>03 Hours</b>   |                                     |                              |
| <b>Reference Books:</b><br><br><b>1. Engineering Fundamentals &amp; Problem Solving by ArvidEide, Roland Jenison, Larry Northup, Steven, McGrawHill Higher Education, 6<sup>th</sup> Edition ( 2011)</b><br><b>2. Engineering Exploration (Edited Book, 2008) by Pearson Publication.</b> |                                     |                              |

[BACK](#)



|   |                                     |                              |
|---|-------------------------------------|------------------------------|
| <b>Program: Biotechnology</b>   |                                     | <b>Semester: I</b>           |
| <b>Course Title: Basic Electronics</b>  |                                     | <b>Course Code:18EECF102</b> |
| <b>L-T-P:4-0-0</b>  | <b>Credits:4</b>                    | <b>Contact Hours:4</b>       |
| <b>ISA Marks:50</b>   | <b>ESA Marks:50</b>                 | <b>Total Marks:100</b>       |
| <b>Teaching Hours:50 Hrs</b>  | <b>Examination Duration:3 Hours</b> |                              |
| <b>Unit I</b>   |                                     |                              |
| <b>Chapter 1: Overview of Electronics in Mechanical Engineering</b>   |                                     |                              |
| Definition & overview of Mechatronics, Mechatronics and Design Innovation, Mechatronics and Manufacturing, Mechatronics and Education; Typical Mechatronics Components; Sensors and Transducers.  |                                     |                              |
| <b>03 Hours</b>   |                                     |                              |
| <b>Chapter 2: Semiconductor Devices and Applications:</b>   |                                     |                              |
| PN junction diode, characteristics and parameters, diode approximations, half wave rectifier, full wave bridge rectifier, full wave bridge rectifier capacitor filter, Zener diode, Voltage regulator design, BJT, Darlington Pair, JFET, MOSFET, UJT, SCR. |                                     |                              |
| <b>10 Hours</b>   |                                     |                              |
| <b>Chapter 3: Operational Amplifiers:</b>   |                                     |                              |
| Ideal op-amp characteristics, op-amp applications: Comparator, Inverting amplifier, Non-inverting amplifier, Voltage follower, Integration, Differentiation, Adder, Subtractor and numerical as applicable.   |                                     |                              |
| <b>08 Hours</b>   |                                     |                              |

## Unit II

### Chapter 4: Digital Logic:

Digital Number system: Binary & Hexadecimal number systems, Conversion, BCD Number system, Gray code, Data word representation, Binary Arithmetic, Boolean Algebra, Logic gates, Combinational & Sequential circuits, Adders, Flip-Flops, Registers, Counters, Multiplexer.

#### Introduction to Digital Electronics (Text-2):

Introduction, Switching and Logic Levels using circuits, Digital Waveform (Sections 9.1 to 9.3). Number system: Binary, Octal, Decimal and Hexadecimal, Inter Conversion, BCD Number system, Gray code, Data word representation, Binary Arithmetic, Boolean Algebra: Laws, rules & theorems of Boolean algebra, Sum of products form (SOP), products of sum form (POS) of Boolean functions. Study of Karnaugh Maps (K-maps) for 2, 3 & 4 variables only. Logic gates, Adders, Encoder, Decoder, Multiplexer and Demultiplexer. Combinational & Sequential circuits, Latches and Flip-Flops (SR, JK, D, T),

**13 Hours**

### Chapter 5: Sensors and Transducers :

Introduction, Classification of sensors and transducers, Contact type – Mechanical switches, Non-contact type - proximity sensors & Hall sensors, principle of working of light sensors, Future Challenges.

**06 Hours**

## Unit III

### Chapter 6: Signal Conditioning:

Analog & Digital signals, Digital to Analog Conversion, R-2R DAC, Analog to Digital Conversion, SAR ADC, Data Acquisition.

**06 Hours**

### Chapter 7: Case Studies of Mechatronic Systems:

Automatic Camera, Drilling Machine, Bar code reader.

**06 Hours**

#### Text Books

1. David A Bell, "Electronic devices and Circuits", PHI New Delhi, 2004.
2. Morris Mano, "Digital logic and Computer design" 21st Indian print Prentice Hall India, 2000.
3. W. Bolton, "Mechatronics - Electronic Control Systems in Mechanical and Electrical Engineering", 3<sup>rd</sup> edition Pearson Education, 2005.
4. David Bradley and David W., "Mechatronics in Action", 2nd edition, Springer, 2010



**Reference Books:**

1. David G Alciatore, Michael B Histan, "Introduction to Mechatronics and Measurement Systems", TMH 3<sup>rd</sup> edition, 2007.
2. K.A Krishnamurthy and M.R.Raghuveer, "Electrical, Electronics and Computer Engineering for Scientist and Engineers", Second Edition New Age International Publishers, Wiley Eastern, 2001.
3. P. Malvino, "Electronic Principles" Sixth edition Tata McGraw Hill, 1999.
4. Floyd, "Digital fundamentals" Third Edition Prentice Hall India, 2001
5. BoylesteadNashelsky, "Electronic devices & Circuit theory" Sixth Edition Prentice Hall India, 2000.
6. RamakantGayekawad "Operational Amplifiers & applications" 3<sup>rd</sup> Edition, PHI, 2000.

[BACK](#)



| Program: Biotechnology                     |  |                              |       | Semester: I   |  |          |
|--|--|------------------------------|-------|---|--|----------|
| Course Title: Basic Mechanical Engineering |  |                              |       | Course Code:15EECF101   |  |          |
| L-T-P:2-1-0                                |  | Credits:3                    |       | Contact Hours:4   |  |          |
| ISA Marks:50                               |  | ESA Marks:50                 |       | Total Marks:100   |  |          |
| Teaching Hours:50                          |  | Examination Duration:3 Hours |       |   |  |          |
| Chapter                                    | Contents   |                              | Hours | Tutorial  |  | Sessions |
| Unit I                                     |  |                              |       |   |  |          |
| 1  | Introduction to Mechanical Engineering:<br><br>Definition of engineering, Mechanical Engineering, Branches of Mechanical Engineering, Who are Mechanical Engineers?, Mechanical Engineers’ top ten achievements.   |                              | 2     | Visit to Workshop and Machine Shop, Tools, Safety Precautions<br><br>Video presentations  |  | 1        |
| 2  | Manufacturing Engineering: Basics of Manufacturing<br><br>What is manufacturing?, The main manufacturing sectors, The importance of the main manufacturing sectors to the Indian economy, Scales of production<br><br>Classification of manufacturing Processes.<br><br>Advances in Manufacturing: CNC machines, Mechatronics and applications |                              | 8     | Demonstration on working of Lathe, milling, drilling, grinding machines<br><br>Demonstration on Welding (Electric Arc Welding, Gas Welding, Soldering)<br><br>Demonstration and Exercises on Sheet metal work.<br><br>Visit to Learning Factory |  | 5        |

**Unit II**

|   |  |   |  |   |
|---|--|---|--|---|
| 3 | <b>Design Engineering: Power Transmission Elements</b><br><br>Overview<br>Design Application: <ul style="list-style-type: none"> <li>• Belt Drives. Types, Length of Belt. Velocity Ratio, Initial Tension. Ratio of Tensions. Power Transmitted, Numerical Problems.</li> <li>• Gears. Spur Gear, Rack and Pinion, Worm Gear, Bevel Gear, Helical Gears. Speed, Torque, and Power in Gear pair. Simple and Compound Gear trains. Numerical Problems.</li> <li>• Ball and Roller Bearings, Types, Applications.</li> </ul> | 6 | Design Problems like a moving experience, aluminium can crusher<br><br>Video presentations | 5 |
| 4 | <b>Thermal Engineering 1: Prime Movers.</b><br><br>Internal Combustion Engines: Classification, IC engine parts, 2 stroke SI and CI engine, 4 Stroke SI and CI Engine, PV diagrams of Otto and Diesel cycles, Comparison of 2 stroke and 4 stroke engine, comparison of CI and SI engine, Problems on Engine Performance, Future trends in IC engines.   | 4 | Case study on power requirement of a bike, car or any machine<br><br>Video presentations   | 1 |

**Unit III**

|   |   |   |   |   |
|---|---|---|---|---|
| 5 | <b>Thermal Engineering 2: Thermal Systems' Applications</b><br>Refrigeration system, Air conditioning system, Pumps, Blowers and Compressors, | 5 | Case study on selection of various thermal systems<br>Video presentations | 1 |
|---|---|---|---|---|



|  |   |  |  |  |
|--|---|--|--|--|
|  | Turbines, and their working principle and specifications. |  |  |  |
|--|---|--|--|--|

**Text Books:**

1. Jonathan Wickert and Kemper Lewis, An Introduction to Mechanical Engineering, Third Edition, 2013- Cengage Learning.
2. K.R.Gopalkrishna, SudhirGopalkrishna, S.C. Sharma. A Text Book of Elements of Mechanical Engineering, 30th Edition, Oct 2010,–Subhash Publishers, Bangalore.

**Reference Books:**

1. Course Material developed by the Department of Mechanical Engineering.
2. SKH Chowdhary, AKH Chowdhary, Nirjhar Roy, The Elements of Workshop Technology - Vol I & II , 11th edition 2001, Media Promoters and Publishers.
3. Basic Manufacturing, Roger Timings, Third edition, Newnes, An imprint of Elsevier.

[BACK](#)





|   |                                      |                             |
|---|--------------------------------------|-----------------------------|
| <b>Program: Biotechnology</b>   |                                      | <b>Semester: I</b>          |
| <b>Course Title: Professional Communication</b>   |                                      | <b>Course Code:15EHS101</b> |
| <b>L-T-P:1-1-0-0</b>  | <b>Credits:2</b>                     | <b>Contact Hours:42</b>     |
| <b>ISA Marks:50</b>   | <b>ESA Marks:50</b>                  | <b>Total Marks:100</b>      |
| <b>Teaching Hours:42</b>  | <b>Examination Duration: 3 Hours</b> |                             |
| <b>Chapter No. 1. Basics- English Communication</b>   |                                      |                             |
| Course Introduction, Explanation of template mix-ups with correct usages & necessity of grammar in error detection, Usage of tenses |                                      |                             |
| <b>09 Hours</b>   |                                      |                             |
| <b>Chapter No. 2. Vocabulary and grammar</b>  |                                      |                             |
| Vocabulary, Word Formation and Active and Passive Voice   |                                      |                             |
| <b>06 Hours</b>   |                                      |                             |
| <b>Chapter No. 3. Bouncing Practice</b>   |                                      |                             |
| Definition and types of bouncing and its practice with examples, reading skills, free style speech. Individual presentation.        |                                      |                             |
| <b>06 Hours</b>   |                                      |                             |
| <b>Chapter No. 4. Rephrasing and Structures</b>   |                                      |                             |
| Comprehension and Rephrasing, PNQ Paradigm and Structural practice  |                                      |                             |
| <b>08 Hours</b>   |                                      |                             |
| <b>Chapter No. 5. Dialogues</b>   |                                      |                             |
| Introduction of dialogues, Situational Role plays,  |                                      |                             |
| <b>03 Hours</b>   |                                      |                             |
| <b>Chapter No. 6. Business Communication</b>  |                                      |                             |
| Covering letter, formal letters, Construction of paragraphs on any given general topic.   |                                      |                             |
| <b>09 Hours</b>   |                                      |                             |

**Reference Books:**

1. Collins Cobuild Advanced Learner's English Dictionary
2. Raymond Murphy - Intermediate English Grammar, Cambridge University Press
3. Martin Hewings- Advanced English Grammar, Cambridge University Press.

[BACK](#)



|  |                                     |                              |
|--|-------------------------------------|------------------------------|
| <b>Program: Biotechnology</b>  |                                     | <b>Semester: II</b>          |
| <b>Course Title: Multivariable calculus</b>  |                                     | <b>Course Code:18EMAB102</b> |
| <b>L-T-P:4-1-0</b>   | <b>Credits:05</b>                   | <b>Contact Hours:50</b>      |
| <b>ISA Marks:50</b>  | <b>ESA Marks:50</b>                 | <b>Total Marks:100</b>       |
| <b>Teaching Hours:05</b>   | <b>Examination Duration:3 Hours</b> |                              |
| <b>Unit I</b>  |                                     |                              |
| <b>1.Partial differentiation</b><br>Function of several variables, Partial derivatives, Level curves, Chain rule, Errors and Approximations. Extreme value problems. Lagrange's multipliers. <div style="text-align: right;"><b>12 Hours</b></div>   |                                     |                              |
| <b>2. Double integrals</b><br>Double integrals- Rectangular and polar coordinates, Change the order of integration. Change of variables, Jacobian. Application of double integrals <div style="text-align: right;"><b>08 Hours</b></div>   |                                     |                              |
| <b>MATLAB:</b> optimization problems, application of double integrals.   |                                     |                              |
| <b>Unit II</b>   |                                     |                              |
| <b>1.Triple integrals</b><br>Triple integrals, Cartesian, change to Cylindrical and Spherical coordinates Application of Triple integrals <div style="text-align: right;"><b>07 Hours</b></div>  |                                     |                              |
| <b>2.Calculus of Vector Fields</b><br>Vector fields, Gradient and directional derivatives. Line and Surface integrals. Independence of path and potential functions. Green's theorem, Divergence of vector field, Divergence theorem, Curl of vector field. Stokes theorem. <div style="text-align: right;"><b>13 Hours</b></div>  |                                     |                              |
| <b>MATLAB:</b> application of Triple integrals, Vector calculus problems   |                                     |                              |
| <b>Unit III</b>  |                                     |                              |
| <b>1.Differential equations of higher orders</b><br>(a)Linear differential equations of second and higher order with constant coefficients the method of Variation of parameters. Initial and boundary value problems.<br>(b) Applications of second order differential equations-Newton's 2 <sup>nd</sup> law, electrical circuits, Simple Harmonic motion. Series solution of differential equations. Validity of Series solution of |                                     |                              |



Differential equations.

**(5+5) Hours**

**MATLAB:** application of differential equations

**Text Books**

1. Early Transcendental Calculus- James Stewart, Thomson Books, 7ed 2010.

**Reference Books:**

1. Calculus Single and Multivariable, Hughes-Hallett Gleason, Wiley India Ed, 4ed, 2009.
2. Thomas Calculus, George B Thomas, Pearson India, 12ed, 2010.

[BACK](#)



|   |                                     |                              |
|---|-------------------------------------|------------------------------|
| <b>Program: Biotechnology</b>   |                                     | <b>Semester: II</b>          |
| <b>Course Title: Engineering Physics</b>  |                                     | <b>Course Code:15EPHB102</b> |
| <b>L-T-P:3-1-0</b>  | <b>Credits:03</b>                   | <b>Contact Hours: 3</b>      |
| <b>ISA Marks:50</b>   | <b>ESA Marks:50</b>                 | <b>Total Marks:100</b>       |
| <b>Teaching Hours:40</b>  | <b>Examination Duration:3 Hours</b> |                              |
| <b>Unit I</b>   |                                     |                              |
| <b>Chapter 1:Concept of Motion - Kinematics in One Dimension</b>  |                                     |                              |
| Introduction, Motion Diagrams, The Particle Model, Position Model, Linear Velocity and Acceleration, Uniform Motion, Instantaneous Velocity, Finding Position from Velocity, Motion with Constant Acceleration, Free Fall Motion on an Inclined Plan, Instantaneous Acceleration, Numerical.  |                                     |                              |
| <b>06 Hours</b>   |                                     |                              |
| <b>Chapter 2:Kinematics in Two Dimensions</b>   |                                     |                              |
| Introduction to Vectors, Properties of vectors, Coordinate Systems and Vector Components, Vector Algebra. Position, velocity and Acceleration vectors, Projectile Motion, Relative Motion, Uniform Circular Motion, Velocity and Acceleration in Uniform Circular Motion, Nonuniform Circular Motion and Angular Acceleration, Numerical. |                                     |                              |
| <b>06 Hours</b>   |                                     |                              |
| <b>Chapter 3:Force and Motion</b>   |                                     |                              |
| Concept of Force, Identifying Forces, A Virtual Experiment,<br><br>Newton's First Law, Newton's Second Law, Free-Body Diagrams, Applications.   |                                     |                              |
| <b>04 Hours</b>   |                                     |                              |



## Unit II

### Chapter 4:Dynamics I

Equilibrium using Newton's second Law, Friction, Drag,

Newton's Third Law, Analyzing Interacting Objects, Newton's Third Law, Applications.

**05 Hours**

### Chapter 5:Dynamics II

Motion in a plane, Dynamics in Two Dimension, Velocity and Acceleration in Uniform Circular Motion, Dynamics of Uniform Circular Motion, Fictitious Forces, Non-uniform Circular Motion, Numerical.

**06 Hours**

### Chapter 6:Impulse and Momentum

Momentum and Impulse, Problems, Conservation of Momentum, Inelastic Collisions, Explosion, Momentum in Two Dimension, Numericals.

**05 Hours**

## Unit III

### Chapter 7:Energy and Work

Energy: Kinetic Energy and Gravitational Potential Energy, Restoring Forces, Hooke's Law, Elastic Potential Energy, Elastic Collisions, Energy Diagrams,

Work: Work and Kinetic Energy, Force, Work and Potential energy, Conservation of Energy, Power, Numericals.

**08 Hours**

### Text Books

1. John W Jewett and Raymond A Serway, Physics for Scientists and Engineers with modern physics, Cengage publication, India Edition, 8<sup>th</sup> Edition.

### Reference Books:

1. Randall D Knight, Physics for Scientists and Engineers, Pearson publication, 2<sup>nd</sup> Edition.
2. Hans C Ohanian and John T Markert, Physics for Engineers and Scientists, W W Norton and Company, Volume 1, 3<sup>rd</sup> Edition

[BACK](#)



|  |                                     |                              |
|--|-------------------------------------|------------------------------|
| <b>Program: Biotechnology</b>  |                                     | <b>Semester: II</b>          |
| <b>Course Title: Engineering Mechanics</b>   |                                     | <b>Course Code:15EPHB102</b> |
| <b>L-T-P:4-0-0</b>   | <b>Credits:03</b>                   | <b>Contact Hours: 4</b>      |
| <b>ISA Marks:50</b>  | <b>ESA Marks:50</b>                 | <b>Total Marks:100</b>       |
| <b>Teaching Hours:50</b>   | <b>Examination Duration:3 Hours</b> |                              |
| <b>Unit I</b>  |                                     |                              |
| <b>Chapter 1: Overview of Civil Engineering</b><br><b>Evolution of Civil Engineering</b><br>Specialization, scope and role.<br><b>Impact of Civil Engineering on</b><br>National economy, environment and social & cultural fabric.<br><b>Challenges and Opportunities for Civil Engineers</b><br>Civil Engineering Marvels, Future challenges, Higher education and Research.<br><b>04 Hours</b>  |                                     |                              |
| <b>Chapter 2: Coplanar concurrent force system</b><br><b>Introduction to Engineering Mechanics:</b><br>Basic idealizations – Particle, Continuum, Body, Rigid body, Deformable body, Definition of force and its elements; Laws of Mechanics – Parallelogram law of forces, Principle of transmissibility, Law of Superposition, Newton’s laws of motion. Classification of force systems<br><b>03 Hours</b><br><b>Resultant of coplanar concurrent force system:</b> Definitions – Resultant, composition & Resolution of a force, Equilibrium, Equilibrant, Formulae for resultant of forces and resolution of a force. Numerical problems on resultant of forces.<br><b>04 Hours</b><br><b>Equilibrium of coplanar concurrent force system:</b><br>Conditions of equilibrium, Action & Reaction, Free body diagram, Lamis’ theorem. Numerical problems on equilibrium of forces.<br><b>05 Hours</b> |                                     |                              |

**Chapter 3: Coplanar non-concurrent force system**

**Resultant of a force system:** Moment, moment of a force, couple, moment of a couple, Characteristics of couple, Equivalent force-couple system, Numerical problems on moment of forces and couples, on equivalent force-couple system. Varignon's principle of moments, Resultant of coplanar- non-concurrent force systems and numerical problems. 5 hrs.

**05 Hours****Unit II****Chapter 4: Equilibrium of a force system (Chapter 3 contd..)**

Conditions of equilibrium, types of support and loading for a statically determinate beam, Reactions at support connections, Numerical problems on equilibrium of force systems and support reactions for a statically determinate beam.

**05 Hours.****Chapter 5: Static Friction**

Introduction, types of friction, definition, limiting friction, coefficient of friction, laws of Coulomb friction, angle of friction and angle of repose, cone of friction. Wedge and belt friction theory. Derivation of belt friction formula. Numerical problems on, impending motion on horizontal and inclined planes (including connected bodies); wedge friction; Ladder friction and Belt friction.

**08 Hours.****Chapter 6: Centroid of Plane Figures**

Introduction, Definition, Methods of determining the centroid, axis of reference, axis of symmetry, Locating the centroid of simple plane figures (triangle, semicircle, quarter of a circle and sector of a circle etc.,) using method of integration, Numerical problems on Centroid of simple built up sections.

**05 Hours**



**Unit III****Chapter 7: Second moment of area (Plane figures)**

Introduction, Definition, Method of determining the second moment of area, Section Modulus, Radius of gyration, perpendicular and Parallel axis theorems, Polar second moment of area, second moment of area of simple plane figures (triangle, rectangle, semicircle, circle etc.,) using method of integration, Numerical problems on MI of simple built up sections.

**05 Hours****Chapter 8: Kinetics of a particle- Work, Power, Energy**

Introduction – Kinematics and Kinetics, Definitions – work, power and energy. Work done by a force (constant, gravitational and spring forces) in rectilinear motion. Numerical problems, Kinetic energy of a particle, principle of work and energy.

**06 Hours.****Text Books:**

1. Beer, F.P. and Johnston, R., Mechanics for Engineers: Statics, McGraw Hill Company, New York, 1988.
2. Bhavikatti, S.S., and Rajasshekarappa K.G., Engineering Mechanics, 3Ed., New Age International Pub. Pvt. Ltd., New Delhi, 2008.
3. Kumar, K.L., Engineering Mechanics, 3ed., Tata McGraw Hill Publishing Company, New Delhi, 2003.
4. Punmia, B.C., Jain, A. and Jain, A., Mechanics of Materials, Lakshmi Publications, New Delhi, 2006

**Reference Books:**

1. Jagadeesh, T.R. and Jayaram, *Elements of Civil Engineering*, Sapna Book House, Bangalore, 2006.
2. Ramamrutham, S., *Engineering Mechanics*, DhanpatRai Publishing Co., New Delhi, 1998.
3. Singer, F.L., *Engineering Mechanics*, 3<sup>rd</sup> edition Harper Collins, 1994.
4. Timoshenko, S.P. and Young, D.H., Engineering Mechanics, 4<sup>th</sup> edition, McGraw Hill Publishing Company, New Delhi, 1956.
5. Irving H Shames, Engineering Mechanics, 3<sup>rd</sup> edition, Prentice-Hall of India Pvt. Ltd, New Delhi- 110 001, 1995.

[BACK](#)



|   |                                     |                               |
|---|-------------------------------------|-------------------------------|
| <b>Program: Biotechnology</b>   |                                     | <b>Semester: II</b>           |
| <b>Course Title: Computer Aided Engineering Drawing</b>   |                                     | <b>Course Code: 15EMEP101</b> |
| <b>L-T-P:0-0-3</b>  | <b>Credits:03</b>                   | <b>Contact Hours: 6</b>       |
| <b>ISA Marks:80</b>   | <b>ESA Marks:20</b>                 | <b>Total Marks:100</b>        |
| <b>Teaching Hours:50</b>  | <b>Examination Duration:3 Hours</b> |                               |
| <b>Unit I</b>   |                                     |                               |
| <b>Chapter 01: Introduction to engineering drawing and orthographic projections.<br/>( Manual Drafting )</b>  |                                     |                               |
| <ul style="list-style-type: none"><li>i. Introduction to engineering drawing – BIS conventions.</li><li>ii. Orthographic projections: first angle projection and third angle projection – symbolic representation.</li><li>iii. Projections of points.</li><li>iv. Projections of lines inclined to both the planes and determination of true length by rotating the view method (Problems on traces of a line and mid-point problems are not included). However application problems are included.</li><li>v. Projection of planes: Planes parallel to one plane and perpendicular to other plane or perpendicular to one plane and inclined to other plane (Two stage problems).</li><li>vi. Projection of simple solids such as prisms, pyramids, cylinders, cones and sphere and their frustums in simple positions (Base parallel to or in one of the three planes).</li></ul> |                                     |                               |
| <b>08 Hours</b>   |                                     |                               |
| <b>Chapter 02: Development of lateral surfaces of solids. (MANUAL)</b>  |                                     |                               |
| <ul style="list-style-type: none"><li>i. Development of lateral surface of prisms and cylinders (Either full or truncated using parallel line development method)</li><li>ii. Development of lateral surface of pyramids and cones (Either full or truncated or of their frustums using radial line development method)</li><li>iii. Development of lateral surfaces of spheres using both the methods and development of transition pieces.</li></ul>  |                                     |                               |
| <b>07 Hours</b>   |                                     |                               |
| <b>Chapter 03: Conversion of pictorial views into orthographic projections using CAD software.</b>  |                                     |                               |
| Drawing orthographic projection of objects shown in pictorial views by first angle method of projection using CAD software. (2D drafting only)  |                                     |                               |
| <b>06 Hours</b>   |                                     |                               |



**Chapter 04: Isometric projection or view using CAD software.**

Drawing isometric projections or views of objects shown in orthographic projections using CAD software.

