# GOVERNMENT COLLEGE OF TECHNOLOGY

(An Autonomous Institution Affiliated to Anna University)
Coimbatore - 641 013

## Curriculum and Syllabi For
## B.Tech. (INDUSTRIAL BIOTECHNOLOGY)
## (Full Time)

# 2016
## Regulations

**OFFICE OF THE CONTROLLER OF EXAMINATIONS**
**GOVERNMENT COLLEGE OF TECHNOLOGY**
**THADAGAM ROAD, COIMBATORE - 641 013**

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# VISION AND MISSION OF THE INSTITUTION

## VISION

To emerge as a centre of excellence and eminence by imparting futuristic technical education in keeping with global standards, making our students technologically competent and ethically strong so that they can readily contribute to the rapid advancement of society and mankind.

## MISSION

- To achieve Academic excellence through innovative teaching and learning practices.
- To enhance employability and entrepreneurship
- To improve the research competence to address societal needs
- To inculcate a culture that supports and reinforces ethical, and professional behaviours for a harmonious and prosperous society

# DEPARTMENT OF INDUSTRIAL BIOTECHNOLOGY

# GOVERNMENT COLLEGE OF TECHNOLOGY

## VISION AND MISSION OF THE DEPARTMENT

### VISION

To achieve the highest caliber in Biotechnology Research and Teaching and to develop intellectual leaders for the betterment of the society, environmental protection and industry needs.

### MISSION

To provide world class quality education to students through advanced skill based learning and molding them as technologically sound and ethically motivated youth through value added activities.

**DEPARTMENT OF INDUSTRIAL BIOTECHNOLOGY**

**GOVERNMENT COLLEGE OF TECHNOLOGY**

## PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

The following Programme Educational Objectives are designed based on the department mission.

**PEO 1 :** Graduates will possess necessary skills and knowledge in the frontier areas of Biotechnology.

**PEO 2 :** Graduates will be able to implement the engineering principles to biological systems for the development of industrial applications as well as Entrepreneurship skills to start biotech industries.

**PEO 3 :** Graduates will think critically and creatively about the use of biotechnology to address local and global problems.

**PEO 4 :** Graduates will consider the social implication of their work as it affects the health, safety and environment of human population.

**PEO 5 :** Graduates will have adequate knowledge in various fields of biotechnology, enabling them to pursue higher education in relevant areas to enhance their professionalism.

**DEPARTMENT OF INDUSTRIAL BIOTECHNOLOGY**

**GOVERNMENT COLLEGE OF TECHNOLOGY**

**PROGRAMME OUTCOMES (POs)**

Students in the Industrial Biotechnology Programme should at the time of their graduation be in the possession of the following.

**PO1** **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.

**PO2** **Problem analysis**: Identify, formulate, review research literature and analyze complex Engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.

**PO3** **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 the public health and safety, and the cultural, societal, and environmental considerations.

**PO4** **Conduct investigations of complex problems**: 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.

**PO5** **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

**PO6** **The engineer and society:** 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.

**PO7** **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of and need for sustainable development.

**PO8** **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

**PO9** **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams and in multidisciplinary settings

**PO10** **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

**PO11** **Project management and finance**: 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.

**PO12** **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**DEPARTMENT OF INDUSTRIAL BIOTECHNOLOGY**

**PROGRAMME SPECIFIC OUTCOMES (PSOs)**

**PSO1:** Demonstrate competence in basic science and engineering courses to pursue higher education.

**PSO2:** Demonstrate an ability to acquire technical skills and work ethics to meet the industry needs and to become an entrepreneur.

BOARD OF STUDIES IN BASIC SCIENCES 2016-17
B.TECH. INDUSTRIAL BIOTECHNOLOGY
CBCS 2016 REGULATIONS

## FIRST SEMESTER

| Sl. No. | Course Code | Course Title | Category | Continuous Assessment Marks | End Sem Marks | Total Marks | Credits | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | L | T | P | C |
| | | **THEORY** | | | | | | | | |
| 1 | 16BHS1Z1 | COMMUNICATION SKILLS IN ENGLISH | HS | 50 | 50 | 100 | 2 | 2 | 0 | 3 |
| 2 | 16BBS1Z2 | ENGINEERING MATHEMATICS I | BS | 50 | 50 | 100 | 3 | 2 | 0 | 4 |
| 3 | 16BBS103 | APPLIED PHYSICS | BS | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 4 | 16BBS104 | CHEMISTRY FOR BIOTECHNOLOGY | BS | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 5 | 16BES105 | BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING | ES | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| | | **PRACTICAL** | | | | | | | | |
| 6 | 16BBS106 | PHYSICS LAB | BS | 50 | 50 | 100 | 0 | 0 | 4 | 2 |
| 7 | 16BES107 | ENGINEERING GRAPHICS | ES | 50 | 50 | 100 | 2 | 0 | 4 | 4 |
| | | **TOTAL** | | 350 | 350 | 700 | 16 | 4 | 8 | 22 |

## SECOND SEMESTER

| Sl. No. | Course Code | Course Title | Category | Continuous Assessment Marks | End Sem Marks | Total Marks | Credits | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | L | T | P | C |
| | | **THEORY** | | | | | | | | |
| 1 | 16BHS2Z1 | TECHNICAL ENGLISH | HS | 50 | 50 | 100 | 2 | 2 | 0 | 3 |
| 2 | 16BBS2Z2 | ENGINEERING MATHEMATICS II | BS | 50 | 50 | 100 | 3 | 2 | 0 | 4 |
| 3 | 16BBS2Z3 | MATERIALS SCIENCE | BS | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 4 | 16BHS2Z4 | ENVIRONMENTAL SCIENCE AND ENGINEERING | HS | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 5 | 16BES2Z5 | PROGRAMMING IN C | ES | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 6 | 16BES206 | ENGINEERING MECHANICS | ES | 50 | 50 | 100 | 3 | 2 | 0 | 4 |
| | | **PRACTICAL** | | | | | | | | |
| 7 | 16BBS207 | CHEMISTRY LAB | BS | 50 | 50 | 100 | 0 | 0 | 4 | 2 |
| 8 | 16BES208 | WORKSHOP PRACTICE | ES | 50 | 50 | 100 | 0 | 0 | 4 | 2 |
| 9 | 16BES2Z9 | PROGRAMMING IN C LAB | ES | 50 | 50 | 100 | 0 | 0 | 4 | 2 |
| | | **TOTAL** | | 450 | 450 | 900 | 17 | 6 | 12 | 26 |

## THIRD SEMESTER

| Sl. No. | Course Code | Course Title | Category | Continuous Assessment Marks | End Sem Marks | Total Marks | Credits | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | L | T | P | C |
| | | **THEORY** | | | | | | | | |
| 1 | 16BBS3Z1 | ENGINEERING MATHEMATICS III | BS | 50 | 50 | 100 | 3 | 2 | 0 | 4 |
| 2 | 16BES302 | PROCESS CALCULATIONS | ES | 50 | 50 | 100 | 2 | 2 | 0 | 3 |
| 3 | 16BPC303 | BASICS OF INDUSTRIAL BIOTECHNOLOGY | PC | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 4 | 16BPC304 | CELL BIOLOGY | PC | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 5 | 16BPC305 | MICROBIOLOGY | PC | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 6 | 16BPC306 | BIOCHEMISTRY | PC | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| | | **PRACTICALS** | | | | | | | | |
| 7 | 16BEE307 | COMMUNICATION SKILLS AND TECHNICAL SEMINAR | EEC | 50 | 50 | 100 | 0 | 0 | 4 | 2 |
| 8 | 16BPC308 | MICROBIOLOGY LABORATORY | PC | 50 | 50 | 100 | 0 | 0 | 4 | 2 |
| 9 | 16BPC309 | BIOCHEMISTRY LABORATORY | PC | 50 | 50 | 100 | 0 | 0 | 4 | 2 |
| | | **TOTAL** | | **450** | **450** | **900** | **17** | **4** | **12** | **25** |

## FOURTH SEMESTER

| Sl. No. | Course Code | Course Title | Category | Continuous Assessment Marks | End Sem Marks | Total Marks | **Credits** | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | **L** | **T** | **P** | **C** |
| | | **THEORY** | | | | | | | | |
| 1 | 16BBS401 | PROBABILITY, STATISTICS AND RANDOM PROCESSES | BS | 50 | 50 | 100 | 3 | 2 | 0 | 4 |
| 2 | 16BES402 | FLUID MECHANICS | ES | 50 | 50 | 100 | 2 | 2 | 0 | 3 |
| 3 | 16BPC403 | MOLECULAR BIOLOGY | PC | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 4 | 16BPC404 | BIOCHEMICAL THERMODYNAMICS | PC | 50 | 50 | 100 | 2 | 2 | 0 | 3 |
| 5 | 16BPC405 | ANALYTICAL TECHNIQUES IN BIOTECHNOLOGY | PC | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 6 | 16BPC406 | IMMUNOLOGY | PC | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| | | **PRACTICALS** | | | | | | | | |
| 7 | 16BPC407 | MOLECULAR BIOLOGY LABORATORY | PC | 50 | 50 | 100 | 0 | 0 | 4 | 2 |
| 8 | 16BPC408 | ANALYTICAL TECHNIQUES LABORATORY | PC | 50 | 50 | 100 | 0 | 0 | 4 | 2 |
| 9 | 16BPC409 | CELL AND IMMUNOLOGY LABORATORY | PC | 50 | 50 | 100 | 0 | 0 | 4 | 2 |
| | | **TOTAL** | | **450** | **450** | **900** | **16** | **6** | **12** | **25** |

## FIFTH SEMESTER

| Sl. No. | Course Code | Course Title | Category | Continuous Assessment Marks | End Sem Marks | Total Marks | Credits | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | L | T | P | C |
| | | **THEORY** | | | | | | | | |
| 1 | 16BPC501 | ENZYME ENGINEERING AND TECHNOLOGY | PC | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 2 | 16BES502 | HEAT AND MASS TRANSFER OPERATIONS | ES | 50 | 50 | 100 | 2 | 2 | 0 | 3 |
| 3 | 16BPC503 | BIOPROCESS PRINCIPLES | PC | 50 | 50 | 100 | 2 | 2 | 0 | 3 |
| 4 | 16BPC504 | GENETIC ENGINEERING | PC | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 5 | 16BPEX | PROFESSIONAL ELECTIVE I | PE | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 6 | 16BPEX | PROFESSIONAL ELECTIVE II | PE | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| | | **PRACTICALS** | | | | | | | | |
| 7 | 16BES507 | CHEMICAL ENGINEERING LABORATORY | ES | 50 | 50 | 100 | 0 | 0 | 4 | 2 |
| 8 | 16BPC508 | BIOPROCESS LABORATORY I | PC | 50 | 50 | 100 | 0 | 0 | 4 | 2 |
| 9 | 16BPC509 | GENETIC ENGINEERING LABORATORY | PC | 50 | 50 | 100 | 0 | 0 | 4 | 2 |
| | | **TOTAL** | | **450** | **450** | **900** | **16** | **4** | **12** | **24** |

## SIXTH SEMESTER

| Sl. No. | Course Code | Course Title | Category | Continuous Assessment Marks | End Sem Marks | Total Marks | Credits | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | L | T | P | C |
| | | **THEORY** | | | | | | | | |
| 1 | 16BPC601 | BIOSAFETY, BIOETHICS AND IPR | PC | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 2 | 16BES602 | CHEMICAL REACTION ENGINEERING | ES | 50 | 50 | 100 | 3 | 2 | 0 | 4 |
| 3 | 16BPC603 | BIOINFORMATICS | PC | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 4 | 16BPC604 | BIOPROCESS ENGINEERING | PC | 50 | 50 | 100 | 2 | 2 | 0 | 3 |
| 5 | 16BPEX | PROFESSIONAL ELECTIVE III | PE | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 6 | 16BOEX | OPEN ELECTIVE I | OE | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| | | **PRACTICALS** | | | | | | | | |
| 7 | 16BPC607 | BIOINFORMATICS LABORATORY | PC | 50 | 50 | 100 | 0 | 0 | 4 | 2 |
| 8 | 16BPC608 | BIOPROCESS ENGINEERING LABORATORY | PC | 50 | 50 | 100 | 0 | 0 | 4 | 2 |
| 9 | 16BEE609 | PERSONALITY AND SKILL DEVELOPMENT | EEC | 50 | 50 | 100 | 0 | 0 | 4 | 2 |
| | | **TOTAL** | | **450** | **450** | **900** | **16** | **4** | **12** | **25** |

## SEVENTH SEMESTER

| Sl. No. | Course Code | Course Title | Category | Continuous Assessment Marks | End Sem Marks | Total Marks | Credits | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | **L** | **T** | **P** | **C** |
| | | **THEORY** | | | | | | | | |
| 1 | 16BHS701 | MANAGEMENT THEORY AND PRACTICE | HS | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 2 | 16BPC702 | DOWNSTREAM PROCESSING | PC | 50 | 50 | 100 | 2 | 2 | 0 | 3 |
| 3 | 16BPC703 | PROTEIN ENGINEERING | PC | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 4 | 16BPEX | PROFESSIONAL ELECTIVE IV | PE | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 5 | 16BPEX | PROFESSIONAL ELECTIVE V | PE | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 6 | 16BOEX | OPEN ELECTIVE II | OE | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| | | **PRACTICALS** | | | | | | | | |
| 7 | 16BEE707 | MINI PROJECT | EEC | 50 | 50 | 100 | 0 | 0 | 8 | 4 |
| 8 | 16BPC708 | DOWNSTREAM PROCESSING LABORATORY | PC | 50 | 50 | 100 | 0 | 0 | 4 | 2 |
| | | **TOTAL** | | **400** | **400** | **800** | **17** | **2** | **12** | **24** |

## EIGHTH SEMESTER

| Sl. No. | Course Code | Course Title | Category | Continuous Assessment Marks | End Sem Marks | Total Marks | Credits | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | **L** | **T** | **P** | **C** |
| | | **THEORY** | | | | | | | | |
| 1 | 16BPEX | PROFESSIONAL ELECTIVE V I | PE | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 2 | 16BOEX | OPEN ELECTIVE III | OE | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| | | **PRACTICALS** | | | | | | | | |
| 3 | 16BEE803 | PROJECT WORK | EEC | 50 | 50 | 100 | 0 | 0 | 16 | 8 |
| | | **TOTAL** | | **150** | **150** | **300** | **6** | **0** | **16** | **14** |

**TOTAL NO. OF CREDITS: 185**

## HUMANITIES AND SOCIAL SCIENCES (HS)

| S. NO. | COURSE CODE | COURSE TITLE | CA Marks | End Sem Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|
| 1. | 16BHS1Z1 | COMMUNICATION SKILLS IN ENGLISH | 50 | 50 | 100 | 2 | 2 | 0 | 3 |
| 2. | 16BHS2Z1 | TECHNICAL ENGLISH | 50 | 50 | 100 | 2 | 2 | 0 | 3 |
| 3. | 16BHS2Z4 | ENVIRONMENTAL SCIENCE AND ENGINEERING | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 4. | 16BHS701 | MANAGEMENT THEORY AND PRACTICE | 50 | 50 | 100 | 3 | 0 | 0 | 3 |

## BASIC SCIENCES (BS)

| S. NO. | COURSE CODE | COURSE TITLE | CA Marks | End Sem Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|
| 1. | 16BBS1Z2 | ENGINEERING MATHEMATICS I | 50 | 50 | 100 | 3 | 2 | 0 | 4 |
| 2. | 16BBS103 | APPLIED PHYSICS | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 3. | 16BBS104 | CHEMISTRY FOR BIOTECHNOLOGY | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 4. | 16BBS106 | PHYSICS LAB | 50 | 50 | 100 | 0 | 0 | 4 | 2 |
| 5. | 16BBS2Z2 | ENGINEERING MATHEMATICS II | 50 | 50 | 100 | 3 | 2 | 0 | 4 |
| 6. | 16BBS2Z3 | MATERIALS SCIENCE | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 7. | 16BBS207 | CHEMISTRY LAB | 50 | 50 | 100 | 0 | 0 | 4 | 2 |
| 8. | 16BBS3Z1 | ENGINEERING MATHEMATICS III | 50 | 50 | 100 | 3 | 2 | 0 | 4 |
| 9. | 16BBS401 | PROBABILITY, STATISTICS AND RANDOM PROCESSES | 50 | 50 | 100 | 3 | 2 | 0 | 4 |