**04 Hours**

**Text Books:**

1. Text Book of Engineering Drawing by K R Gopalakrishna
2. Text Book of Engineering Drawing by N D Bhatt and V M Panchal

[BACK](#)

|  |                                     |                              |
|--|-------------------------------------|------------------------------|
| <b>Program: Biotechnology</b>  |                                     | <b>Semester: II</b>          |
| <b>Course Title: Basic Electrical Engineering</b>  |                                     | <b>Course Code:18EEEF102</b> |
| <b>L-T-P:3-0-0</b>   | <b>Credits:03</b>                   | <b>Contact Hours: 40</b>     |
| <b>ISA Marks:50</b>  | <b>ESA Marks:50</b>                 | <b>Total Marks:100</b>       |
| <b>Teaching Hours:40</b>   | <b>Examination Duration:3 Hours</b> |                              |
| <b>Unit-I</b>  |                                     |                              |
| <b>1.Overview of Electrical Engineering</b><br>Specialization, scope & role, impact of Electrical Engineering on national economy, environment, Sources of generation, sustainability, challenges and opportunities for electrical engineers, electrical engineering marvels, future challenges. <p style="text-align: right;"><b>02 Hours</b></p>   |                                     |                              |
| <b>2.DC Circuits</b><br>Voltage and current sources, Kirchoff's current and voltage laws, loop and nodal analysis of simple circuits with dc excitation. Time-domain analysis of first-order RL and RC circuits. <p style="text-align: right;"><b>05 Hours</b></p>   |                                     |                              |
| <b>3.AC Circuits</b><br>Representation of sinusoidal waveforms, peak and rms values, phasor representation, real power, reactive power, apparent power, power factor. Analysis of single-phase series and parallel R-L-C ac circuits. Three-phase balanced circuits, voltage and current relations in star and delta connections. power measurement using two watt meters <p style="text-align: right;"><b>08 Hours</b></p>  |                                     |                              |
| <b>Unit II</b>   |                                     |                              |
| <b>4.Electrical Actuators</b><br>Electromagnetic principles, Solenoid, Relays, classification of Electric motors, DC motors-shunt, series, compound, separately excited, PMDC motors – Speed Control, Stepper Motors, BLDC motors, three phase induction motor, Characteristics and applications, selection of motors for various applications. <p style="text-align: right;"><b>09 Hours</b></p>  |                                     |                              |
| <b>5.Power Electronics (Text1, chapter 45)</b><br>Introductory, Thyristor, Some thyristor circuits, Limitations to thyristor operation, The thyristor in practice, The fully controlled AC/DC converter, AC/DC inversion, Switching devices in inverters, Three-phase rectifier networks, The three-phase fully controlled converter, Inverter-fed induction motors, Soft-starting induction motors, DC to DC conversion switched-mode power <p style="text-align: right;"><b>06 Hours</b></p> |                                     |                              |



### Unit III

#### 6. Electrical Wiring, Safety and protection (ref :Text3-page 1 to 10)

Types of wires and cables for internal wiring, Types of switches and Circuits, Types of wiring, Safety precautions and rules in handling electrical appliances, Electric shock, first aid for electrical shocks, Importance of grounding and earthing, Methods for earthing, Fuses, MCB, ELCB and Relays, Lockout and Tagout, Electrical Codes and Standards.

**05 Hours**

#### 7. Batteries:

Basics of lead acid batteries, Lithium Ion Battery , Battery storage capacity, Coulomb efficiency, Numerical of high and low charging rates, Battery sizing. Numericals..

**05 Hours**

#### Text Books:

1. Hughes, Electrical & Electronic Technology, 8th , Pearson Education, 2001
2. P C Sen, Principles of Electrical Machines and Power Electronics, 2nd, Wiley Publications
3. Gilbert M Masters, Renewable and efficient Electrical Power systems, Published by John Wiley & Sons 2004 edition
4. Frank D. Petruzella, Electric Motors and Control Systems, McGraw Hill Education Private Limited 2009 Edition

#### Reference Books:

1. D C Kulshreshtha, Basic Electrical Engineering, McGraw Hill Publications
2. David G Alciatore and Michel B Hsiao, Introduction to Mechatronics and Measurement Systems, 3rd, Tata McGraw Hill Education Private Limited, New Delhi., 2005
3. Vincent Del Toro, Electrical Engineering Fundamentals, 2<sup>nd</sup> edition Prentice Hall India

[BACK](#)



| <b>Program: Biotechnology</b>             |   | <b>Semester: II</b>   |  |
|---|---|---|--|
| <b>Course Title: Social Innovation</b>    |   | <b>Course Code:15EHSP101</b>  |  |
| <b>L-T-P:0-1-1</b>                        | <b>Credits:02</b>   | <b>Contact Hours: 28</b>  |  |
| <b>ISA Marks:80</b>                       | <b>ESA Marks:20</b>   | <b>Total Marks:100</b>  |  |
| <b>Teaching Hours:28</b>                  | <b>Examination Duration:3 Hours</b>   |   |  |
| Module                                    | Topics  | Assignments   | Support activities / Tools   |
| <b>KNOWLEDGE, TOOLS &amp; DEVELOPMENT</b> | <b>Course sensitization</b><br><br><b>1.Introduction to Social Innovation:</b> <ul style="list-style-type: none"> <li>Awakening social consciousness<br/>(<a href="http://www.yourstory.com">www.yourstory.com</a>)</li> <li>Social Innovation and Leadership</li> <li>Engineering&amp; Social innovation (EPICS)</li> </ul> <b>(Connecting SI Course to Mini Project, Capstone Project, Campus Placements)</b> <ul style="list-style-type: none"> <li>Course Overview</li> <li>Students' Self Introduction Activity</li> <li>Group formation Activity</li> </ul> | <u><b>Reading assignments</b></u> <ul style="list-style-type: none"> <li>Read the handout on "The Process of Social Innovation" by Geoff Mulgan</li> <li>Design thinking for Social Innovation</li> </ul> <u><b>Written Assignments</b></u> <ul style="list-style-type: none"> <li>Writing about AkshayaPatra in class.<br/>(Background information about Akshayapatra and the Social Cuase it is addressing)</li> <li>Brainstorming Session on Social Innovators in Class</li> </ul> | <ul style="list-style-type: none"> <li>Class activity on Behavioural Blocks to Innovation<br/>Discussion on the behavioural blocks.</li> <li>Introducing oneself with three Adjectives-<br/>Appreciating diversity and discovering self</li> <li>Group Formation Activity</li> </ul> <b>(Forming square)</b><br><br>(Making four equilateral triangles out of popsicle sticks to enhance group cohesiveness amongst the group mates) |
|   |   |   |  |



**Seven Mindsets:**

**1. Empathy**

(Example of The Boy and the Puppies)

**2. Optimism**

( Person Paralyzed waist down / Glass Half full Half Empty)

**3. Iteration**

(Thomas Alva Edison)

**4. Creative Confidence**

(Origami – Josef Albers)

**5. Making it**

**6. Embracing Ambiguity**

(Confusion is the Welcome doormat at the door of Creativity)

**7. Learning from Failure**

(Designing Website first and then asking the stakeholders about the website)

(Spending one lakh for the business which is never launched)

**Reading assignments**

- Handout on “ Create Mindsets”

- (How to train the Dragon?  
Common Video for all the mindsets)
- Watching in Class TED Talk on “How to build your Creative Confidence by David Kelley – IDEO Founder)

|                                |                              |   |  |  |
|--------------------------------|------------------------------|---|--|--|
| KNOWLEDGE, TOOLS & DEVELOPMENT | Process of Social Innovation | <p>Engage</p> <p>Community study and Issue Identification</p> | <p><u>Reading assignments</u></p> <ul style="list-style-type: none"> <li>• Handout on Community Study and Issue Identification</li> <li>• Case Study on “EGramSeva”</li> <li>• Case Study on “JananiAgri Serve”</li> </ul> <p><u>Class Presentations</u></p> <ul style="list-style-type: none"> <li>• Initial observations being made by the group ( Literature Survey of Places of Hubli-Dharwad)www.readwhere.com</li> <li>• Detailed interaction / engagements with the society and finalize the social issue for intervention</li> </ul> <p><b>Use template 1: Frame your Design Challenge</b></p> | <ul style="list-style-type: none"> <li>• Activity on Observation skills</li> </ul> <p>To know how to use one’s observation skills in understanding the social conditions</p> <ul style="list-style-type: none"> <li>• Experience sharing by senior students</li> <li>• Brainstorming</li> </ul> <p>Deliberations on the initial observations and arrive at the “Social Issue”</p> <ul style="list-style-type: none"> <li>• Familiarization of the respective templates with the help of sample case study</li> </ul> |
|                                |                              | PEER REVIEW   |  |  |





|  |   |  |  |
|--|---|--|--|
|  | <p><b>Inspiration</b></p> <ul style="list-style-type: none"><li>• Plan for the Research</li><li>• Development of Interview guide</li><li>• Capture your Learnings</li></ul> | <p><b><u>Reading assignments</u></b></p> <ul style="list-style-type: none"><li>• Handout on Overview of Inspiration</li></ul> <p><b><u>Class Presentations</u></b></p> <ul style="list-style-type: none"><li>• Entirety of the Social Issue</li><li>• Identification of the Stake Holders</li></ul> <p><b>(Examples on Fluorescent Curtain and Students' Punctuality for Class)</b></p> <ul style="list-style-type: none"><li>• Interview Questions</li></ul> <p><b>(Role Play on Interview with Stakeholders)</b></p> <ul style="list-style-type: none"><li>• Category wise Learnings capture</li></ul> <p><b>Use template 2: Plan your Research</b></p> <p><b>Template 3. Development of Interview Guide</b></p> <p><b>Template 4. Capture your Learning</b></p> | <ul style="list-style-type: none"><li>• Familiarization of the respective templates with the help of sample case study</li></ul> |
|--|---|--|--|



|  |  |   |   |  |
|--|--|---|---|--|
|  |  | <b>Ideation</b><br><br><b>3.1 Synthesis</b> <ul style="list-style-type: none"><li>• Search for meaning</li><li>• Create “How might we” question</li></ul> | <b><u>Reading assignments</u></b> <ul style="list-style-type: none"><li>• Handout on Overview of Ideation-Synthesis</li></ul> <b><u>Class Presentations</u></b> <ul style="list-style-type: none"><li>• Create insights</li><li>• “How might we” questions</li></ul> <b>Use template 5: Create Insights</b><br><br><b>Template 6: Create “How Might We’ Questions</b> | <ul style="list-style-type: none"><li>• Familiarization of the respective templates with the help of sample case study</li></ul> |
|  |  | <b>PEER REVIEW</b>  |   |  |



|  |  |  |   |  |
|--|--|--|---|--|
|  |  | <b>Implementation</b> <ul style="list-style-type: none"><li>• Create an action plan</li><li>• Community Partners (if any)</li><li>• Budgeting &amp; Fundraising<ol style="list-style-type: none"><li>1. Peer to Peer</li><li>2. Crowd Funding</li><li>3. Giving Kiosks</li><li>4. Donation</li><li>5. Envelop Funding</li><li>6. Marathons/ Walkathons</li><li>7. Conducting Yoga Classes</li></ol></li></ul> ( <a href="http://www.causevox.com">www.causevox.com</a> / <a href="http://www.blog.fundly.com">www.blog.fundly.com</a> ) <ul style="list-style-type: none"><li>• Duration</li><li>• Ethical concerns</li><li>• Launch your solution</li><li>• Feedback (Impact)</li></ul> | <b><u>Reading assignments</u></b> <ul style="list-style-type: none"><li>• Handout on Overview of Implementation</li></ul> <b><u>Class Presentations</u></b> <ul style="list-style-type: none"><li>• Pilot implementation plan with required resources and Budget indicating stake holders &amp; their enagement</li></ul> | <ul style="list-style-type: none"><li>• Familiarization of the respective templates with the help of sample case study</li></ul> |
|  |  |  |   |  |



|  |  |  |  |
|--|--|--|--|
|  | <b>5.0 Reflect</b><br><br>Reflection of the overall learning by the students | <b><u>Reading assignments</u></b> <ul style="list-style-type: none"><li>• Handout on Overview of students Reflection</li></ul> <b>Use template 9: Reflection on the Process</b><br><br><b><u>Class Presentations</u></b><br><br>Final Presentation- After Implementation | <ul style="list-style-type: none"><li>• Familiarization of the respective templates with the help of sample case study</li></ul> |
|--|--|--|--|

[BACK](#)



|  |   |                              |
|--|---|------------------------------|
| <b>Program: Biotechnology</b>                |   | <b>Semester: II</b>          |
| <b>Course Title: Engineering Physics lab</b> |   | <b>Course Code:16EPHP102</b> |
| <b>L-T-P:0-0-1</b>                           | <b>Credits:1</b>                                  | <b>Contact Hours: 2</b>      |
| <b>ISA Marks:80</b>                          | <b>ESA Marks:20</b>                               | <b>Total Marks:100</b>       |
| <b>Teaching Hours:24 Hours</b>               | <b>Examination Duration:3 Hours</b>               |                              |
| <b>List of Experiments</b>                   |   |                              |
| 1  | Experimental Data Error Analysis                  |                              |
| 2  | Coefficient of Friction                           |                              |
| 3  | Centripetal Force                                 |                              |
| 4  | Young's Modulus by Searle's method                |                              |
| 5  | The Law of Forces by three wire suspension table  |                              |
| 6  | Force Table and Vector addition of forces         |                              |
| 7  | Moment of inertia and rotational motion           |                              |
| 8  | Projectile motion                                 |                              |
| 9  | Variable g pendulum                               |                              |
| 10   | Study of one dimension motion by linear air track |                              |

[BACK](#)



|   |                                      |                              |
|---|--------------------------------------|------------------------------|
| <b>Program: Biotechnology</b>   |                                      | <b>Semester: III</b>         |
| <b>Course Title: Numerical Methods and Differential Equations</b>   |                                      | <b>Course Code:15EMAB205</b> |
| <b>L-T-P:4-0-0</b>  | <b>Credits:4.0</b>                   | <b>Contact Hours:4</b>       |
| <b>ISA Marks:50</b>   | <b>ESA Marks:50</b>                  | <b>Total Marks:100</b>       |
| <b>Teaching Hours:40</b>  | <b>Examination Duration: 3 Hours</b> |                              |
| <b>Unit I</b>   |                                      |                              |
| <b>1.Interpolation techniques</b>   |                                      |                              |
| Finite differences, Forward, Backward and central difference Operators. Newton Gregory forward and backward interpolation formulae. Sterling's formulae for central difference Newton's divided difference formula for unequal intervals.   |                                      |                              |
| <b>06 Hours</b>   |                                      |                              |
| <b>2.Matrices and System of linear equations</b>  |                                      |                              |
| Introduction to system of linear equations, Rank of a matrix by elementary row transformations. Consistency of system of linear equation solution of system by (i) Direct methods-Gauss elimination, Gauss Jordon method (ii) Iterative methods- Gauss-Seidal method. Eigen values and Eigenvectors of a matrix. Largest Eigen value and the corresponding Eigenvector by power method. Engineering problems. |                                      |                              |
| <b>08 Hours</b>   |                                      |                              |
| <b>3. Partial differential equations</b>  |                                      |                              |
| Introduction, classification of PDE, Formation of PDE, Solution of equation of the type $Pp + Qq = R$ , Solution of partial differential equation by direct integration method, Method of separation of variables.  |                                      |                              |
| <b>06 Hours</b>   |                                      |                              |
| <b>Unit II</b>  |                                      |                              |
| <b>4. Partial differential equations-Modeling:</b>  |                                      |                              |
| Vibration of one-dimensional string-wave equation and heat equation. Laplace equation. Finite difference method, finite difference solution for wave equation, heat equation and Laplace equation.  |                                      |                              |
| <b>08 Hours</b>   |                                      |                              |
| <b>5. Laplace Transforms</b>  |                                      |                              |
| Definition, transforms of elementary functions- transforms of derivatives and integrals- Properties. Periodic functions, Unit step functions and Unit impulse functions. Inverse Transforms- properties- Convolution Theorem. Applications to differential equations  |                                      |                              |
| <b>12 Hours</b>   |                                      |                              |
| FMCD2009 / 2.0  |                                      | 54                           |

**Unit III****6. Fourier Series:**

Fourier series representation of a function, Even and odd functions, half range series, Practical Harmonic Analysis.

**05 Hours****7. Fourier Transform:**

Exponential Representation of non-periodic functions, Fourier transforms properties of Fourier Transform: Fourier Sine and Cosine transforms and inverse transforms.

**05 Hours****Text Books**

1. Kreyszig E., Advanced Engineering Mathematics, 8ed, John Wiley & sons, 2003.
2. Potter M C, Jack Goldberg and Aboufadel E F, Advanced Engineering Mathematics, 3ed, Oxford Indian Edition, 2005.

**Reference Books**

1. Simmons G F and Krantz S G, Differential Equations, TATA McGraw-Hill, 2007.
2. Sastry S S, Introductory method for numerical analysis, 3ed, PHI, 2003.
3. Chapra S C and Canale R P, Numerical methods for Engineers, 5ed, TATA McGraw-Hill, 2007

[BACK](#)



|   |                                      |                              |
|---|--------------------------------------|------------------------------|
| <b>Program: Biotechnology</b>   |                                      | <b>Semester: III</b>         |
| <b>Course Title: Microbiology</b>   |                                      | <b>Course Code: 15BTC201</b> |
| <b>L-T-P:4-0-0</b>  | <b>Credits:4.0</b>                   | <b>Contact Hours:04</b>      |
| <b>ISA Marks:50</b>   | <b>ESA Marks:50</b>                  | <b>Total Marks:100</b>       |
| <b>Teaching Hours:50</b>  | <b>Examination Duration: 3 Hours</b> |                              |
| <b>Unit I</b>   |                                      |                              |
| <b>1. Introduction</b>  |                                      |                              |
| <p>The scope of Microbiology, Historical Foundations, Taxonomy and classification of microorganisms, Bergey's Manual of Systematic Bacteriology, prokaryotic and eukaryotic cells, Eubacteria and Archaeobacteria, study of different types of microorganisms: bacteria, yeasts, viruses, fungi, protozoa (structure, classification, modes of reproduction &amp; growth). Microbes and human society: Microbial applications in agriculture, veterinary, healthcare, industry and environment.</p> |                                      |                              |
| <b>05 Hours</b>   |                                      |                              |
| <b>2. Functional anatomy of Prokaryotic and Eukaryotic cells:</b>   |                                      |                              |
| <p>Size, shape and arrangement of bacterial cells, structures external to cell wall, cell wall and structures internal to cell wall including endospores. Structure and functions of eukaryotic cell. Genome structure in prokaryotic and Eukaryotic cells, Genotype &amp; Phenotype, Genetic transfer and recombination (Transformation, Conjugation &amp; Transduction), Genes and evolution.</p>   |                                      |                              |
| <b>07 Hours</b>   |                                      |                              |
| <b>3. Microscopic Examination</b>   |                                      |                              |
| <p>Bright-field Microscopy, Dark-field Microscopy, Phase-contrast Microscopy, Fluorescence Microscopy and Electron Microscopy. Preparation of specimen for light and electron microscopy. Advances in Scanned Probe Microscopy, Scanning Tunneling Microscopy, Atomic Force Microscopy.</p>   |                                      |                              |
| <b>04 Hours</b>   |                                      |                              |
| <b>4. Microbial Growth</b>  |                                      |                              |
| <p>The requirements for growth (Physical &amp; Chemical requirements), Culture media &amp; their classification, Effect of different factors on growth, Growth of bacterial culture: bacterial division, generation time, phases of growth. Fundamentals of microbial growth Kinetics. Chemostat &amp; Turbidostat, Measurement of growth: Direct and Indirect methods.</p>   |                                      |                              |
| <b>04 Hours</b>   |                                      |                              |



## Unit II

### 5. Microbial Techniques

Pure culture techniques (streak plate, spread plate, pour plate), Staining techniques (simple and differential staining techniques), Enumeration techniques (Direct Microscopic Count, plating techniques, membrane filtration, Electronic enumeration, etc). Characterization: Phenotypic and Biochemical characterization. 16S rRNA gene homology.

**10 Hours**

### 6. Microbial Metabolism

Catabolic and Anabolic reactions, Energy production, Carbohydrate catabolism: Glycolysis, Alternatives to Glycolysis, Cellular respiration, Energy production by aerobic process, Energy production by anaerobic process, Energy production by photosynthesis, Mechanism of ATP synthesis. Lipid and Protein catabolism, Photosynthesis: Light dependent and light independent reactions. Metabolic diversity among microorganisms: autotrophs and heterotrophs. Metabolic pathways of energy use: Polysaccharide biosynthesis, lipid biosynthesis, amino acid and protein biosynthesis. The integration of metabolism. Utilization of Energy and Biosynthesis: Utilization of energy for biosynthetic and non-biosynthetic processes.

**10 Hours**

## Unit III

### 7. Control & Preservation of Microorganisms

Control of microorganisms by physical methods (heat, filtration, radiation). Microbial death kinetics, Thermal death point, Thermal death time, Decimal reduction time. Control of microorganisms by chemical methods (phenols, alcohols, halogens, dyes, detergents, heavy metals, etc), Common preservation techniques for microbes.

**05 Hours**

### 8. Applied and Industrial Microbiology

Food Microbiology, role of microorganisms in food production, Industrial Microbiology: Introduction to Fermenter & fermentation processes, Media for industrial application, Industrial Products: amino acids, vitamins, enzymes, pharmaceuticals, organic acids (discussion of case study), r-DNA technology & therapeutic products from microbes. Biosynthetic pathways and Introduction to Metabolic Engineering.

**05 Hours**

**Text Books:**

1. Chan & Pelzar, Microbiology, Publisher: Tata McGraw Hill 5<sup>th</sup> Edition 2008.
2. Tortora, Microbiology: An Introduction, Publisher: Pearson Education, 8<sup>th</sup> Edition, 2004

**Reference Books:**

1. Stanier Ingraham & Wheeler, General Microbiology, Pub: Mac Millan 5<sup>th</sup> edition. 2007.
2. Heritage, Introductory Microbiology Pub: Cambridge, 1<sup>st</sup> edition, 2007

[BACK](#)

|   |                                      |                               |
|---|--------------------------------------|-------------------------------|
| <b>Program: Biotechnology</b>   |                                      | <b>Semester: III</b>          |
| <b>Course Title: Biochemistry</b>   |                                      | <b>Course Code: 15EBTC202</b> |
| <b>L-T-P:4-0-0</b>  | <b>Credits:4.0</b>                   | <b>Contact Hours:04</b>       |
| <b>ISA Marks:50</b>   | <b>ESA Marks:50</b>                  | <b>Total Marks:100</b>        |
| <b>Teaching Hours:50</b>  | <b>Examination Duration: 3 Hours</b> |                               |
| <b>Unit I</b>   |                                      |                               |
| <b>1. Biochemical Foundation &amp; Carbohydrates</b><br>Types of chemical reactions, Solution chemistry. pH (Henderson-hasselbatch equation) Buffers and their Biological importance, carbohydrates- chemical structure and properties classification- Monosaccharide's, Disaccharides, Sugar derivatives, deoxy sugars, amino sugars, and sugar acids, phosphorylated sugars, structure and properties of polysaccharides, Homopolysaccharides, Heteropolysaccharides - Peptidoglycan, Glycosaminoglycans, Glycoconjugates, Glycobiology . Biological importance of carbohydrates. |                                      |                               |
|   |                                      | <b>07 Hours</b>               |
| <b>2. Lipids</b><br>Definition and classification of lipid – simple, compound and derived lipids. Structure, classification and properties of fatty acids, Essential and non-essential fatty acid with physiological importance. Structure and physiological functions of phospholipids, Sphingolipids, cerebroside and gangliosides. Steroids- Structure and functions of cholesterol,. Eicosanoids, lipoproteins and terpenes. Vitamins-classifications and functions   |                                      |                               |
|   |                                      | <b>05 Hours</b>               |
| <b>3. Amino acids and Proteins</b><br>Definition, Classification and properties of amino acids, reactions, rare amino acids, essential and nonessential amino acids with physiological importance. Peptides - Definition of peptide bond, Biologically important peptides. Proteins – Classification- primary, secondary- Alpha helix, Beta sheets, tertiary and quaternary proteins-hemoglobin. Ramachandran plot, polypeptide sequencing- Edman degradation, Chemical synthesis of Peptides.  |                                      |                               |
|   |                                      | <b>05 Hours</b>               |
| <b>4. Nucleic acids</b><br>Structure and properties of purines, pyrimidines, nucleosides and nucleotides. Nucleic acids- Structure of DNA, RNA -Types,  |                                      |                               |
|   |                                      | <b>03 Hours</b>               |
| <b>Unit II</b>  |                                      |                               |
| <b>5. Carbohydrate metabolism</b><br>Glycolysis-aerobic and in anaerobic pathway, Energy yield of glycolysis Regulation of glycolysis- metabolic and hormonal. Fates of pyruvate. Glycogen - synthesis and degradation. Regulation  |                                      |                               |

of glycogen metabolism. Gluconeogenesis, Pentose phosphate pathway. Significance of pentose phosphate pathway and regulation. Production of Acetyl-CoA, Reactions of Citric acid cycle, Anaplerotic reactions, regulation of citric acid cycle. Glyoxylate cycle, Electron transport chain, ATP synthesis, shuttle systems and Oxidative phosphorylation. Cyclic and Non-cyclic Photophosphorylation and Calvin Cycle (C3) in plants Disorders of carbohydrate metabolism. Production of microbial polysaccharides; industrial and Medical application of exopolysaccharides.

**10 Hours**

#### **6. Metabolism of Amino acids**

General reactions of amino acid metabolism, urea cycle, amino acid biosynthesis-aspartate and glutamate family and degradation of aromatic amino acid - phenylalanine and tyrosine, metabolic disorders of amino acid metabolism, biosynthesis of plant substances and neurotransmitters, Environmental and Industrial Significance of Amino acid metabolism.

**05 Hours**

#### **7. Metabolism of Fatty acids**

Fatty acid oxidation, biosynthesis of fatty acids, Ketone bodies, phospholipids and spingolipids cholesterol biosynthesis, Regulation, metabolic disorders of lipid metabolism. Environmental and Industrial Significance of lipid metabolism

**05 Hours**

### **Unit III**

#### **8. Metabolism of Nucleic acids**

Biosynthesis and degradation of purines and pyrimidines, salvage pathway, uric acid production, regulation, metabolic disorders of nucleic acid metabolism.

**05 Hours**

#### **9. Biological Membranes And Transport Mechanism**

Composition and functions of biological membranes (fluid mosaic model) – Proteins, Carbohydrates, Glycoprotein and glycolipids, Membrane transport - Passive transport and Active transport. Mechanism of Na<sup>+</sup> and K<sup>+</sup>, glucose and amino acid transport. Role of transport in signal transduction processes.

**05 Hours**

#### **Text Books**

1. David L. Nelson, Michael M. Cox, Lehninger Principles of Biochemistry, Sixth Edition, W.H. Freeman, 2012.
2. Jeremy M. Berg, John L. Tymoczko, Lubert Stryer. , Biochemistry, 7th revised International edition, Palgrave MacMillan, 2011.



### Reference Books

1. Donald Voet and Judith G. Voet. , Biochemistry, 4th edition, Wiley; , 2010
2. Geoffrey L. Zubay, Principles of Biochemistry , Edition: 4th, William C Brown Pub, 1999.

[BACK](#)



|  |                                      |                               |
|--|--------------------------------------|-------------------------------|
| <b>Program: Biotechnology</b>  |                                      | <b>Semester: III</b>          |
| <b>Course Title: Bioprocess Calculations</b>   |                                      | <b>Course Code: 15EBTF201</b> |
| <b>L-T-P:4-0-0</b>   | <b>Credits:4.0</b>                   | <b>Contact Hours:04</b>       |
| <b>ISA Marks:50</b>  | <b>ESA Marks:50</b>                  | <b>Total Marks:100</b>        |
| <b>Teaching Hours:50</b>   | <b>Examination Duration: 3 Hours</b> |                               |
| <b>Unit I</b>  |                                      |                               |
| <b>1.Units and dimensions</b>  |                                      |                               |
| Introduction to Fundamental and derived Units. FPS, MKS, CGS and SI system. Conversion from one system to another system with examples.  |                                      |                               |
| <b>04 Hours</b>  |                                      |                               |
| <b>2.Basics of chemical calculation</b>  |                                      |                               |
| Introduction, concept of mole, Atomic mass and molar mass, composition of mixtures of solids, liquids and gaseous. Ideal gas law, Amagats law and Dalton's law. Verification of Vol %=Mol %. Physical properties of solution, normality, morality and molality. Solving problems for normality, morality and molality. |                                      |                               |
| <b>08 Hours</b>  |                                      |                               |
| <b>3.Material balances without chemical reaction</b>   |                                      |                               |
| General material balance equation, simplification for steady state without chemical reaction. Material balances of unsteady-state operation. Problems on mixing of streams, Distillation, Drying, Absorption, evaporation, Filtration, Extraction & Crystallization.   |                                      |                               |
| <b>08 Hours</b>  |                                      |                               |
| <b>Unit II</b>   |                                      |                               |
| <b>4.Material balances with chemical reaction</b>  |                                      |                               |
| Introduction, Concept of limiting, excess reactant and inerts. Conversion, yield and selectivity. Fuels and combustion-Definition of ultimate and proximate analysis of coal, air fuel ratio calculation. Problems.  |                                      |                               |
| <b>10 Hours</b>  |                                      |                               |
| <b>5.Energy Balance</b>  |                                      |                               |
| General steady state energy balance Equation. Thermopysics-Enthalpy, Heat capacities of solids, liquids and gases. Heat capacities of mixture, Thermo chemistry-Heat of combustion, formation and reaction. Effect of temperature on heat of reaction. Definition and significances of NCV and GCV and problems.       |                                      |                               |
| <b>10 Hours</b>  |                                      |                               |



### Unit III

#### 6a .Stoichiometry of microbial growth and product formation kinetics

Introduction and definition of various yield coefficients. Elemental balances and Degree of reduction. Problems.

**05 Hours**

#### 6b .Stoichiometry of microbial growth and product formation kinetics

Introduction and Basic cell kinetic models, Structured, unstructured and mixed growth kinetic models

**05 Hours**

#### Text Books

1. B.I Bhatt and S.M.Vora, Stoichiometry, Tata McGraw Hill publications, 4<sup>th</sup> edn, 2007.
2. David Himmelblau, Basic principles and calculation in chemical engineering, Pearson Education Limited, 6<sup>th</sup> edn, 2005

#### Reference Books

1. Hougen, Watson and Rigatz, Chemical Process principles Part-I, CBS Publishers & Distributors, 2<sup>nd</sup> edn, 2004.
2. J E Bailey and D F Ollis, Biochemical engineering Fundamentals, McGraw Hill Publication, 2<sup>nd</sup> edn, 1986.

[BACK](#)

|   |                                      |                               |
|---|--------------------------------------|-------------------------------|
| <b>Program: Biotechnology</b>   |                                      | <b>Semester: III</b>          |
| <b>Course Title: Unit Operations-I</b>  |                                      | <b>Course Code: 17EBTF201</b> |
| <b>L-T-P:: 3-0-0</b>  | <b>Credits:3.0</b>                   | <b>Contact Hours: 03</b>      |
| <b>ISA Marks:50</b>   | <b>ESA Marks:50</b>                  | <b>Total Marks:100</b>        |
| <b>Teaching Hours:40</b>  | <b>Examination Duration: 3 Hours</b> |                               |
| <b>Unit I</b>   |                                      |                               |
| <b>1. Basics of mass transfer</b><br>Introduction to Mass Transfer, Classification of mass transfer operations, Diffusion, Fick's law of diffusion, Vapour Liquid Equilibrium ( $T_{xy}$ & $x_y$ plots), Raoult's law, Relative volatility and its importance. Prediction of VLE data for binary mixture (Ideal system).  |                                      |                               |
|   |                                      | <b>05 Hours</b>               |
| <b>2. Distillation</b><br>Types of distillation: simple/Batch distillation, Multi stage tray tower distillation, Packed column distillation & steam distillation. Determination of theoretical stages in multistage tray tower distillation column: Construction of equilibrium curve, Equations for operating lines of rectifying section & stripping section, Equation for feed line (q-line). Concept of Reflux ratio, Types of Refluxes: Total reflux, Minimum reflux & Optimum reflux. Conceptual numerical Problems on determination of number of theoretical stages. |                                      |                               |
|   |                                      | <b>10 Hours</b>               |
| <b>Unit II</b>  |                                      |                               |
| <b>3. Drying &amp; Crystallization:</b><br>Importance of Drying, Terminologies and definitions, Drying rate curves under constant drying conditions, Drying Equipments: Tray dryer, Freeze dryer/Lyophilizer, spray dryer etc . <i>Crystallization</i> : Concept of Crystallization, Principle and Applications   |                                      |                               |
|   |                                      | <b>05 Hours</b>               |
| <b>4. Extraction</b><br>Introduction, Liquid-Liquid & Solid-Liquid Extraction Principles, selection of solvents. Batch and Continuous Extraction. Extraction Processes: Aqueous two phase Extraction, Super critical Fluid extraction.  |                                      |                               |
|   |                                      | <b>04 Hours</b>               |
| <b>5. Adsorption</b><br>Concept of Adsorption, Types of Adsorption, Adsorption Isotherms, Applications of Adsorption in Chromatography.   |                                      |                               |
|   |                                      | <b>03 Hours</b>               |



## 6. Heat transfer

Heat transfer: Introduction, Modes of heat transfer: conduction, convection and radiation. Conduction: Fourier's law of heat conduction, Thermal conductivity. Steady state heat conduction through unilayer and multilayer plain wall, Unilayer & multilayer Cylindrical pipe. Conceptual problems.

**04 Hours**

### Unit III

## 7. Convective heat transfer & Heat transfer equipment's

Forced and natural convection, individual and overall heat transfer coefficient, Correlation for  $h$  and  $U$  for the flow in circular tubes and annulus. Calculation of  $h$  (film heat transfer coefficient) based on dimensionless number, Concept of Log Mean Temperature Difference (LMTD). Typical heat transfer equipments: Double pipe heat exchanger, Shell and tube heat exchanger. (Line diagram and operation).

**05 Hours**

## 8. Condensation & Boiling

Condensation: Drop wise & Film wise condensation. Boiling: Phenomenon, different regimes of Boiling (descriptive only). Insulation, Critical thickness of Insulation.

**05 Hours**

### Text Books

1. McCabe W. L. and Smith J. C, Unit operations of chemical engineering, 7th, McGraw-Hill, 2005
2. C. J. Geankoplis, Transport Processes and unit operations, 4th, Prentice Hall of India, 2004

### Reference Books

1. George Granger Brown, Unit Operations, 1st, CBS Publishers & Distributors, 2004
2. Alan S Foust, Principles of Unit operations, 2nd, John Wiley & Sons, 1980

[BACK](#)



|   |                                      |                               |
|---|--------------------------------------|-------------------------------|
| <b>Program: Biotechnology</b>   |                                      | <b>Semester: III</b>          |
| <b>Course Title: Microbiology Lab</b>   |                                      | <b>Course Code: 15EBTP201</b> |
| <b>L-T-P:: 0-0-1</b>  | <b>Credits:1.0</b>                   | <b>Contact Hours: 03</b>      |
| <b>ISA Marks:80</b>   | <b>ESA Marks:20</b>                  | <b>Total Marks:100</b>        |
| <b>Teaching Hours:24</b>  | <b>Examination Duration: 3 Hours</b> |                               |
| <b>List of Experiments:</b> <ol style="list-style-type: none"><li>1. Laboratory safety precautions, material safety guidelines, cleaning &amp; storage practices, culture disposal practices.</li><li>2. Study of Laboratory equipments: Microscope, Autoclave, Laminar Air Flow Bench, Hot Air Oven, Bacteriological Incubator and Freeze Drier. SOP and Calibration.</li><li>3. Media preparation: Nutrient broth/Agar, Mac-Conkey's medium and Potato-Dextrose broth/Agar.</li><li>4. Micrometry: Bacterial Cell measurement</li><li>5. Pure culture techniques: Streak plate Method, Spread plate Method, Pour plate Method.</li><li>6. Isolation and enumeration of microorganisms from environmental sources. (Open-ended experiment)</li><li>7. Simple and Differential Staining Techniques (Gram staining technique).</li><li>8. Hanging drop technique for motility and Endospore staining.</li><li>9. Study of bacterial growth curve (difference between non spore former and spore former) Sterilization by Filtration and antibiotic susceptibility testing.</li></ol> |                                      |                               |
| <b>Text Books/Reference Books:</b> <ol style="list-style-type: none"><li>1. Microbiology: A Lab Manual Seventh Edition by Cappuccino J G and Sherman N 2012 Pearson education Inc, 2012 (ISBN 978-81-317-1437-9).</li><li>2. Laboratory experiments in Microbiology, Ninth Edition by Ted R. Johnson and Christine Case. Pearson Education (ISBN 978-0-321-56028-5)</li><li>3. Techniques in Microbiology: A Student Handbook by John M. Lammert. Pearson Education (ISBN 978-0-13-224011-6)</li></ol>  |                                      |                               |

[BACK](#)



|  |                                      |                               |
|--|--------------------------------------|-------------------------------|
| <b>Program: Biotechnology</b>  |                                      | <b>Semester: III</b>          |
| <b>Course Title: Biochemistry Lab</b>  |                                      | <b>Course Code: 15EBTP202</b> |
| <b>L-T-P:: 0-0-1</b>   | <b>Credits:1.0</b>                   | <b>Contact Hours: 02</b>      |
| <b>ISA Marks:80</b>  | <b>ESA Marks:20</b>                  | <b>Total Marks:100</b>        |
| <b>Teaching Hours:24</b>   | <b>Examination Duration: 3 Hours</b> |                               |
| <b>List of Experiments:</b> <ol style="list-style-type: none"><li>1. Biochemical Measurements: Molarity, Normality, Molality, Moles, weight/volume measurements, percent solution, concentration Units. pH measurements and Buffer preparation, SOP's, Instrument calibrations.</li><li>2. Qualitative analysis of carbohydrates and Lipids</li><li>3. Qualitative analysis of amino acids and proteins.</li><li>4. Estimation of reducing sugar by Folin – Wu method.</li><li>5. Estimation of reducing sugar by Nelson –Somogyi/DNS method.</li><li>6. Estimation of Amino acids by ninhydrin method.</li><li>7. Estimation of Proteins by Lowry's method.</li><li>8. Estimation of Inorganic Phosphate by Fiske-Subbarao method.</li><li>9. Estimation of Urea by DAMO method</li><li>10. Estimation of DNA by Diphenylamine method.</li><li>11. Estimation of RNA by Orcinol method.</li></ol> |                                      |                               |
| <b>Text Books/Reference Books:</b> <ol style="list-style-type: none"><li>1. David Plummer An introduction to Practical biochemistry.Third edition,McGraw-Hill,1987.</li><li>2. Sadasivam S and Manickam A.,Biochemical methods.Second edition,New Age International,2005.</li></ol>  |                                      |                               |

[BACK](#)



|  |                                      |                               |
|--|--------------------------------------|-------------------------------|
| <b>Program: Biotechnology</b>  |                                      | <b>Semester: III</b>          |
| <b>Course Title: Unit Operations-I Lab</b>   |                                      | <b>Course Code: 17EBTP201</b> |
| <b>L-T-P:: 0-0-1</b>   | <b>Credits:1.0</b>                   | <b>Contact Hours: 02</b>      |
| <b>ISA Marks:80</b>  | <b>ESA Marks:20</b>                  | <b>Total Marks:100</b>        |
| <b>Teaching Hours:24</b>   | <b>Examination Duration: 3 Hours</b> |                               |
| <b>List of Experiments:</b> <ol style="list-style-type: none"><li>1. Diffusivity measurements</li><li>2. Drying characteristics.</li><li>3. Liquid Extraction</li><li>4. Convective mass transfer</li><li>5. Simple distillation</li><li>6. Steam distillation</li><li>7. Heat transfer in packed bed</li><li>8. Vertical condenser</li><li>9. Adsorption studies</li><li>10. Leaching</li></ol> |                                      |                               |
| <b>Text Books/Reference Books:</b> <ol style="list-style-type: none"><li>1. McCabe W. L. and Smith J. C, Unit operations of chemical engineering, 7th, McGraw-Hill, 2005</li><li>2. C. J. Geankoplis, Transport Processes and unit operations, 4th, Prentice Hall of India,2004</li></ol>  |                                      |                               |

[BACK](#)



|   |                                      |                               |
|---|--------------------------------------|-------------------------------|
| <b>Program: Biotechnology</b>   |                                      | <b>Semester: IV</b>           |
| <b>Course Title: Biostatistics</b>  |                                      | <b>Course Code: 19EMAB210</b> |
| <b>L-T-P:: 3-1-0</b>  | <b>Credits:4.0</b>                   | <b>Contact Hours: 03</b>      |
| <b>ISA Marks:50</b>   | <b>ESA Marks:50</b>                  | <b>Total Marks:100</b>        |
| <b>Teaching Hours:40</b>  | <b>Examination Duration: 3 Hours</b> |                               |
| <b>Unit I</b>   |                                      |                               |
| <b>1. Statistics</b>  |                                      |                               |
| Introduction, Scope of biostatistics, Variables, Measurement scales, Ordered array, Graphical representation of data: histogram, frequency curve, Ogive curves. Descriptive statistics: Measure of central tendency (arithmetic mean, median, mode, quartiles); Measures of dispersion (Quartile deviation, Standard deviation, coefficient of variation), Measure of skewness(Pearson and Bowley's)  |                                      |                               |
| <b>05 hours</b>   |                                      |                               |
| <b>2.Bivariate Distribution Fitting of curves</b>   |                                      |                               |
| Correlation, linear regression, curve fitting (non-linear and exponential).   |                                      |                               |
| <b>04 Hours</b>   |                                      |                               |
| <b>3. Probability</b>   |                                      |                               |
| Definition of probability, addition rule, conditional probability, multiplication rule, Baye's rule, sensitivity, specificity, predictive value positive and negative, Probability in Genetics: Punnett square, Hardy - Weinberg law, Wahlund's Principle   |                                      |                               |
| <b>06 Hours</b>   |                                      |                               |
| <b>4. Probability distributions</b>   |                                      |                               |
| Discrete probability distributions - Binomial, Poisson, Continuous Probability Distribution – Normal, Exponential, Gamma distribution   |                                      |                               |
| <b>05 Hours</b>   |                                      |                               |
| <b>Unit II</b>  |                                      |                               |
| <b>5. Sampling and Statistical Inference</b>  |                                      |                               |
| Introduction, Sampling, Sampling distribution, sample size determination, Confidence intervals, Tests of hypothesis, p-value, t-test for single mean, difference of mean (with equal variance and unequal variance), paired t-test, Chi Square test for goodness of fit and independence of attributes, analysis of variance (one-way and two-way classifications). Case studies of statistical designs of biological experiments (RCBD, RBD) |                                      |                               |

**10 Hours**
**6. Design of Experiments-1**

Introduction, OFAT,  $2^2$  and  $2^3$  factorial experiments: Data table, Graphical representation, Main and interaction effects, ANOVA Table

**05 Hours**
**Unit III**
**7. Design of Experiments -2**

Fractional factorial design, Placket-Burman design, Response Surface Methods-Central Composite Design

**06 Hours**
**8. Population Growth Models**

Introduction, Discrete time and continuous growth, Density Independent growth model: Geometric and Exponential growth model, Density dependent growth: Logistic growth model

**05 Hours**
**Text Books**

1. Gupta S C and Kapoor V K, Fundamentals of Mathematical Statistics, 11<sup>th</sup> Ed, Sultan Chand & Sons, New Delhi, 2000.
2. J. Susan Milton, Jesse C. Arnold, Introduction to Probability and Statistics: Principles and Applications for Engineering and the Computing Sciences, 4<sup>th</sup> Ed, TATA McGraw-Hill Edition 2007.

**Reference Books**

1. Miller, Freud and Johnson, Probability and Statistics for Engineering, 5Ed, PHI 2000.
2. Sundar Rao P.S.S and Richard J, An Introduction to Biostatistics, 3Ed, Prentice Hall of India, 2003.
3. Marcello Pagano and Kimberlee Gauvreau, Principles of Biostatistics, 2Ed, Thompson Learning, 2000.

[BACK](#)



|   |                                      |                               |
|---|--------------------------------------|-------------------------------|
| <b>Program: Biotechnology</b>   |                                      | <b>Semester: IV</b>           |
| <b>Course Title: Immunology</b>   |                                      | <b>Course Code: 15EBTC203</b> |
| <b>L-T-P:: 3-0-0</b>  | <b>Credits:3.0</b>                   | <b>Contact Hours: 04</b>      |
| <b>ISA Marks:50</b>   | <b>ESA Marks:50</b>                  | <b>Total Marks:100</b>        |
| <b>Teaching Hours:40</b>  | <b>Examination Duration: 3 Hours</b> |                               |
| <b>Unit I</b>   |                                      |                               |
| <b>1. Immune system</b><br>History and Scope of Immunology and Immune system, Classification of Immune system, Types of Immune responses, Molecules ,Cells and Organs of Immune system and Anatomy of immune response.  |                                      |                               |
|   |                                      | <b>06 Hours</b>               |
| <b>2. Humoral Immunity</b><br>Overview of Humoral immunity, B- Lymphocytes – Development and their activation, Antibody response, Structure and functions of Immunoglobulins, Classes and sub-classes of immunoglobulins, genetic control of antibody production, Monoclonal and Polyclonal antibodies, Production of Monoclonal antibodies and quality screening processes in large scale monoclonal antibody production |                                      |                               |
|   |                                      | <b>05 Hours</b>               |
| <b>3. Cell Mediated Immunity</b><br>Overview of cell mediated immunity and its significance, T-Lymphocytes – Development, Types and their activation, Major Histocompatibility (MHC) Complex, Antigen Presenting Cells (APC) and antigen processing and presentation, Mechanism of Phagocytosis- Oxygen dependent and Oxygen independent.   |                                      |                               |
|   |                                      | <b>04 Hours</b>               |
| <b>Unit II</b>  |                                      |                               |
| <b>4. Regulation of Immune Response and Immune tolerance</b><br>Immune response – Nature and necessity of its regulation, Complement System- Types, activation and types and their biological applications, Cytokines – types and their role in immune response, Immune Tolerance and their types, Hypersensitivity reactions – Types and Treatments. <b>Food allergy</b> , Case study on mechanism of immunity booster.  |                                      |                               |
|   |                                      | <b>05 Hours</b>               |
| <b>5. Immunological disorders</b><br>Auto immune disorders – Features, important types and Experimental models of auto immune diseases Immunodeficiency Disorders – Types and features.   |                                      |                               |
|   |                                      | <b>04 Hours</b>               |



## **6. Transplantation immunology**

Transplantation antigens – Types and functions, Types of Transplantations, Immunological basis of Graft rejection , and their disease association, Role of HLA in graft rejection, Tumor specific antigens, Tissue typing, Immune suppression and immune suppressive drugs.

**06 Hours**

### **Unit III**

## **7. Molecular Immunology**

Vaccines – Types and their development, Production of Recombinant DNA vaccines, Application of PCR technology to produce antibodies, Immune Therapy with genetically engineered antibodies, Catalytic antibodies, immunotherapeutic applications of hematopoietic stem cells, Purification and preparation of antigens in vaccine development and Immunoinformatics.

**06 Hours**

## **8. Immunodiagnosis**

Immunization and Antiserum, Antigen-Antibody interactions – Precipitation reactions and Agglutination reactions Immuno-electrophoresis and Immunofluorescence assay, Principle and applications of ELISA and RIA and Western blotting analysis.

**04 Hours**

### **Text Books**

1. Janis. Kuby, Immunology, V, WH Freeman and Company, 2003
2. Pandian and Senthil Kumar, Immunology and Immunotechnology , Panima Publishing Corporation, 2007

### **Reference Books**

- 1 P.M. Ladyard, Immunology , Bios Scientific Publishers Ltd , 2000
- 2 Roitt I, Essential Immunology, Blackwell Scientific Publications.

[BACK](#)



|   |                                      |                               |
|---|--------------------------------------|-------------------------------|
| <b>Program: Biotechnology</b>   |                                      | <b>Semester: IV</b>           |
| <b>Course Title: Enzyme Technology</b>  |                                      | <b>Course Code: 17EBTC201</b> |
| <b>L-T-P:: 4-0-0</b>  | <b>Credits:4.0</b>                   | <b>Contact Hours: 04</b>      |
| <b>ISA Marks:50</b>   | <b>ESA Marks:50</b>                  | <b>Total Marks:100</b>        |
| <b>Teaching Hours:50</b>  | <b>Examination Duration: 3 Hours</b> |                               |
| <b>Unit I</b>   |                                      |                               |
| <b>1. Introduction to enzymes</b><br>History, nomenclature, classification of enzymes, sources of enzymes, properties of enzyme, Types of specificities, mechanism of enzyme action-Lock and Key model and Induced fit model, Enzyme catalysis -Acid base catalysis, covalent catalysis, metal ion catalysis, Proximity and orientation effects. Mechanism of coenzymes (NAD/NADP,FAD/FADH <sub>2</sub> ,PLP, Coenzyme A, TPP, Biotin)  |                                      |                               |
|   |                                      | <b>07 Hours</b>               |
| <b>2. Purification of enzymes</b><br>Objectives and strategies in enzyme purification, choice of source-plant, animal and microbial, purification of intracellular and extracellular enzymes (Comprehensive flow sheet for enzyme purification),methods of homogenization, methods of separation-Enzyme fractionation by precipitation (using Temperature, salt, solvent, pH, etc.), liquid-liquid extraction, ionic exchange, gel chromatography, affinity chromatography and other special purification methods., Methods of characterization of enzymes; Analysis of yield, purity and activity of enzymes. Molecular weight determination-SDS-PAGE, MALDI-TOF |                                      |                               |
|   |                                      | <b>08 Hours</b>               |
| <b>3. Enzymatic techniques</b><br>Enzyme assay, Enzyme and isoenzyme measurement methods with examples(fixed incubation and kinetic methods) Methods for investigating the kinetics of Enzyme catalyzed reactions-Initial velocity studies, rapid-reaction techniques, Standardization and optimization methods, stability and activity of enzymes  |                                      |                               |
|   |                                      | <b>05 Hours</b>               |
| <b>Unit II</b>  |                                      |                               |
| <b>4. Enzyme Kinetics and Enzyme Inhibitions.</b><br>Kinetics of single substrate reactions; Derivation of Michaelis -Menten equation, turnover number; K <sub>cat</sub> value, determination of Km and Vmax, Line Weaver Burk plot, Eadie Hofstee plot, Hanes woolf plot, Importance of Km & Vmax; Enzyme inhibitions- reversible, competitive, uncompetitive and non-competitive inhibitions and kinetics, allosteric and irreversible inhibition. Substrate inhibitions, Multi-substrate reactions-ordered mechanisms, random  |                                      |                               |

mechanisms, Ping-pong mechanism. Allosteric enzymes and regulation - The Monod - Changeux - Wyman model (MCW) and The Koshland - Nemethy - Filmer (KNF) model, Feedback regulation and covalent regulation.

**07 Hours**

### 5. Enzymes Of Medical Importance

Acetylcholinesterase, angiotensin converting enzyme (ACE), ACE Inhibitors, HMG Co A reductase inhibitors, pseudocholinesterase, 5'-nucleotidase (5NT), glucose-6-phosphate dehydrogenase (GPD), CKisoforms, immunoreactive trypsinogen (IRT) and chymotrypsin; amylase isoenzymes. Importance of enzymes in diagnostics, Enzyme pattern in diseases like Myocardial infarctions, (SGOT, SGPT & LDH). Isoenzymes (CK, LD, ALP). Enzymes in immunoassay techniques, Therapeutic enzymes.

**07 Hours**

### 6. Enzyme Immobilization

Techniques of enzyme immobilization, adsorption - matrix entrapment- encapsulation- cross-linking - covalent binding - examples; whole cell immobilization and their application, kinetics of immobilized enzymes, effect of solute, partition & diffusion on the kinetics of immobilized enzymes, uses of immobilized enzymes, Design of Immobilized Enzyme Reactors- Stirred tank reactors (STR), Continuous Flow Stirred Tank Reactors (CSTR), Packed- bed reactors (PBR), Fluidized-bed Reactors (FBR); Membrane reactor

**06 Hours**

## Unit III

### 7. Industrial Applications of enzymes:

Enzymes used in detergents, use of proteases in food, leather and wool industries, uses of lactase in dairy industry, methods involved in production of glucose and maltose syrup from starch (using starch hydrolyzing enzymes), Glucose from cellulose, glucose oxidase and catalase in food industry,

**05 Hours**

### 8. Enzyme transformation and Enzyme Biosensors

The design and construction of novel enzymes- Enzyme Engineering and site directed mutagenesis, Designer enzymes, synzymes, Biocatalysts from extreme Thermophilic and Hyperthermophilic microorganisms (extremozymes) Elements of biosensors, Design of enzyme electrodes and their applications as biosensors in industry, health care and environment.