## ENGINEERING SCIENCES (ES)

| S. NO. | COURSE CODE | COURSE TITLE | CA Marks | End Sem Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|
| 1. | 16BES105 | BASICS OF ELECTRICAL AND ELECTRONIC ENGINEERING | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 2. | 16BES107 | ENGINEERING GRAPHICS | 50 | 50 | 100 | 0 | 0 | 4 | 2 |
| 3. | 16BES2Z5 | PROGRAMMING IN C | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 4. | 16BES206 | ENGINEERING MECHANICS | 50 | 50 | 100 | 3 | 2 | 0 | 4 |
| 5. | 16BES208 | WORKSHOP PRACTICE | 50 | 50 | 100 | 0 | 0 | 4 | 2 |
| 6. | 16BES2Z9 | PROGRAMMING IN C LAB | 50 | 50 | 100 | 0 | 0 | 4 | 2 |
| 7. | 16BES302 | PROCESS CALCULATIONS | 50 | 50 | 100 | 2 | 2 | 0 | 3 |
| 8. | 16BES402 | FLUID MECHANICS | 50 | 50 | 100 | 2 | 2 | 0 | 3 |
| 9. | 16BES502 | HEAT AND MASS TRANSFER OPERATIONS | 50 | 50 | 100 | 2 | 2 | 0 | 3 |
| 10. | 16BES507 | CHEMICAL ENGINEERING LABORATORY | 50 | 50 | 100 | 0 | 0 | 4 | 2 |
| 11. | 16BES602 | CHEMICAL REACTION ENGINEERING | 50 | 50 | 100 | 3 | 2 | 0 | 4 |

## PROFESSIONAL CORE (PC)

| S. NO. | COURSE CODE | COURSE TITLE | CA Marks | End Sem Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|
| 1. | 16BPC303 | BASICS OF INDUSTRIAL BIOTECHNOLOGY | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 2. | 16BPC304 | CELL BIOLOGY | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 3. | 16BPC305 | MICROBIOLOGY | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 4. | 16BPC306 | BIOCHEMISTRY | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 5. | 16BPC308 | MICROBIOLOGY LABORATORY | 50 | 50 | 100 | 0 | 0 | 4 | 2 |
| 6. | 16BPC309 | BIOCHEMISTRY LABORATORY | 50 | 50 | 100 | 0 | 0 | 4 | 2 |
| 7. | 16BPC403 | MOLECULAR BIOLOGY | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 8. | 16BPC404 | BIOCHEMICAL THERMODYNAMICS | 50 | 50 | 100 | 2 | 2 | 0 | 3 |
| 9. | 16BPC405 | ANALYTICAL TECHNIQUES IN BIOTECHNOLOGY | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 10. | 16BPC406 | IMMUNOLOGY | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 11. | 16BPC407 | MOLECULAR BIOLOGY LABORATORY | 50 | 50 | 100 | 0 | 0 | 4 | 2 |
| 12. | 16BPC408 | ANALYTICAL TECHNIQUES LABORATORY | 50 | 50 | 100 | 0 | 0 | 4 | 2 |
| 13. | 16BPC409 | CELL AND IMMUNOLOGY LABORATORY | 50 | 50 | 100 | 0 | 0 | 4 | 2 |
| 14. | 16BPC501 | ENZYME ENGINEERING AND TECHNOLOGY | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 15. | 16BPC503 | BIOPROCESS PRINCIPLES | 50 | 50 | 100 | 2 | 2 | 0 | 3 |
| 16. | 16BPC504 | GENETIC ENGINEERING | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 17. | 16BPC508 | BIOPROCESS LABORATORY I | 50 | 50 | 100 | 0 | 0 | 4 | 2 |
| 18. | 16BPC509 | GENETIC ENGINEERING LABORATORY | 50 | 50 | 100 | 0 | 0 | 4 | 2 |
| 19. | 16BPC601 | BIOSAFETY, BIOETHICS AND IPR | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 20. | 16BPC603 | BIOINFORMATICS | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 21. | 16BPC604 | BIOPROCESS ENGINEERING | 50 | 50 | 100 | 2 | 2 | 0 | 3 |
| 22. | 16BPC607 | BIOINFORMATICS LABORATORY | 50 | 50 | 100 | 0 | 0 | 4 | 2 |
| 23. | 16BPC608 | BIOPROCESS ENGINEERING LABORATORY | 50 | 50 | 100 | 0 | 0 | 4 | 2 |
| 24. | 16BPC702 | DOWNSTREAM PROCESSING | 50 | 50 | 100 | 2 | 2 | 0 | 3 |
| 25. | 16BPC703 | PROTEIN ENGINEERING | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 26. | 16BPC708 | DOWNSTREAM PROCESSING LABORATORY | 50 | 50 | 100 | 0 | 0 | 4 | 2 |

## PROFESSIONAL ELECTIVES (PE)

| S. NO. | COURSE CODE | COURSE TITLE | CA Marks | End Sem Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|
| 1. | 16BPEX01 | BIOFUELS | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 2. | 16BPEX02 | BIOPOLYMER TECHNOLOGY | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 3. | 16BPEX03 | INDUSTRIAL HAZARD MANAGEMENT | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 4. | 16BPEX04 | FOOD PROCESS ENGINEERING | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 5. | 16BPEX05 | MEDICAL BIOTECHNOLOGY | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 6. | 16BPEX06 | MARINE BIOTECHNOLOGY | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 7. | 16BPEX07 | PLANT BIOTECHNOLOGY | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 8. | 16BPEX08 | CANCER BIOLOGY | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 9. | 16BPEX09 | ENVIRONMENTAL BIOTECHNOLOGY | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 10. | 16BPEX10 | MOLECULAR PATHOGENESIS | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 11. | 16BPEX11 | NANOBIOTECHNOLOGY | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 12. | 16BPEX12 | ANIMAL BIOTECHNOLOGY | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 13. | 16BPEX13 | GENOMICS AND PROTEOMICS | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 14. | 16BPEX14 | MATHEMATICAL AND NUMERICAL METHODS FOR BIOTECHNOLOGY | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 15. | 16BPEX15 | BIOENTREPRENEURSHIP | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 16. | 16BPEX16 | IMMUNOTECHNOLOGY | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 17. | 16BPEX17 | BIOPHARMACEUTICAL TECHNOLOGY | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 18. | 16BPEX18 | BIOPROCESS ECONOMICS AND PLANT DESIGN | 50 | 50 | 100 | 3 | 0 | 0 | 3 |

## EMPLOYABILITY ENHANCEMENT COURSES (EEC)

| S. NO. | COURSE CODE | COURSE TITLE | CA Marks | End Sem Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|
| 1. | 16BEE307 | COMMUNICATION SKILLS AND TECHNICAL SEMINAR | 50 | 50 | 100 | 0 | 0 | 4 | 2 |
| 2. | 16BEE609 | PERSONALITY AND SKILL DEVELOPMENT | 50 | 50 | 100 | 0 | 0 | 4 | 2 |
| 3. | 16BEE707 | MINI PROJECT | 50 | 50 | 100 | 0 | 0 | 8 | 4 |
| 4. | 16BEE803 | PROJECT WORK | 50 | 50 | 100 | 0 | 0 | 16 | 8 |

## OPEN ELECTIVES (OE)

| S. NO | COURSE CODE | COURSE TITLE | CAT | CA Marks | End sem Marks | Total Marks | Credits | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | L | T | P | C |
| 1 | 16AOEX01 | NANOSCIENCE AND TECHNOLOGY | OE | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 2 | 16AOEX02 | MATERIAL CHARACTERIZATIONS | OE | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 3 | 16AOEX03 | ELECTROCHEMICAL TECHNOLOGY | OE | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 4 | 16AOEX04 | POLYMER TECHNOLOGY | OE | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 5 | 16COEX05 | DISASTER MANAGEMENT AND MITIGATION | OE | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 6 | 16COEX06 | ENVIRONMENTAL MANAGEMENT | OE | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 7 | 16COEX07 | TOWN PLANNING AND ARCHITECTURE | OE | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 8 | 16MOEX08 | TOTAL QUALITY MANAGEMENT FOR ENGINEERS | OE | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 9 | 16MOEX09 | COMPOSITE MATERIALS | OE | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 10 | 16MOEX10 | AUTOMOBILE ENGINEERING | OE | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 11 | 16EOEX11 | RENEWABLE ENERGY SOURCES AND TECHNOLOGY | OE | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 12 | 16EOEX12 | SMART GRID TECHNOLOGY | OE | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 13 | 16LOEX13 | PRINCIPLES OF COMMUNICATION | OE | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 14 | 16LOEX14 | MICROCONTROLLERS AND ITS APPLICATIONS | OE | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 15 | 16NOEX15 | INDUSTRIAL AUTOMATION SYSTEMS | OE | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 16 | 16NOEX16 | MEASUREMENTS AND INSTRUMENTATION | OE | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 17 | 16SOEX17 | ENTERPRISE JAVA | OE | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 18 | 16SOEX18 | CYBER SECURITY | OE | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 19 | 16SOEX19 | NETWORK ESSENTIALS | OE | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 20 | 16IOEX20 | PROGRAMMING IN PYTHON | OE | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 21 | 16IOEX21 | BIG DATA SCIENCE | OE | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 22 | 16IOEX22 | OBJECT ORIENTED PROGRAMMING USING C++ | OE | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 23 | 16BOEX23 | COMPUTATIONAL BIOLOGY | OE | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 24 | 16BOEX24 | BIOLOGY FOR ENGINEERS | OE | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 25 | 16BOEX25 | FUNDAMENTALS OF BIOENGINEERING | OE | 50 | 50 | 100 | 3 | 0 | 0 | 3 |

## ONE CREDIT COURSES (OC)

| S. NO | COURSE CODE | COURSE TITLE | CAT | CA Marks | End Sem Marks | Total Marks | Credits | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | L | T | P | C |
| 1 | 16BOC1Z1 | HUMAN VALUES I | OC | 100 | - | 100 | 1 | 0 | 0 | 1 |
| 2 | 16BOC202 | HUMAN VALUES AND PROFESSIONAL ETHICS | OC | 100 | - | 100 | 1 | 0 | 0 | 1 |
| 3 | 16BOC003 | YOGA FOR YOUTH EMPOWERMENT | OC | 100 | - | 100 | 1 | 0 | 0 | 1 |

**CREDIT SUMMARY**

| S. No. | Subject Area | Credits per Semester | | | | | | | | Credits Total | % of Total Credits | Total No. of subjects | AICTE Recommended Range of Credits % | | Satisfied |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | I | II | III | IV | V | VI | VII | VIII | | | | MIN | MAX | |
| 1 | HS | 3 | 6 | | | | | 3 | | 12 | 6 | 4 | 5 | 10 | Yes |
| 2 | BS | 12 | 9 | 4 | 4 | | | | | 29 | 16 | 9 | 15 | 20 | Yes |
| 3 | ES | 7 | 11 | 3 | 3 | 5 | 4 | | | 33 | 18 | 11 | 15 | 20 | Yes |
| 4 | PC | | | 16 | 18 | 13 | 13 | 8 | | 68 | 37 | 26 | 30 | 40 | Yes |
| 5 | PE | | | | | 6 | 3 | 6 | 3 | 18 | 10 | 6 | 10 | 15 | Yes |
| 6 | OE | | | | | | 3 | 3 | 3 | 9 | 5 | 3 | 5 | 10 | Yes |
| 7 | EEC | | | 2 | | | 2 | 4 | 8 | 16 | 9 | 4 | 10 | 15 | Yes |
| | TOTAL | 22 | 26 | 25 | 25 | 24 | 25 | 24 | 14 | 185 | | | | | |
| 8 | Non-Credit / Mandatory | | | | | | | | | | | | | | |

HS- Humanities and Social Science

BS- Basic Science

ES- Engineering Science

PC- Professional Core

PE- Professional Elective

OE- Open Elective

EEC- Employment Enhancement Course

IE-Industrial Elective

**EEC**

1. Industrial Training / Internship 1 Credit - 2 Weeks

   2 Credit - 4 Weeks

   3 Credit - 6 Weeks

2. Mini Project
3. Project

**16BHS1Z1** **COMMUNICATION SKILLS IN ENGLISH** **Category : HS**

*Common to all branches*

L T P C
2 2 0 3

**PRE-REQUISITES: NIL**

**COURSE OBJECTIVES:**

- To make the learners understand the usage of basic grammar in English.
- To enhance the learner's speaking skills through appropriate listening practice.
- To instill reading habits to practice communicative tasks and comprehension
- To improve the learner's writing skills through various means
- To enrich the vocabulary of learners for speaking and writing

**UNIT I** **6+6 Periods**

**Listening** - Listening to practice basic pronunciation at phonemic and word level, Listening to informal conversations of exchanging greetings and introducing oneself/others; **Speaking**- Introducing oneself, one's family / friend, speaking about one's place; **Reading**-Reading to practice stress and pause; **Writing**-Autobiographical writing, Letter to seek permission, Letter to issue certificates; **Grammar**-Use of Auxiliary Verbs, Adjectives and Adverbs; **Vocabulary**-Word formation, Synonyms and Antonyms of High frequency words.

**UNIT II** **6+6 Periods**

**Listening-**Listening to Telephone Conversations for taking and leaving messages, making enquiries; **Speaking—**Role-play activities based on real life situations, Narrating daily routines; **Reading**–skimming and scanning, Reading for comprehension with exercises; **Writing**-Advertisements and slogan writing, Imperative instructions, Definitions; **Grammar** – Tenses, Prepositions; **Vocabulary**-Commonly confused words

**UNIT III** **6+6 Periods**

**Listening** -Listening to give instructions, Making requests and responding to requests, Thanking someone and responding to thanks; **Speaking** -Group Discussion on chosen topics, Describing a simple process; **Reading**-Reading and interpreting visual material, Critical reading; **Writing** –Letter to the Editor of a Newspaper, Recommendations; **Grammar**- Impersonal Passive, Subject-verb agreement; **Vocabulary**- Collocation, Word Association

**UNIT IV** **6+6 Periods**

**Listening**-Listening to accept/refuse invitation, Listening to apologize, Listening to congratulate; **Speaking** – Debates on current social affairs; **Reading** –Reading to make inference, Paraphrasing; **Writing-** Personal letter (Inviting your friend to a function, congratulating someone on his / her success, thanking one's friends / relatives); **Grammar** – 'Wh'-questions, Modal verbs; **Vocabulary** -Single word substitutes -Use of abbreviations & acronyms

**UNIT V** **6+6 Periods**

**Listening** -Video Listening to different accents, Viewing Speeches, Viewing English songs, Viewing short films; **Speaking** -Giving impromptu talks, Making presentations on given topics; **Reading** – Extensive reading; **Writing** –Writing General Article, Writing Short Stories; **Grammar** - Common Errors in English; **Vocabulary** –Word Pairs with Repetitive meaning.

LECTURE: 30 PERIODS TUTORIAL:30 PERIODS PRACTICAL: 0 PERIODS TOTAL: 60 PERIODS

**TEXT BOOKS**

| AUTHOR NAME | TITLE OF BOOK | PUBLISHER, YEAR OF PUBLICATION |
|---|---|---|
| *Department of English, Anna University. Mindscape* | *English for Technologists and Engineers* | *Orient Blackswan, Chennai. 2012* |
| *Sadanand, Kamlesh & Punitha, Susheela* | *Spoken English: A Foundation Course (Part 1)* | *Orient Blackswan, Hyderabad. 2014* |

**REFERENCE BOOKS**

| AUTHOR NAME | TITLE OF BOOK | PUBLISHER, YEAR OF PUBLICATION |
|---|---|---|
| *Raman, Meenakshi & Sangeetha Sharma* | *Technical Communication: Principles and Practice* | *Oxford University Press, New Delhi. 2011* |
| *Vijay, Anbazhagan.J, & Jaishree.N* | *Technical English-I* | *Global Publishers, Chennai, 2016* |
| *Rizvi, Ashraf. M.* | *Effective Technical Communication* | *Tata McGraw-Hill, New Delhi. 2005* |
| *Rutherford, Andrea. J* | *Basic Communication Skills for Technology* | *Pearson, New Delhi. 2001* |
| *Redston, Chris, Cunningham, Gillie* | *Face 2 Face: Elementary Student's Book* | *Cambridge University Press, New Delhi. 2009* |

**EXTENSIVE READING**

(Not for Examination)

Kalam, Abdul. A.P.J Wings of Fire. Universities Press, Hyderabad. 1999.