**05 Hours**

### Text Books

1. David L. Nelson, Michael M. Cox, Lehninger Principles of Biochemistry. , 6, W.H. Freeman, 2012



2. Trevor Palmer, 2. Enzymes: Biochemistry, Biotechnology and Clinical Chemistry, 1, East-West Press Pvt. Ltd, 2004

#### References

1. Laurence A. Moran, Raymond S. Ochs, J. David Rawn, and K. Gray Scrimgeour. , Principles of biochemistry., 3, Prentice Hall, 2002
2. Faber, Biotransformation in Organic Chemistry , 4, Springer, 2000  
Aehle W, Enzymes in industry- production and applications, 3, Wiley-VCH, 2007
3. Nicholas .C. Price and Lewis Stevens, Fundamentals of Enzymology , 3, Oxford University Press , 1991

[BACK](#)

|  |                                      |                               |
|--|--------------------------------------|-------------------------------|
| <b>Program: Biotechnology</b>  |                                      | <b>Semester: IV</b>           |
| <b>Course Title: Cell and Molecular Biology</b>  |                                      | <b>Course Code: 15EBTC205</b> |
| <b>L-T-P:: 4-0-0</b>   | <b>Credits:4.0</b>                   | <b>Contact Hours: 04</b>      |
| <b>ISA Marks:50</b>  | <b>ESA Marks:50</b>                  | <b>Total Marks:100</b>        |
| <b>Teaching Hours:50</b>   | <b>Examination Duration: 3 Hours</b> |                               |
| <b>Unit I</b>  |                                      |                               |
| <b>1. Cell Biology and Biotechnology</b>   |                                      |                               |
| Organization of Prokaryotic and Eukaryotic cells. Structure and functions of membranes, nucleus, endoplasmic reticulum, Golgi complex, mitochondria, chloroplast and vacuoles. Cell division, Cell Cycle regulation and Cancer. Applications of cell biology and its principles in Genetic Engineering and Microbial, Plant & Animal Biotechnology   |                                      |                               |
| <b>05 Hours</b>  |                                      |                               |
| <b>2. Molecular Biology and Nucleic Acids</b>  |                                      |                               |
| Development and scope of Molecular Biology, Central Dogma of Molecular Biology and its updated view, Classical experiments and Nucleic acids as genetic material, Overview of Genome: Viral genome, bacterial genome, Mitochondrial genome, Eukaryotic genome. Organization of Prokaryotic and Eukaryotic genome/Chromosomes. Typical Gene structure in Prokaryotes and Eukaryotes. Structure and forms of nucleic acids, factors determine the structure of DNA. Denaturation and melting curves. Overview of Isolation, Purification, Estimation and Storage of Nucleic acids. |                                      |                               |
| <b>10 Hours</b>  |                                      |                               |
| <b>3. Replication of DNA</b>   |                                      |                               |
| An overview and Basic rules for DNA Replication, Enzymes and proteins of DNA Replication, DNA Replication is Semi conservative, Origin of DNA Replication, Replicon and Replication fork, Unidirectional and Bidirectional replication of DNA, Mechanism of DNA replication in prokaryotes and in Eukaryotes.  |                                      |                               |
| <b>05 Hours</b>  |                                      |                               |
| <b>Unit II</b>   |                                      |                               |
| <b>4. Transcription</b>  |                                      |                               |
| General features of Transcription process, Types of RNA molecules, Prokaryotic and eukaryotic RNA polymerases, Promoter structure and Mechanism of transcription in prokaryotes and eukaryotes, Post transcriptional modifications of mRNA, tRNA and rRNA, Transcription inhibitors  |                                      |                               |
| <b>05 Hours</b>  |                                      |                               |

## 5. Translation

Features of Genetic code and Wobble hypothesis, Overview of protein synthesis, Components required for protein synthesis, Mechanism of protein synthesis in prokaryotes and eukaryotes, Post-translational modifications and Protein targeting, Inhibitors in translation

**04 Hours**

## 6. Regulation of Gene Expression in Prokaryotes and Eukaryotes.

Regulation of gene activity, Gene regulation in Prokaryotes: Constitutive, Inducible and repressible gene expression systems, Operon model for gene expression regulation in prokaryotes, Positive and Negative regulation of – Lac Operon – Regulation, Catabolic repression and Gratuitous inducers etc, Trp Operon and Gal Operon. Gene regulation in Eukaryotes, Regulation of Gene expression at Genome level, Transcriptional level –Acetylation of Histones, Chromatin remodeling, DNA Methylation, DNA elements, Transcription factors, Insulators, Regulatory proteins and Hormones. Gene regulation at Post transcriptional level – Splicing, RNA interference, Transport of mRNA and by regulating mRNA stability.

**07 Hours**

## 7. Mutations and DNA Repair

Mutation – Source of genetic variability, basic features of Mutation process, Molecular basis of Mutation, Conditional lethal mutations as a powerful tool for genetic studies and Ames test of Mutagenicity testing. DNA damage and different types of DNA repair systems and Human diseases.

**04 Hours**

### Unit III

## 8. Polymerase Chain Reaction

Principle of polymerase chain reaction (PCR) - Components of PCR reaction and optimization of PCR. Primer design and types of PCR– Inverse PCR, Hot-start PCR, Loop mediated PCR -, Reverse transcription PCR and Real time PCR. Chemistry of primer synthesis.

**05 Hours**

## 9. Analysis of Gene Expression

Analyzing Transcription – Northern Blots, RNase protection assay, Reverse Transcription (RT) PCR and Primer extension assay. Transcriptome Analysis – Differential screening and Array based methods. Promoter activity study – Reporter genes and Run-On assays. Translational



Analysis – Western Blots and 2-D Analysis.

**05 Hours**

**Text Books**

1. Cell and Molecular Biology – S C Rastogi, New Age International Publishers, New Delhi (1996).
2. Fundamentals of Molecular Biology Ane's Student Edition. - Veer Bala Rastogi, Ane Books India, New Delhi (2008)

**Reference Books**

1. Instant Notes in Molecular Biology – P.C. Turner, Viva Series Publishing, New Delhi
2. Essentials of Molecular Biology – V Malathi, Dorling Kindersley (India) Pvt Ltd, New Delhi (2013).

[BACK](#)

|  |                                      |                               |
|--|--------------------------------------|-------------------------------|
| <b>Program: Biotechnology</b>  |                                      | <b>Semester: IV</b>           |
| <b>Course Title: Unit Operations-II</b>  |                                      | <b>Course Code: 17EBTF202</b> |
| <b>L-T-P:: 3-0-0</b>   | <b>Credits:3.0</b>                   | <b>Contact Hours: 40</b>      |
| <b>ISA Marks:50</b>  | <b>ESA Marks:50</b>                  | <b>Total Marks:100</b>        |
| <b>Teaching Hours:40</b>   | <b>Examination Duration: 3 Hours</b> |                               |
| <b>Unit I</b>  |                                      |                               |
| <b>1. Basic concepts</b><br>Fluid definition, Properties of biological fluids, Classification of biological fluids, Types of fluid flow, Reynolds number, pressure measurement devices: manometers, Bourdon gauge, bellow gauge, capsule gauge, Hydrostatic equilibrium, Newton's law of viscosity.  |                                      |                               |
|  |                                      | <b>04 Hours</b>               |
| <b>2. Fluid dynamics</b><br>Basic equations of fluid flow: Mass balance, Continuity equation, Bernoulli's equation, Laminar Flow through Circular pipe, Velocity and shear stress distribution, Boundary layer, Boundary layer separation, minor loss and major loss.  |                                      |                               |
|  |                                      | <b>05 Hours</b>               |
| <b>3. Flow past immersed bodies</b><br>Drag, lift, Drag coefficient, Kozney- Carman equation, Ergun's Equation. Motion of particles through fluids, Settling, Types of settling, Stoke's law, Newton's law, Criteria for settling regime, Numerical problems.  |                                      |                               |
|  |                                      | <b>06 Hours</b>               |
| <b>Unit II</b>   |                                      |                               |
| <b>4. Transportation and metering of liquids</b><br>Pipe and tube, joints and fittings, valves—Diaphragm/pneumatic valve, pinch valve, ball valve, plug valve. Pumps: peristaltic pumps, sinusoidal pumps, single use diaphragm pumps. Characteristic curves of a pump, Measurement of fluid flow rates, venturimeter, rotameter, pitot tube, vortex-shedding meter, turbine meter, magnetic meters, ultrasonic meters, thermal meters. Numerical problems |                                      |                               |
|  |                                      | <b>08 Hours</b>               |
| <b>5. Mechanical separations</b><br>Filtration, Filter media, Filter aids, factors affecting rate of filtration, specific cake resistance, media resistance. Types of filters, Membrane processes—ultra filtration and microfiltration, Filtration equipment: rotary drum filter, leaf filter. Sedimentation, Kynch theory of sedimentation, Thickener, Numerical problems.  |                                      |                               |
|  |                                      | <b>07 Hours</b>               |



### Unit III

#### 6. Mixing and agitation of liquids

Mixing and Agitation, Flow patterns in agitated tanks, Mechanism of mixing, Estimation of mixing time, Types of Impellers & propellers, Standard turbine design, Numerical problems.

**05 Hours**

#### 7. Dimensional Analysis and similitude

Units and dimensions, Dimensionless number, Rayleigh and Buckingham  $\pi$  theorem. Model and prototype. Similitude. Problems on Rayleigh and Buckingham  $\pi$  theorem.

**05 Hours**

#### Text Books:

1. Unit operations of chemical engineering by McCabe W. L., Smith J. C, and Peter Harriott, 7<sup>th</sup> edition, McGraw-Hill, 2005.
2. Transport Processes and Separation Process Principles by C. J. Geankoplis, 4<sup>th</sup> edition, Prentice Hall of India, 2004.

#### Reference Books:

1. Fluid Mechanics by John F. Douglas, Janusz M. Gasiorek, John A. Swaffield, 4<sup>th</sup> edition, Pearson Education limited 2007.
2. Principles of Unit operations by Alan S Foust, 2<sup>nd</sup> edition, John Wiley & Sons, 2005.
3. Engineering Fluid Mechanics by K. L. Kumar, 7<sup>th</sup> edition, Eurasia Publishing house (P) Ltd, 2007.

[BACK](#)



|   |                                      |                               |
|---|--------------------------------------|-------------------------------|
| <b>Program: Biotechnology</b>   |                                      | <b>Semester: IV</b>           |
| <b>Course Title: Enzyme Technology Lab</b>  |                                      | <b>Course Code: 15EBTP204</b> |
| <b>L-T-P:: 3-0-0</b>  | <b>Credits:3.0</b>                   | <b>Contact Hours: 40</b>      |
| <b>ISA Marks:80</b>   | <b>ESA Marks:20</b>                  | <b>Total Marks:100</b>        |
| <b>Teaching Hours:24</b>  | <b>Examination Duration: 3 Hours</b> |                               |
| <b>List of Experiments</b> <ol style="list-style-type: none"> <li>1. Biochemical Measurements: Molarity, Normality, Molality, Moles, weight/volume measurements, percent solution, concentration Units. pH measurements and Buffer preparation, SOP's, Instrument calibrations.</li> <li>2. Determination of activity of amylase enzyme</li> <li>3. Estimation of protein content of amylase and specific activity</li> <li>4. Effect of temperature on enzyme activity</li> <li>5. Effect of pH on enzyme activity</li> <li>6. Effect of substrate concentration on enzyme activity</li> <li>7. Effect of enzyme concentration on enzyme activity</li> <li>8. Effect of inhibitor on enzyme activity</li> <li>9. Enzyme immobilization and kinetics of immobilized enzyme</li> <li>10. Molecular weight determination by SDS PAGE</li> <li>11. Staining the gel using CBB and silver staining</li> </ol> |                                      |                               |
| <b>Text Books/ Reference Books:</b> <ol style="list-style-type: none"> <li>1. Introduction to Practical biochemistry – David Plummer, McGraw-Hill Publishing Co, 3<sup>rd</sup> edition, pp:332.</li> <li>2. Biochemical methods- Sadasivam and Manickam(1996), New Age International Publishers, 2<sup>nd</sup> edition, pp256.</li> <li>3. Experimental Biochemistry – A Student Companion by Beedu Shashidhar Rao and Vijay Deshpande.(2005) I.K International Pvt. Ltd, New Delhi. pp301</li> </ol>   |                                      |                               |

[BACK](#)

|  |                                      |                               |
|--|--------------------------------------|-------------------------------|
| <b>Program: Biotechnology</b>  |                                      | <b>Semester: IV</b>           |
| <b>Course Title: Cell and Molecular Biology Lab</b>  |                                      | <b>Course Code: 15EBTP205</b> |
| <b>L-T-P:: 0-0-1</b>   | <b>Credits:1.0</b>                   | <b>Contact Hours: 02</b>      |
| <b>ISA Marks:80</b>  | <b>ESA Marks:20</b>                  | <b>Total Marks:100</b>        |
| <b>Teaching Hours:24</b>   | <b>Examination Duration: 3 Hours</b> |                               |
| <b>List of Experiments</b> <ol style="list-style-type: none"> <li>1. Basic Calculations and Solutions preparation skills and Good Lab Practices(GLPs)for the Molecular biology lab</li> <li>2. Study <b>SOPs</b> of Cell and Molecular Biology laboratory equipments – Table top cooling Centrifuge, UV – Visible Spectrophotometer, PCR machine and Gel Documentation system.</li> <li>3. Staining and microscopic observation of plant/animal cells and chromosomes</li> <li>4. Study of Mitosis and Meiosis Cell Divisions</li> <li>5. Isolation of genomic DNA from Bacteria/ Plant/ Animal cells</li> <li>6. UV Spectrophotometric analysis of DNA and RNA</li> <li>7. Calculation of T<sub>m</sub> value of isolated DNA sample</li> <li>8. Agarose gel electrophoresis and gel elution method.</li> <li>9. Isolation and agarose gel electrophoresis estimation of Plasmid DNA</li> <li><b>10.</b> Extraction of Total RNA from different biological sources</li> </ol> |                                      |                               |
| <b>Text Books/ Reference Books</b> <ol style="list-style-type: none"> <li>1. Cell and Molecular Biology – A Lab Manual K V Chaitanya PHI Learning Private Limited Delhi – 110092, 2013.</li> <li>2. Molecular Cloning Volumes I, II and III – Sambrook J <i>et al</i> (2000) Cold Spring Harbour Laboratory Press, 2000</li> </ol>   |                                      |                               |

[BACK](#)



|  |                                      |                               |
|--|--------------------------------------|-------------------------------|
| <b>Program: Biotechnology</b>  |                                      | <b>Semester: IV</b>           |
| <b>Course Title: Unit Operations-II Lab</b>  |                                      | <b>Course Code: 17EBTP202</b> |
| <b>L-T-P:: 0-0-1</b>   | <b>Credits:1.0</b>                   | <b>Contact Hours: 02</b>      |
| <b>ISA Marks:80</b>  | <b>ESA Marks:20</b>                  | <b>Total Marks:100</b>        |
| <b>Teaching Hours:24</b>   | <b>Examination Duration: 3 Hours</b> |                               |
| <b>List of Experiments</b> <ol style="list-style-type: none"><li>1. Pressure drop correlations through packed bed.</li><li>2. Studies on sedimentation.</li><li>3. Studies on agitation and mixing</li><li>4. Constant pressure filtration using leaf filter</li><li>5. Pressure drop correlations through circular pipes</li><li>6. Study of fluid flow patterns</li><li>7. Terminal settling velocity</li><li>8. Studies on Bernoulli's equation</li><li>9. Studies on flowmeter</li></ol> |                                      |                               |
| <b>Text Books/ Reference Books:</b> <ol style="list-style-type: none"><li>1. Unit operations of chemical engineering by McCabe W. L., Smith J. C, and Peter Harriott, 7<sup>th</sup> edition, McGraw-Hill, 2005.</li><li>2. Transport Processes and Separation Process Principles by C. J. Geankoplis, 4<sup>th</sup> edition, Prentice Hall of India, 2004.</li></ol>   |                                      |                               |

[BACK](#)

|   |                                      |                               |
|---|--------------------------------------|-------------------------------|
| <b>Program: Biotechnology</b>                             |                                      | <b>Semester: V</b>            |
| <b>Course Title: Genetic Engineering and Applications</b> |                                      | <b>Course Code: 15EBTC301</b> |
| <b>L-T-P:: 4-0-0</b>                                      | <b>Credits:4.0</b>                   | <b>Contact Hours: 4</b>       |
| <b>ISA Marks:50</b>                                       | <b>ESA Marks:50</b>                  | <b>Total Marks:100</b>        |
| <b>Teaching Hours:50</b>                                  | <b>Examination Duration: 3 Hours</b> |                               |

### Unit I

#### 1. Basics of Recombinant DNA technology

Development and Scope of Recombinant DNA Technology and Genetic Engineering. Emergence and commercialization of Molecular Biotechnology. Ethical, Social, Economical and Political issues related to Gene modification and Genetic Engineering. Gene Cloning: Introduction and Steps involved in gene cloning. Subcloning and its applications. Vectors in GE - biology, features, types, cloning & expression vectors

**06 Hours**

#### 2. Enzymes in Genetic Engineering

DNA modifying enzymes and necessity of DNA modification in gene cloning. Enzymes used for DNA modification. Restriction Endonucleases, classification & mode of action, Role and applications of different DNA modifying enzymes in gene cloning process - DNA Polymerases, Reverse Transcriptase, RNA Polymerase, Alkaline Phosphatases, Polynucleotide Kinase and DNA Ligases etc.

**05 Hours**

#### 3. Molecular Cloning Strategies and Genetic Transformation

Isolation and purification of nucleic acid (genomic/plasmid DNA and RNA), Quantification on and storage of nucleic acids, Construction of cDNA library, Construction of Genomic library, Screening and preservation of DNA libraries. DNA Cloning – Methods and applications. Genetic Transformation of prokaryotes and DNA Transfection in Eukaryotic hosts. Biological and Non-biological methods of gene transfer in hosts. Chloroplast transformation.

**09 Hours**

### Unit II

#### 4. Selection, Screening and Analysis of Recombinants

Introduction to screening and analysis of recombinants. Genetic selection and screening methods - Selectable Marker genes, Reporter genes. Screening using Nucleic acid hybridization methods - Preparation of probes for hybridization experiments and different blotting techniques. Screening by PCR based methods. Screening by Immunological methods

and Analysis of cloned genes.

**07 Hours**

### **5. Production of Proteins from Cloned Genes**

Introduction to recombinant gene expression, scope and applications of recombinant gene expression. Special vectors for expression of foreign genes in E coli. General problems with the production of recombinant protein in E coli. Production of recombinant proteins by Eukaryotic cells.

**07 Hours**

### **6. Directed Mutagenesis and Protein Engineering**

Oligonucleotide – Directed Mutagenesis with M13 DNA, Plasmid DNA, PCR Amplification etc. Protein Engineering – Meaning and Scope, Protein Engineering for adding disulphide bonds, increasing enzymatic activity, decreasing protease sensitivity, modifying protein specificity, Increasing enzyme stability and specificity etc.

**06 Hours**

## **Unit III**

### **7. Genetic Engineering and Microbial Biotechnology**

Genetic manipulation of Microorganisms – Introduction and scope. Applications of Recombinant Microorganism – Production of recombinant therapeutic proteins, Production of Antibiotics, Combating Human diseases, Microbial pesticides, EffilSant utilization of Carbohydrates and Bioremediation or Environmental cleanup.

**05 Hours**

### **8. Plant and Animal Transgenic Technology and Applications**

Applications of Transgenic Plant Technology – Development of Insect resistant plants, Herbicide resistant plants, Pathogens resistant plants, and Abiotic stress tolerant plants. Plants as Bioreactors for large scale production. Applications of Animal cloning and Transgenic technology - Cloning in Domestic animals. Applications of Transgenic Animals - as research models, and as bioreactors for large scale production of substances for Human welfare.

**05 Hours**

### **Text Books**

1. Genetic Engineering by Smitha Rastogi and Neelam Pathak, Oxford University Press, USA (2009)
2. Molecular Biotechnology – Principles and applications of Recombinant DNA by Bernard r Glick and Jack J Pasternak, ASM Press, American SoISAty for Microbiology, Washington DC 2003



### Reference Books

1. Gene Cloning and DNA Analysis by T A Brown. Wiley-Blackwell (2010)
2. An Introduction to Genetic Engineering – Third Edn By Desmond S T Nicholl, Cambridge University Press, Singapore 2008.

[BACK](#)

|  |                                      |                               |
|--|--------------------------------------|-------------------------------|
| <b>Program: Biotechnology</b>  |                                      | <b>Semester: V</b>            |
| <b>Course Title: Bioinformatics</b>  |                                      | <b>Course Code: 19EBTC301</b> |
| <b>L-T-P:: 4-0-0</b>   | <b>Credits:4.0</b>                   | <b>Contact Hours: 04</b>      |
| <b>ISA Marks:50</b>  | <b>ESA Marks:50</b>                  | <b>Total Marks:100</b>        |
| <b>Teaching Hours:50</b>   | <b>Examination Duration: 3 Hours</b> |                               |
| <b>Unit - I</b>  |                                      |                               |
| <b>1.Database</b><br>Bioinformatics: Definition, components, multidisciplinary nature, and applications of bioinformatics; Databases: Introduction, meaning, types and characteristics of databases, types of databases, Biological database: Classification, Primary Database: NCBI, Genbank, DDBJ, EMBL. File formats, Secondary Database: PROSITE, PIR, UNIPROT, BLOCKS, Pfam; metabolic pathway database: KEGG, Structure Database: PDB, MMBD, CATH, SCOP; Ligand Database, Enzyme database, human disease database, microbial and viral genome database, structure visualization tools. |                                      |                               |
|  |                                      | <b>07 Hours</b>               |
| <b>2.Pairwise Sequence Alignment</b><br>Pairwise sequence alignment: Definition, significance, and applications; Types of pairwise sequence alignment: Local and Global alignment; Methods of pairwise sequence alignment: Dot matrix, Dynamic programming: features of dynamic programming, Global Alignment: Needleman & Wunsch Algorithm, Local Alignment: Smith – Waterman Algorithm, and Word method: BLAST, PSI-BLAST, PHI-BLAST and FASTA; Substitution matrices: PAM and BLOSUM; gap penalties.  |                                      |                               |
|  |                                      | <b>08 Hours</b>               |
| <b>3.Multiple Sequence Alignment</b><br>Multiple Sequence Alignment: Meaning, significance, and applications; Methods of MSA: Progressive Alignment methods, Iterative methods, Local Multiple sequence Alignment: Profile Analysis, BLOCK analysis, Pattern searching and Motif analysis, Statistical methods or Probabilistic models; Multiple Sequence Alignment editors.   |                                      |                               |
|  |                                      | <b>05 Hours</b>               |
| <b>Unit - II</b>   |                                      |                               |
| <b>4.Phylogenetics analysis</b><br>Phylogenetic analysis: Meaning and significance; Concepts of evolutionary trees: Tree terminology, types of phylogenetic trees; fundamentals of phylogenetic models, Phylogenetic Data Analysis: Alignment: Building the data model, and extraction of phylogenetic data set; Determining substitution models: Models of Substitution Rates Between Bases, Models of  |                                      |                               |

Among-Site Substitution Rate Heterogeneity, Models of Substitution Rates Between Amino Acids; Tree Building methods: Distance based methods: Neighbor Joining (NJ) method, Fitch-Margoliash (FM) method; Character based methods: Maximum parsimony, Maximum Likelihood; Tree Evaluation methods, Phylogenetic Softwares

**07 Hours**

### **5. Gene Prediction**

Gene structure, Prokaryote and Eukaryote gene prediction, Prokaryote and Eukaryote promoter site prediction Gene Prediction tools, Genomic database, Next Generation Sequencing.

**05 Hours**

### **6. Protein Prediction**

Protein structures: Secondary Structure: Alpha helix, beta Sheets, phi & psi angles, Ramachandran plots. Protein Structure Prediction: Use of sequence patterns and Amino acid; Protein Secondary Structure Prediction methods: Chou-Fasman, neural network, and nearest neighbor method; Tertiary Structure Predictions: Homology modeling; Protein sequence and structure analysis: Physicochemical parameters, binding site, sub-cellular location, protein stability, and patterns.

**08 Hours**

## **Unit - III**

### **7. In-silico Drug Designing-I**

Introduction to traditional drug designing, Introduction in-silico drug designing approach, Methodology for in-silico drug designing: Structure based and Ligand based drug designing; De novo drug designing, pharmacophore modeling in drug designing, Ligand screening, drug designing based on template, Steps in drug designing: Target identification, target validation, lead identification and validation; different tools used for drug designing.

**05 Hours**

### **8. In-silico Drug Designing-II**

Molecular Modeling, Lipinski's rule, Virtual Screening, Process of Docking, Quantitative structure-activity relationship (QSAR), Physical and Chemical basis of receptor ligand interactions, ADMET property analysis, Molecular dynamics simulation of protein and protein-drug interaction.

**05 Hours**

### **Text Books**

1. Andreas D. Baxevanis, B. F. Francis Ouellette, Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, 3rd, Wiley-Inte, 2005
2. David Mount, Bioinformatics: Sequence and Genome Analysis , 2nd, Cold Sprin, 2004





**Reference Books:**

1. P. Rastogi, N. Mendiritta, S. C. Rastogi, Bioinformatics: Methods and Applications: Genomics, Proteomics and Drug Discovery, 4th, Prentice-H, 2013.
2. Anand Solomon K, Molecular Modelling and Drug Design , 1st, MJP Publis, 2015
3. Richard Durbin, Sean R. Eddy, Anders Krogh, Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids, 1st, Cambridge , 1998

[BACK](#)



|   |                                      |                               |
|---|--------------------------------------|-------------------------------|
| <b>Program: Biotechnology</b>   |                                      | <b>Semester: V</b>            |
| <b>Course Title: Reaction Engineering</b>   |                                      | <b>Course Code: 15EBTC303</b> |
| <b>L-T-P:: 4-0-0</b>  | <b>Credits:4.0</b>                   | <b>Contact Hours: 50</b>      |
| <b>ISA Marks:50</b>   | <b>ESA Marks:50</b>                  | <b>Total Marks:100</b>        |
| <b>Teaching Hours:50</b>  | <b>Examination Duration: 3 Hours</b> |                               |
| <b>Unit-I</b>   |                                      |                               |
| <b>1: Introduction</b>  |                                      |                               |
| Introduction to homogeneous and heterogeneous reaction in ideal reactors. Elementary and Non-elementary reactions kinetics of homogeneous and heterogeneous reaction system.  |                                      |                               |
| <b>06 Hours</b>   |                                      |                               |
| <b>2: Interpretation of Batch Reactor data</b>  |                                      |                               |
| Introduction to analysis of experimental reactor data, evaluation of rate equation, integral and differential analysis of kinetic data's, constant volume system and variable volume System. Total pressure technique of analyzing the kinetic data of gaseous reaction system.   |                                      |                               |
| <b>08 Hours</b>   |                                      |                               |
| <b>3. Introduction to Bioreactor Design.</b>  |                                      |                               |
| General discussion on basics bioreactor design. General material balance equation for various conditions. Ideal reactors for a single reaction. Design equations for homogeneous system: batch, stirred tank and tubular flow reactor, size comparison of reactor systems.  |                                      |                               |
| <b>08 Hours</b>   |                                      |                               |
| <b>Unit-II</b>  |                                      |                               |
| <b>4 Design for Multiple Reactions</b>  |                                      |                               |
| Introduction, general design approach to multiple reactions. Quantitative and qualitative analysis of product distribution. Effect of temperature and pressure on single reaction. General graphical procedure, optimum temperature progression. Factors affecting choice of reactors: optimum yield, conversion, selectivity and reactivity. |                                      |                               |
| <b>08 Hours</b>   |                                      |                               |
| <b>5 Non-Ideal Reactors</b>   |                                      |                               |
| Non-ideal reactors, residence time distribution studies, Stimulus Response Technique, pulse and step input response of reactors, RTD's for CSTR and PFR, Relationship between C, E and F-curve. Kinetic models for non-Ideal reaction system, Axial Dispersion Model  |                                      |                               |
| <b>04 Hours</b>   |                                      |                               |

### 6 Microbial kinetics:

Introduction to microbial kinetics, Yield coefficient, Simple kinetic models for microbial growth, transient growth kinetics Factors affecting the kinetics of Monod model; Growth of Filamentous Organisms. kinetic Models for product formation and substrate degradation

**08 Hours**

### Unit-III

### 7 Heterogeneous Reactor System:

Heterogeneous reactions in Bioprocessing. The rate equation for surface for kinetics, Pore diffusion kinetics with combined with surface kinetics. Porous catalyst particle Performance equation for reactor containing Porous catalyst particles. External and internal mass transfer effects.