## Websites

1. http://www.usingenglish.com
2. http://www.uefap.com

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to

**CO1:** The learner will be able to understand basic grammar and the learner will have sufficient command over language by training his tongue and tuning his ear through apt listening tasks.

**CO2:** Reading tasks will enable the learner practice phonological and linguistic aspect of learning, help comprehend and create interest in extensive reading.

**CO3:** The learner shall be able to write appropriately for a given context and use the right word at the right place.

**COURSE ARTICULATION MATRIX:**

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PS 01 | PS 02 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | - | - | M | - | M | - | - | - | - | - | - | - | M | - |
| **CO2** | - | - | - | - | - | M | - | - | - | - | M | - | - | - |
| **CO3** | - | - | - | - | - | - | - | - | - | M | - | - | - | - |
| **CO4** | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **CO5** | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **16BHS1Z1** | - | - | L | - | L | L | - | - | - | L | L | - | L | - |

**L – Low, M – Moderate (Medium), H – High**

**16BBS1Z2** **ENGINEERING MATHEMATICS I** **Category : BS**

*Common to all branches*

L T P C

3 2 0 4

**PRE-REQUISITES: NIL**

**COURSE OBJECTIVES:**

- To familiarize techniques of matrix algebra including properties of eigen values and eigen vectors.
- To gain the knowledge of hyperbolic functions and application problems in differential calculus.
- To familiarize with functions of several variables and Functions of two variables including extremum problems, Jacobian and Leibnitz rule of integration.
- To perform double and triple integration with relevant to surface area and volume of solid.

**UNIT I** **MATRICES** **9 + 6 Periods**

Eigen values and Eigen vectors of a real matrix-Characteristic equation-Properties of Eigen values and eigen vectors-Cayley Hamilton theorem - Diagonalization of matrices-Reduction of a quadratic form to canonical form by orthogonal transformation-Nature of quadratic forms.

**UNIT II** **HYPERBOLIC FUNCTIONS AND DIFFERENTIAL CALCULUS** **9 + 6 Periods**

Hyperbolic and Inverse Hyperbolic functions-Identities- Real and Imaginary parts-Solving Problems using Hyperbolic functions.

Curvature and radius of curvature-Cartesian and polar coordinates- center of curvature and Evolutes-Envelopes and Evolute as envelope of normal.

**UNIT III** **FUNCTIONS OF SEVERAL VARIABLES** **9 + 6 Periods**

Functions of two variables- Taylor's theorem (statement only) and expansions-Maxima and Minima-Constrained extremum by Lagrange's multiplier method-Jacobians-Differentiation under integral sign

**UNIT IV** **INTEGRAL CALCULUS** **9 + 6 Periods**

Definite and Indefinite integrals-Substitution rule-Techniques of Integration-Integration by parts-Trigonometric substitutions-Integration of rational function by partial fractions-Integration of irrational functions-Improper integrals.

**UNIT V** **MULTIPLE INTEGRALS** **9 + 6 Periods**

Beta and Gamma integrals and properties. Double Integrals-Change of order of integration-Double integrals in polar coordinates-Area enclosed by plane curves-Triple integrals-Volume as a triple integral-Transformation to Polar, Cylindrical and Spherical polar coordinates.

LECTURE: 30 PERIODS TUTORIAL:30 PERIODS PRACTICAL: 0 PERIODS TOTAL: 60 PERIODS

**TEXT BOOKS**

| **AUTHOR NAME** | **TITLE OF BOOK** | **PUBLISHER, YEAR OF PUBLICATION** |
|---|---|---|
| *Veerarajan T* | *Engineering Mathematics for Semesters I and II* | *Tata McGraw Hill Publishing Co., New Delhi, 2015.* |
| *Kandasamy P, ThilagavathyK and Gunavathy K* | *Engineering Mathematics for I year B.E/B.Tech.* | *S.Chand& Co, Ramnagar, New Delhi, Reprint 2013.* |
| *S. Narayanan and Manicavachagom Pillai T.K.* | *Calculus, Vol.I , II and III,* | *S. Viswanathan, Printers and Publishers Pvt. Ltd, Chennai, 2009.* |

**REFERENCE BOOKS**

| AUTHOR NAME | TITLE OF BOOK | PUBLISHER, YEAR OF PUBLICATION |
|---|---|---|
| *Erwin Kreyszig* | *Advanced Engineering Mathematics* | *Wiley & sons (Asia) Ltd, 10th Edition, 2015.* |
| *Ray Wylie.C and Louis Barrett* | *Advanced Engineering Mathematics* | *Tata McGraw Hill Company, New Delhi, 2004.* |
| *Grewal B. S* | *Higher Engineering Mathematics* | *Khanna Publishers, New Delhi, 43rd Edition, 2014.* |
| *Ramana B V* | *Higher Engineering Mathematics* | *Tata McGraw Hill Co. Ltd, NewDelhi, 11th Print, 2010.* |
| *Bali N., Goyal M and Watkins C* | *Advanced Engineering Mathematics* | *Firewall Media (An Imprint of Laxmi Publications Pvt Ltd), New Delhi, 7th Edition, 2009.* |
| *Bali N.P and Goyal M* | *A text book of Engineering Mathematics* | *University Science Press (An Imprint of Laxmi Publications Pvt Ltd), New Delhi,2014* |

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to

**CO1:** Acquire knowledge of eigen values and eigen vectors including properties through matrix theory.

**CO2**: Understand the hyperbolic functions and applications of differential calculus.

**CO3**: Acquire fluency in partial differentiation and solving problems related to maxima and minima for more independent variables.

**CO4**: Understand the standard types of integration and solution to various integrals.

**CO5:** Understand the multiple integrals and their applications to engineering problems.

**COURSE ARTICULATION MATRIX:**

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PS 01 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | H | H | H | M | - | - | - | - | - | H | M | M | H |
| **CO2** | H | M | M | - | - | - | - | - | - | M | - | - | H |
| **CO3** | H | H | H | - | - | - | - | - | - | L | - | - | H |
| **CO4** | H | H | M | M | - | - | - | - | - | M | L | L | L |
| **CO5** | H | M | M | - | - | - | - | - | - | L | L | L | H |
| **16BBS1Z2** | H | H | M | M | - | - | - | - | - | M | L | L | H |

**L – Low, M – Moderate (Medium), H – High**

**16BBS103** **APPLIED PHYSICS** **Category: BS**

*Common to Civil, Mechanical, Production and Industrial Biotechnology branches*

L T P C
3 0 0 3

**PRE-REQUISITES: NIL**

**COURSE OBJECTIVES:**

To enhance the fundamental knowledge in Physics and its applications relevant to various streams of Engineering and Technology. Upon completion of this course the students will be familiar with:

- Concepts, types of lasers and its applications, fibre optic principles and its applications.
- Basics of properties of matter & thermal physics
- Origin of quantum physics, Schrödinger's equation and applications.
- Principles of acoustics, ultrasonics and their industrial applications.
- Fundamentals of vacuum science, production and measurement.

**UNIT I LASERS & FIBRE OPTICS 9 Periods**

Introduction- Principle of laser action - characteristics of laser - Spontaneous emission and Stimulated emission –Einstein's coefficients - population inversion – methods of achieving population inversion –Optical Resonator -Types of Lasers – Principle, construction and working of Nd-YAG, $CO_2$, Semiconductor laser - applications of laser-Hologram.

Introduction – Basic Principles involved in fiber optics- Total internal reflection – Structure of optical fiber –Propagation of light through optical fiber –Derivation for Numerical Aperture and acceptance angle - fractional index change - Classification of optical fiber based on materials, refractive index profile and Modes - Fiber optical communication links-Fiber optic sensors-displacement

**UNIT II PROPERTIES OF MATTER & THERMAL PHYSICS 9 Periods**

Elasticity- Hooke's law- stress-strain diagram - Factors affecting elasticity - Bending moment - Depression of a cantilever - Young's modulus by uniform bending - I shaped girders.

Thermal expansion - thermal stress - thermal conductivity - heat conduction in solids - flow of heat through compound media - Forbe's and Lee's disc method: theory and experiment.

**UNIT III QUANTUM PHYSICS AND APPLICATIONS 9 Periods**

Limitations of classical Physics - Introduction to Quantum theory - Dual nature of matter and radiation- de-Broglie wavelength in terms of voltage, energy, and temperature –Heisenberg's Uncertainty principle – verification – physical significance of a wave function- Schrödinger's Time independent and Time dependent wave equations –- Particle in a one dimensional potential well - Scanning Electron Microscope (SEM)-Transmission Electron Microscope (TEM).

**UNIT IV ACOUSTICS & ULTRASONICS 9 Periods**

Classification of sound - loudness and intensity - Weber-Fechner law - standard intensity and intensity level - decibel - reverberation - reverberation time - sound absorbing materials - Determination of absorption coefficient - factors affecting acoustics of buildings.

Introduction - properties of ultrasonic waves - production of ultrasonic waves; Magnetostriction effect- Magnetostriction generator- Piezoelectric effect- Piezoelectric generator- Acoustic grating - Determination of wavelength and velocity of ultrasonics-cavitation - applications- ultrasonic drilling- ultrasonic welding- ultrasonic soldering and ultrasonic cleaning-Non- destructive Testing- Pulse echo system

**UNIT V** **VACUUM SCIENCE** **9 Periods**

Introduction - Importance of vacuum in industries - Pumping speed and throughput - Types of pumps-Rotary vane type Vacuum pump(oil sealed), Diffusion Pump and Turbo Molecular Pump - Measurement of High Vacuum-McLeod Gauge-Pirani Gauge-Penning Gauge - Application to thin film technology.

LECTURE: 45 PERIODS TUTORIAL:0 PERIODS PRACTICAL: 0 PERIODS TOTAL: 45 PERIODS

**TEXT BOOKS**

| AUTHOR NAME | TITLE OF BOOK | PUBLISHER, YEAR OF PUBLICATION |
|---|---|---|
| *Arumugam M* | *Engineering Physics* | *Anuradha Publishers, 2010. (**UNIT I** & **UNIT III**)* |
| *P.K.Palanisamy* | *Engineering physics-I* | *SciTech Publications (India) Pvt. Ltd,2015. (**UNIT II** & **UNIT IV**)* |
| *Ganesan S and Iyandurai N* | *Applied Physics* | *KKS Publishers, Chennai, 2007.(**UNIT V**)* |

**REFERENCE BOOKS**

| AUTHOR NAME | TITLE OF BOOK | PUBLISHER, YEAR OF PUBLICATION |
|---|---|---|
| *Avadhanulu M N and Kshirsagar P G* | *A Textbook of Engineering Physics* | *S.Chand and Company Ltd, New Delhi, 2010.* |
| *Gaur R.K. and Gupta S.L* | *Engineering Physics* | *Dhanpat Rai Publishers, 2009.* |
| *K.Rajagopal* | *Engineering Physics* | *PHI Learning Private limited, New Delhi,2015.* |

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to

**CO1:** Analyze the construction and working of Nd-YAG, $CO_2$, Semiconductor lasers. Explain fiber optics and classify fibers based on index profiles and modes. [Familiarity]

**CO2:** Acquire knowledge in properties of matter and thermal Physics [Application]

**CO3:** Analyze the dual nature of matter using Heisenberg's Uncertainty principle, Schrodinger's time independent and dependent wave equations. [Assessment]

**CO4:** Apply piezoelectric detector method for industrial applications. [Usage and Assessment]

**CO5:** Production & Measurement of vacuum. [Familiarity]

**COURSE ARTICULATION MATRIX:**

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PS 01 | PS02 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | M | M | M | M | M | M | M | - | - | - | - | - | H | H |
| **CO2** | H | H | H | H | H | H | H | - | - | - | - | - | H | H |
| **CO3** | M | M | - | - | M | M | M | - | - | - | - | - | H | H |
| **CO4** | H | H | H | H | H | H | H | - | - | - | - | - | H | H |
| **CO5** | H | H | H | H | H | H | H | - | - | - | - | - | H | H |
| **16BBS103** | H | H | H | H | H | H | H | - | - | - | - | - | H | H |

**L – Low, M – Moderate (Medium), H – High**

**16BBS104** **CHEMISTRY FOR BIOTECHNOLOGY** **Category: BS**

L T P C
3 0 0 3

**PRE-REQUISILTES: NIL**

**COURSE OBJECTIVES:**

- The course is aimed at imparting knowledge of organic chemistry topics which would be useful for students to understand chemistry applied in Biotechnology.

**UNIT I** **POLYMER TECHNOLOGY** **9 Periods**

Polymers - definitions of monomer, polymer, functionality, degree of polymerisation – Free radical mechanism -Individual polymers - PVC, PMMA, Teflon, polyamide, poly carbonate, epoxy, polyurethane - preparation, properties and their end users - compounding of plastics - components and functions - fabrication techniques - compression, injection, extrusion and blow moulding - Conducting polymers - structures of polypyrrole, polyaniline and poly acetylene - conduction mechanism of polyacetylene only - Biodegradable polymers – polylactide, starch and cellulose.

**UNIT II** **STEREOCHEMISTRY AND HETEROCYCLIC COMPOUNDS** **9 Periods**

Stereoisomerism - types of stereoisomerism - configurational isomers - enantiomers and diastereosiomers - chirality, optical activity - Fischer projections - optical isomerism- - configurations – D & L, R & S systems – Geometrical – E & Z nomenclature - applied to cyclic structures- conformational isomerism – ethane, n-butane and cyclo hexane. Hetero cyclic compounds- pyrrole, pyridine, quinoline, isoquinoline, indole - aromaticity, synthesis and reactions of the compounds.

**UNIT III** **INSTRUMENTAL METHODS OF CHEMICAL ANALYSIS** **9 Periods**

Electromagnetic radiation - characteristics (wave length, wave no, frequency and energy) – Molecular spectroscopy - electronic spectra - Beer Lambert law – deviations - analysis of ferrous iron, nucleic acids, electronic transitions in organic molecules - Woodward – Fischer rules for calculating absorption maximum in dienes and unsaturated ketones - IR spectroscopy – principle - fundamental vibrations, finger print region - simple instrumentation and sampling, interpretation of simple compounds (ethanol, benzene and benzoic acid).

**UNIT IV** **BASIC REACTION MECHANISM IN ORGANIC CHEMISTRY** **9 Periods**

Bonding in organic molecules - carbanion, carbocation and free radicals - inductive effect, electronic effect and resonance effect - Nucleophilic substitution – $S_N1$ and $S_N2$ – evidences - Electrophilic-substitution – aromatic and aliphatic -Elimination – E1 and E2 substitution – applied to simple reactions.

**UNIT V** **NANOCHEMISTRY** **9 Periods**

Nano materials – definitions of 1D, 2D and 3D structures -general methods of synthesis and characterisation - bottom up and top down approaches - wet chemical, CVC, laser ablation and ball milling techniques - self assembled structures – Characteristics – classification - dendrimers – applications in Biotechnology.

LECTURE: 45 PERIODS TUTORIAL:0 PERIODS PRACTICAL: 0 PERIODS TOTAL: 45 PERIODS

**TEXT BOOKS**

| **AUTHOR NAME** | **TITLE OF BOOK** | **PUBLISHER, YEAR OF PUBLICATION** |
|---|---|---|
| *Jain P.C. and Monica Jain* | *Engineering Chemistry* | *Dhanpat Rai Publications. Pvt. Ltd, New Delhi, 16th Edition, 2015.* |
| *ArunBhal and Bahl.B.S* | *Advanced Organic Chemistry* | *S. Chand & Company Ltd, New Delhi, 2014.* |

**REFERENCE BOOKS**

| AUTHOR NAME | TITLE OF BOOK | PUBLISHER, YEAR OF PUBLICATION |
|---|---|---|
| *Vairam S, Subha Ramesh* | *Engineering Chemistry* | *Wiley India, 2015.* |
| *O.P. Aggarwal, Avinash Aggarwal* | *Engineering Chemistry* | *Khanna Publishers, 2010.* |
| *Kuriakose J.C., and Rajaram J* | *Chemistry in Engineering and Technology, Vol.1 & II* | *Tata Mc Graw Hill Publishing company Pvt. Ltd, New Delhi, 2010.* |
| *I.L. Finar* | *Organic Chemistry* | *EBS Publications, 2013.* |
| *B. Sivasankar* | *Engineering Chemistry* | *Tata McGraw Hill Publications, 2008.* |

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to

**CO1:** Understand the mechanism of organic reactions and apply them in synthesis of biomolecules.

**CO2:** Learn the principles of stereoisomerism, configurations in simple organic molecules and extend the knowledge to biomolecules and the properties of heterocyclic compounds.

**CO3:** Be familiar with the various instrumental methods used for the analysis of simple compounds and interpretation of biomolecules.

**CO4:** Know about the different types of polymeric materials, properties and fabrication which match the specific applications.

**CO5:** Gain the knowledge about fundamental of nanomaterials, synthesis, structures and application in Biotechnology field.

**COURSE ARTICULATION MATRIX:**

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PS 01 | PS02 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | M | M | L | M | M | L | M | M | M | M | M | M | M | M |
| **CO2** | M | H | M | L | M | L | L | L | M | M | M | M | M | M |
| **CO3** | H | M | M | L | M | H | L | M | L | L | M | M | M | L |
| **CO4** | H | H | H | M | M | H | M | M | L | M | M | M | M | M |
| **CO5** | M | L | M | L | M | L | M | L | L | M | L | M | M | L |
| **16BBS104** | H | M | M | L | M | L | L | L | M | M | L | M | M | L |

**L – Low, M – Moderate (Medium), H – High**

| 16BES105 | BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING | Category : ES |
|---|---|---|
| | Common to Mechanical, Production and Industrial Biotechnology branches | L T P C<br>3 0 0 3 |

**PRE-REQUISITES: NIL**

**COURSE OBJECTIVES:**

- To study the basic concepts of electric circuits, electronic devices and communication engineering.
- To know the fundamental of energy conversion, construction, principle of operation, characterization of DC machines and AC machines.

**UNIT I ELECTRICAL CIRCUITS & MEASUREMENTS 9 Periods**

Ohm's Law – Kirchoff's Laws – Steady State Solution of DC circuits – Introduction to AC Circuits – Waveforms and RMS Value – Power and Power factor – Single Phase and Three Phase Balanced Circuits.

Operating Principles of Moving Coil and Moving Iron Instruments (Ammeters and Voltmeters), Dynamometer type Watt meters and Energy meters.

**UNIT II ELECTRICAL MACHINES 9 Periods**

Construction, Principle of Operation, Basic Equations and Types, Characteristics and Applications of DC Generators, DC Motors, Single Phase Transformer, Single Phase induction motor.

**UNIT III SEMICONDUCTOR DEVICES AND APPLICATIONS 9 Periods**

Characteristics of PN Junction Diode – Zener Effect – Zener Diode and its Characteristics – Half wave and Full wave Rectifiers - Voltage Regulation.

Bipolar Junction Transistor – CB, CE, CC Configurations and Characteristics – Working principle and Characteristics of FET, JFET, MOSFET – Characteristics and Simple Application of SCR, DAC, TRIAC & UJT – Elementary Treatment of Small Signal Amplifier.

**UNIT IV DIGITAL ELECTRONICS 9 Periods**

Binary Number System – Logic Gates – Boolean Algebra – Half and Full Adders - Flip-Flops – Registers and Counters – A/D and D/A Conversion (Simple concepts).

**UNIT V FUNDAMENTALS OF COMMUNICATION ENGINEERING 9 Periods**

Types of Signals: Analog and Digital Signals – Modulation and Demodulation: Principles of Amplitude and Frequency Modulations.

Communication Systems: Radio, TV, Microwave, Satellite, RADAR and Optical Fibre (Block Diagram Approach only).

LECTURE: 45 PERIODS TUTORIAL:0 PERIODS PRACTICAL: 0 PERIODS TOTAL: 45 PERIODS

**TEXT BOOKS**

| AUTHOR NAME | TITLE OF BOOK | PUBLISHER, YEAR OF PUBLICATION |
|---|---|---|
| *Muthusubramanian R, Salivahanan S and Muraleedharan K A* | *Basic Electrical and Electronics Engineering* | *Tata McGraw Hill, Second Edition, (2009).* |
| *Mittle.V.N and Arvind Mittal* | *Basic Electrical Engineering* | *Tata McGraw Hill, Second Edition, New Delhi, 2005.* |
| *Sedha R.S* | *A Text book of Applied Electronics* | *S. Chand & Co., 2008.* |

**REFERENCE BOOKS**

| AUTHOR NAME | TITLE OF BOOK | PUBLISHER, YEAR OF PUBLICATION |
|---|---|---|
| *Nagsarkar T K and Sukhija M S* | *Basics of Electrical Engineering* | *Oxford Press (2005).* |
| *Mehtra V.K and Rohit Mehta* | *Priniciples of Electrical Engineering and Electronics* | *S. Chand & Co. 2nd Edition 2015.* |
| *Mahmood Nahvi and Joseph A. Edminister* | *Electric Circuits, Schaum' Outline Series* | *McGraw Hill, Sixth edition (2014)* |
| *Premkumar N and Gnanavadivel J* | *Basic Electrical and Electronics Engineering* | *Anuradha Publishers, 4th Edition (2008).* |

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to

**CO1:** Analyze simple DC and AC Circuits.

**CO2:** Understand the significance of Electrical machines.

**CO3:** Apply knowledge on semiconductor devices and Integrated circuits.

**CO4:** Understand the concepts of communication engineering.

**CO5:** Design simple circuits using electronic components for specific applications.

**COURSE ARTICULATION MATRIX: :**

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PS 01 | PS02 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | H | H | - | - | - | M | M | - | - | - | L | M | H | M |
| **CO2** | H | M | M | - | - | - | M | - | - | - | L | - | M | M |
| **CO3** | H | L | L | - | M | - | L | - | - | - | - | - | H | M |
| **CO4** | H | - | L | - | M | M | L | - | - | - | L | L | M | L |
| **CO5** | H | M | H | M | M | L | - | - | - | - | L | M | M | H |
| **16BES105** | H | M | M | M | M | M | M | - | - | - | L | M | M | M |

**L – Low, M – Moderate (Medium), H – High**

**16BBS106** **PHYSICS LAB** **Category : BS**

*Common to Civil, Mechanical, Production and Industrial Biotechnology branches*

L T P C
0 0 4 2

**PRE-REQUISITES: NIL**

**COURSE OBJECTIVES:**

- To have a practical knowledge about the concepts behind physics and the need to apply in the emerging technology.

**LIST OF EXPERIMENTS**

1. Spectrometer - Diffraction Grating Normal Incidence Method
2. Air Wedge –Determination of thickness of a paper
3. Young's Modulus – Cantilever Bending - Koenig's Method
4. a. Laser - Particle size Determination

   b. Optical fiber - Determination of NA & Acceptance angle
5. Ammeter and Voltmeter Calibration – Low Range
6. Resistance Of The Given Coil Of Wire – Carey Foster's Bridge
7. Determination of Band gap Energy of Semiconductor
8. Ultrasonic Interferometer - Velocity of sound & Compressibility of liquids.
9. Transistor Characteristics
10. Torsional pendulum –Determination of Rigidity Modulus & Moment of Inertia

LECTURE: 0 PERIODS TUTORIAL:0 PERIODS PRACTICAL: 60 PERIODS TOTAL: 60 PERIODS

**COURSE OUTCOMES:**

Upon completion of this practical classes, the students will be able to

**CO1:** Determinate all physical properties of any matter, basic idea of calibrating electrical measuring instruments and thereby effectively using it for particular applications.

**CO2:** Experiment intrinsic characteristic features of electronic devices for electrical and electronic applications.

**COURSE ARTICULATION MATRIX:**

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PS 01 | PS02 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | M | M | M | M | M | M | M | - | - | - | - | - | - | - |
| **CO2** | M | M | M | M | M | M | M | - | - | - | - | - | - | - |
| **16BBS106** | M | M | M | M | M | M | M | - | - | - | - | - | - | - |

**L – Low, M – Moderate (Medium), H – High**

**16BES107** **ENGINEERING GRAPHICS** **Category : ES**

*Common to Civil, Mechanical, Production and Industrial Biotechnology branches*

L T P C
2 0 4 4

**PRE-REQUISITES: NIL**

**COURSE OBJECTIVES:**

- Geometrical constructions
- Orthographic projections.
- Performing section of solids and development of the same.
- Interpretation of solids.
- Pictorial view of solids

**UNIT I GEOMETRICAL CONSTRUCTIONS 15 Periods**

Dimensioning-Lettering-Types of Lines-Scaling conventions-Dividing a given straight line in to any number of equal parts- Bisecting a given angle- Drawing a regular polygon given one side-Special methods of constructing a pentagon and hexagon- Construction of curves like ellipse, parabola, cycloid and involute using one method.

**UNIT II ORTHOGRAPHIC PROJECTIONS 25 Periods**

Introduction to Orthographic Projection-Projection of points-Projection of straight lines with traces-Projection of planes-Conversion of pictorial views to orthographic views-Projection of solids - Auxiliary projections.

**UNIT III SECTION OF SOLIDS AND DEVELOPMENT 20 Periods**

Section of solids- Development of surfaces

**UNIT IV INTERPENETRATION OF SOLIDS AND PICTORIAL VIEWS 20 Periods**

Cylinder and cylinder, cone and cylinder only Isometric projections - Conversion of orthographic views to pictorial views (simple objects).

**UNIT V INTRODUCTION TO AUTOCAD 10 Periods**

**Object Construction:** Page layout – Layers and Line types – Creating, Editing and selecting the Geometric Objects. Viewing, Annotating, Hatching and Dimensioning the drawing –Creating Blocks and Attributes

LECTURE:30 PERIODS TUTORIAL:0 PERIODS PRACTICAL:60 PERIODS TOTAL:90 PERIODS

**REFERENCE BOOKS:**

| AUTHOR NAME | TITLE OF BOOK | PUBLISHER, YEAR OF PUBLICATION |
|---|---|---|
| *K.Vengopal* | *Engineering Graphics* | *New Age International (P) Limited, 2015.* |
| *Dhananjay.A.Jolhe* | *Engineering Drawing* | *Tata McGraw Hill Publishing Co., 2007.* |
| *K.V.Nataraajan* | *A text book of Engineering Graphics* | *Dhanalakashmi Publishers, Chennai, 2006.* |
| *M.B.Shah and B.C. Rana* | *Engineering Drawing* | *Pearson Education, 2005.* |
| *Luzadder and Duff* | *Fundamentals of Engineering Drawing* | *Prentice Hall of India Pvt Ltd, XI Edition, 2001.* |
| *K.L.Narayana and P.Kannaiah* | *Text book on Engineering Drawing* | *2nd Ed., Scitech Publications (India) Pvt. Ltd, Chennai, 2009.* |

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to

**CO1:** Represent planes and solids as per international standards.

**CO2:** Generate and interpret multiple views through development, interpretation and sectional views.

**CO3:** Generate and interrupt orthographic views.

**CO4:** Generate and interrupt pictorial views and interpenetration.

**CO5:** Generate and interrupt perspective views.

**CO6:** Apply the concept of AUTOCAD in engineering graphics.

**COURSE ARTICULATION MATRIX:**

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PS0 1 | PS0 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | - | H | H | - | - | M | - | L | H | M | - | M | M | M |
| **CO2** | - | - | H | - | - | M | - | L | H | M | - | M | M | M |
| **CO3** | - | - | H | - | - | M | - | L | H | M | - | M | M | M |
| **CO4** | - | - | H | - | - | M | - | L | H | M | - | M | M | M |
| **CO5** | - | H | H | H | - | M | - | L | H | M | - | M | M | M |
| **16BES107** | - | L | H | L | - | M | - | L | H | M | - | M | M | M |

**L – Low, M – Moderate (Medium), H – High**

**16BHS2Z1** **TECHNICAL ENGLISH** **Category : HS**

*Common to all branches* L T P C

2 2 0 3

**PRE-REQUISITES: NIL**

**COURSE OBJECTIVES:**

- To make learners acquire guided listening and speaking skills in both formal and informal contexts.
- To help them develop reading skills by familiarizing them with different types of reading tasks and strategies
- To make them understand advance level of grammar and equip them with writing skills needed for academic as well as workplace contexts.
- To explore the learner to Technical English and Technical Vocabulary.

**UNIT I** **6+6 Periods**

**Listening** - Listening to ask for/ give opinions, Listening to persuade/dissuade people, Listening to make complaints, Listening to transfer information; **Speaking** –Role play activities on a formal/corporate context, Delivering Welcome Address- **Reading** – Reading to infer lexical and contextual meaning; **Writing** - Effective use of SMS on Whatsapp/ Hike/ Messenger, Writing E-mails on a business context, Technical style; **Grammar** – Use of relative / reflexive pronouns, Discourse Markers; **Vocabulary**- Homonyms and Homophones

**UNIT II** **6+6 Periods**

**Listening** - Listening to express regrets/sympathy/condolences, Listening and Note-taking; **Speaking** – Addressing at an official meeting to deal with problems/ sensitive issues, Discussion on a movie with a poignant social message/ or on a recently read book; **Reading** - Reading a short story or an article from newspaper; **Writing** - Writing a review of a book/movie/music concert/sports event, Graph Description; **Grammar** – Noun/Adjective/Adverbial phrases, Cause and effect expressions; **Vocabulary** - Using phrasal verbs in sentences, Jargon

**UNIT III** **6+6 Periods**

**Listening** - Listening to a talk about using quantities, Listening to describe manner and frequency, Listening to expressions of assumptions/inference, Listening to make comparisons; **Speaking** –Making conversation to practice stress, pause, pronunciation and intonation, Introducing the chief-guest; **Reading** - Speed reading – reading passages with time limit - **Writing** – Notice, Agenda and Minutes of meetings; - Elements of Writing Technical articles –**Grammar** - Numerical expressions, Conditional clauses; **Vocabulary** - Same word used as different parts of speech, Register

**UNIT IV** **6+6 Periods**

**Listening** - Listening to talks about future events/plans, Listening to a talk about making arrangements, Listening to language of reporting, Viewing a model discussion; **Speaking** – Discussion on a formal/corporate context, Proposing vote of thanks; **Reading** - Reading the job advertisements and the profile of the company concerned; **Writing** - Process Description, Applying for a job with résumé; **Grammar** - Direct and indirect speech; **Vocabulary** - Idioms

**UNIT V** **6+6 Periods**

**Listening** – Listening to expressions of possibility, Listening to expressions of obligations, Listening to expressions of ability, Viewing model interviews; **Speaking** - Mock interview; **Reading** - Note making, Intensive reading; **Writing** – Checklist, - Feasibility / Project report; **Grammar** – Time Statements and Contracted Time Statements; **Vocabulary** – Nominal Compounds

LECTURE: 30 PERIODS TUTORIAL:30 PERIODS PRACTICAL: 0 PERIODS TOTAL: 60 PERIODS

**TEXT BOOKS**

| AUTHOR NAME | TITLE OF BOOK | PUBLISHER, YEAR OF PUBLICATION |
|---|---|---|
| *Department of English, Anna University. Mindscapes* | *English for Technologists and Engineers.* | *Orient Blackswan, Chennai. 2012* |
| *Sadanand, Kamlesh & Punitha, Susheela* | *Spoken English: A Foundation Course (Part 2).* | *Orient Blackswan, Hyderabad. 2014* |

**REFERENCE BOOKS**

| AUTHOR NAME | TITLE OF BOOK | PUBLISHER, YEAR OF PUBLICATION |
|---|---|---|
| *Raman, Meenakshi & Sangeetha Sharma* | *Technical Communication: Principles and Practice* | *Oxford University Press, New Delhi. 2011* |
| *Vijay, Anbazhagan.J, & Jaishree.N* | *Technical English-II* | *Global Publishers, Chennai, 2016* |
| *Rizvi, Ashraf. M.* | *Effective Technical Communication* | *Tata McGraw-Hill, New Delhi. 2005* |
| *Herbert, A.J* | *Structure of Technical English* | *The English Language Society, London. 1971* |
| *Michigan, E.A* | *Word Power and Speed Reading: English Improvement Series* | *Infinity Books, New Delhi, 2007* |
| *Rajendrapal & Korlahalli. J.S* | *Essentials of Business Communication* | *Sultan Chand & Sons* |

**WEBSITES**

1. http://www.usingenglish.com
2. http://www.uefap.com

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to

**CO1:** The learners will be able to speak convincingly at work place and social contexts through guided listening tasks and different genres and strategies of reading.

**CO2:** The learner will understand advance level of grammar and write professionally to a larger Extent for workplace and general contexts.