**04 Hours**

### 8 Reactor Engineering

Bioreactor configurations: Bubble column, airlift reactor, packed bed, fluidized bed, trickle bed,

**04 Hours**

### Text Books:

1. Chemical Reaction Engineering by Octave and Levenspiel., John Wiley, 3<sup>rd</sup> Edition, 2006.
2. Elements of Chemical Reaction Engineering by Fogler, H.S., Prentice Hall, 1986.

### Reference Books:

1. Bioprocess Engineering Principles by Pouline M Doran Academic Press , 2003
2. Biochemical Engineering Fundamentals By Bailey and Ollies McGraw Hill 2<sup>nd</sup> Edition
3. Chemical Reactor Analysis and Design by Forment G F and Bischoff K B. John wiley,1976
4. Chemical engineering By J.F Richardson and J.M Coulson Volume 6

[BACK](#)



|   |                                      |                              |
|---|--------------------------------------|------------------------------|
| <b>Program: Biotechnology</b>   |                                      | <b>Semester: V</b>           |
| <b>Course Title: Biological Thermodynamics</b>  |                                      | <b>Course Code: 15BTC304</b> |
| <b>L-T-P:: 3-0-0</b>  | <b>Credits:3.0</b>                   | <b>Contact Hours: 40</b>     |
| <b>ISA Marks:50</b>   | <b>ESA Marks:50</b>                  | <b>Total Marks:100</b>       |
| <b>Teaching Hours:40</b>  | <b>Examination Duration: 3 Hours</b> |                              |
| <b>Unit I</b>   |                                      |                              |
| <b>1. Basic concepts</b>  |                                      |                              |
| System, Surrounding, State and Properties, Intensive and extensive properties, State and path functions, Heat reservoir, Hess Law, energy and biological world, energy flow transformation, energy conversions, energy, nutritional requirements of living systems, Flow of electrons in organism, energy flow in metabolic process, division of labor in cells, Numerical problems   |                                      |                              |
| <b>06 Hours</b>   |                                      |                              |
| <b>2. Basic laws of thermodynamics</b>  |                                      |                              |
| Zeroth law, First law of Thermodynamics, cyclic process, non-flow process, flow Process, internal energy, Heat capacity, second law of thermodynamics, Concept of entropy, Calculation of entropy changes, Third law of thermodynamics. Numerical problems.   |                                      |                              |
| <b>09 Hours</b>   |                                      |                              |
| <b>Unit II</b>  |                                      |                              |
| <b>3. PVT behavior</b>  |                                      |                              |
| P-V-T Behavior of pure fluid, Processes involving ideal gases, Equation of state for real gases: Vander Waals equation, Redlich-Kwong equation, Peng-Robinson equation, Virial equation. Compressibility charts: Principle of corresponding states, Numerical problems.   |                                      |                              |
| <b>07 Hours</b>   |                                      |                              |
| <b>4. Thermodynamic properties of Biological fluids</b>   |                                      |                              |
| Classification of thermodynamic properties, Work function, Gibbs free energy, Gibbs-Helmholtz equation, ATP Synthesis in cell and Protein Folding, Metabolic reactions in cells. Entropy - heat capacity relationships, Relationships between $C_p$ and $C_v$ , Activity of molecule, Chemical potential, Oxidation-Reduction reaction, Cell Membrane Transportation & Protein Extraction, Osmosis, Nernst equation in membrane transportation, Numerical problems. |                                      |                              |
| <b>08 Hours</b>   |                                      |                              |



### Unit III

#### 5. Statistical Thermodynamics

Boltzmann distribution & partition function, Protein folding and helix-coil transition, Binding equilibria, Oxygen binding to myoglobin & Hemoglobin.

**04 Hours**

#### 6. Reaction Equilibria

Reaction Stoichiometry, Effect of temperature on standard heat of reaction. energy coupling reactions, activation energy, Criteria of chemical reaction equilibrium, Relationship between Equilibrium constant and standard free energy change, Effect of temperature, pH and pressure on equilibrium constants and other factors affecting equilibrium conversion, Numerical problems.

**06 Hours**

#### Text Books

1. Biological Thermodynamics by Donald T. Haynie, 2<sup>nd</sup> edition, Cambridge University Press, 2008
2. Introduction to chemical engineering thermodynamics by J.M.Smith, H. C. VanNess, M.M. Abbott, 7<sup>th</sup> edition, Tata McGraw-Hill, New Delhi, 2005.

#### Reference Books

1. Thermodynamics. An engineering approach, by Yunus A. Cengel, Michael A. Boles, 8<sup>th</sup> edition, McGraw- Hill, 2014.
2. Chemical Engineering Thermodynamics by Y.V.C. Rao. 2<sup>nd</sup> edition, Universities Press, 1997.
3. Chemical and Process Thermodynamics by B.G.Kyle. 3<sup>rd</sup> edition, Prentice Hall of India Private limited, 2015.

[BACK](#)



|  |                                      |                               |
|--|--------------------------------------|-------------------------------|
| <b>Program: Biotechnology</b>  |                                      | <b>Semester: V</b>            |
| <b>Course Title: Research Methodology</b>  |                                      | <b>Course Code: 15EBTC305</b> |
| <b>L-T-P:: 3-0-0</b>   | <b>Credits:3.0</b>                   | <b>Contact Hours: 40</b>      |
| <b>ISA Marks:50</b>  | <b>ESA Marks:50</b>                  | <b>Total Marks:100</b>        |
| <b>Teaching Hours:40</b>   | <b>Examination Duration: 3 Hours</b> |                               |
| <b>Unit I</b>  |                                      |                               |
| <b>1. Introduction to Research and Research Methodology</b>  |                                      |                               |
| Introduction, Objectives and scope of research, Research methods and Methodology. Types of research – Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical Concept of Translatory research.   |                                      |                               |
| <b>04 Hours</b>  |                                      |                               |
| <b>2. Research Philosophy and Formulation of Research Problem</b>  |                                      |                               |
| Concept of Research Philosophy- (Ontology, Logic, Method and Epistemeology) Formulation of Research Problem- Necessity of defining the research problem and framing the problem statement.   |                                      |                               |
| <b>03 Hours</b>  |                                      |                               |
| <b>3. Sources and Review of Literature</b>   |                                      |                               |
| Introduction and need for Literature Review., Search Procedures and Gap analysis. Sources of Literature - Research articles, review articles, Research communications, Book chapters. Bibliometrics- Citation index, Impact factor, author h-index and i10-index, awareness on predatory journals and its identification, grants and funding agencies for biotechnology research |                                      |                               |
| <b>08 Hours</b>  |                                      |                               |
| <b>Unit II</b>   |                                      |                               |
| <b>4. Sampling &amp; Data Collection</b>   |                                      |                               |
| Explain sampling and its significance. Describe different methods of sampling.   |                                      |                               |
| <b>03 Hours</b>  |                                      |                               |
| <b>5. Statistical Analysis of Data</b>   |                                      |                               |
| Measures of Central Tendency, Measures of Dispersion and variance, Correlation and Regression Development of hypothesis and testing : Chi- square test, Student's t-test, ANOVA  |                                      |                               |
| <b>07 Hours</b>  |                                      |                               |
| <b>6. Design of Experiments</b>  |                                      |                               |
| Introduction and significance of DOE, Types - Factorial Design, Plackett Burman Design, Central Composite Design, Response Surface Methodology, Design of matrix and analysis, Contour   |                                      |                               |



plots and response surface plots, QBD principles, Introduction to Artificial Intelligence and its application in biotechnology

**05 Hours**

### **Unit III**

#### **7. Environment, Ethics and IPR in Research**

Impacts of Research on Environment, - Ethical issues, ethical committees, Research Generated Intellectual Property Rights- Copy-right & royalty, Patent law, Trade mark, Trade secret, Geographical Indicator, Industrial Design. Concept of Plagiarism

**05 Hours**

#### **8. Research Communication**

Written Communication- Introduction, Structure and components of scientific reports – Bibliography, referencing and footnotes. Oral Presentation – Developing and delivering presentation

**05 Hours**

#### **Text Books**

1. C.R. Kothari and Guarav Garg, Research Methodology, III Edition, New Age International Publisher, New Delhi, 2014
2. N. Gurumani, Research Methodology for Biological Sciences, I Edition, MJP Publishers, Chennai, 2007

#### **Reference Books**

1. Design and Analysis of Experiments by Montgomery D. C. John Wiley Publishers
2. An Introduction to Research Methodology by Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K. RBSA Publishers

[BACK](#)



|  |                                      |                               |
|--|--------------------------------------|-------------------------------|
| <b>Program: Biotechnology</b>  |                                      | <b>Semester: V</b>            |
| <b>Course Title: Genetic Engineering &amp; Immunotechnology Lab</b>  |                                      | <b>Course Code: 15EBTP301</b> |
| <b>L-T-P:: 0-0-1</b>   | <b>Credits:1.0</b>                   | <b>Contact Hours: 02</b>      |
| <b>ISA Marks:80</b>  | <b>ESA Marks:20</b>                  | <b>Total Marks:100</b>        |
| <b>Teaching Hours:24</b>   | <b>Examination Duration: 3 Hours</b> |                               |
| <b>List of Experiments:</b> <ol style="list-style-type: none"><li>1. Preparation of Competent <i>E coli</i> cells (<b>Structured Inquiry</b>)</li><li>2. Ligation of DNA fragment with vector and Transformation (Demonstration)</li><li>3. Restriction digestion analysis of plasmid DNA (Structured Inquiry)</li><li>4. Introduction to PCR –Programming, and amplification of DNA (Exercise)</li><li>5. Screening of Transformants by Colony PCR (Demonstration)</li><li>6. TA Cloning method for cloning of PCR product. (<b>Structured Inquiry</b>)</li><li>7. Demonstration of Southern blotting (Demonstration)</li><li>8. Agglutination techniques – Heam agglutination techniques and Bacterial agglutination techniques (Exercise)</li><li>9. Radial diffusion and Rocket Immuno electrophoresis (Exercise)</li><li>10. Dot-ELISA(Enzyme Linked Immuno Sorbent Assay) (Exercise)</li></ol> |                                      |                               |
| <b>Text Books/Reference Books:</b> <ol style="list-style-type: none"><li>1. Principles of Gene Manipulations- Introduction to Genetic Engineering, by R.W. Old and S.D. Primrose( 2007), Blackwell SISAntific Publications.</li><li>2. Molecular Cloning- By T.Maniatis, E.F. Fritsch and J. Sambrook, Cold spring Harbour (2009)</li></ol>  |                                      |                               |

[BACK](#)





|  |                                      |                               |
|--|--------------------------------------|-------------------------------|
| <b>Program: Biotechnology</b>  |                                      | <b>Semester: V</b>            |
| <b>Course Title: Bioinformatics Lab</b>  |                                      | <b>Course Code: 15EBTP302</b> |
| <b>L-T-P:: 0-0-1</b>   | <b>Credits:1.0</b>                   | <b>Contact Hours: 02</b>      |
| <b>ISA Marks:80</b>  | <b>ESA Marks:20</b>                  | <b>Total Marks:100</b>        |
| <b>Teaching Hours:24</b>   | <b>Examination Duration: 3 Hours</b> |                               |
| <b>List of Experiments:</b> <ol style="list-style-type: none"><li>1. Searching bibliographic database for relevant information and retrieve from nucleic acid and Protein sequence database</li><li>2. PDB: Protein Data Bank and structure visualization</li><li>3. Searching sequence database using BLAST algorithm &amp; Pair wise alignment of the sequences</li><li>4. Multiple Sequence Alignment &amp; Phylogenetic Analysis: CLUSTALW/Phylogeny</li><li>5. Gene structure Prediction</li><li>6. Protein Secondary Structure Prediction</li><li>7. Protein Tertiary Structure Prediction</li><li>8. Protein Sequence analysis: Physicochemical parameters, binding site, sub-cellular location, protein stability, patterns and conserve domain.</li><li>9. Identification of ligands/Virtual Screening</li><li>10. Molecular Docking and interaction analysis</li><li>11. Define gene structure and design primers specific to the identified gene of microorganisms and draw restriction digestion map for sequence identified</li></ol> |                                      |                               |
| <b>Text Books/Reference Books</b> <ol style="list-style-type: none"><li>1. Andreas D. Baxevanis, B. F. Francis Ouellette, Bioinformatics: A Practical Guide to the</li><li>2. Analysis of Genes and Proteins, 3rd, Wiley-Inte, 2005</li><li>3. David Mount, Bioinformatics: Sequence and Genome Analysis , 2nd, Cold Sprin, 2004</li></ol>   |                                      |                               |

[BACK](#)



|  |                                      |                               |
|--|--------------------------------------|-------------------------------|
| <b>Program: Biotechnology</b>  |                                      | <b>Semester: VI</b>           |
| <b>Course Title: Bioprocess Engineering</b>  |                                      | <b>Course Code: 15EBTC306</b> |
| <b>L-T-P:: 4-0-0</b>   | <b>Credits:4.0</b>                   | <b>Contact Hours: 04</b>      |
| <b>ISA Marks:50</b>  | <b>ESA Marks:50</b>                  | <b>Total Marks:100</b>        |
| <b>Teaching Hours:50</b>   | <b>Examination Duration: 3 Hours</b> |                               |
| <b>Unit - I</b>  |                                      |                               |
| <b>1.Media and Inoculum development for industrial fermentations</b><br>Bioprocess development: An interdisciplinary challenge, Biotechnology & Bioprocess Engineering, steps in bioprocess development, Media ingredients, medium formulation, oxygen requirements, antifoams, medium optimization, Ingredients for mammalian cell culture and plant cell culture. Introduction, Criteria for transfer of inoculum, development of inocula for bacterial processes, yeast processes and mycelial processes. Inoculum development for plant Fermenter. |                                      |                               |
|  |                                      | <b>08 Hours</b>               |
| <b>2.Sterilization</b><br>Media sterilization, Design of sterilization process: Batch Process (Dell factor, holding time, and thermal death kinetics), continuous sterilization process; sterilization of fermenter and other ancillaries. Scale up of sterilization, filter sterilization of air and media.   |                                      |                               |
|  |                                      | <b>05 Hours</b>               |
| <b>3.Design of bioreactors</b><br>Basic objective of fermenter design, aseptic operation & containment regulation, achievement and maintenance of aseptic conditions, body construction, agitator and sparger design, baffles, stirrer glands and bearings. Animal cell bioreactors. Single use bioreactor, perfusion system, Data analysis software for fermenter Ex:simca software.  |                                      |                               |
|  |                                      | <b>07 Hours</b>               |
| <b>Unit - II</b>   |                                      |                               |
| <b>4.Scale Up of Bioreactor</b><br>Scale up of bioreactors: Introduction, Scale-Up methods: Geometric and Dynamic Similarity, Criteria for scale-up: Constant power consumption/volume, constant KLa, constant mixing time, constant tip speed, Regime analysis: Time constant for transport phenomena, time constant for conversion. Scale down approach.   |                                      |                               |
|  |                                      | <b>05 Hours</b>               |
| <b>5.Heat Transfer</b><br>Heat transfer in Bioprocess: Design equation for heat transfer process, Energy balance, Logarithmic and arithmetic mean temperature difference, Calculation for heat transfer coefficient, applications of design equations, Relationship in between heat transfer, cell concentrations and stirring conditions, Numerical based examples on above.  |                                      |                               |
|  |                                      | <b>04 Hours</b>               |

### 6. Mass Transfer

Mass transfer in Bioprocess: Role of diffusion in bioprocessing, Different equations in mass transfer ( liquid-solid, liquid-liquid and gas-liquid) , Oxygen uptake in cell culture: Factors affecting cellular oxygen demand, Oxygen transfer from gas bubble to cells, Oxygen transfer in fermenter, measuring dissolved oxygen concentrations, Measurement of KLa: Oxygen balance method, Gassing out techniques ( static method of Gassing out and dynamic method of Gassing out) Sulphite oxidation, Factors affecting KLa, Oxygen transfer in large vessels, Numerical based examples on above.

**05 Hours**

### 7. Fermenter fluid rheology

Fermentation broth: Viscosity, Viscosity measurement, Rheological properties of fermentation broths, Factors affecting broth viscosity , Mixing in Fermenters: Mechanism of mixing, Assessing mixing effectiveness, estimation of mixing time, Power requirement for mixing: Ungassed Newtonian fluids, ungassed non-Newtonian fluids, Gassed fluids, Calculation of power requirements, Scale up of mixing systems, Improving mixing in Fermenters, Effect of rheological properties on mixing, Role of shear in stirred fermenters: Interaction between cells and turbulent eddies, Bubble shear, operating conditions for shear damage. Numericals

**06 Hours**

## Unit - III

### 8. Bioreactor kinetics

Batch reactor kinetics, CSTR kinetics, Fedbatch kinetics and plug flow kinetics, Numericals

**05 Hours**

### 9. Solid State fermentation:

Introduction, SSF v/s SMF, Types of SSF reactors, Microbial growth kinetics in SSF, Heat & Mass Transfer in SSF

**05 Hours**

### Text Books

1. Pauline M. Doran, Bioprocess Engineering Principles, 2, Academic Press, 2003
2. Stanbury & Whittaker, Principles of Fermentation Technology, 2, Pergamon Press, 2000

### Reference Books

1. Michael L. Shuler & Fikret Kargi, Bioprocess Engineering, 2, Prentice Hall, 2001
2. Bailey, James E.; Ollis, David F., Biochemical Engineering Fundamentals, McGraw-Hill Education, 1986

[BACK](#)

|   |                                      |                               |
|---|--------------------------------------|-------------------------------|
| <b>Program: Biotechnology</b>   |                                      | <b>Semester: VI</b>           |
| <b>Course Title: Bioprocess Control and Automation</b>  |                                      | <b>Course Code: 19EBTC302</b> |
| <b>L-T-P:: 4-0-0</b>  | <b>Credits:4.0</b>                   | <b>Contact Hours: 04</b>      |
| <b>ISA Marks:50</b>   | <b>ESA Marks:50</b>                  | <b>Total Marks:100</b>        |
| <b>Teaching Hours:50</b>  | <b>Examination Duration: 3 Hours</b> |                               |
| <b>Unit I</b>   |                                      |                               |
| <p><b>1 Instrumentation &amp; Process Dynamics:</b> Introduction to Measurement of important physicochemical and biochemical parameters in bioprocess. Methods of on line and off line estimation of biomass, substrates and products. Brief introduction to typical automatic control system and its components. Open loop and closed loop control systems.</p>  |                                      |                               |
| <b>05 Hours</b>   |                                      |                               |
| <p><b>2 First &amp; Second Order Systems:</b> Mathematical representation of physical systems. Transfer function representation of linear first order systems, Examples: mercury in glass thermometer &amp; Liquid level system. Mathematical forms of standard Input function/Forcing Functions such as Step input, Impulse Input, Linearly increasing Input and Sinusoidal Input. Response of first order system for step input, Features of step response, Response of linearly increasing input. Conceptual numerical. First Order Systems in Series: Interacting and Non-Interacting systems &amp; their Transfer function representation. Second Order Systems: Transfer function representation of Second order systems, Example: Pneumatic Control Valve.</p> |                                      |                               |
| <b>10 Hours</b>   |                                      |                               |
| <b>Unit II</b>  |                                      |                               |
| <p><b>3 Controller and Final Control Elements:</b> Different types of controllers-P (Special case of P-controller i.e ON-OFF controller), PI, PD, PID controllers. Derivation of Transfer Functions of different types of controllers. Final control element: The role of Final control Element in control system. Example: Pneumatic Control Valve: Working of Pneumatic control valve, Types of Pneumatic Control Valves i.e. Air to close &amp; air to open.</p>   |                                      |                               |
| <b>10 Hours</b>   |                                      |                               |
| <p><b>4 Block Diagram Reduction:</b> Block diagram representation of control systems, Block diagram reduction in case of Servo and Regulatory control systems. Reduction of block diagrams for single input &amp; Single output systems (SISO) &amp; Multiple Input &amp; Multiple Output Systems (MIMO), Problems on block diagram reduction.</p>  |                                      |                               |
| <b>05 Hours</b>   |                                      |                               |



**5 Block Diagram Reduction (MIMO systems):** Analysis of Multiple Input Multiple Output Systems: Introduction to Multiple Input & Multiple Output Systems (MIMO), Examples of MIMO systems. Analysis of MIMO systems considering only one Input at a time while other Inputs are Suppressed. Considering only one output at a time while other outputs are Suppressed. Problems on block diagram reduction considering MIMO systems.

**10 Hours**

### Unit III

**6 Transient response of different controllers for Servo & Regulatory control Problems:** Transient response of P, PI, PD & PID controllers for servo and regulatory problems. The determination of offset in all cases.

**05 Hours**

**7 Analysis of Stability:** Concept of stability, stability criterion. Routh test for stability. Theorems of Routh Array test, Conceptual numerical on Routh test for stability.

**05 Hours**

#### Text Books:

1. Process System analysis and control by Donald R Coughnowr, 2<sup>nd</sup> Edn. Mc Graw Hill, 1991
2. Chemical Process Control by George Stephanopoulos, Prentice Hall of India, 1999

#### Reference Books:

1. Process Control-Peter Harriott, Tata McGraw-Hill Publishing Company Limited, 2004.

[BACK](#)

|   |                                      |                               |
|---|--------------------------------------|-------------------------------|
| <b>Program: Biotechnology</b>   |                                      | <b>Semester: VI</b>           |
| <b>Course Title: Bioprocess Engineering Lab</b>   |                                      | <b>Course Code: 22EBTP303</b> |
| <b>L-T-P:: 0-0-1.5</b>  | <b>Credits:1.5</b>                   | <b>Contact Hours: 03</b>      |
| <b>ISA Marks:80</b>   | <b>ESA Marks:20</b>                  | <b>Total Marks:100</b>        |
| <b>Teaching Hours:36</b>  | <b>Examination Duration: 3 Hours</b> |                               |
| <b>List of Experiments:</b> <ol style="list-style-type: none"> <li>1. Study of lab fermenter: Design, components, and process control.</li> <li>2. Study of pilot scale fermenter: Design, components, and process control.</li> <li>3. Understanding aseptic operation and containment regulation of fermenter.</li> <li>4. Sterilization-in-place: Sterilization of media in lab fermenter.</li> <li>5. Clean-in-place: Procedure involved in maintenance and cleaning of fermenter.</li> <li>6. Monitoring and control of Operation parameters: Maintenance and Calibration of fermenter sensors, control of process parameters.</li> <li>7. Fermentation methods: Understanding aseptic operation and containment regulation of fermenter: Inoculation, aeration and sampling procedures.</li> <li>8. Determination of kinetic parameters of microorganism using batch mode.</li> <li>9. Design an experiment to determine mixing time, power requirement, and <math>K_{La}</math> of fermenter.</li> <li>10. Introduction to bioprocess modeling and simulation software: SuperPro.</li> <li>11. Model batch reactor using SuperPro</li> </ol> |                                      |                               |
| <b>Text Books/Reference Books</b> <ol style="list-style-type: none"> <li>1. Debabrata Das and Debayan Das; Biochemical Engineering: A Laboratory Manual; Jenny Stanford Publishing; 1st edition (11 January 2021).</li> <li>2. S. N. Mukhopadhyay; Process Biotechnology: Theory and Practice; The Energy and Resources Institute, TERI.</li> <li>3. Pauline M. Doran, Bioprocess Engineering Principles, 2, Academic Press, 2013.<br/>Stanbury &amp; Whittaker, Principles of Fermentation Technology, Butterworth-Heinemann; 3rd edition (14 September 2016)</li> </ol>   |                                      |                               |

[BACK](#)

|   |                                      |                               |
|---|--------------------------------------|-------------------------------|
| <b>Program: Biotechnology</b>   |                                      | <b>Semester: VI</b>           |
| <b>Course Title: Bioprocess Control &amp; Reaction Engineering Lab</b>  |                                      | <b>Course Code: 19EBTP301</b> |
| <b>L-T-P:: 0-0-1.5</b>  | <b>Credits:1.5</b>                   | <b>Contact Hours: 02</b>      |
| <b>ISA Marks:80</b>   | <b>ESA Marks:20</b>                  | <b>Total Marks:100</b>        |
| <b>Teaching Hours:24</b>  | <b>Examination Duration: 3 Hours</b> |                               |
| <b>List of Experiments:</b> <ol style="list-style-type: none"> <li>1. Study of characteristics of Transducers (such as Resistance Temperature Detector (RTD) sensor, Thermister, Thermocouple).</li> <li>2. Determination of Time constant of given first order system (such as mercury in glass thermometer, bimetallic thermometer, RTD sensor using step response).</li> <li>3. Response of first order system for step &amp; Impulse inputs.</li> <li>4. Response of first order systems arranged in Non-interacting mode for standard inputs (like step input, Impulse Input).</li> <li>5. Response of first order systems arranged in Interacting mode for standard inputs (like step input, Impulse Input).</li> <li>6. Transient response of change in set point/load variable on different control systems (such as Temperature, Pressure and Flow control systems) using different controllers (such as P-controller, PI-Controller, ON-Off controller etc).</li> <li>7. Linearization of Non Linear Systems (such as control Valve).</li> <li>8. Analyze the characteristics of different types of reactors (PFR &amp; MFR)</li> <li>9. Determination of Vessel dispersion number</li> <li>10. Determination of rate constant for first order reaction.</li> </ol> |                                      |                               |
| <b>Text Books/Reference Books:</b> <ol style="list-style-type: none"> <li>1. Process System analysis and control by Donald R Coughnowr, 2<sup>nd</sup> Edn.Mc Graw Hill,1991</li> <li>2. Chemical Process Control by George Stephanopoulos, Prentice Hall of India, 1999</li> </ol>   |                                      |                               |