**CO3:** The learners will familiarize themselves with Technical Vocabulary and Technical English.

**COURSE ARTICULATION MATRIX:**

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PS 01 | PS 02 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | - | - | L | - | L | M | - | - | - | - | M | - | - | M |
| **CO2** | - | - | - | - | - | - | - | - | - | H | - | - | - | - |
| **CO3** | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **CO4** | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **CO5** | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **16BHS2Z1** | - | - | L | - | - | M | - | - | - | H | M | - | - | M |

**L – Low, M – Moderate (Medium), H – High**

**16BBS2Z2** **ENGINEERING MATHEMATICS II** **Category : BS**

*Common to all branches* L T P C

3 2 0 4

**PRE-REQUISITES:**

- Basics of - trigonometry- differential and integral formulae.

**COURSE OBJECTIVES:**

- To acquire knowledge of techniques of ordinary differential equations leading to engineering problems.
- To acquire knowledge of vector Calculus with engineering applications.
- To gain standard techniques of complex variable applicable to fluid dynamics, heat conduction, and elasticity.
- To develop skill of solving transforms leading to engineering applications.

**UNIT I ORDINARY DIFFERENTIAL EQUATIONS 9 + 6 Periods**

Second and Higher order Differential Equations, Method of variation of parameters- Method of undetermined coefficients-Homogeneous equations of Euler's and Legendre's type-System of Simultaneous first order Linear equations with constant coefficients - Method of reduction of order.

**UNIT II VECTOR CALCULUS 9 + 6 Periods**

Gradient and directional derivative, Divergence and Curl – Irrotational and Solenoidal fields- Vector identities - Line, Surface and Volume Integrals – Green's Theorem in a Plane , Gauss Divergence and Stoke's Theorems (Statements only) –Verifications and Applications.

**UNIT III COMPLEX DIFFERENTIATION 9 + 6 Periods**

Functions of a Complex variable-Analytic functions- Cauchy Riemann equations and sufficient conditions (excluding proof)–Harmonic conjugates–Construction of analytic functions-Conformal mappings: $w=z+a$, $az$, $1/z$, $z^2$, $e^z$ , sinz, cosz and Bilinear Transformation.

**UNIT IV COMPLEX INTEGRATION 9 + 6 Periods**

Cauchy's integral theorem, Cauchy's integral formula -Taylor's and Laurent's theorems (Statements only) and expansions – Poles and Residues – Cauchy's Residue theorem – Contour integration – Circular and semi circular contours with no pole on real axis.

**UNIT V LAPLACE TRANSFORMATIONS 9 + 6 Periods**

Laplace transforms- Properties and standard transforms-Transforms of unit step, **UNIT I**mpulse and error functions –Transforms of periodic functions- Inverse Laplace transforms- Initial and Final value theorems- Convolution theorem (Statement only) and applications - Applications to Solution of Linear differential equations of second order with constant coefficients.

LECTURE: 45 PERIODS TUTORIAL:30 PERIODS PRACTICAL: 0 PERIODS TOTAL: 75 PERIODS

**TEXT BOOKS**

| **AUTHOR NAME** | **TITLE OF BOOK** | **PUBLISHER, YEAR OF PUBLICATION** |
|---|---|---|
| *Veerarajan T* | *Engineering Mathematics for Semesters I and II* | *Tata McGraw Hill Publishing Co., New Delhi, 2015.* |
| *Kandasamy P, Thilagavathy K and Gunavathy K* | *Engineering Mathematics for I year B.E/B.Tech* | *S.Chand& Co, Ramnagar, New Delhi, Reprint 2013.* |
| *S. Narayanan and Manicavachagom Pillai T.K.* | *Calculus-Vol.III* | *S. Viswanathan, Printers and Publishers Pvt. Ltd, Chennai, 2009.* |

**REFERENCE BOOKS**

| AUTHOR NAME | TITLE OF BOOK | PUBLISHER, YEAR OF PUBLICATION |
|---|---|---|
| *Erwin Kreyszig* | *Advanced Engineering Mathematics* | *Wiley & sons(Asia) Ltd, 10th Edition, 2015.* |
| *Ray Wylie.C and Louis Barrett* | *Advanced Engineering Mathematics* | *Tata McGraw Hill Company, New Delhi, 2004.* |
| *Grewal B. S* | *Higher Engineering Mathematics* | *Khanna Publishers, New Delhi, 43rd Edition, 2014.* |
| *Ramana B V* | *Higher Engineering Mathematics* | *Tata McGraw Hill Co. Ltd, NewDelhi, 11th Print, 2010.* |
| *Bali N., Goyal M and Watkins C* | *Advanced Engineering Mathematics* | *Firewall Media (An Imprint of Laxmi Publications Pvt Ltd), New Delhi, 7th Edition,2009.* |
| *Bali N.P and Goyal M* | *A text book of Engineering Mathematics* | *University Science Press (An Imprint of Laxmi Publications Pvt Ltd), New Delhi,2014.* |

**COURSE OUTCOMES:**

Upon completion of this course, the student will be able to

**CO1:** Understand the kinds of differential equations and their solutions in the field of engineering.

**CO2:** Evaluate gradient, divergence and curl and also line, surface and volume integrals in cartesian form and simple coordinate systems and calculate integrals applying Greens, stokes and Gauss theorems.

**CO3:** Understand the concepts of analytic functions and conformal mappings.

**CO4:** Evaluate contour integrals using calculus of residues.

**CO5:** Apply Laplace transform methods to solve differential equations.

**COURSE ARTICULATION MATRIX: :**

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PS 01 | PS02 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | H | H | H | H | - | - | - | - | - | M | H | H | H | M |
| **CO2** | H | H | M | M | - | - | - | - | - | M | - | M | H | M |
| **CO3** | H | H | M | H | - | M | - | - | - | M | M | M | L | L |
| **CO4** | H | H | M | M | - | M | - | - | - | M | M | M | L | L |
| **CO5** | H | H | H | H | - | H | - | - | - | M | M | H | H | M |
| **16BBS2Z2** | H | H | M | H | - | M | - | - | - | M | M | M | H | M |

**L – Low, M – Moderate (Medium), H – High**

**16BBS2Z3** **MATERIALS SCIENCE** **Category : BS**

*Common to all branches*

L T P C

3 0 0 3

**PRE-REQUISITES: NIL**

**COURSE OBJECTIVES:**

To enhance the fundamental knowledge in Physics and its applications relevant to various streams of Engineering and Technology. Upon completion of this course the students will be familiar with:

- The properties of conducting materials.
- The application of magnetic and super conducting materials.
- Application and properties of dielectric and ferro electric materials.
- Applications and properties of Modern engineering materials.
- Nano materials and its properties.

**UNIT I CONDUCTING MATERIALS 9 Periods**

Introduction to Conductors – classical free electron theory of metals – Draw backs of classical theory – quantum theory - Electrical and Thermal conductivity of Metals – Derivation for Wiedeman – Franz law – Lorentz number — Fermi distribution function - effect of temperature – density of energy states – calculation of Fermi energy- carrier concentration in metals.

**UNIT II SEMICONDUCTING MATERIALS AND DEVICES 9 Periods**

Introduction – Properties – elemental and compound semiconductors - Intrinsic and extrinsic semiconductors – properties - Carrier concentration in intrinsic Semiconductor - variation of Fermi level with temperature and carrier concentration - Electrical Conductivity – band gap determination - extrinsic semiconductors - Carrier concentration in P- type and N-type semiconductors – variation of Fermi level with temperature and impurity concentration – Hall effect- Determination of Hall Co-efficient in N type and P type Semiconductor - Applications.

**UNIT III MAGNETIC AND SUPER CONDUCTING MATERIALS 9 Periods**

Introduction - Origin of magnetic moment - Bohr magneton - Dia, Para, and Ferro magnetic materials - Domain theory of ferromagnetism - Hysteresis - Hard and Soft magnetic materials. Ferrites - structure and applications. - Magneto optical recording and readout – Superconductivity - Types of superconductors - BCS theory of superconductivity (qualitative) - properties- High Tc superconductors, Applications of superconductors- SQUID, Cryotron, Magnetic levitation.

**UNIT IV DIELECTRICS AND FERROELECTRICS 9 Periods**

Introduction to dielectric materials – Electric polarization and Dipole moment - Electrical susceptibility – dielectric constant – Various polarization mechanisms in dielectrics - electronic, ionic, orientational and space charge polarization– frequency and temperature dependence of polarization – internal field – Claussius – Mosotti relation (derivation) – dielectric loss – dielectric breakdown – Applications of dielectric materials - Ferro electricity –Ferro electric materials -$BaTiO_3$ – Applications- Ferro electric energy converter

**UNIT V MODERN ENGINEERING MATERIALS 9 Periods**

Metallic glasses- preparation of metallic glasses - properties – applications of the metallic glasses - Shape Memory Alloys (SMA) - Characteristics, properties of NiTi alloy - applications of the Shape memory alloys - advantages and disadvantages of SMA - Nanomaterials-synthesis –chemical vapour deposition – Sol Gel – ball Milling – properties of nanoparticles and applications of nanoparticles – Carbon Nanotubes (CNT) – structure – properties – applications of CNTs.

LECTURE: 45 PERIODS TUTORIAL:0 PERIODS PRACTICAL: 0 PERIODS TOTAL: 45 PERIODS

**TEXT BOOKS**

| AUTHOR NAME | TITLE OF BOOK | PUBLISHER, YEAR OF PUBLICATION |
|---|---|---|
| *P.K.Palanisamy* | *Engineering Physics–II* | *Scitech Publications (India ) Pvt. Ltd 2015 (**UNIT I, UNIT III** & **UNIT IV**)* |
| *Dr.Jayakumar .S* | *Materials science* | *R.K.Publishers,2008.(**UNIT II** & IV)* |
| *Dr.V.Rajendran* | *Material Science* | *Tata McGraw Hill Publications, NewDelhi, 2011.* |

**REFERENCE BOOKS**

| AUTHOR NAME | TITLE OF BOOK | PUBLISHER, YEAR OF PUBLICATION |
|---|---|---|
| *Charles P.Poole, Jr; Frank J.Owens* | *Introduction to Nanotechnology* | *Wiley India, 2012.* |
| *Gaur R.K. and Gupta S.L* | *Engineering Physics* | *Dhanpat Rai Publishers, 2009.* |
| *K.Rajagopal* | *Engineering Physics* | *PHI Learning Private Ltd, New Delhi, 2015.* |

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to

**CO1:** Analyze the properties of conducting materials. [Familiarity]

**CO2:** List and analyze the properties of Semiconducting materials and Devices. [Familiarity]

**CO3:** Identify, analyze the properties and applications of magnetic & super conducting materials. [Familiarity]

**CO4:** List and analyze the properties of dielectric Ferro electric materials. [Familiarity & Application]

**CO5**: List the properties and applications of modern engineering materials. [Familiarity & Application]

**COURSE ARTICULATION MATRIX: :**

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PS 01 | PS02 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | M | M | - | - | - | M | M | - | - | - | - | - | M | M |
| **CO2** | M | M | M | M | M | M | M | - | - | - | - | - | M | M |
| **CO3** | M | M | M | M | M | M | M | - | - | - | - | - | H | H |
| **CO4** | M | M | M | M | M | M | M | - | - | - | - | - | M | M |
| **CO5** | H | H | H | H | H | H | H | - | - | - | - | - | H | H |
| **16BBS2Z3** | M | M | M | M | M | M | M | - | - | - | - | - | M | M |

**L – Low, M – Moderate (Medium), H – High**

**16BHS2Z4 ENVIRONMENTAL SCIENCE AND ENGINEERING Category : HS**

*Common to all branches* L T P C

3 0 0 3

**PRE-REQUISITES: NIL**

**COURSE OBJECTIVES:**

- The course is aimed at creating awareness among students and also to inseminate the critical ideas of preserving environment.

**UNIT I ENVIRONMENTAL RESOURCES 9 Periods**

Natural resources -Forest – benefits, over exploitation, deforestation & consequences – Water - unique features, hydrological cycle & over exploitation – Food -effect of modern agriculture, fertilizers, pesticides, eutrophication & biomagnifications - Energy resources - renewable & non-renewable resources - wind, solar and tidal - harnessing methods.

**UNIT II ECO SYSTEM AND BIODIVERSITY 9 Periods**

Ecology - ecosystem, physical and chemical components of ecosystem, biological components of ecosystem - forest ecosystem, desert ecosystem and pond ecosystem, Energy flow in ecosystem, nitrogen cycle and carbon dioxide cycle, food pyramid, ecological succession, Biodiversity - types, values of biodiversity, hot spots of biodiversity, endangered and endemic species, conservation of biodiversity – in situ – ex situ conservation.

**UNIT III ENVIRONMENTAL POLLUTION 9 Periods**

Air pollution, classification of air pollutants – sources, effects and control of gaseous pollutants $SO_2$, $NO_x$, $H_2S$, CO, $CO_2$ and particulates, control methods - cyclone separator and electrostatic precipitator - Water pollution - classification of water pollutants, organic and inorganic pollutants, sources, effects and control of water pollutants Soil pollution - sources, effects and control - Noise pollution - decibel scale, sources, effects and control.

**UNIT IV ENVIRONMENTAL THREATS 9 Periods**

Acid rain, greenhouse effect, global warming and ozone depletion, disaster management, flood, drought, earthquake and tsunami, Threats to biodiversity - destruction of habitat, habit fragmentation - hunting, over exploitation and man - wildlife conflicts, The IUCN red list categories, status of threatened species.

**UNIT V SOCIAL ISSUES AND ENVIRONMENT 9 Periods**

Sustainable development - sustainable technologies, need for energy and water conservation, rain water harvesting, water shed management, waste land reclamation, Pollution control Act, Wild life protection act, Forest conservation act, population growth - exponential and logistic growth, variation in population among nations, population policy, women and child welfare programs, role of information technology in human and health, HIV/AIDS - effects and preventive measures.

LECTURE: 45 PERIODS TUTORIAL:0 PERIODS PRACTICAL: 0 PERIODS TOTAL: 45 PERIODS

**TEXT BOOKS**

| **AUTHOR NAME** | **TITLE OF BOOK** | **PUBLISHER, YEAR OF PUBLICATION** |
|---|---|---|
| *Sharma J.P* | *Environmental Studies, 3rd Edition* | *University Science Press, New Delhi 2009.* |
| *Anubha Kaushik and C.P. Kaushik* | *Environmental Science and Engineering, 3rd Edition* | *New age International Publishers, New Delhi, 2008.* |

**REFERENCE BOOKS**

| AUTHOR NAME | TITLE OF BOOK | PUBLISHER, YEAR OF PUBLICATION |
|---|---|---|
| *R.K. Trivedi* | *Hand book of Environmental laws, Rules, Guidelines, Compliances and Standards, Vol.I&II,* | *Environ Media, 2006.* |
| *G. Tyler Miller Jr* | *Environmental Science, 10th Edition* | *Thomson Brooks/Cole Publishing, 2004.* |
| *Gilbert M. Masters* | *Introduction to Environmental Engineering and Science, 2nd Edition* | *Pearson Education, 2004.* |

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to

**CO1:** To know about the various environmental resources, the effective utility and problems accompanied in over exploitation.

**CO2:** To acquire knowledge about the interaction of biosphere with environment and conservation methods of bio diversity.

**CO3:** To be aware of the source of various types of pollution, their ill effects and preventive methods.

**CO4:** To understand the environmental threats, Acid rain, Green house effect and Ozone depletion and natural disasters.

**CO5:** To create an idea about sustainable development and social issues.

**COURSE ARTICULATION MATRIX: :**

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PS 01 | PS 02 | PS 03 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | M | L | L | L | L | L | L | L | L | L | L | L | M | - | L |
| **CO2** | M | L | H | L | L | L | M | M | L | M | L | L | L | - | - |
| **CO3** | L | L | H | L | L | L | L | L | L | L | L | L | H | - | M |
| **CO4** | L | L | H | L | L | L | H | H | L | M | L | L | H | - | L |
| **CO5** | M | L | M | L | L | L | H | H | L | L | L | L | H | - | L |
| **16BHS2Z4** | M | L | H | L | L | L | H | H | L | L | L | L | H | - | L |

**L – Low, M – Moderate (Medium), H – High**

**16BES2Z5** **PROGRAMMING IN C** **Category : ES**

*Common to all branches*

L T P C

3 0 0 3

**PRE-REQUISITES: NIL**

**COURSE OBJECTIVES:**

Upon completion of this course, the students will be familiar with,

- The Computer and Programming fundamentals
- Data types in C and Flow control statements
- Functions, Arrays, Pointers And Strings
- Bitwise Operators, Preprocessor Directives, Structures and Unions
- Structures, List Processing, Input And Output

**UNIT I COMPUTER AND PROGRAMMING FUNDAMENTALS 9 Periods**

Computer fundamentals – Evolution, classification, Anatomy of a computer: CPU, Memory, I/O – Introduction to software – Generation and classification of programming languages – Compiling – Linking and loading a program – Translator – loader – linker – develop a program – software development – Introduction to OS –Types of OS – Algorithms – Structured programming concept.