[BACK](#)



|  |                                      |                               |
|--|--------------------------------------|-------------------------------|
| <b>Program: Biotechnology</b>  |                                      | <b>Semester: VI</b>           |
| <b>Course Title: Bio Analytical Techniques</b>   |                                      | <b>Course Code: 19EBTE301</b> |
| <b>L-T-P:3-0-0</b>   | <b>Credits:3.0</b>                   | <b>Contact Hours: 03</b>      |
| <b>ISA Marks:50</b>  | <b>ESA Marks:50</b>                  | <b>Total Marks:100</b>        |
| <b>Teaching Hours:40</b>   | <b>Examination Duration: 3 Hours</b> |                               |
| <b>Unit I</b>  |                                      |                               |
| <b>1. Introduction to Bio-analysis</b>   |                                      |                               |
| Introduction to instrumentation, Functional elements of an instrumentation system, static and dynamic characteristics, calibration of instrumental methods, Types of errors, Methods of expressing precision and accuracy, Confidence limits, Uncertainties in Instrumental measurements – Sensitivity and detection, preparation & storage of solutions, usage of laboratory glasswares, statistical analysis of experimental data, Electrodes and Biochemical preparation. |                                      |                               |
| <b>05 Hours</b>  |                                      |                               |
| <b>2. Spectroscopy</b>   |                                      |                               |
| General principles–Radiation, energy and atomic structure- types of spectra and their biochemical usefulness basic laws of light absorption. Electromagnetic radiation & Spectrum, Beer – Lambert’s Law and apparent deviations; UV – VIS Spectrophotometer  |                                      |                               |
| <b>05 Hours</b>  |                                      |                               |
| <b>3. Advanced Spectroscopy</b>  |                                      |                               |
| Spectrofluorimetry, Atomic absorption spectroscopy, IR spectroscopy, FTIR, Nuclear Magnetic Resonance, Mass spectroscopy, ORD, CD, X-ray diffraction.  |                                      |                               |
| <b>05 Hours</b>  |                                      |                               |
| <b>Unit II</b>   |                                      |                               |
| <b>4. Chromatographic techniques</b>   |                                      |                               |
| Analytical techniques for biomolecules purification, Paper chromatography, thin layer chromatography, Column chromatography, Gas chromatography, Ion-exchange chromatography, molecular exclusion chromatography, affinity chromatography, High performance liquid chromatography & UPLC- Principles, Methods, Instrumentation, Detectors, Analysis of data.   |                                      |                               |
| <b>08 Hours</b>  |                                      |                               |





### 5. Electrophoretic techniques

Theory & application of polyacrylamide & Agarose gel electrophoresis for protein & nucleic acids, capillary electrophoresis, pulsed field gel electrophoresis, Iso-electric focusing, 2D-gel electrophoresis and Immunoelectrophoresis

**06 Hours**

### Unit III

### 6. Centrifugation techniques

Basic principles of sedimentation, centrifuges and their uses, preparative ultracentrifuges, density gradient, analytical ultra-centrifuges, applications

**06 Hours**

### 7. Advanced Instrumental methods

LC-MS, GC-MS, HPTLC, SEM, Atomic Force Microscopy, transmission electron microscopy (TEM)

**04 Hours**

### Text Books

1. Wilson K & Walker J., Principles and Techniques of Practical Biochemistry, 5<sup>th</sup> edition, Cambridge Univ. Press., 2000.
2. Rodney Boyer, Modern Experimental Biochemistry, 3<sup>rd</sup> edition, Pearson Education, 2002
3. Chatwal and Anand, Spectroscopy, Himalaya Publishing house-New Delhi, 2016

### Reference Books

1. Willard H. W. & Meritt L. L, Instrumental methods for chemical analysis, 7<sup>th</sup> edition. CBS Publishers & Distributors, 2004
2. Chatwal and Anand, Instrumental methods for chemical analysis, Himalaya Publishing house, 2012

[BACK](#)



|   |                                      |                               |
|---|--------------------------------------|-------------------------------|
| <b>Program: Biotechnology</b>   |                                      | <b>Semester: VI</b>           |
| <b>Course Title: Bioprocess Plant Design and Economics</b>  |                                      | <b>Course Code: 18EBTE301</b> |
| <b>L-T-P:3-0-0</b>  | <b>Credits:3.0</b>                   | <b>Contact Hours: 03</b>      |
| <b>ISA Marks:50</b>   | <b>ESA Marks:50</b>                  | <b>Total Marks:100</b>        |
| <b>Teaching Hours:40</b>  | <b>Examination Duration: 3 Hours</b> |                               |
| <b>Unit I</b>   |                                      |                               |
| <b>1. Introduction to Process Design Development</b>  |                                      |                               |
| Design project procedure, design information from the literature and other sources of information, flow diagrams, preliminary design, and comparison of different processes, Equipment design and specialization, factors affecting the investment.   |                                      |                               |
| <b>06 Hours</b>   |                                      |                               |
| <b>2. General Design Considerations</b>   |                                      |                               |
| Marketability of the product, availability of technology, Health and safety hazards, raw materials, human resources, loss prevention Environmental protection and utilities, site characteristics, plant location, plant layout, plant operation and control, utilities, structural design, storage, materials handling, materials and fabrication Selection, optimum design and design strategy. Waste disposal, physical treatment, chemical treatment and biological treatment, govt. regulations and other legal restrictions, community factors. Safety and hazard control measures.   |                                      |                               |
| <b>10 Hours</b>   |                                      |                               |
| <b>Unit II</b>  |                                      |                               |
| <b>3. Cost Analysis and Manufacturing Cost</b>  |                                      |                               |
| Cost Analysis: Factors involved in project cost estimation. Cash flow diagrams for the industrial operation, Cumulative cash position, factors affecting the Investment and production cost, Different methods employed for the estimation of the capital investment. Estimation of equipment cost by sixth tenth rule, Cost index. Marshall and swift installed – equipment indexes, Engineers News-Record construction index, Nelson –Farrar refinery construction index. and Chemical Engineering plant cost index Manufacturing Costs: Direct Production costs, indirect cost and fixed charges (including depreciation, taxes, insurance, rental costs etc.) |                                      |                               |
| <b>10 Hours</b>   |                                      |                               |
| <b>4. Bioprocess Economics:</b>   |                                      |                               |
| Economic analysis for the production of following Products.( Historical Perspective, Fermentation Technology, Recovery of product and process economics of following  |                                      |                               |

products)

- High volume, low value products. (Citric acid, Ethanol and Amino acids etc)
- Medium volume, medium value products.( Antibiotics, Crude Enzymes and Vitamins etc)
- Low volume, high value products. ( MAb, purified Enzymes and Therapeutic proteins etc)

**06 Hours**

### Unit III

#### 5. Profitability Analysis and Optimization Technique

i) Importance of profitability analysis in investment decision making. Different Methods for calculating the profitability. Minimum Acceptable Rate of return. Methods that Do not consider Time value of money.

**04 Hours**

ii) General procedure to find the optimum conditions, factors affecting the optimization, comparison of analytical and graphical methods. Linear programming, Simultaneous Equations and dynamic programming

**04 Hours**

#### Text Books:

1. Peters and Timmerhaus, Plant Design and Economics for Chemical Engineers, McGraw Hill 5<sup>th</sup> edition, 2004.
2. Chemical Engineering plant design, Frank C Vilbrandt and Charles E Dryden , McGraw Hill 4<sup>th</sup> edition, 1959

#### Reference Books:

1. Rudd and Watson, Strategy of Process Engineering, Wiley, 1987.
2. Backhurst, J.R And Harker, J. H - Process Plant Design, Heieman Educational Books, (1973
3. Biochemical Engineering Fundamentals, James E Baily David F Oillis. McGraw-Hil International Edition

[BACK](#)



|  |                                      |                               |
|--|--------------------------------------|-------------------------------|
| <b>Program: Biotechnology</b>  |                                      | <b>Semester: VI</b>           |
| <b>Course Title: Insilco Modeling and Drug Design</b>  |                                      | <b>Course Code: 15EBTE302</b> |
| <b>L-T-P:3-0-0</b>   | <b>Credits:3.0</b>                   | <b>Contact Hours: 03</b>      |
| <b>ISA Marks:50</b>  | <b>ESA Marks:50</b>                  | <b>Total Marks:100</b>        |
| <b>Teaching Hours:40</b>   | <b>Examination Duration: 3 Hours</b> |                               |
| <b>Unit I</b>  |                                      |                               |
| <b>1. Insilico Drug Design</b>   |                                      |                               |
| Generation of rational Approaches in Drug Design Molecular modeling: The second generation, Conception frame and methodology of molecular modeling, Importance of the “ Bioactive Confirmation”, Molecular Mimicry and Structural Similarities, Molecular Mimicry, Structural similarities and Superimposition Techniques, Rational Drug design and Chemical Intuition   |                                      |                               |
| <b>08 Hours</b>  |                                      |                               |
| <b>2. Molecular Modeling :</b>   |                                      |                               |
| Constructing and Initial Model, Refining the Model, Manipulating the Model, Visualization. Structure generation or Retrivel, structure visualization, Confirmation generation, Deriving Bioactive Confirmations Molecule Superposition and Alignment Deriving the Pharmacophoric Pattern, Receptor Mapping, Estimating Biological Activities, Molecular Interactions: Docking Calculation of Molecular Properties, Energy Calculations ( no derivation), Example of Small Molecular Modeling Work,   |                                      |                               |
| <b>08 Hours</b>  |                                      |                               |
| <b>Unit II</b>   |                                      |                               |
| <b>3. Computer Assisted New LEAD Design.</b>   |                                      |                               |
| Introduction, Basic Concepts, Molecular Recognition by Receptor and Ligand Design, Active Confirmation, Approaches to Discover New Functions, Approaches to the Cases with known and unknown receptor structure  |                                      |                               |
| <b>03 Hours</b>  |                                      |                               |
| <b>4. Docking Methods</b>  |                                      |                               |
| Program GREEN Grid: Three-Dimensional Description of Binding Site Environment and Energy Calculation, Automatic Docking Method, Three Dimensional Database Search Approaches, Automated Structure Construction Methods with known Three Dimensional Structure of the Receptor, Structure construction in the case of Unknown Receptor Structure. Scope and Limitation Points for Consideration in Structure Methods, Handling of X Ray Structure of Protein, Future Perspectives, Types of programs available for molecular modeling scope and limitations-interpretation of results |                                      |                               |
| <b>11 Hours</b>  |                                      |                               |

### Unit III

#### 5. Computer Assisted Drug Discovery-Part-I.

The Drug Development Process, Introduction, The Discovery and Development Process, New Lead Discovery Strategies, Composition of Drug Discovery Teams, The Practice of Computer-Assisted Drug Discovery (CADD),

**05 Hours**

#### 6. Computer Assisted Drug Discovery-Part-II.

Current Practice of CADD in the Pharmaceutical Industry, Management Structure of CADD Groups, Contributions and Achievements of CADD Groups, Limitations of CADD Support, Inherent Limitations of CADD Support, State of Current Computational Models, Software and Hardware Constraints.

**05 Hours**

#### Text Books:

1. Moody P.C.E. and A.J.Wilkinson Protein Engineering, IRL Press Oxford 1990.
2. The molecular modeling perspective in drug design by N Claude Cohen, 1996, Academic Press

#### Reference Books:

1. M.Michael Gromiha, Protein Bioinformatics- From Sequence to Function. Academic press 2010
2. Branden C. and Tooze R. Introduction of Protein structure, Garland 1993

[BACK](#)



|  |                                      |                               |
|--|--------------------------------------|-------------------------------|
| <b>Program: Biotechnology</b>  |                                      | <b>Semester: VII</b>          |
| <b>Course Title: Downstream Processing Technology</b>  |                                      | <b>Course Code: 22EBTC401</b> |
| <b>L-T-P:: 4-0-0</b>   | <b>Credits:4.0</b>                   | <b>Contact Hours: 04</b>      |
| <b>ISA Marks:50</b>  | <b>ESA Marks:50</b>                  | <b>Total Marks:100</b>        |
| <b>Teaching Hours:50</b>   | <b>Examination Duration: 3 Hours</b> |                               |
| <b>Unit I</b>  |                                      |                               |
| <b>1. Introduction</b>   |                                      |                               |
| Role and importance of downstream processing in biotechnological processes. Characteristics of biological mixtures: morphology of cells, concentration of cells, products and by-products, rheological behavior. Process design criteria for various classes of byproducts (high volume, low value products and low volume, high value products), Steps involved: pretreatment, solid/liquid separation, concentration, purification, formulation. case studies, costing of product and numerical  |                                      |                               |
| <b>09 Hours</b>  |                                      |                               |
| <b>2. Primary Separation Techniques</b>  |                                      |                               |
| Cell disruption methods for intracellular products: mechanical methods, physical methods and chemical methods. Removal of insolubles, Biomass (and particulate debris) heat and photosensitive materials separation techniques; Pretreatment of fermentation broth: heating, coagulation and flocculation, adsorption on filter aids. Theory of centrifugation and methods of centrifugation: tubular bowl centrifuge, disc stag centrifuge, decanter centrifuge. Theory of filtration and methods of filtration: plate and frame filter press, rotary drum filter and types of filter media, numerical. |                                      |                               |
| <b>11 Hours</b>  |                                      |                               |
| <b>Unit II</b>   |                                      |                               |
| <b>3. Membrane separation processes</b>  |                                      |                               |
| Membrane – based separations theory; Design and configuration of membrane separation equipment; Concentration polarization and fouling – causes, consequences and control techniques. Membrane modules: tubular module, flat sheet modules, spiral wound module, hollow fiber membrane. Classification of membrane processes: Based on hydrostatic pressure, concentration and applied electric field  |                                      |                               |
| <b>12 Hours</b>  |                                      |                               |
| <b>4. Enrichment operations</b>  |                                      |                               |
| Precipitation methods with salts (salting-in and salting-out), organic solvents, polymers,   |                                      |                               |

isoelectric precipitation. Extraction methods for separation: Reversed micellar extraction and Aqueous two-phase extraction, Supercritical extraction; In situ product removal / integrated bio-processing, SDS PAGE: determination of molecular weight of unknown protein. Numerical.

**08 Hours**

### Unit III

#### 5. Product recovery-I

Introduction to chromatography: Principle, instrumentation and practices (Van Deemter equation). Derivation of equation for resolution of peaks, Preparative High Performance Liquid Chromatography for recovery of product, Ion Exchange Chromatography for separation of ionic compounds, numericals.

**05 Hours**

#### 6. Product recovery-II

Gel Filtration Chromatography for molecular weight determination. Affinity Chromatography for purification of protein in cell free extract. Polishing Operations: Crystallization, Drying and Freeze drying or lyophilization

**05 Hours**

#### Text Books:

1. B. Sivasankar, Bioseparations: Principles and Techniques , Eastern Economy Edit, Prentice-H, 2005
2. P.A. Belter E.L. Cussler, W.S. Hu, Bioseparations: downstream processing for biotechnology, John-Wiley, New York, 1988

#### Reference Books:

1. BIOTOL, Product Recovery in Bioprocess Technology, VCH, 1990
2. Shuler and Kargi , Bioprocess Engineering , Prentice Hall, 1992
3. Asenjo J. and Dekker M, Separation Processes in Biotechnology , 1993 CRC Press

[BACK](#)



|   |                                      |                               |
|---|--------------------------------------|-------------------------------|
| <b>Program: Biotechnology</b>   |                                      | <b>Semester: VII</b>          |
| <b>Course Title: Bioprocess Equipment Design</b>  |                                      | <b>Course Code: 15EBTC402</b> |
| <b>L-T-P:: 3-0-0</b>  | <b>Credits:3.0</b>                   | <b>Contact Hours: 03</b>      |
| <b>ISA Marks:50</b>   | <b>ESA Marks:50</b>                  | <b>Total Marks:100</b>        |
| <b>Teaching Hours:40</b>  | <b>Examination Duration: 3 Hours</b> |                               |
| <b>Unit – I</b>   |                                      |                               |
| <b>1.Notation and terminologies</b>   |                                      |                               |
| Pipe Joints: Flanged pipe joint, Hydraulic pipe joint, Gland & stuffing box expansion joint, Union joint, Socket & spigot Joint. Welded joints: Butt, Fillet, lap welded joint. Vessel openings: Manholes, nozzles, drains, sight Glasses. Pipe design: Basic notation and terminologies, Schedule 10 and 40. Introduction to design.   |                                      |                               |
| <b>04 Hours</b>   |                                      |                               |
| <b>2.Materials of Construction</b>  |                                      |                               |
| Material properties: Mechanical & types of Corrosion; Materials used: Stainless steel and their alloys, properties of different metals used in stainless steel, Selection criteria, Different Standards (Indian steel codes, American Society for Mechanical Engineers-Bioprocess Engineer (ASME BPE ) standard, AISI (American Iron & Steel Institute) standard), different Stainless steel grade: 304, 316. |                                      |                               |
| <b>08 Hours</b>   |                                      |                               |
| <b>Unit – II</b>  |                                      |                               |
| <b>1.Design of Bioreactor</b>   |                                      |                               |
| Fermenter: Steps involved in the design: Volume of Reactor, H/D ratio, impeller design, baffle design, shaft design, Thickness of the shell, thickness of the top & bottom cover, thickness of jacket, heat transfer area of jacket, power number, power required to drive the Impeller.  |                                      |                               |
| <b>09 Hours</b>   |                                      |                               |
| <b>2.Design of shell and tube Heat exchanger</b>  |                                      |                               |
| Heat exchangers: Steps involved in the design, Energy balance, LMTD, Tubing characteristics,  |                                      |                               |



Tube side heat transfer coefficient, baffle spacing, shell side heat transfer coefficient, Fouling, Overall heat transfer coefficient, Tube side & shell side Pressure drop Calculations.

**09 Hours**

### Unit – III

#### 3. Equipment qualification & Validation

Design qualification, FAT (factory acceptance test), Site acceptance test, Commissioning, Installation Qualification, Operational qualification, Performance qualification, Equipment Validation.

**05 Hours**

#### 4. Bioreactor Accessories

Sterilization by filters, Design criteria for filters, filter housing, Filter Integrity test: Diffusive air flow test, Bubble point test, Pressure drop test, Water intrusion test; Valves: Diaphragm valve, Pneumatic valve, pinch valve, Non-return safety Valve; Aseptic seals in fermenter (Gasket, Lip seal, O rings).

**05 Hours**

#### Text Books:

1. Chemical Engineering Design by R K Sinnott, vol-6, 4th edition, Butterworth-Heinemann, 2005.
2. Process Equipment Design by M. V. Joshi & V. V. Mahajani, 5th edition, Macmillan India Ltd, 2016.

#### Reference Books:

1. Fermentation & Biochemical engineering handbook by H. C. Vogel & C. L. Todaro, 3<sup>rd</sup> edition, Standard publishers distributors.
2. Introduction to chemical equipment design by B. C. Bhattacharyya, 1<sup>st</sup> e-book edition, CBS Publishers & distributors, 2018

[BACK](#)



|  |                                      |                               |
|--|--------------------------------------|-------------------------------|
| <b>Program: Biotechnology</b>  |                                      | <b>Semester: VII</b>          |
| <b>Course Title: Industrial Biotechnology</b>  |                                      | <b>Course Code: 20EBTE401</b> |
| <b>L-T-P:: 3-0-0</b>   | <b>Credits:3.0</b>                   | <b>Contact Hours: 03</b>      |
| <b>ISA Marks:50</b>  | <b>ESA Marks:50</b>                  | <b>Total Marks:100</b>        |
| <b>Teaching Hours:40</b>   | <b>Examination Duration: 3 Hours</b> |                               |
| <b>Unit I</b>  |                                      |                               |
| <b>1 Introduction</b>  |                                      |                               |
| History of fermentation products, Range of fermentation process: Traditional approach: biomass, enzymes, metabolites and biotransformation; Modern fermentation process: rDNA products, animal cell culture: therapeutic proteins, monoclonal antibodies; application of system biology approach; generalized representation of typical fermentation process.              |                                      |                               |
| <b>05 Hours</b>  |                                      |                               |
| <b>2. Isolation and improvement of industrial microorganisms</b>   |                                      |                               |
| Isolation methods: Primary screening and secondary screening; Improvement of industrial microorganism: selection of induced mutants for primary and secondary metabolites, isolation of revertant mutants, use of rDNA systems, and improvement by other properties.   |                                      |                               |
| <b>05 Hours</b>  |                                      |                               |
| <b>3. Fermentation products</b>  |                                      |                               |
| Beverages (beer), Ethanol, Aminoacids, enzymes (lipase/protease), penicillin, therapeutic proteins, monoclonal antibodies and vaccines.  |                                      |                               |
| <b>05 Hours</b>  |                                      |                               |
| <b>Unit II</b>   |                                      |                               |
| <b>4 Bioreactor configuration-I</b>  |                                      |                               |
| CSTR with recycle, CSTR in series, Airlift reactor, Fluidized bed bioreactor, bubble column bioreactor, packed bed bioreactor, trickle bed bioreactor, deep jet bioreactor, rotating disc bioreactor.  |                                      |                               |
| <b>05 Hours</b>  |                                      |                               |
| <b>5. Bioreactor configuration-II</b>  |                                      |                               |
| Animal cell bioreactors:- Homogeneous reactor: Solid and macro porous micro carriers bioreactor; Heterogeneous reactor: Hollow fiber bioreactor, Packed glass bed bioreactor, fluidized bed bioreactor, cell encapsulation; Disposable bioreactor: Wave bioreactor and stirred bag bioreactor, Perfusion system- single use reactor and Open race ponds, photo bioreactor. |                                      |                               |
| <b>05 Hours</b>  |                                      |                               |
| <b>6. Advance downstream processing</b>  |                                      |                               |
| Process integration in product recovery, large scale refolding of therapeutic proteins, advanced membrane technology, Chromatography: column quantification and validation, AKTA purifier, reversed micellar technique for bio separation Single use technology in purification.   |                                      |                               |

### Unit III

#### 7. Fermentation monitoring and control:

On-line and off-line monitoring instruments, Bioprocess modeling for control, Estimation technique: Traditional method, linear black-box model and non-linear model; control strategies for fermentation, real time data analysis: Raman spectroscopy.

**05 Hours**

#### 8. Fermentation data analysis:

Introduction, classification of fermentation measurement and quantities, calculation of metabolites, estimation of unmeasured variables, calculation of integral and averaged variable, physiological variable and pattern recognition technique, SIMCA software.

**05 Hours**

#### Text Books:

1. L.E.Casida, JR, Industrial Microbiology, New Age International (P) Ltd Publication.
2. Prescott and Dun, Industrial Microbiology, McGraw-Hill Book Company, Inc. New York

#### Reference Books:

1. D.Lanch, Drew, Wang, Comprehensive Biotechnology-Volume 3, Elsevier Publication.
2. George T. Austin, Nicholas Basta; Shreves Chemical Process Industries Handbook; McGraw Hill Professional, 1998

[BACK](#)



|   |                                      |                              |
|---|--------------------------------------|------------------------------|
| <b>Program: Biotechnology</b>   |                                      | <b>Semester: VII</b>         |
| <b>Course Title: Food Processing Technology</b>   |                                      | <b>Course Code:15EBTE402</b> |
| <b>L-T-P:: 3-0-0</b>  | <b>Credits:3.0</b>                   | <b>Contact Hours: 03</b>     |
| <b>ISA Marks:50</b>   | <b>ESA Marks:50</b>                  | <b>Total Marks:100</b>       |
| <b>Teaching Hours:40</b>  | <b>Examination Duration: 3 Hours</b> |                              |
| <b>Unit I</b>   |                                      |                              |
| <b>1. Fundamentals of Food Processing Technology</b>  |                                      |                              |
| Basic concepts about properties of foods: liquid, solid and gases; Introduction to food processing: scope and significance; Principles of food processing and preservation  |                                      |                              |
| <b>04 Hours</b>   |                                      |                              |
| <b>2. Microbial Food Spoilage</b>   |                                      |                              |
| Food as substrate for microorganisms, Primary sources of microorganisms in foods, Microbes induced biochemical changes in foods, Microbiological Examination of foods, Food poisoning, and types. , A brief account of various organisms related with food poisoning- <i>E. coli</i> , <i>Clostridium</i> , <i>Bacillus</i> , <i>Staphylococcus</i> and <i>Vibrio</i> |                                      |                              |
| <b>07 Hours</b>   |                                      |                              |
| <b>3. Food biotechnology and Applications</b>   |                                      |                              |
| Enzymes, organic acids, antibiotics, baker's yeast, single cell protein and Mushrooms. Biocolours, Concept of fermented foods and beverages, Probiotics, Prebiotics & Symbiotics, Genetically Modified Foods  |                                      |                              |
| <b>04 Hours</b>   |                                      |                              |
| <b>Unit II</b>  |                                      |                              |
| <b>4. Unit Operations in Food Processing</b>  |                                      |                              |
| Introduction, Food Engineering operations- raw material preparation, cleaning, sorting, grading and peeling. Food conversion operations- size reduction, emulsification, filtration, membrane separation, centrifugation and extraction. Pulsed Electric Field processing, High-Pressure Processing,  |                                      |                              |
| <b>04 Hours</b>   |                                      |                              |
| <b>5. Thermal Processing of Foods</b>   |                                      |                              |
| Heat processing using steam or water, Blanching, Pasteurization, Heat Sterilization, Evaporation, Distillation, Extrusion and Canning. dielectric heating, ohmic and infrared heating. Dehydration, Intermediate Moisture Foods, Baking and Roasting, Heat processing using hot oils- Frying.   |                                      |                              |
| <b>06 Hours</b>   |                                      |                              |



## **6.Non-Thermal Processing of Foods**

Chilling, Freezing, Freeze-drying, Vacuum Concentration, Processing by chemical methods-sugar, salt, curing, smoking, acid and chemicals. Irradiation of foods. Controlled and Modified–Atmosphere Packaging. Concept of hurdle technology.

**05 Hours**

### **Unit III**

## **7. Food Product Development**

Concept and need of new product development, testing and sensory evaluation, Development of product formulation and development,, Role of food ingredients in human health Packaging and shelf life of food products. Concept of Functional Foods and Nutraceuticals.

**05 Hours**

## **8. Food laws, Labeling and Regulatory Bodies**

Food Laws- General Standards and Regulations as per FSSAI, . Regulatory bodies governing food laws. Certification and labeling of foods. Concept of HACCP and AGMARK

**05 Hours**

### **Text Books:**

1. P.J.Fellows, Food Processing Technology. Principles and Practices, Second Edition, Woodland Publishing Ltd,Cambridge,England,2002
2. Avantina Sharma, Text Book of Food Science and Technology, International Book Distributing Co, Lucknow, UP, 2006

### **Reference Books:**

1. Ramaswamy H & Marcotte M. Food Processing: Principles and Applications. Taylor & Francis. 2006

[BACK](#)



|  |                                      |                              |
|--|--------------------------------------|------------------------------|
| <b>Program: Biotechnology</b>                    |                                      | <b>Semester: VII</b>         |
| <b>Course Title: Environmental Biotechnology</b> |                                      | <b>Course Code:22EBTE401</b> |
| <b>L-T-P:: 3-0-0</b>                             | <b>Credits:3.0</b>                   | <b>Contact Hours: 03</b>     |
| <b>ISA Marks:50</b>                              | <b>ESA Marks:50</b>                  | <b>Total Marks:100</b>       |
| <b>Teaching Hours:40</b>                         | <b>Examination Duration: 3 Hours</b> |                              |

### Unit I

#### 1. Introduction

Issues and scope of Environmental Biotechnology, Environment and Biotechnology, Areas of applications for Biotechnology. Microbes and Environment, Genetically modified organisms and Legislation.