**UNIT II DATA TYPES AND FLOW OF CONTROL 9 Periods**

An overview of C – Programming and Preparation – Program Output – Variables – Expressions, and Assignment, The use of #include, printf(), scanf() – Lexical elements, operators and the C systems – The fundamental data types – Flow of control

**UNIT III FUNCTIONS, ARRAYS, POINTERS AND STRINGS 9 Periods**

Functions and storage classes - 1D Arrays – Pointers – Call by reference – Relationship between Arrays and Pointers – Pointer arithmetic and element size – Arrays as function argument – Dynamic memory allocation – Strings – String handing functions – Multidimensional Arrays.

**UNIT IV ARRAY OF POINTERS, BITWISE OPERATORS, PREPROCESSOR DIRECTIVES 9 Periods**

Arrays of Pointers – Arguments to main () - Ragged Arrays – Functions as Arguments – Arrays of Pointers to Functions - Type qualifiers.-Bitwise operators and expressions – Masks – Software tools – Packing and unpacking – Enumeration types – The preprocessor directives.

**UNIT V STRUCTURES AND UNIONS, I/O AND FILE OPERATIONS 9 Periods**

Structures and Unions – Operator precedence and associativity – Bit fields – Accessing bits and bytes - Input and Output functions – File Processing Functions – Environment variables – Use of make and touch.

LECTURE: 45 PERIODS TUTORIAL:0 PERIODS PRACTICAL: 0 PERIODS TOTAL: 45 PERIODS

**TEXT BOOKS**

| **AUTHOR NAME** | **TITLE OF BOOK** | **PUBLISHER, YEAR OF PUBLICATION** |
|---|---|---|
| *Pradip Dey, Manas Ghosh* | *Computer Fundamentals and Programming in C, Second Edition* | *Oxford University Press, 2013.* |
| *Al Kelley, Ira Pohl* | *A Book on C-Programming in C, Fourth Edition* | *Addison Wesley, 2001.* |

**REFERENCE BOOKS**

| AUTHOR NAME | TITLE OF BOOK | PUBLISHER, YEAR OF PUBLICATION |
|---|---|---|
| *Stephen G. Kochan* | *Programming in C-A complete introduction to the C programming language, Third Edition* | *Sams Publication, 2004.* |
| *Yashavant P. Kanetkar* | *Let Us C, 13th edition* | *BPB Publications, 2013.* |
| *Brian W. Kernighan and Dennis Ritchie* | *The C Programming Language", Second Edition* | *Prentice Hall Software Series, 1988.* |
| *Stephen Prata* | *C Primer Plus, Fifth Edition* | *Sams Publishing, 2005.* |

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to

**CO1:** Articulate the programming environment [Familiarity]

**CO2:** Write algorithm for solving the given problem statement [usage]

**CO3:** Use right data types and flow control statement [Assessment]

**CO4:** Write programs using functions, arrays, pointers and strings [Usage]

**CO5:** Use right storage classes, preprocessor directives, bitwise operators in programs [Assessment]

**CO6:** Use structures, unions and files [Usage]

**COURSE ARTICULATION MATRIX:**

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PS 01 | PS02 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | H | H | M | H | H | - | M | M | M | M | L | M | M | M |
| **CO2** | H | H | M | H | H | - | - | M | M | M | L | M | M | M |
| **CO3** | H | H | M | H | H | - | - | M | M | M | L | M | M | M |
| **CO4** | H | H | M | H | H | - | - | M | M | M | L | M | M | M |
| **CO5** | H | H | M | H | H | - | - | M | M | M | L | M | M | M |
| **16BES2Z5** | H | H | M | H | H | - | M | M | M | M | L | M | M | M |

**L – Low, M – Moderate (Medium), H – High**

**16BES206** **ENGINEERING MECHANICS** **Category : ES**

*Common to all except ECE, CSE and IT branches*

L T P C
3 2 0 4

**PRE-REQUISITES: NIL**

**COURSE OBJECTIVES:**

- To analyze the force systems, friction and to study the dynamics of particles, impulse and momentum.

**UNIT I** **INTRODUCTION TO MECHANICS AND FORCE CONCEPTS** **9 + 6 Periods**

Principles and Concepts – Laws of Mechanics – system of forces – resultant of a force system – resolution and composition of forces – Lami's theorem – moment of a force – physical significance of moment-Varignon's theorem – resolution of a force into force and couple – forces in space – addition of concurrent forces in space – equilibrium of a particle in space.

**UNIT II** **FRICTION** **9 + 6 Periods**

Frictional resistance – classification of friction- laws of friction – coefficient of friction-angle of friction – angle of repose — cone of friction – free body diagram-advantages-equilibrium of a body on a rough inclined plane – non-concurrent force system - ladder friction – rope friction – wedge friction.

**UNIT III** **GEOMETRICAL PROPERTIES OF SECTION** **9 + 6 Periods**

Centroids – Determination by integration – moment of inertia – theorems of moment of inertia –Product of Inertia – Principal moment of inertia of plane areas - radius of gyration.

**UNIT IV** **BASICS OF DYNAMICS - KINEMATICS** **9 + 6 Periods**

Kinematics and kinetics – displacements, velocity and acceleration - Equations of motion – Rectilinear motion of a particle with uniform velocity, uniform acceleration, varying acceleration – motion curves – motion under gravity – relative motion – curvilinear motion of particles – projectiles – angle of projection – range – time of flight and maximum height.

**UNIT V** **BASICS OF DYNAMICS - KINETICS** **9 + 6 Periods**

Newton's second law of motion – linear momentum – D'Alembert's principle, Dynamics equilibrium — work energy equation of particles– law of conservation of energy – principle of work and energy.

Principle of impulse and momentum – Equations of momentum – Laws of conservation of momentum. Impact – Time of compression, restitution, collision – Co-efficient of restitution – types of impact – collision of elastic bodies by direct central impact and oblique impact – collision of small body with a massive body – Kinetic energy of a particle.

LECTURE: 45 PERIODS TUTORIAL:30 PERIODS PRACTICAL: 0 PERIODS TOTAL: 75 PERIODS

**TEXT BOOKS**

| **AUTHOR NAME** | **TITLE OF BOOK** | **PUBLISHER, YEAR OF PUBLICATION** |
|---|---|---|
| *S.S. Bhavikatti and K.G. Rajasekarappa* | *Engineering Mechanics* | *New Age International Pvt Ltd. 1999.* |
| *S.C. Natesan* | *Engineering Mechanics* | *Umesh Publications, 5-B north market, Naisarak, Delhi, 2002.* |

**REFERENCE BOOKS**

| AUTHOR NAME | TITLE OF BOOK | PUBLISHER, YEAR OF PUBLICATION |
|---|---|---|
| *F.B. Beer and E.R. Johnson* | *Vector Mechanics for Engineers* | *Tata Mc.Graw Hill Pvt Ltd, 10th Edition, 2013.* |
| *S. Timoshenko and Young* | *Engineering Mechanics* | *Mc.Graw Hill, 4th Edition, 1995.* |
| *Irving Shames and Krishna Mohana Rao* | *Engineering Mechanics* | *Prentice Hall of India Ltd, Delhi, 2006.* |
| *Domkundwar V.M and Anand V. Domkundwar* | *Engineering Mechanics (Statics and Dynamics)* | *Dhanpat Rai and Co. Ltd, 1st Edition, 2006.* |
| *Suhas Nitsure* | *Engineering Mechanics* | *Technical Publications, Pune, 1st edition, 2006.* |
| *R.C. Hibbeller* | *Engineering Mechanics* | *Prentice Hall of India Ltd, 13th Edition, 2013.* |
| *Vela Murali* | *Engineering Mechanics* | *Oxford university Press,1st Edition,2010.* |

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to

**CO1:** Analyze the problems related to force systems and friction

**CO2:** Apply concepts of centre of gravity and moment of inertia

**CO3:** Solve problems on dynamics, momentum and impulse

**COURSE ARTICULATION MATRIX:**

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PS 01 | PS02 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | M | H | M | L | L | - | - | - | L | - | L | - | H | L |
| **CO2** | L | H | L | - | L | - | - | - | L | - | L | - | H | L |
| **CO3** | M | H | M | L | L | - | - | - | L | - | L | - | H | L |
| **16BES206** | M | H | M | L | L | - | - | - | L | - | L | - | H | L |

**L – Low, M – Moderate (Medium), H – High**

| 16BBS207 | CHEMISTRY LAB<br>Common to Civil, Mechanical, Production and IBT branches | Category: BS<br>L T P C<br>0 0 4 2 |
|---|---|---|

**PRE-REQUISITES: NIL**

**COURSE OBJECTIVE:**

- The course is aimed at imparting knowledge of experimental techniques which would be useful for students to apply the practical principles relevant conventional engineering field.

**LIST OF EXPERIMENTS**

1. Estimation of hardness by EDTA method.
2. Estimation of chloride by Argentometric method.
3. Determination of dissolved oxygen by Winkler's method.
4. Conductometric titration of mixture of strong acid and weak acid using strong base.
5. Potentiometric titration of ferrous iron by dichromate.
6. Estimation of copper in brass by EDTA method.
7. Estimation of Iron by Spectrophotometry
   Estimation of HC1 by pH titration.

LECTURE: 0 PERIODS TUTORIAL:0 PERIODS PRACTICAL: 60 PERIODS TOTAL: 60 PERIODS

**REFERENCE BOOKS**

| AUTHOR NAME | TITLE OF BOOK | PUBLISHER, YEAR OF PUBLICATION |
|---|---|---|
| *A.O. Thomas,* | *Practical Chemistry* | *Scientific Book Centre, Cannanore, 2003.* |
| *Jeffery G H, Basset J. Menthom J, Denney R.C.* | *Vogel's Text book of quantitative analysis, 5th Edition* | *EBS, 1988.* |

**COURSE OUTCOMES:**

Upon completion of this practical clasees, the students will be able to

**CO1:** Understand the nature of hardness, chloride level, pollution level using dissolved oxygen content, iron present in water and analyse them in water.

**CO2:** Apply the EMF and conductometric measurements in quantitative analysis of

**COURSE ARTICULATION MATRIX:**

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PS 01 | PS02 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | H | M | L | L | M | L | L | L | L | M | L | M | M | L |
| **CO2** | H | M | L | L | M | L | L | L | L | M | L | M | M | L |
| **CO3** | H | M | L | L | M | L | L | L | L | M | L | M | M | L |
| **CO4** | H | M | L | L | M | L | L | L | L | M | L | M | M | L |
| **CO5** | H | M | L | L | M | L | L | L | L | M | L | M | M | L |
| **16BBS207** | H | M | L | L | M | L | L | L | L | M | L | M | M | L |

**L – Low, M – Moderate (Medium), H – High**

**16BES208** **WORKSHOP PRACTICE** **Category : ES**

*Common to Civil, Mechanical, Production and Industrial Biotechnology branches*

L T P C
0 0 4 2

**PRE-REQUISITES: NIL**

**COURSE OBJECTIVES:**

- To make various basic prototypes in the carpentry trade such as Lap joint, Lap Tee joint, Dove tail joint, Mortise & Tenon joint and Cross-Lap joint.
- To make various welding joints such as Lap joint, Lap Tee joint, Edge joint, Butt joint and Corner joint.

**LIST OF EXPERIMENTS**

1. Introduction to use of tools and equipments in Carpentry, Welding, Foundry and Sheet metal
2. Safety aspects in Welding, Carpentry and Foundry
3. Half lap Joint and Dovetail Joint in Carpentry
4. Welding of Lap joint, Butt joint and T-joint
5. Preparation of Sand mould for cube, conical bush, pipes and V pulley
6. Fabrication of parts like tray, frustum of cone and square box in sheet metal
7. Electrical wiring – simple house wiring
8. Plumbing

LECTURE: 0 PERIODS TUTORIAL:0 PERIODS PRACTICAL: 60 PERIODS TOTAL: 60 PERIODS

**COURSE OUTCOMES:**

Upon completion of this practical classes, the students will be able to

**CO1:** Use tools and equipments used in Carpentry, Welding, Foundry and Sheet metal.
**CO2:** Make half lap joint and dovetail joint in carpentry.
**CO3:** Make welded lap joint, butt joint and T-joint.
**CO4:** Prepare sand mould for cube, conical bush, pipes and V pulley.
**CO5:** Fabricate parts like tray, frustum of cone and square box in sheet metal
**CO6:** Carry out minor works/repair related to electrical wiring and plumbing.

**COURSE ARTICULATION MATRIX: :**

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PS 01 | PS 02 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | - | H | H | - | - | M | - | L | H | M | - | M | M | M |
| **CO2** | - | - | H | - | - | M | - | L | H | M | - | M | M | M |
| **CO3** | - | - | H | - | - | M | - | L | H | M | - | M | M | M |
| **CO4** | - | - | H | - | - | M | - | L | H | M | - | M | M | M |
| **CO5** | - | H | H | H | - | M | - | L | H | M | - | M | M | M |
| **16BES208** | - | L | H | L | - | M | - | L | H | M | - | M | M | M |

**L – Low, M – Moderate (Medium), H – High**

**16BES2Z9** **PROGRAMMING IN C LAB** **Category : ES**

*Common to all branches*

L T P C

0 0 4 2

**PRE-REQUISITES: NIL**

**COURSE OBJECTIVES:**

- Data types in C and Flow control statements
- Functions, Arrays, Pointers And Strings
- Dynamic memory allocation and command line arguments
- Bitwise Operators, Preprocessor Directives, Structures and Unions
- Structures, List Processing, Input And Output

**PRACTICALS**

**EXERCISES ILLUSTRATING THE FOLLOWING CONCEPTS:**

1. Operators , Expressions and IO formatting
2. Decision Making and Looping
3. Arrays and Strings
4. Functions and Recursion
5. Pointers
6. Dynamic Memory Allocation
7. Structures
8. Unions
9. Files
10. Command line arguments
11. Mini Project

LECTURE: 0 PERIODS TUTORIAL:0 PERIODS PRACTICAL: 60 PERIODS TOTAL: 60 PERIODS

**COURSE OUTCOMES:**

Upon completion of this practical classes, the students will be able to

**CO1:** Use appropriate data types and flow control statements [Usage]

**CO2:** Write programs using functions, arrays, pointers and strings [Usage]

**CO3:** Write programs using dynamic memory allocation [Usage]

**CO4:** Implement programs using right storage classes, preprocessor directives, bitwise operators [Usage]

**CO5:** Work with command line arguments, structures, unions and files [Usage]

**CO6:** Develop applications using C [Usage]

**COURSE ARTICULATION MATRIX: :**

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PS 01 | PS 02 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | H | H | M | H | H | - | - | M | M | M | L | M | M | M |
| **CO2** | H | H | M | H | H | - | - | M | M | M | L | M | M | M |
| **CO3** | H | H | M | H | H | - | - | M | M | M | L | M | M | M |
| **CO4** | H | H | M | H | H | - | - | M | M | M | L | M | M | M |
| **CO5** | H | H | M | H | H | - | - | M | M | M | L | M | M | M |
| **16BES2Z9** | H | H | M | H | H | - | - | M | M | M | L | M | M | M |

**L – Low, M – Moderate (Medium), H – High**

**16BBS3Z1** **ENGINEERING MATHEMATICS III** **Category: BS**

*(Common to all Branches)*

| L | T | P | C |
|---|---|---|---|
| 3 | 2 | 0 | 4 |

**PRE-REQUISITES: NIL**

**COURSE OBJECTIVES:**

- To gain the knowledge of formation of Fourier series.
- To familiarize with Infinite and finite Fourier transforms functions.
- To be familiar with solution of first and second order differential equations.
- To acquire knowledge of techniques to solve one and two dimensional partial differential equations concerning to engineering applications.