**03 Hours**

#### 2. Waste Water Treatment

Sources of water pollution, Waste water characteristics: Physical, Chemical and Biological characteristics. Chemical Oxygen Demand (COD) and Biochemical Oxygen Demand (BOD). Introduction to physical and chemical waste water treatment methods. Biological wastewater treatment methods: Aerobic suspended growth treatment processes (Activated Sludge Process, aerated lagoons etc), Aerobic attached growth treatment processes (Trickling Filter, Rotating Biological contactors), Anaerobic suspended growth treatment processes- contact digestors, packed column reactors, UASB. Bioelectrochemical systems (BES) including microbial fuel cells (MFCs).

**12 Hours**

### Unit II

#### 3. Solid waste Management

Basic aspects, Generation of solid wastes, general composition of Municipal solid waste, On site handling, storage and processing, Collection of solid wastes. Solid waste processing techniques and equipments. Recovery of biological conversion products from solid waste such as composting, sanitary landfilling, recycling, vermicomposting, incineration. Solid waste management for energy recovery-Biogas production, processing of lignocellulosic waste biomass for ethanol production

**08 Hours**

#### 4. Bioremediation and Bioleaching

Uses of bacteria for bioremediation, co-culture and mixed culture biotechnology bioremediation of aromatic and aliphatic hydrocarbons, PCB dechlorination, immobilization techniques for bioremediation, biosorption & bioaccumulation, bioaugmentation and biostimulation genetic engineering of microbes for bioremediation. Phytoremediation-plants capable of assimilating heavy metals. Bioleaching using microbes, role of Thiobacilli, direct &

indirect bioleaching, copper extraction by leaching, dump leaching.

**07 Hours**

### Unit III

#### 5. Biofuels

Environmental Biotechnology and biofuels: biogas; bioethanol/biomethane; biodiesel; biohydrogen, bioelectricity; Description of the industrial processes involved, microorganisms and biotechnological interventions for optimization of production; phycoremediation- biofuels through algal biotechnology; Microbiologically enhanced oil recovery (MEOR); Production of biosurfactants: bioemulsifiers;

**05 Hours**

#### 6. Environmental Impact Assessment

Introduction, Scope and history of EIA, Need of Environmental Impact assessment. Stakeholder and public involvement, Identification and quantification of environmental effects and Environmental Impact statement (EIS), Environmental Regulations.

**05 Hours**

#### Text Books

1. Pramod Kumar, Vipin Kumar, Pravin Kumar Sachan, Textbook of Environmental Biotechnology, Woodhead Publishing India in Energy, 2019.
2. Indu Shekhar Thakur, Environmental Biotechnology, 2<sup>nd</sup> edition: Basic Concepts and Applications, Dreamtech Press, 2019.
3. Pradipta Kumar Mohapatra, Textbook of Environmental Biotechnology, I K International Publishing House, 2007.

#### Reference Books

1. Ozcan Konur, Bioenergy and Biofuels, 1<sup>st</sup> edition, CRC press, 2018.
2. P. Rajendran, P. Gunasekaran, Microbial Bioremediation, 1<sup>st</sup> edition, Mjp Publishers, 2011

[BACK](#)

|  |                                      |                              |
|--|--------------------------------------|------------------------------|
| <b>Program: Biotechnology</b>  |                                      | <b>Semester: VII</b>         |
| <b>Course Title: Quality Assurance &amp; Regulations</b>   |                                      | <b>Course Code:18EBTE403</b> |
| <b>L-T-P:: 3-0-0</b>   | <b>Credits:3.0</b>                   | <b>Contact Hours: 03</b>     |
| <b>ISA Marks:50</b>  | <b>ESA Marks:50</b>                  | <b>Total Marks:100</b>       |
| <b>Teaching Hours:40</b>   | <b>Examination Duration: 3 Hours</b> |                              |
| <b>Unit I</b>  |                                      |                              |
| <b>1. Introduction</b>   |                                      |                              |
| Introduction to Quality and Quality Regulation, Validation and Regulatory Affairs in Bio (Pharmaceutical) Manufacturing: An Introduction to FDA Operations & Industry Compliance Regulations, The Fundamentals of Regulatory Compliance with respect to Good Clinical Practice (GCP), Good Manufacturing Practice (GMP) & Good Laboratory Practice (GLP).  |                                      |                              |
| <b>06 Hours</b>  |                                      |                              |
| <b>2. Quality and Quality Management</b>   |                                      |                              |
| Terms Relating to Quality Management System, Quality Policy, Quality Objectives, Quality Planning, Quality Control, Quality Assurance, Quality Improvement, Continual Improvement, Effectiveness, Efficiency; Relating to Process and Product, Quality Characteristics; Terms Relating to Conformity, Non-Conformity, Defect, Preventive Action, Corrective Action, Rework, Repair, Scrap, Concession, Deviation Permit, Release; Terms Relating to Documentation. |                                      |                              |
| <b>10 Hours</b>  |                                      |                              |
| <b>Unit II</b>   |                                      |                              |
| <b>3. Process Validation</b>   |                                      |                              |
| Definition and concept of validation, An introduction to process validation, Validation and Qualification, IQ, OQ and PQ. A Review of Prospective, Concurrent, Retrospective Validation Calibration and performance evaluation. Validation of Water & Thermal Systems, including HVAC Facilities & Cleaning Validation. Validation septic Processes, Computer software validation in pharmaceuticals (CSV).  |                                      |                              |
| <b>10 Hours</b>  |                                      |                              |
| <b>4. Analytical Method Validation</b>   |                                      |                              |
| FDA and ICH guidelines. Analytical method validation, Specificity, Linearity, Accuracy, Precision, Limits of detection (LOD) and quantification (LOQ), Minimum detectable amount (MDA), Sample stability and method robustness, System suitability, Statistical process control for HPLC, Troubleshooting out-of-control systems, Case studies, Validation of Analytical Methods.  |                                      |                              |
| <b>06 Hours</b>  |                                      |                              |



### Unit III

#### 5. Quality Standards

Introduction, ISO 9000 Series of Standards, Management Responsibility, Quality System, Contract Review, Design Control, Document and Data Control, Control of Quality Records, Internal Quality Audits, Training, Servicing, Environmental Management System.

**04 Hours**

#### 6. Implementation and Regulation

Role of QC and QA in Bio/Pharmaceutical organization, Quality System, Contract Review, Design Control, Document and Data Control, Product Identification and Traceability, Process Control, Control of Quality Records, Internal Quality Audits, Training.

**04 Hours**

#### Text Books:

1. Pharmaceutical Process Validation by Robert Nash and Alfred Wachter, Marcel Dekker. Publisher: Marcel Dekker Inc. 2011.
2. Good Manufacturing Practices for Pharmaceuticals: A Plan for Total Quality Control From Manufacturer to Consumer, Sidney J. Willig, Publisher: Marcel Dekker Inc. 2005.

#### Reference Books:

1. Validation of Pharmaceutical Processes: Sterile Products, Frederick J. Carlton (Ed.) and James Agalloco (Ed.), Marcel Dekker, 2008.
2. Validation Standard Operating Procedures: A Step by Step Guide for Achieving Compliance in the Pharmaceutical, Medical Device, and Biotech Industries, Syed Imtiaz Haider, Saint Lucie Press, 2004.

[BACK](#)

|   |                                      |                              |
|---|--------------------------------------|------------------------------|
| <b>Program: Biotechnology</b>   |                                      | <b>Semester: VII</b>         |
| <b>Course Title: Process Safety &amp; Risk management in Industrial Biotechnology</b>   |                                      | <b>Course Code:22EBTE402</b> |
| <b>L-T-P:: 3-0-0</b>  | <b>Credits:3.0</b>                   | <b>Contact Hours: 03</b>     |
| <b>ISA Marks:50</b>   | <b>ESA Marks:50</b>                  | <b>Total Marks:100</b>       |
| <b>Teaching Hours:40</b>  | <b>Examination Duration: 3 Hours</b> |                              |
| <b>Unit I</b>   |                                      |                              |
| <b>1.Introduction</b>   |                                      |                              |
| Introduction to Industrial Hygiene, Basic Laboratory Safety & Personal Protective equipment's (PPE). Risk & Risk Assessment, definition of Hazard and process of hazard identification, frequency and severity of Hazard, Occupational Health and Safety Administration, Safety and loss prevention, scope and outline of risk management. Legislation regarding process safety.  |                                      |                              |
| <b>05 Hours</b>   |                                      |                              |
| <b>2. Biological Hazards &amp; Containment Levels</b>   |                                      |                              |
| Classification of biological hazards, Major pathological mechanisms for health effects associated with hazardous biological agents, Biological Agents, major pathological mechanisms. Biosafety level: The BSL ranges from the lowest biosafety level-1 (BSL-1) to the highest at level-4 (BSL-4) based on the agents. Biohazard risk classification used by the World Health Organization. Bio-waste. Genetically Modified Organisms (GMO): requirements, or other Environmental safety regulations. Containment Levels: Containment requirements based on the assessment of potential biohazard, Biological safety cabinets (Class-I, Class-II& Class-III) to provide personnel & environmental protection, Biological safety cabinets for safety in Research & Manufacturing of Biological products. |                                      |                              |
| <b>10 Hours</b>   |                                      |                              |
| <b>Unit II</b>  |                                      |                              |
| <b>3.Chemical safety and Fire Safety</b>  |                                      |                              |
| Toxicity and safe handling of materials. Identification Material Safety Data Sheet (MSDS), evaluating exposure to volatile toxicants. Industrial hygiene, Industrial Hygiene Regulations. Runaway Reactions. Nature of Accidents and major disasters. Some Case Studies: Bhopal Gas Tragedy, The Flixborough UK, Cyclohexane Disaster, Seveso Accident: July 10, 1976, etc. Fire and Explosion, Work Place Hazards, Dangerous Substance, Fire triangle, Effective Ignition Source, Fire Extinguishers. Designs to prevent Fire and Explosion. General Design Methods to prevent Fire.   |                                      |                              |
| <b>05 Hours</b>   |                                      |                              |
| <b>4. Safe Handling Radioactive Materials/Radioactive Isotopes</b>  |                                      |                              |
| Introduction to safe handling radioactive materials, Personal Protective Equipment and Clothing, Precautions for Using Radioactive Material, Radioactive Materials Safe Work Practices, Fume Hoods and Biosafety Cabinets, Good Laboratory Practices, Radiation Safety Committee (RSC).   |                                      |                              |

**05 Hours**

### **5. Risk Assessment**

Risk Management, evaluating and analyzing risks associated with those hazards, actions to eliminate the hazards, Risk Matrix, Acceptable risks and safety priorities, cost of saving a life, frequency of accidents, safety check lists, assessment of risks from complex plants, Action and Recommendation. Environmental hazards.

**05 Hours**

### **Unit III**

### **6. Hazard Identification and evaluation Techniques**

Process for identifying hazards, Hazard Identification techniques such as HAZOP (Hazard and Operability Analysis): basic principles, explanation of guide words, procedures, critical examination of flowsheets, FMEA (Failure Modes and Effects Analysis), FTA (Fault Tree Analysis). Event Tree Analysis (ETA), Cause Consequence Analysis & Layer of Protection Analysis. What-If Analysis.

**05 Hours**

### **7. Process Safety Audit and Standards**

Safety Audit: Key Elements of a Workplace Safety Audit, Safety Audit Checklist, Safety Audit Report, Industrial Process Safety standards: Laws & Regulations. Occupational Health Hazards. Occupational Safety and Health Administration (OSHA) and National Institute of Occupational Safety and Health (NIOSH), Toxic Substance and Control Act (TSCA).

**05 Hours**

### **Text Books:**

1. Crowl D.A. and Louvar J.F., Chemical Process Safety: Fundamentals with Applications. 3<sup>rd</sup> Edition. Prentice Hall Publisher.
2. Lees F.P. Lee's Loss Prevention in Process industries: Hazard Identification, Assessment and control. 4<sup>th</sup> Edition. Sa Mannan Publisher.
3. Chemical Process Safety: Fundamentals with Applications (International Series in the Physical and Chemical Engineering Sciences) Hardcover. 2011 by Daniel Crowl and Joseph Louvar. 3<sup>rd</sup> Edition. Pearson Prentice Hall Publisher.

### **Reference Books:**

1. Chemical Process Safety: Fundamentals with Applications, 3e Paperback – 1 January 2013 by Daniel A. Crowl and Joseph F. Louvar. 3<sup>rd</sup> Edition. Pearson Prentice Hall Publisher.
2. What Went Wrong? Case Histories of Process Plant Disasters: How They Could Have Been Avoided. By Kletz T. 5<sup>th</sup> Edition. Butterworth-Heinemann Publisher.

[BACK](#)

|  |                                      |                              |
|--|--------------------------------------|------------------------------|
| <b>Program: Biotechnology</b>  |                                      | <b>Semester: VII</b>         |
| <b>Course Title: Plant and Animal Biotechnology</b>  |                                      | <b>Course Code:15EBTE403</b> |
| <b>L-T-P:: 3-0-0</b>   | <b>Credits:3.0</b>                   | <b>Contact Hours: 03</b>     |
| <b>ISA Marks:50</b>  | <b>ESA Marks:50</b>                  | <b>Total Marks:100</b>       |
| <b>Teaching Hours:40</b>   | <b>Examination Duration: 3 Hours</b> |                              |
| <b>Unit I</b>  |                                      |                              |
| <b>1. Introduction to plant tissue culture</b>   |                                      |                              |
| Introduction and scope of plant tissue culture. Historical events in the development of plant tissue culture method. Practical applications and recent advances. Laboratory organization, Cell culture media and its components. Aseptic manipulation in plant tissue culture laboratory. . Ethical and Social issues related to development and release of transgenic plants with case studies – Bt Cotton.           |                                      |                              |
| <b>05 Hours</b>  |                                      |                              |
| <b>2. Methods and Techniques in Plant tissue Culture.</b>  |                                      |                              |
| Callus and suspension culture, Micropropagation, Protoplast culture & Somatic Hybridization, Anther & Ovary Culture, Somatic Embryogenesis, Embryo & Endosperm culture, Somaclonal variation Germplasm storage by cryopreservation – pretreatment for cryopreservation, freezing, thawing, plant growth and regeneration and applications.   |                                      |                              |
| <b>04 Hours</b>  |                                      |                              |
| <b>3. Introduction to animal cell and tissue culture</b>   |                                      |                              |
| History and Scope of Animal cell and Tissue culture, Advantages and Disadvantages of Cell culture, laboratory facilities for tissue culture. Culture media for cells and tissues. Laboratory layout, Essential equipment's and Consumable items, Aseptic Techniques- elements of aseptic environment and culturing vessels Types of tissue culture – Primary cultures and Cell lines maintenance of cell line cultures |                                      |                              |
| <b>06Hours</b>   |                                      |                              |
| <b>Unit II</b>   |                                      |                              |
| <b>4.Culture characterization and culture maintenance</b>  |                                      |                              |
| Need for characterization, Parameters of Characterization, Cell Morphology, Confocal microscopy, DNA content analysis, Enzyme activity and Antigenic markers. Contamination in cell culture – sources, monitoring and eradication of contamination Cryopreservation and transportation.  |                                      |                              |
| <b>04 Hours</b>  |                                      |                              |



### **5. Animal Cell culture Scale up and Automation**

Introduction to scale up and automation. Scale up in suspension culture: Continuous culture, Scale & complexities, Mixing & Aeration. Scale up in Monolayer culture: Multi surface propagators, Roller culture, Microcarriers, and Perfused Monolayer culture. Process control and Automation: Robotic cell culture and High throughput screening.

**05 Hours**

### **6. Animal cell culture and Biopharmaceuticals production**

Mammalian cells as desired expression systems for protein biopharmaceuticals, Construction and selection of high-producing cell lines, Medium development for mammalian cell culture, and Process development for mammalian cell culture. Single use disposable animal cell culture technologies for biopharmaceutical manufacturing.

**06 Hours**

## **Unit III**

### **7. Plant Cell culture and Secondary Metabolite production**

Introduction, Selection of high yield cells and Mass cultivation of plant cells: Free cell suspension culture, Immobilized plant cell culture, and Two phase system culture. Elicitor induced accumulation of products. Biotransformation using plant cell cultures, Genetic modification and factors limiting large scale production of useful compounds.

**05 Hours**

### **8. Animal cell culture applications and Tissue engineering**

Hybridoma Technology and Animal cell culture applications in Monoclonal antibodies production. Products of Animal tissue culture – Erythropoietin, Tissue Plasminogen Activator & Factor VIII etc. Tissue Engineering – Introduction, Cell types, Extracellular matrix and Tissue engineering concepts. Artificial skin development by tissue engineering and its applications.

**05 Hours**

#### **Text Books:**

1. Introduction to Plant tissue culture Second edition. M K Razdan Oxford & IBH Publishing Co Pvt Ltd, New Delhi. 2003
2. Animal Cell Culture – Concept and Application by Sheelendra M Bhatt, Narosa Publishing House, New Delhi ISBN: 978-81-7319-926-4

#### **Reference Books:**

1. Introduction to Plant Cell, Tissue and Organ culture Sunil D Purohit PHI Learning Private Ltd, New Delhi 2013. ISBN – 978-81-203-4677-2
2. Culture of Animal Cells - A Manual of Basic Technique by R. Ian Freshney A John Wiley & Sons, Inc., Publication New York (2000)

[BACK](#)

|  |                                      |                              |
|--|--------------------------------------|------------------------------|
| <b>Program: Biotechnology</b>  |                                      | <b>Semester: VII</b>         |
| <b>Course Title: Biopharmaceuticals</b>  |                                      | <b>Course Code:15EBTE404</b> |
| <b>L-T-P:: 3-0-0</b>   | <b>Credits:3.0</b>                   | <b>Contact Hours: 03</b>     |
| <b>ISA Marks:50</b>  | <b>ESA Marks:50</b>                  | <b>Total Marks:100</b>       |
| <b>Teaching Hours:40</b>   | <b>Examination Duration: 3 Hours</b> |                              |
| <b>Unit I</b>  |                                      |                              |
| <b>1. Introduction:</b>  |                                      |                              |
| Introduction to pharmaceutical industry, API and pharmaceutical products, Formulation Industry, Introduction to dosage forms, Biopharmaceuticals & Biotechnology, Biopharmaceuticals: Current status & future prospects. Drug discovery & development process, Sources of Biopharmaceuticals, Dosage forms and routes of drug administration.                                |                                      |                              |
| <b>06 Hours</b>  |                                      |                              |
| <b>2. Pharmacokinetic and Pharmacodynamics of Peptide &amp; Protein Drugs:</b>   |                                      |                              |
| Introduction to pharmacokinetics and pharmacodynamics, drug as agonist & antagonist, Pharmacokinetics of protein therapeutics, ADME study for small molecules & protein therapeutics, optimization of pharmacokinetic profile, Pharmacodynamics of protein therapeutics, PK/PD Models.   |                                      |                              |
| <b>10 Hours</b>  |                                      |                              |
| <b>Unit II</b>   |                                      |                              |
| <b>3. The Drug Manufacturing Process:</b>  |                                      |                              |
| Pharmacopeias, good manufacturing practices (GMP), good laboratory practices (GLP), manufacturing facilities, clean rooms, water plant & grades of water, production of final product & formulation, analysis of final product (Qualitative & Quantitative), documentation: SOP, specifications & records, batch manufacturing records (BMR), batch packaging records (BPR). |                                      |                              |
| <b>08 Hours</b>  |                                      |                              |
| <b>4. Therapeutic Agents:</b>  |                                      |                              |
| The cytokines (Interleukins & Interferons), haemopoietic growth factors (erythropoietin), hormones of therapeutic interest (insulin & glucagon), preservation and clinical use of blood products, therapeutic enzymes, monoclonal & polyclonal antibodies, vaccines and vaccine technology (with appropriate case studies).  |                                      |                              |
| <b>08 Hours</b>  |                                      |                              |

### Unit III

#### 5. Quality in Pharmaceutical Industry:

Quality Assurance & Quality Control, validation & qualification studies, aseptic fill-process validation, cleaning validation, Validation Master Plan, Qualification: IQ, OQ and PQ. Calibration of analytical instruments.

**04 Hours**

#### 6. Regulatory issues and Drug product approval

Drug approval process (NDA & ANDA), Regulatory framework: Quality, Safety & Efficacy, Biosimilars and follow-on biologics, FDA & its Organizational structure, European regulations, Drug Registration in Japan, World harmonization of drug approvals (The ICH).

**04 Hours**

#### Text Books:

1. Biopharmaceuticals: Biochemistry & Biotechnology. Author: Gary Walsh. Second Edition, 2011. Pub: John Wiley & Sons.
2. Pharmaceutical Biotechnology: Fundamentals and Applications. Ed: Daan J.A. Crommelin et al. Third Edition. Publisher: Informa Healthcare.

#### Reference Books:

1. Molecular Biotechnology: Principles & Applications of r-DNA. Author: Bernard Glick & Jack Pasternak. 2002. Pub: Panima Books.
2. Manual of Industrial Microbiology & Biotechnology by Arnold L. Demain. 1999 Pub: ASM Press.
3. Biopharmaceuticals: An Industrial perspective. Authors: Gary Walsh & Brendan Murphy. 2009. Pub: Spring Books.

[BACK](#)



|   |                                      |                              |
|---|--------------------------------------|------------------------------|
| <b>Program: Biotechnology</b>   |                                      | <b>Semester: VII</b>         |
| <b>Course Title: Genomics and Proteomics</b>  |                                      | <b>Course Code:15EBTE405</b> |
| <b>L-T-P:: 3-0-0</b>  | <b>Credits:3.0</b>                   | <b>Contact Hours: 03</b>     |
| <b>ISA Marks:50</b>   | <b>ESA Marks:50</b>                  | <b>Total Marks:100</b>       |
| <b>Teaching Hours:40</b>  | <b>Examination Duration: 3 Hours</b> |                              |
| <b>Unit I</b>   |                                      |                              |
| <b>1. Introductory Genomics</b>   |                                      |                              |
| Genomics- Introduction, History and Scope and types, Structure of prokaryotic and eukaryotic genome, Mitochondrial and Chloroplast genome, C- value of genome. Genomics Approaches – traditional and updated, Genome mapping as an approach of genomics and recent approaches of genomics.  |                                      |                              |
| <b>04 Hours</b>   |                                      |                              |
| <b>2. Genome Analysis and markers</b>   |                                      |                              |
| Genome analysis and markers – Introduction, necessity and tools of genome analysis and markers. Genome Sequencing - Whole genome Shot gun, Hierarchial Shotgun, High-throughput sequencing, Chromosome walking, Chromosome jumping, Next Generation Sequencing. Molecular Markers: Concept of Markers, different types of markers and their general applications. Brief introduction to nature and applications of RFLP, RAPD, AFLP, SNP, Micro satellites, Minisatellites, Short Sequence Repeats, VNTR, EST, STS, Marker Assisted Selection |                                      |                              |
| <b>07 Hours</b>   |                                      |                              |
| <b>3. Genomics- Recent Advancements and Applications</b>  |                                      |                              |
| Microarray analysis, Genomic libraries, Gene-disease associations. Genomics Applications: Nutrigenomics, Toxicogenomics, Pharmacogenomics, Metagenomics, Medical applications, Human Genome Project. Model Organisms for Genomics studies- Yeast and Drosophila   |                                      |                              |
| <b>04 Hours</b>   |                                      |                              |
| <b>Unit II</b>  |                                      |                              |
| <b>4. Introductory Proteomics</b>   |                                      |                              |
| Proteomics- Introduction, History, Scope and Types. Protein – Sequence, Structure and function relationship. Different approaches for proteomics studies and their applications.  |                                      |                              |
| <b>04 Hours</b>   |                                      |                              |
| <b>5. Proteome separation and Purification</b>  |                                      |                              |
| Proteome extraction and purification. Separation of Proteins- ion-exchange, size exclusion and affinity chromatography techniques, 1-D by Isoelectric focusing, 2-D by SDS-PAGE. Protein  |                                      |                              |





Identification- Edman degradation, Mass Spectrometry, MALDI-TOF, Electrospray ionization, Peptide mass fingerprinting.

**08 Hours**

#### **6. Proteomics- Recent Advancements and Applications**

Applications of proteome analysis to drug; Protein-protein interaction Protein engineering: Protein chips. Clinical and biomedical application of proteomics.

**03 Hours**

### **Unit III**

#### **7. Bioinformatics tools in Genomics**

Raw genome sequences, Major Genomic Databases, Genome Annotation, similarity search, Genome sequence alignment tools.

**05 Hours**

#### **8. Bioinformatics tools in Proteomics**

Proteome Databases, Proteome Annotation, Protein characterization and function, Families, patterns, domains and profiles.

**05 Hours**

#### **Text Books:**

1. Bioinformatics- Methods and Applications. Genomics, Proteomics and Drug Discovery. S.C. Rastogi, N. Mendiratta and P. Rastogi. PHI Learning Private Limited, delhi.
2. GENES IX Benjamn Lewin Oxford University and Cell Press 2010

#### **Reference Books:**

1. Introduction to Genomics- Arthur Lesk. Oxford University & Cell Press
2. Principles of Proteomics by R M Twyman BIOS Scientific Publishers 2004

[BACK](#)



|  |                                      |                              |
|--|--------------------------------------|------------------------------|
| <b>Program: Biotechnology</b>  |                                      | <b>Semester: VII</b>         |
| <b>Course Title: Bioethics, Safety &amp; IPR</b>   |                                      | <b>Course Code:20EBTE403</b> |
| <b>L-T-P:: 3-0-0</b>   | <b>Credits:3.0</b>                   | <b>Contact Hours: 03</b>     |
| <b>ISA Marks:50</b>  | <b>ESA Marks:50</b>                  | <b>Total Marks:100</b>       |
| <b>Teaching Hours:40</b>   | <b>Examination Duration: 3 Hours</b> |                              |
| <b>Unit I</b>  |                                      |                              |
| <b>1. Perceptions about Biotechnology:</b> Biotechnology and social responsibility, Positive & negative perceptions of Biotechnology, Public acceptance issues, surveys, areas of public concern for Biotechnology. Socio, ethical, economic and legal aspects of Biotechnology. Public education & Biotechnology.   |                                      |                              |
| <b>06 Hours</b>  |                                      |                              |
| <b>2. Bioethics:</b> Legality, morality, and ethics, Principles of bioethics: autonomy, human rights, beneficence, justice, equity, etc. Expanding scope of ethics from Biomedical practice to Biotechnology, ethical conflicts in Biotechnology.  |                                      |                              |
| <b>05 Hours</b>  |                                      |                              |
| <b>3.Biosafety concept and issues :</b> Rational vs. subjective perception of risks and benefits, Hazards of BT , relationship between risk and hazard, Ethical implications of biotechnology products and techniques,   |                                      |                              |
| <b>05 Hours</b>  |                                      |                              |
| <b>Unit II</b>   |                                      |                              |
| <b>4. National and International Regulations:</b> Cartagena protocol, OECD consensus documents and Codex Alimentarius; Indian regulations – EPA act and rules, guidance documents, regulatory framework – RCGM, GEAC, IBSC and other regulatory bodies; category of rDNA experiments; field trails – biosafety research trials – standard operating procedures - guidelines of state governments; GM labeling – Food Safety and Standards Authority of India (FSSAI) |                                      |                              |
| <b>10 Hours</b>  |                                      |                              |
| <b>5. Biosafety &amp; Management:</b> Laboratory associated Biosafety practices, assessment of biohazard, Biosafety levels,. Risk analysis and assessment, Containment levels-physical, biological containments,. Good manufacturing practice and Good lab practices (GMP and GLP).  |                                      |                              |
| <b>05 Hours</b>  |                                      |                              |

**Unit III**

**6. Intellectual Property rights:** Introduction to history of GATT, WTO, WIPO and TRIPS; Introduction to IPR, Types of IP: Patents, Trademarks, Copyright, Design & Related Rights. Plant variety protection, Traditional knowledge, breeders rights, Geographical indications, Biodiversity and farmers rights. Patenting in biotechnology, case studies.