| **UNIT- I** | **FOURIER SERIES** | **9+6 Periods** |
|---|---|---|
| Dirichlet's conditions - Full range Expansions - Odd and even functions - Half range sine and cosine series – Parseval's identity on a Fourier series - Harmonic analysis. | | |
| **UNIT- II** | **FOURIER TRANSFORMS** | **9+6 Periods** |
| Fourier integral theorem (statement only) - Infinite Fourier transform pair - Fourier sine and cosine transform pair - Properties - Transforms of simple functions - Parseval's identity on a Fourier transform - Finite Fourier transforms. | | |
| **UNIT- III** | **PARTIAL DIFFERENTIAL EQUATIONS** | **9+6 Periods** |
| Formation of partial differential equations - First order PDE - Standard types and Lagrange's type - Linear partial differential second and higher order with constant coefficients - Homogeneous and Non-homogeneous types. | | |
| **UNIT- IV** | **BOUNDARY VALUE PROBLEMS** | **9+6 Periods** |
| Method of separation of variables and Fourier series solution: One dimensional wave equation, one and two dimensional heat flow. | | |
| **UNIT- V** | **Z TRANSFORMS** | **9+6 Periods** |
| Z transforms-properties - Inverse Z transforms - Initial and final value theorems - Convolution theorem - Formation of difference equations - Solution to difference equations of second order difference equations with constant coefficients with Z transform. | | |

**Contact Periods:**

**Lecture: 45 Periods** **Tutorial : 30 Periods** **Practical : 0 periods** **Total: 75 Periods**

**TEXT BOOKS:**

| AUTHOR NAME | TITLE OF BOOK | PUBLISHER, YEAR OF PUBLICATION |
|---|---|---|
| *Veerarajan T* | *Transforms and partial differential equations* | *Tata McGraw Hill Publishing Co., New Delhi, 2015* |
| *Kandasamy, Thilagavathy Gunavathy* | *Engineering Mathematics for Semesters III B.E. / B.Tech.* | *S.Chand & Co, Ramnagar, New Delhi, 2013* |

**REFERENCE BOOKS:**


1. *Grewal B .S, "Higher Engineering Mathematics" Khanna Publishers, New Delhi, 43rd Edition,2014.*
2. *Ramana B. V, "Higher Engineering Mathematics" Tata McGraw Hill Co. Ltd., New Delhi, 11th Edition, Reprint, 2010.*
3. *Bali N., Goyal M, "Transforms and Partial differential equations" University Science Press, New Delhi, 2013*
4. *Ray Wylie C and Louis C Barrett, "Advanced Engineering Mathematics", McGraw Hill Education(India) Pvt Ltd, New Delhi, 6th Edition, Reprint ,2014.*
5. *Donald. A McQuarrie, Mathematical Methods for Scientists and Engineers, Viva Books Pvt. Lt. New Delhi 1st Edition, reprint 2015.*

**COURSE OUTCOME:**

**CO1:** Understand the concepts of Fourier series and its construction when discrete and continuous form is known.
**CO2:** Acquire fluency in Fourier transforms in order to solve improper integrals.
**CO3:** Understand the standard and special types of partial differential equations.
**CO4:** Gain fluency in solving boundary value problems.
**CO5:** Understand the Z transform methods to find solutions of difference equations.

**COURSE ARTICULATION MATRIX:**

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PS01 | PS02 | PS03 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | H | H | H | - | - | - | - | - | - | H | - | - | - | - | - |
| **CO2** | M | H | M | - | - | - | - | - | - | M | - | - | - | - | - |
| **CO3** | H | M | - | - | - | - | - | - | - | L | - | - | - | - | - |
| **CO4** | H | H | M | - | - | M | - | - | - | M | M | - | - | - | - |
| **CO5** | M | M | M | - | - | - | - | - | - | - | - | - | - | - | - |
| **16BBS3Z1** | H | H | M | - | - | M | - | - | - | - | M | - | - | - | - |

**L – Low, M – Moderate (Medium), H – High**

**16BES302** **PROCESS CALCULATIONS** **Category: ES**

| L | T | P | C |
|---|---|---|---|
| 2 | 2 | 0 | 3 |

**PRE-REQUISITES: NIL**

**COURSE OBJECTIVES:**

- To understand the importance of stoichiometry – material and energy balances.
- To deal with the laws of conservation of mass and energy.
- To apply chemical engineering principles in problem solving.

| **UNIT I** | **OVERVIEW OF PROCESS INDUSTRY** | **7 Periods** |
|---|---|---|
| Systems of units - Fundamental and derived quantities, unit conversion, composition conversion - Atomic weight, molecular weight, equivalent weight, molar concept, mole percent, weight percent, volume percent, molarity, molality, normality etc., Basics of unit operations and unit processes involved in biotechnology industries and its applications. | | |
| **UNIT II** | **BEHAVIOUR OF IDEAL GAS** | **7 Periods** |
| Ideal and real gas law – Gas constant – Calculation of pressure, volume and temperature using ideal gas law – Use of partial pressure and pure component volume in gas calculations – Applications of real gas relationship in gas calculations. | | |
| **UNIT III** | **MATERIAL BALANCE** | **12 Periods** |
| Stoichiometric principles – Applications of material balance to unit operations, material balance with and without chemical reactions – Limiting reactant and excess reactant – Conversion and yield – Recycle, bypassing and purging. | | |
| **UNIT IV** | **ENERGY BALANCE** | **12 Periods** |
| Fundamentals of energy balance calculations – Concepts of heat capacity, latent heat, sensible heat, vapor pressure and internal energy – Energy balance with and without chemical reactions. | | |
| **UNIT V** | **FUELS AND COMBUSTION** | **7 Periods** |
| Types of fuels - Solid, liquid & gaseous fuels - Ultimate and proximate analysis. Determination of composition by orsat analysis of products of combustion of solid, liquid and gas fuels – Calculations of excess air from orsat techniques – Problems on combustion process. | | |

**Contact Periods:**
**Lecture: 30 Periods** **Tutorial: 30 Periods** **Total : 60 Periods**

**TEXT BOOKS:**

| AUTHOR NAME | TITLE OF BOOK | PUBLISHER, EDITION, YEAR OF PUBLICATION |
|---|---|---|
| *McCabe Smith Harriott* | *Unit Operations of Chemical Engineering* | *McGraw-Hill company 7th edition 2005* |
| *Himmelblau MD James B.Riggs* | *Basic principles and calculations in Chemical Engineering* | *Prentice Hall PTR 8th edition 2004* |

**REFERENCE BOOKS:**


1. *Perry's W H., "Chemical Engineering Handbook", McGraw-Hill Company, 2008.*
2. *Bhatt B.I and Vora S.M. "Stoichiometry" Tata McGraw-Hill, New Delhi,4th Edition. 2004.*
3. *K.V. Narayanan, B.Lakshmikutty, "Stoichiometry and Process calculations", Prentice hall of India, 2nd edition. 2017.*

**COURSE OUTCOME:**

Upon completion of the course, the students will be able to

**CO1:** Present an overview of industrial chemical Bioprocesses.
**CO2:** Develop a fundamental understanding of the basic principles of chemical engineering processes and calculations.
**CO3:** Apply the gas laws to solve problems related to ideal gases and mixtures.
**CO4:** Establish mathematical methodologies for the computation of material balances and energy balances.
**CO5:** Perform calculations on combustion systems using chemical engineering principles.

**COURSE ARTICULATION MATRIX:**

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PS0 1 | PS0 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | L | - | - | - | - | L | M | L | L | L | L | L | H | M |
| **CO2** | M | M | H | - | - | - | - | - | M | M | - | M | H | M |
| **CO3** | L | L | M | L | | - | L | - | H | M | - | M | H | H |
| **CO4** | M | H | H | H | M | - | L | - | M | M | - | M | H | H |
| **CO5** | M | M | M | M | M | - | - | - | H | H | - | M | H | H |
| **16BES302** | M | M | M | L | M | L | L | L | M | M | L | M | H | H |

**L – Low, M – Moderate (Medium), H – High**

**16BPC303 BASICS OF INDUSTRIAL BIOTECHNOLOGY Category: PC**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**PRE-REQUISITES: NIL**

**COURSE OBJECTIVES:**

- To understand the basics of traditional and modern industrial fermentation process.
- To gain the knowledge about the primary and secondary microbial metabolites.
- To learn about the production process of pharmaceutically important bioproducts.

| **UNIT I** | **INTRODUCTION TO INDUSTRIAL BIOPROCESS** | **9 Periods** |
|---|---|---|
| Biotechnology: Scope and importance, Commercial potential of Biotechnology in India. Historical overview of industrial fermentation process - Traditional and modern Biotechnology. Industrial Fermentation - Microorganisms, mode of operation, fermentation processes - Pictorial representation. | | |
| **UNIT II** | **PRODUCTION OF PRIMARY METABOLITES** | **9 Periods** |
| A brief outline of processes for the production of some commercially important organic acids (citric acid, lactic acid & acetic acid); amino acids (glutamic acid & tryptophan) and alcohols (ethanol & butanol). | | |
| **UNIT III** | **PRODUCTION OF SECONDARY METABOLITES** | **9 Periods** |
| Production processes for various classes of secondary metabolites: antibiotics: (penicillin streptomycin & erythromycin), vitamins (Vit $B_{12}$ and Vit $B_2$) and steroid biotransformation. | | |
| **UNIT IV** | **PRODUCTION OF ENZYMES AND OTHER PRODUCTS** | **9 Periods** |
| Production of industrial enzymes (proteases & amylases), Production of biopesticide, Biofertilizers, biopreservative (Nisin), biopolymers (xanthan gum & PHB), cheese, SCP. | | |
| **UNIT V** | **PRODUCTION OF MODERN BIOTECHNOLOGY PRODUCTS** | **9 Periods** |
| Production of recombinant proteins having therapeutic and diagnostic applications (insulin, human growth hormone), Production of recombinant vaccines (Hepatitis B vaccine, cholera vaccine), production of monoclonal antibodies. | | |

**Contact Periods:**
**Lecture: 45 Periods** **Total: 45 periods**

**TEXT BOOKS:**

| AUTHOR NAME | TITLE OF BOOK | PUBLISHER, EDITION, YEAR OF PUBLICATION |
|---|---|---|
| *WulfCruger AnnelieseCruger* | *A Textbook of Industrial Microbiology* | *Panima Publishing Corporation, 2nd Edition, 2005.* |
| *Michael J. Waites, Neil L.Morgan, John.S. Rockey and Grey Higton* | *Industrial Microbiology: An Introduction* | *Blackwell, 2001.* |

**REFERENCE BOOKS:**


1. *CasidaJr, L. E., "Industrial Microbiology", Wiley, 1968.*
2. *Presscott and Dunn's "Industrial Microbiology", CBS Publisher, 1987.*
3. *Okafor, N., "Modern Industrial Microbiology and Biotechnology", CRC Press, 2007*

**COURSE OUTCOME:**

Upon completion of the course, the students will be able to

**CO1:** Understand the basics of fermentation process which helps to develop new microbial product.

**CO2:** Gain the knowledge about the steps and operations involved in microbial primary metabolites production.

**CO3:** Illustrate the secondary metabolites production with flow-sheeting.

**CO4:** Acquire knowledge about the industrially relevant microbial strains and processes for production of enzyme, biopolymer and food products.

**CO5:** Learn about the use of recombinant technology in pharmaceutically important microbial bioproducts production.

**COURSE ARTICULATION MATRIX:**

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | H | M | M | - | M | L | - | - | - | - | - | M | H | H |
| **CO2** | M | M | - | M | H | - | - | - | - | - | - | - | M | M |
| **CO3** | M | M | - | - | M | - | - | - | - | - | - | - | M | H |
| **CO4** | M | M | - | - | M | - | - | - | - | - | - | - | M | H |
| **CO5** | M | - | - | M | M | L | M | L | - | - | - | - | M | H |
| **16BPC303** | M | M | L | M | M | L | L | L | - | - | - | L | M | H |

**L – Low, M – Moderate, H- High**

**16BPC304** **CELL BIOLOGY** **Category: PC**

**PRE-REQUISITES: NIL**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

- Gain the knowledge related to the basics of different types cell structure and morphology
- Understand the biomolecules transport mechanism across the biomembranes and functions of receptor in cell signaling process
- Get familiarize the cell signaling and signal transduction process inside and outside the cell
- Know the basics of different types of cell culture

| UNIT I | CELL STRUCTURE AND FUNCTION OF THE ORGANELLES | 9 Periods |
|---|---|---|
| Structure of Prokaryotic and Eukaryotic cells and brief on their organelles, principles of membrane organization, membrane proteins, extra cellular matrix, cytoskeleton structures, cell junction and cell adhesions, types of cell division, mitosis & meiosis, cell cycle and molecules that control cell cycle. | | |
| **UNIT II** | **TRANSPORT ACROSS BIO MEMBRANES** | **10 Periods** |
| Osmosis and reverse osmosis, Passive & active transport, permeases, sodium potassium pump, Ca2+ ATPase pumps, voltage and ligand gated channels, lysosomal and vacuolar membrane ATP dependent proton pumps, Co- transport - Symport, antiport, Endocytosis and exocytosis. Entry of virus and toxins into cells. | | |
| **UNIT III** | **RECEPTORS AND MODES OF CELL SIGNALLING** | **8 Periods** |
| Cytosolic, nuclear and membrane bound receptors with examples, autocrine, paracrine and endocrine modes of action, quantification and characterisation of receptors. | | |
| **UNIT IV** | **SIGNAL TRANSDUCTION** | **9 Periods** |
| Signal amplification, role of secondary messengers - Cyclic AMP, inositol tri phosphates and cyclic GMP; G proteins - Role in signal transduction, calcium ion flux and its role in cell signaling, role of protein kinases - Serine –Threonine kinases, tumor necrosis factor receptor families. | | |
| **UNIT V** | **BASICS OF CELL CULTURE** | **9 Periods** |
| Cell line, generation of cell lines, maintenance of stock cells, characterization of cells, morphological analysis techniques in cell culture, primary cultures, contamination, differentiation, three dimensional cultures, role of matrix in cell growth. | | |

**Contact Periods:**
**Lecture: 45 Periods** **Total: 45 periods**

**TEXT BOOKS:**

| AUTHOR NAME | TITLE OF BOOK | PUBLISHER, EDITION, YEAR OF PUBLICATION |
|---|---|---|
| *Darnell J, Lodish H, Baltimore D* | *Molecular Cell Biology* | *W.H.Freeman; 8th edition,2016* |
| *Brai De Robertis& De Robertis,* | *Cell Biology* | *Lippincott Williams & Wilkins, 8th edition,2010* |
| *Geoffrey M. Cooper and Robert E. Hausman* | *The Cell: A Molecular Approach* | *ASM Press and Sinauer Associates, 5th edition, 2009.* |

**REFERENCE BOOKS:**


1. *Kimball T.W.,"Cell Biology", Wesley Publishers; 3rd edition, 1984.*
2. *James D. Watson, "Molecular Biology of the Cell". 3rd edition, 2004.*
3. *Channarayappa, "Cell biology," Universities Press, 2010.*
4. *Rastogi.S.C, "Cell biology," New Age International publishers, 2005.*


**COURSE OUTCOME:**

Upon completion of the course, the students will be able

**CO1:** Understand the mechanisms and role of cell in human body system.

**CO2:** Obtain the knowledge related to the transport mechanisms involved in the activation of cell Signalling.

**CO3:** Describe the receptor and ligand complex molecules for the activation cell signalling.

**CO4:** Illustrate the mechanisms of secondary messengers in signal transduction.

**CO5:** Get familiarized the basics of cell culture.

## COURSE ARTICULATION MATRIX:

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | L | M | - | L | - | L | -- | L | - | - | L | - | H | M |
| **CO2** | L | M | L | - | L | L | -- | - | L | - | - | - | H | M |
| **CO3** | L | L | L | - | L | L | - | L | - | - | - | - | M | H |
| **CO4** | L | L | - | L | - | - | - | - | - | - | - | L | H | M |
| **CO5** | L | - | - | - | L | - | L | - | M | - | - | L | H | H |
| **16BPC304** | L | M | L | L | L | L | L | L | M | - | L | L | H | M |

**L – Low, M – Moderate, H- High**

**16BPC305** **MICROBIOLOGY** **Category: PC**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**PRE-REQUISITES: NIL**

**COURSE OBJECTIVES:**

- Understand the basics of classification, types of microbes and its existence
- Perform staining, examine and identify microbes by understanding its structure
- Understand the requirements of bacteria for its growth and will be able to quantify it by various techniques and methods of controlling it.
- Learn the application of microbes in industries and other bioremediation strategies.