**05 Hours**

**7. Food, Agri and Pharma Sector:** The GM-food debate and biosafety assessment procedures for biotech foods including transgenic food crops, case studies- Golden Rice and Flav Savr Tomatto. Biosafety assessment of pharmaceutical products such as drugs/vaccines etc. Biosafety issues in Clinical Trials.

**05 Hours****Text Books:**

1. Bioethics & Biosafety- Sateesh MK, I.K. International Publishing House
2. Intellectual Property rights on Biotechnology – Singh K, BCIL, New Delhi.
3. Biotechnology: Expanding Horizons - B D Singh, Kalayani Publishers, 2010

**Reference Books:**

1. Bioethics & Biosafety – R. Rallapalli & Gita Bali, APH publication, 2007
2. Safety considerations for Biotechnology-Paris, OECD publications

[BACK](#)

|   |                                      |                              |
|---|--------------------------------------|------------------------------|
| <b>Program: Biotechnology</b>   |                                      | <b>Semester: VII</b>         |
| <b>Course Title: Vaccine Technology</b>   |                                      | <b>Course Code:21EBTE401</b> |
| <b>L-T-P:: 3-0-0</b>  | <b>Credits:3.0</b>                   | <b>Contact Hours: 03</b>     |
| <b>ISA Marks:50</b>   | <b>ESA Marks:50</b>                  | <b>Total Marks:100</b>       |
| <b>Teaching Hours:40</b>  | <b>Examination Duration: 3 Hours</b> |                              |
| <b>Unit I</b>   |                                      |                              |
| <b>1 History of Vaccine Discovery and Development</b>   |                                      |                              |
| Variolation and Vaccination in Late Imperial era, early methods of vaccination, Edward Jenner's Role in the Introduction of Smallpox Vaccine, Eradication of small pox. Fight against polio, Historical background of vaccination, vaccine preventable infectious diseases, Over view of bacterial and viral vaccines and their importance to public health. Epidemiology and pathophysiology of vaccine preventable diseases with special emphasis on Diphtheria, and Tetanus. |                                      |                              |
| <b>07 Hours</b>   |                                      |                              |
| <b>2. Role of vaccines in epidemiology and public health system.</b>  |                                      |                              |
| Active and passive immunization, General immunization practices, Strategies for improving vaccination levels. Timing and Spacing of Vaccines.. Adverse Reactions Following Vaccination. Contraindications and Precautions to Vaccination. Role of B and T cells, primary and secondary immune response, Immunological memory, Booster doses, Factors influencing the magnitude of vaccine performance, adjuvants. Immune correlates in vaccine development.                     |                                      |                              |
| <b>08 Hours</b>   |                                      |                              |
| <b>Unit II</b>  |                                      |                              |
| <b>3. Vaccine design, development and types:</b>  |                                      |                              |
| Subunit vaccine component - antigen, delivery system. Structure-based Vaccine design - tools and techniques. Characters of effective vaccines: Vaccines, Live, killed, attenuated, sub unit vaccines, conjugated vaccines. Vaccine technology- Role and properties of adjuvants, recombinant DNA and protein based vaccines, plant-based vaccines, reverse vaccinology; Peptide vaccines, conjugate vaccines, Edible vaccines.  |                                      |                              |
| <b>06 Hours</b>   |                                      |                              |
| <b>4. Vaccine manufacturing and Quality Control.</b>  |                                      |                              |
| Commercial scale vaccine manufacturing: Upstream (use of cell lines, human diploid) and downstream (chromatography) of active substances. Vaccine formulation (liquid and lyophilization). Use of additives/adjuvants/stabilizers. Vaccine safety and efficacy of vaccines (in vitro and in vivo). cGMP implementation in the production of safe vaccines. Case study of vaccine manufacturing: HBV and polio vaccine   |                                      |                              |
| <b>09 Hours</b>   |                                      |                              |

**Unit III****5. Policies, ethical considerations and Regulatory affairs of vaccines.**

Regulation and testing of vaccines, Regulation of vaccines in developing countries, Role and functioning of National Regulatory Authorities (ICMR) and WHO .Different stages of review and regulation of vaccines (investigational new drug application, biologics license application, post-licensure). Evolution of vaccine regulations overtime and the current status of NRAs functionality globally. Brief on Indian regulatory system.

**05 Hours****6. Recent advancements in vaccinology:**

Concepts of reverse vaccinology, case study of Reverse Vaccinology. Novel vaccine delivery systems. Tools & servers for computational Vaccine design-from Genome to Vaccine. Antigenicity modification, epitope replacement, germline targeting. Antigenically variable infectious agents and their vaccines.

**05 Hours****Text Books:**

1. IAP Textbook of Vaccines by Nitin K Shah, Rohit Agrawal, Vipin M Vashishtha, TU Sukumaran
2. Vaccines. 6th Edition, Stanley Plotkin Walter Orenstein Paul Offit.

**Reference Books:**

1. Vaccine Development and Manufacturing. Emily P. Wen (Editor), Ronald Ellis (Editor), Narahari S. Pujar (Editor).
2. Vaccines & Vaccine Technologies. Jose Ronnie Vasconcelos

[BACK](#)

|  |                                      |                              |
|--|--------------------------------------|------------------------------|
| <b>Program: Biotechnology</b>  |                                      | <b>Semester: VII</b>         |
| <b>Course Title: Downstream Processing Technology Lab</b>  |                                      | <b>Course Code:23EBTP401</b> |
| <b>L-T-P:: 0-0-1</b>   | <b>Credits:1.0</b>                   | <b>Contact Hours: 02</b>     |
| <b>ISA Marks:80</b>  | <b>ESA Marks:20</b>                  | <b>Total Marks:100</b>       |
| <b>Teaching Hours:24</b>   | <b>Examination Duration: 3 Hours</b> |                              |
| <b>List of Experiments</b> <ol style="list-style-type: none"> <li>1. Cell disruption technique: Sonication.</li> <li>2. Determination of cake and filter medium resistance for separation of biomass by Filtration.</li> <li>3. Determination of settling velocity and RCF of biomass separation by centrifugation.</li> <li>4. Determination of percentage recovery of proteins from broth by aqueous Two – Phase Extraction process.</li> <li>5. Determination of Isoelectric point of protein by isoelectric precipitation.</li> <li>6. Membrane Separation methods: Tangential Flow Filtration.</li> <li>7. Extraction of chlorophyll and beta-carotene: Column chromatography</li> <li>8. Determination of protein molecular weight: SDS-PAGE</li> <li>9. Estimation of metabolite using high performance liquid chromatography</li> <li>10. Determination of asymmetry and HETP of Akta Start column chromatography</li> </ol> |                                      |                              |
| <b>Text Books/ Reference Books:</b> <ol style="list-style-type: none"> <li>1. Bioseparations: Principle &amp; Technique; Shiv Shankar B.; PHI LEARNING PRIVATE LIMITED;2009</li> <li>2. Bioseparations: Downstream Processing for Biotechnology; Paul A. Belter E. L. Cussler Wei-Shou Hu; WILEY INDIA PVT. LTD.-NEW DELHI; 2011</li> <li>3. Separation Processes in Biotechnology; Juan A. Asenjo; CRC Press (28 June 1990).<br/>Protein Purification : Principles and Practice; Robert K Scopes;Springer; 2010 December</li> </ol>   |                                      |                              |

[BACK](#)

|  |                                      |                              |
|--|--------------------------------------|------------------------------|
| <b>Program: Biotechnology</b>  |                                      | <b>Semester: VIII</b>        |
| <b>Course Title: Biological Data Analysis</b>  |                                      | <b>Course Code:18EBTE402</b> |
| <b>L-T-P:: 3-0-0</b>   | <b>Credits:3.0</b>                   | <b>Contact Hours: 03</b>     |
| <b>ISA Marks:50</b>  | <b>ESA Marks:50</b>                  | <b>Total Marks:100</b>       |
| <b>Teaching Hours:40</b>   | <b>Examination Duration: 3 Hours</b> |                              |
| <b>Unit I</b>  |                                      |                              |
| <b>1.Introduction to Basic statistics:</b>   |                                      |                              |
| Strategy of Experimentation, History of the Design of Experiments, Basic Principles of DOE: Randomization, Replication, Blocking, Multi-factor Designs, Confounding; Steps for Planning, Conducting and Analyzing an Experiment, Typical applications of Experimental design, Basic Principles, Guidelines for Designing, Concepts of random variable, probability, density function, cumulative distribution function. Concept of confidence level. Statistical Distributions: Normal, Log Normal & Weibull distributions. Hypothesis testing, Probability plots. |                                      |                              |
|  |                                      | <b>04 Hours</b>              |
| <b>2. Screening Design:</b>  |                                      |                              |
| Introduction, Terminology: factors, levels, interactions, treatment combination, Orthogonal array, PB design, analysis of PD design, Numericals.   |                                      |                              |
|  |                                      | <b>05 Hours</b>              |
| <b>3.Full Factorial Design:</b>  |                                      |                              |
| Basic Definitions and Principles, The Advantage of Factorials, The Two-Factor Factorial Design, Statistical Analysis of the Fixed Effects Model, Model Adequacy Checking, Estimating the Model Parameters, Concept of the General Factorial Design, $2^k$ Factorial Design, The $2^2$ Design, The $2^3$ Design, The General $2^k$ Design.  |                                      |                              |
|  |                                      | <b>07 Hours</b>              |
| <b>Unit II</b>   |                                      |                              |
| <b>4. Response surface methods:</b>  |                                      |                              |
| Introduction, Central composite design, Box Behnken design, importance of counter and surface plots.   |                                      |                              |
|  |                                      | <b>05 Hours</b>              |
| <b>5. R Programming Basics:</b>  |                                      |                              |
| Overview of R programming, Environment setup with R Studio, R Commands, Variables and Data Types, Control Structures, Vectors, Factors, Functions, Matrices, Arrays and Lists.   |                                      |                              |
|  |                                      | <b>06 Hours</b>              |
| <b>6. Interfacing:</b>   |                                      |                              |
| Interfacing R to other languages, Parallel R, Basic Statistics: Linear Model, Generalized Linear Models, Non-linear models, Time Series, Autocorrelation and Clustering.   |                                      |                              |
|  |                                      | <b>05 Hours</b>              |

**Unit III****7. Introduction to Bioconductor for Sequence Data:**

Sequencing Resources, Ranges Infrastructure, DNA /amino acid sequence from FASTA files, Reads from FASTQ files, Aligned Reads from BAM files, Called Variants from VCF files, Genome Annotations from BED, WIG, GTF files.

**04 Hours****8. Biological Data Analysis:**

Preparing count matrices, The DESeq, DataSet, sample information, and formula design, exploratory analysis and visualization, Differential expression analysis, Plotting results, Annotating and exporting results

**04 Hours****Text Books:**

1. R for Everyone: Advanced Analytics and Graphics: by Jared P. Lander Addison Wesley Data & Analytics Series, 2013.
2. Design and analysis of experiments” by D.C. Montgomery, 7th edition John Wiley and sons, New York

**Reference Books:**

1. A Little Book of R for Bioinformatics: by Avril Coghlan, Release 0.1
2. Das. M.M. and Giri N.C. : - Design and Analysis of Experiments

[BACK](#)





|  |                                      |                              |
|--|--------------------------------------|------------------------------|
| <b>Program: Biotechnology</b>  |                                      | <b>Semester: VIII</b>        |
| <b>Course Title: Genomic Data Analysis</b>   |                                      | <b>Course Code:21EBTE402</b> |
| <b>L-T-P:: 3-0-0</b>   | <b>Credits:3.0</b>                   | <b>Contact Hours: 03</b>     |
| <b>ISA Marks:50</b>  | <b>ESA Marks:50</b>                  | <b>Total Marks:100</b>       |
| <b>Teaching Hours:40</b>   | <b>Examination Duration: 3 Hours</b> |                              |
| <b>Unit I</b>  |                                      |                              |
| <b>1.Introduction to Genomics and Data science:</b>  |                                      |                              |
| Genomics- Introduction, Structure of prokaryotic and eukaryotic genome, Central dogma, Genome analysis– Introduction, necessity and tools of genome analysis Genome Sequencing methods, Next Generation Sequencing, Introduction to Data Science: Data, Information, Data science, Data science process, Data analytics process, exploratory data analysis, data types and plotting. |                                      |                              |
| <b>05 Hours</b>  |                                      |                              |
| <b>2. Python for genomic data science:Part I</b>   |                                      |                              |
| Introduction, Installation, Jupyter note book, types and sequence, python numbers and strings, variables, handling numerical data, python objects, data structure.   |                                      |                              |
| <b>10 Hours</b>  |                                      |                              |
| <b>Unit II</b>   |                                      |                              |
| <b>3. Python for genomic data science:Part II</b>  |                                      |                              |
| Ifs and loops, python functions, library, communication with outside, modules and package.   |                                      |                              |
| <b>05 Hours</b>  |                                      |                              |
| <b>4. Genomic analysis: Algorithms</b>   |                                      |                              |
| Introduction, DNA as string, manipulation of DNA, Dynamic programming: Local and Global alignment, BLAST algorithm, DNA assembly.  |                                      |                              |
| <b>05 Hours</b>  |                                      |                              |
| <b>5. Biopython</b>  |                                      |                              |
| Introduction, working with sequence, sequence objects, sequence alignment, reading genomic sequence files.   |                                      |                              |
| <b>05 Hours</b>  |                                      |                              |

**Unit III****6. Introduction to Galaxy software**

Introduction, galaxy platform, working with genomic data, creation of work flow, annotation, sharing and publishing of genomic data, Genome and RNA sequence analysis.

**05 Hours****7. Introduction to Bioconductor for Sequence Data**

Sequencing Resources, Ranges Infrastructure, DNA /amino acid sequence from FASTA files, Reads from FASTQ files, Aligned Reads from BAM files, Called Variants from VCF files, Genome Annotations from BED, WIG, GTF files.

**05 Hours****Text Books:**

1. Bioinformatics with Python Cookbook, Second Edition: Tiago Antao, Ingram short title; 2nd edition (1 January 2018), ISBN-13 : 978-1789344691.
2. R Bioinformatics Cookbook, Dan MacLean, Packt Publishing Limited (11 October 2019), ISBN-13 : 978-1789950694.
3. Hahne F, Huber W, Gentleman R, Falcon S. Bioconductor Case Studies. Springer Publishing Company, 2008. Mathur SK.

**Reference Books:**

1. Lee JK. Statistical Bioinformatics: A Guide for Life and Biomedical Science Researchers. Hoboken, N.J.: WileyBlackwell, 2010.
2. Statistical Bioinformatics with R. Academic Press, 2010.
3. Genome Data Analysis, Ju Han Kim, 2019, Springer Singapore

[\*\*BACK\*\*](#)

|   |                                      |                              |
|---|--------------------------------------|------------------------------|
| <b>Program: Biotechnology</b>   |                                      | <b>Semester: VIII</b>        |
| <b>Course Title: Bio-business &amp; Entrepreneurship</b>  |                                      | <b>Course Code:20EBTE402</b> |
| <b>L-T-P:: 3-0-0</b>  | <b>Credits:3.0</b>                   | <b>Contact Hours: 03</b>     |
| <b>ISA Marks:50</b>   | <b>ESA Marks:50</b>                  | <b>Total Marks:100</b>       |
| <b>Teaching Hours:40</b>  | <b>Examination Duration: 3 Hours</b> |                              |
| <b>Unit-I</b>   |                                      |                              |
| <b>1. Entrepreneurship</b><br>Concept of Entrepreneurship - Development of Entrepreneurship; Stages in entrepreneurial process; Role of entrepreneurs in Economic Development; Characteristics of successful Entrepreneur, Classification of Entrepreneurs, Myths of Entrepreneurship, Entrepreneurial Development models, Entrepreneurial development cycle, Problems faced by Entrepreneurs. Entrepreneurship in India: Small scale industries: Definition; Characteristics; Need and rationale. Objectives; Scope; Introduction to bio-business, from the Indian context, SWOT analysis of bio-business. |                                      |                              |
|   |                                      | <b>10 Hours</b>              |
| <b>2. Social Responsibilities of Business</b><br>Meaning of Social Responsibility, Social Responsibilities of Business towards Different Groups, Social Audit, Business Ethics and Corporate Governance Institutional Support for Business Enterprises: Introduction, Policies & Schemes of Central Level Institutions, State Level Institutions.   |                                      |                              |
|   |                                      | <b>05 Hours</b>              |
| <b>Unit-II</b>  |                                      |                              |
| <b>3. Entrepreneurship opportunity in biotechnology</b><br>Business opportunity, Essential requirement, marketing strategies, schemes, challenges and scope-with case studies on entrepreneurship opportunities in different domains of Biotechnology (Agri biotechnology, industrial Biotechnology, food biotechnology, Biopharma, Nutraceuticals. etc).   |                                      |                              |
|   |                                      | <b>05 Hours</b>              |
| <b>4. Project management, technology management and startup schemes</b><br>Meaning of Project; Project Identification; Project Selection; Project Report; Need and Significance of Report; Contents; Formulation; Guidelines by Planning Commission for Project report; Network Analysis; Errors of Project Report; Project Appraisal. Identification of business opportunities: Market Feasibility Study; Technical Feasibility Study; Financial Feasibility Study & Social Feasibility Study.   |                                      |                              |
|   |                                      | <b>10 Hours</b>              |

### Unit-III

#### 5. Startup Schemes

Building Biotech business challenges in Indian context-biotech partners (BIRAC, DBT, Incubation centers. Etc.), operational biotech parks in India. Indian Company act for Bio business-schemes and subsidies. Patent expiry and Entrepreneurship opportunity, Principles of Technology leasing, licensing and transfer, Business incubation support schemes, Successful startups-case study.

**05 Hours**

#### 6. Funding Opportunities

Startup schemes in Indian government Sources of Funding for startups. Crowd funding, Self-funding, Venture Capitalists, Angel Investment. Banking support for startup business. Types of companies: Sole proprietorship company, Partnership company, Private Limited, Limited company etc.

**05 Hours**

#### Text Books:

1. Principles of Management – P. C.Tripathi, P.N. Reddy – Tata McGraw Hill,
2. Entrepreneurship Development - S.S.Khanka - S.Chand & Co.
3. Project Management by Sahni, Ane Books.

#### Reference books

1. Management Fundamentals - Concepts, Application, Skill Development - Robers Lusier - Thomson
2. Project Management for Business & Technology, Nicholas, PHI.

[BACK](#)

|   |                                      |                              |
|---|--------------------------------------|------------------------------|
| <b>Program: Biotechnology</b>                           |                                      | <b>Semester: VIII</b>        |
| <b>Course Title: Phytochemicals and Herbal Products</b> |                                      | <b>Course Code:22EBTE403</b> |
| <b>L-T-P:: 3-0-0</b>                                    | <b>Credits:3.0</b>                   | <b>Contact Hours: 03</b>     |
| <b>ISA Marks:50</b>                                     | <b>ESA Marks:50</b>                  | <b>Total Marks:100</b>       |
| <b>Teaching Hours:40</b>                                | <b>Examination Duration: 3 Hours</b> |                              |

  

|   |  |
|---|--|
| <b>Unit I</b>   |  |
| <b>1. Crude Drugs, Medicinal and Aromatic Plants</b><br>Crude Drugs - Scope and Importance, Classification (Taxonomical, Morphological Chemical, Pharmacological); Collection and processing of Crude Drugs; Utilization of Medicinal and Aromatic Plants in India and world; Genetics as applied to Medicinal herbs; Biogenesis of Phytopharmaceuticals.   |  |
| <b>07 Hours</b>   |  |
| <b>2. Types of Phytochemicals</b><br>Carbohydrates and its derived products- Structures, types and extraction methods : Glycosides - Digitalis, Aloe, Dioscorea; Volatile Oils - Clove, Peppermint Oil; Alkaloids – classification and functions, Triterpenoids, Phenols, Quinines, Cinchona; Flavonoids-and Resins; Tannins (Hydrolysable and Condensed types). Application of phytochemicals in industry and healthcare; Antioxidants, Biocides, Biofungicides, Biopesticides. Case studies |  |
| <b>08 Hours</b>   |  |

  

|   |  |
|---|--|
| <b>Unit II</b>  |  |
| <b>3. Analysis of Phytochemicals</b><br>Methods of Drug evaluation (Morphological, Microscopic, Physical and Chemical); Preliminary screening, Assay of Drugs - Biological evaluation / assays, Microbiological methods, Chemical Methods of Analysis and Detection of Adulterants: Chemical estimations; Drug adulteration - Types of adulterants. |  |
| <b>07 Hours</b>   |  |
| <b>4. Techniques for Extraction and characterization of phytochemicals</b><br>Extraction and characterization techniques, Cold extraction, hot extraction, Soxhlet apparatus, Solvents: Petroleum ether, chloroform, ethanol, water, Separation techniques: TLC, column, HPLC, Characterization techniques: UV spectra, IR spectra, GC/MS, HPTLC.   |  |
| <b>08 Hours</b>   |  |

**Unit III****5. Herbal Products and regulation**

History, Scope, and Current aspects of herbs and herbal medicines; Preparation of standardized extracts of Garcinea, Forskolin, Garlic, Turmeric and Capsicum, issues of licensing of herbal drugs. Herbal drug standardization: Regulatory bodies and guidelines, WHO and AYUSH guidelines.

**05 Hours****6. Herbal Informatics**

Applications of informatics in Herbal medicine, Databases and Tools for listing of phytochemicals and their applications. Databases: Super Natural II, CMAUP, BATMAN, ZINC, PubChem, ChEBI, KNApSAcK. Tools : Openbabel, Chemtools, ChemDraw, PkCSM. Molecular docking and analysis. Tools : MGL tools, Autodock Vina, PLIP. Network pharmacology and its application. Tools and Databases: Cytoscape, BindingDb.

**05 Hours****Text Books:**

1. Shah B, Textbook of Pharmacognosy and Phytochemistry, 2<sup>nd</sup> edition, CBS publisher, 2019.
2. Dr. Deep Panhekar, Ms. Trupti P. Sawant, Dr. D. P. Gogle, Phytochemicals - Extraction, Separation & Analysis Techniques | Phytochemistry - Study of Plants | | Plant Physiology, Plant Biotechnology and Plant Pathology Book, Global Education Limited; First Edition, 2019.
3. John R Harrison, International Regulation of Natural Health Products, Universal Publishers, 2008.

**Reference Books:**

1. R Amjesh, Bioinformatics in Drug Discovery from Medicinal Plants, LAP Lambert Academic Publishing, 2018.
2. Shao Li, Network Pharmacology Kindle Edition, Springer, 2021.

[BACK](#)



|  |                                      |                              |
|--|--------------------------------------|------------------------------|
| <b>Program: Biotechnology</b>  |                                      | <b>Semester: VIII</b>        |
| <b>Course Title: Industrial Waste Management</b>   |                                      | <b>Course Code:19EBTO401</b> |
| <b>L-T-P:: 3-0-0</b>   | <b>Credits:3.0</b>                   | <b>Contact Hours: 03</b>     |
| <b>ISA Marks:50</b>  | <b>ESA Marks:50</b>                  | <b>Total Marks:100</b>       |
| <b>Teaching Hours:40</b>   | <b>Examination Duration: 3 Hours</b> |                              |
| <b>Unit I</b>  |                                      |                              |
| <b>1 Introduction</b>  |                                      |                              |
| Introduction to waste management, general outline of waste management, Importance of waste management in industries.   |                                      |                              |
| <b>04 Hours</b>  |                                      |                              |
| <b>2 Waste Water Treatment</b>   |                                      |                              |
| Waste water characteristics: Physical, Chemical and Biological characteristics. Chemical Oxygen Demand (COD) and Biochemical Oxygen Demand (BOD). Introduction to physical and chemical waste water treatment methods. Biological wastewater treatment methods: Aerobic suspended growth treatment processes (Activated Sludge Process, aerated lagoons etc), Aerobic attached growth treatment processes (Trickling Filter). Anaerobic treatment. |                                      |                              |
| <b>11 Hours</b>  |                                      |                              |
| <b>Unit II</b>   |                                      |                              |
| <b>3. Solid Waste Management</b>   |                                      |                              |
| Basic aspects, Generation of industrial solid wastes, general composition of Municipal solid waste, On site handling, storage and processing, Collection of solid wastes. Solid waste processing techniques and equipments. Recovery of biological conversion products from solid waste such as composting and anaerobic digestion. Disposal of solid wastes.  |                                      |                              |
| <b>09 Hours</b>  |                                      |                              |
| <b>4. Control of Air Pollution</b>   |                                      |                              |
| Sources and classification of air pollutants, Effects of air pollution on human health, animals and plants. Sampling procedures, Control of air pollution by equipments, odour combatment techniques, Air pollution Legislation and Regulation.  |                                      |                              |
| <b>06 Hours</b>  |                                      |                              |
| <b>Unit III</b>  |                                      |                              |
| <b>5. Bioremediation</b>   |                                      |                              |
| Introduction, Uses of bacteria for bioremediation, bioremediation of aromatic and aliphatic hydrocarbons, PCB dechlorination, immobilization techniques for bioremediation, biosorption  |                                      |                              |



& bioaccumulation, genetic engineering of microbes for bioremediation. Phytoremediation-plants capable of assimilating heavy metals.

**05 Hours**

## **6. EM Technology**

Introduction, Important organisms: Photosynthetic bacteria, Lactobacillus, yeast; their roles, Formulation of EM Mixture, Use of EM technology for treating industrial wastes – case studies.

**05 Hours**

### **Text Books:**

1. Wastewater Engineering-Metcalf and Eddy. McGraw-Hill International Edition.1991
2. Solid Wastes-George Tchobanoglous, Hilary Theisen and Rolf Eliassen. McGraw Hill Kogakusha,Ltd.

### **Reference Books:**

1. Basic Biotechnology by Colin Ratledge, Cambridge Pub. 2001
2. Air Pollution – M.N.Rao and H.V.N Rao.Tata Mc Grew Hill.

[BACK](#)