| UNIT I | INTRODUCTION | 9 Periods |
|---|---|---|
| History of microbiology, Microbial existence - Soil, Water and Air; classification and nomenclature of microorganism, microscopic examination of microorganisms, light and electron microscopy; principles of different staining techniques like gram staining, acid fast staining, capsular staining, flagella staining, Spore staining. | | |
| **UNIT II** | **MICROBES-STRUCTURE AND MULTIPLICATION** | **9 Periods** |
| Colony morphology and arrangement of bacterial cells; Structure and multiplication of bacteria, fungi (Rhizopus) and viruses (TMV); life history of mycoplasma, actinomycetes (Streptomyces), yeast, and bacteriophage - T-even. Lambda phages. | | |
| **UNIT III** | **MICROBIAL NUTRITION, GROWTH AND METABOLISM** | **9 Periods** |
| Nutritional requirements of bacteria and different media used for bacterial culture; growth curve and different methods to quantify the bacterial growth, aerobic and anaerobic bioenergetics and utilization of energy for biosynthesis of important molecules. | | |
| **UNIT IV** | **APPLIED MICROBIOLOGY** | **9 Periods** |
| Microbes in wastewater treatment - Aerobic and anaerobic digestion; biogas; bioremediation; leaching of ores by microorganisms. Applications of microbial enzymes in dairy industry, Microbial production of Plastics (PHB, PHA). | | |
| **UNIT V** | **CONTROL OF MICROORGANISMS** | **9 Periods** |
| Host-microbe interactions, clinically important microorganisms; Physical and chemical control of microorganisms; anti-bacterial, anti-fungal and anti-viral agents, mode of action of antibiotics and its resistance. | | |

**Contact Periods:**
**Lecture: 45 Periods** **Total : 45 Periods**

**TEXT BOOKS:**

| AUTHOR NAME | TITLE OF BOOK | PUBLISHER, EDITION, YEAR OF PUBLICATION |
|---|---|---|
| *Pelczar MJ, Chan ECS, Krein NR* | *Microbiology* | *McGraw Hill Education, 5th Edition, 2001.* |
| *Prescott LM, Harley JP, Klein DA* | *Microbiology* | *Wm. C. Brown Publishers, 10th Edition, 2016.* |

**REFERENCE BOOKS:**

1. *Kathleen Park Talaro and Barry Chess, "Foundations in Microbiology", McGraw Hill Education, 9th Edition. 2015.*

**COURSE OUTCOME:**

Upon completion of the course, the students will be able to

**CO1:** Understand the Morphology, cell structure, growth and metabolism of Micro organisms
**CO2:** Demonstrate the ubiquity and diversity of microorganisms in the human body and the environment.
**CO3:** Differentiate the various types of microorganisms and the major diseases they cause.
**CO4:** Explore the routes of transmission of infection and the methods used to control the spread of infection
**CO5:** Identify the importance of microbes in applied microbiology and biotechnology.

**COURSE ARTICULATION MATRIX:**

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | L | - | - | - | - | L | M | M | M | M | - | M | H | L |
| **CO2** | L | M | - | - | - | L | M | M | M | M | - | M | H | L |
| **CO3** | H | L | - | - | - | M | H | M | M | M | - | M | H | M |
| **CO4** | M | L | - | - | - | - | H | M | M | M | - | M | H | L |
| **CO5** | M | - | H | M | M | H | H | H | H | M | - | M | H | H |
| **16BPC305** | M | M | L | L | L | M | H | M | M | M | - | M | H | M |

**L – Low, M – Moderate (Medium), H – High**

**16BPC306** **BIOCHEMISTRY** **Category: PC**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**PRE-REQUISITES: NIL**

**COURSE OBJECTIVES:**

* To understand structural, functional properties, synthesis of carbohydrates and proteins, lipids and nucleic acids
* To understand structural, functional properties and metabolic pathways of nucleic acids and lipids.
* To learn basic information and the mechanisms of structural and cytoskeletal proteins involved organelle movements

| **UNIT I** | **CARBOHYDRATES** | **10 Periods** |
|---|---|---|
| Carbohydrates - Classification, Structure and Properties of Carbohydrates (Mono, Di, Oligo& polysaccharides) - Mutarotation, Conjugated carbohydrates, Metabolism concepts - Glycolysis, TCA cycle, pentose phosphate shunt and Respiratory chain - ATP synthesis. | | |
| **UNIT II** | **PROTEINS** | **10 Periods** |
| Classification of Amino acids, Structure and Properties of Amino acids - Peptide bond - Classification of Proteins – Primary – Secondary - Tertiary and Quaternary structure of proteins - Fibrous and globular proteins, Conjugated proteins, Metabolism concepts - Nitrogen metabolism and urea cycle, Biosynthesis of six essential amino acids (Met, Thr, Lys, Ile, Val, Leu) and aromatic amino acids. | | |
| **UNIT III** | **NUCLEIC ACIDS** | **7 Periods** |
| Nucleic Acids – Structure of Purines – Pyrimidines – Nucleosides - Nucleotides - Ribonucleic acids – Deoxyribonucleic acids - Nucleoprotein complexes, Metabolism concepts - Biosynthesis of nucleotides, denovo and salvage pathways for purines and pyrimidines. | | |
| **UNIT IV** | **LIPIDS** | **10 Periods** |
| Structure and properties of Lipids – Classification, (Fatty acids, Glycerolipids, Phospholipids, Glycolipids, Sphingolipids, Steroids),Metabolism concepts - Fatty acid synthesis and oxidative degradation, Triacylglycerol, phospholipid biosynthesis and degradation; Cholesterol biosynthesis. | | |
| **UNIT V** | **METABOLIC DISORDERS** | **8 Periods** |
| Metabolic disorders associated with carbohydrates, branched chain and aromatic amino acid degradation, nucleic acids and lipids. | | |

**Contact Periods:**
**Lecture: 45 Periods** **Total: 45 periods**

**TEXT BOOKS:**

| AUTHOR NAME | TITLE OF BOOK | PUBLISHER, EDITION, YEAR OF PUBLICATION |
|---|---|---|
| *David L. Nelson and Michael M. Cox* | *Lehninger's —Principles of Biochemistry* | *Macmillan, 6th Edition,2013* |
| *LubertStryer* | *Biochemistry* | *WH Freeman & Co., 5th Edition,2002.* |
| *Voet and Voet* | *Biochemistry* | *John Wiley & Sons Inc., 3rd Edition, 2004.* |

**REFERENCE BOOKS:**


1. *Murray, R.K., Granner, B.K., Mayes, P.A., Rodwell. V.W., ―Harper's Biochemistry, Prentice Hall, 2006.*
2. *Salway, J.G., "Metabolism at a Glance", 2nd Edition, Blackwell Science Ltd., 2000.*


**COURSE OUTCOMES**

Upon completion of the course, the students will be able to

**CO1:** Understand the structural, functional properties of carbohydrates and its metabolism
**CO2:** Understand about basics of amino acids, biosynthesis and structure of protein
**CO3:** Acquire knowledge about nucleic acids and its synthesis pathways.
**CO4:** Classify the lipids and to understand the metabolic pathways of lipids.
**CO5:** Describe the metabolic disorders associated with the biomolecules

**COURSE ARTICULATION MATRIX:**

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | H | M | - | - | - | - | - | - | - | - | - | M | H | M |
| **CO2** | M | M | - | - | - | L | - | - | - | - | - | - | H | M |
| **CO3** | M | - | L | - | - | - | - | - | - | - | - | - | H | M |
| **CO4** | M | - | - | - | - | - | - | - | M | M | - | - | H | M |
| **CO5** | M | - | - | L | - | - | - | - | - | - | - | L | M | H |
| **16BPC306** | M | M | L | L | - | L | - | - | M | M | - | M | H | M |

**L – Low, M – Moderate, H- High**

**16BEE307 COMMUNICATION SKILLS AND TECHNICAL SEMINAR Category: EEC**

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 4 | 2 |

**PRE-REQUISITES: NIL**

1. 16BHS1Z1- Communication Skills in English
2. 16BHS2Z1- Technical English

**COURSE OBJECTIVES:**

- To enable the students to present the basic technical concepts and ideas, in a clear and efficient manner with an effective using of different teaching aids.
- To enable the students to gain confidence in facing the placement interviews.

| DESCRIPTION |
|---|
| During the seminar session each student is expected to prepare and present a topic on engineering/ technology, for duration of about 8 to 10 minutes. Three periods per week are to be allotted and 15 students are expected to present the seminar. A faculty guide is to be allotted and he / she will guide and monitor the progress of the student and maintain attendance also. Students are encouraged to use various teaching aids such as overhead projectors, power point presentation and demonstrative models. |

**Contact Periods:**
**Practical: 60 periods** **Total: 60 periods**

**COURSE OUTCOME:**
Upon completion of the course, the students will be able to

**CO1:** Establish inter personal skills and be an effective goal oriented team player.
**CO2:** Re-engineer attitude and understand its influence on behavior.
**CO3:** Develop into professionals with idealistic, practical and moral values
**CO4:** Progress in communication and problem solving skills.
**CO5:** Gain confidence in expressing the views and thoughts in a confident and consoling manner

**COURSE ARTICULATION MATRIX:**

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | - | - | - | - | - | - | - | - | H | H | H | M | L | H |
| **CO2** | - | - | - | - | - | - | L | M | M | L | M | L | L | H |
| **CO3** | - | - | - | - | - | M | - | H | L | L | L | L | L | H |
| **CO4** | - | - | - | - | - | - | - | - | H | H | M | L | L | M |
| **CO5** | - | - | - | - | - | - | - | - | M | H | M | L | L | M |
| **16BEE307** | - | - | - | - | - | M | L | H | H | H | M | L | L | H |

**L – Low, M – Moderate, H- High**

**16BPC308** **MICROBIOLOGY LABORATORY** **Category: PC**

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 4 | 2 |

**PRE-REQUISITES: NIL**

**COURSE OBJECTIVES:**

- To identify & demonstrate the proper safety procedures concerning lab safety.
- To identify the parts & function of microscope.
- To demonstrate the ability to prepare the slides for microscopic examinations.
- To identify the purpose & principle associated with different media types used in lab.
- To identify the purpose of using biochemical test in determining the metabolic differences between microbes.

**LIST OF EXERCISES**

1. Laboratory safety and sterilization techniques.
2. Microscopic methods in the identification of microorganisms.
3. Preparation of culture media – nutrient broth and nutrient agar.
4. Culturing of microorganisms – isolation, identification of microorganisms from different sources in broth and in plates (pour plates, streak plates, isolation and preservation of bacterial cultures).
5. Staining techniques – simple and grams.
6. Motility Test – Hanging drop technique.
7. Antibiotic sensitivity assay – Disc Diffusion method.
8. Growth Kinetics – Growth curve of Bacteria and Yeast.
9. Biochemical Tests.
10. Phage Assay.

**Contact Periods:**
**Practical: 60 Periods** **Total: 60 Periods**

**REFERENCE BOOKS:**

1. *James G. cappuccino & Natalie, "Microbiology, A Laboratory manual", Pearson Education publishers, 11th edition. 2016.*

**COURSE OUTCOME:**

Upon completion of the course, the students will be able to

**CO1:** Identify& demonstrate the proper safety procedures concerning lab safety**.**
**CO2:** Identify the parts & function of microscope**.**
**CO3:** Demonstrate the ability to prepare the slides for microscopic examinations.
**CO4:** Identify the purpose & principle associated with different media types used in lab.
**CO5:** Identify the purpose of using biochemical test in determining the metabolic differences between Microbes.

**COURSE ARTICULATION MATRIX:**

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | - | - | - | - | - | - | M | M | - | - | - | M | H | H |
| **CO2** | M | M | - | - | L | - | M | - | M | H | - | M | H | L |
| **CO3** | M | M | - | - | L | - | M | - | M | H | - | M | H | L |
| **CO4** | L | M | M | - | - | - | L | - | M | L | - | L | H | M |
| **CO5** | M | M | H | - | M | L | L | L | M | M | - | M | M | L |

**L – Low, M – Moderate (Medium), H – High**

**16BPC309** **BIOCHEMISTRY LABORATORY** **Category: PC**

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 4 | 2 |

**PRE-REQUISITES: NIL**

1. 16BBS104 - Chemistry for Biotechnology
2. 16BBS207 – Chemistry Laboratory

**COURSE OBJECTIVES:**

* To provide firm foundation of basic laboratory techniques.
* To provide hands on training on the simple experiments for identification, quantification of bio molecules and preparation of bio active compounds.

**LIST OF EXERCISES**

1. Units, Volume/Weight measurements, concentrations, pH measurements, Preparation of buffers, Sensitivity, Specificity, precision and Accuracy.
2. Qualitative tests for carbohydrates
3. Quantitative tests for reducing sugars by Benedict's method.
4. Qualitative tests for Amino Acids
5. Protein estimation - Biuret, Folin and Bradford Assay
6. Extraction of lipids and Saponification of Fats
7. Synthesis of Aspirin
8. Preparation of oleic acid from tartaric acid
9. Isolation of lycopene from tomato
10. Isolation and estimation of starch from potato tubers

**Contact Periods:**
**Practical: 60 Periods** **Total: 60 Periods**

**TEXT BOOKS:**

| AUTHOR NAME | TITLE OF BOOK | PIBLISHER, EDITION, YEAR OF PUBLICATION |
|---|---|---|
| *David. T. Plummer* | *An Introduction to Practical Biochemistry* | *McGraw – Hill3rd edition 2006* |
| *Vogel A.I, Tatchell A.R, Fummis B.S., Hannaford A.J., Smith P.W.G* | *Text Book of Practical Organic Chemistry* | *Prentice Hall5th edition 1996* |

**COURSE OUTCOME:**

Upon completion of the course, the students will be able to

**CO1:** Prepare reagents accurately and reproducibly for experiments.
**CO2:** Operate pH meter, weighing balance, colorimeter and spectrophotometer.
**CO3:** Do the experiments for isolation and extraction of any bioactive compounds.
**CO4:** Identify and quantify the bio molecules (Carbohydrate, Protein, Nucleic acid, Lipids) in any Sample.
**CO5:** Understand the practical accession behind preparation and separation of various pharmaceutical and other organic chemicals.

**COURSE ARTICULATION MATRIX:**

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | M | L | H | - | - | - | - | - | - | - | - | M | H | H |
| **CO2** | M | L | H | - | H | - | - | - | - | - | - | M | H | H |
| **CO3** | M | L | H | - | L | - | - | - | - | - | - | M | M | H |
| **CO4** | M | L | H | - | L | - | - | - | - | - | - | M | M | H |
| **CO5** | M | L | H | - | - | - | - | - | - | - | - | M | L | M |

**L – Low, M – Moderate, H- High**

**16BBS401 PROBABILITY, STATISTICS AND RANDOM PROCESSES Category: BS**

| L | T | P | C |
|---|---|---|---|
| 3 | 2 | 0 | 4 |

**PRE-REQUISITES: NIL**

**COURSE OBJECTIVES:**

- To gain the knowledge of probability concepts and statistical distributions both discrete and continuous cases including correlation analysis.
- To gain the knowledge of testing hypothesis for large and small samples.
- To familiarize with design of experiments.
- To be familiar with first and second order stationary, ergodic, Markov processes and also auto correlation, cross correlation, power spectral density and cross spectral density.

| UNIT I | PROBABILITY AND RANDOM VARIABLES | 9+6 Periods |
|---|---|---|
| Axioms of probability – Conditional probability - Independent events – Total probability – Baye's theorem – Random variables – Discrete and continuous random variables – Moments – Moment generating functions and their properties. | | |
| **UNIT II** | **PROBABILITY DISTRIBUTIONS** | **9+6 Periods** |
| Binomial, Poisson, Geometric, Uniform, Exponential, Normal, Gamma, Weibull (Mean, Variance and Simple problems) Chebychev's inequality (Simple problems). Correlation -Regression - Multiple and Partial correlation – Partial correlation (Problems only). | | |
| **UNIT III** | **TEST OF HYPOTHESIS** | **9+6 Periods** |
| Large samples: Tests of means, variances and proportions. Small samples: Tests of means, variances and attributes using t, F, Chi Square distribution – Interval estimation for mean, standard deviation and proportion.<br>Large sample test based on Normal distribution for single mean and difference means - Test based on t, Chisquare, and F distributions for testing mean and variances - Contingency table - Goodness of fit. | | |
| **UNIT IV** | **DESIGN OF EXPERIMENTS** | **9+6 Periods** |
| One way and two way classifications - Completely randomized block design - Latin square design - 2x2 factorial design. | | |
| **UNIT V** | **RANDOM PROCESS** | **9+6 Periods** |
| Classification of random process - Stationary process - Auto correlation and Cross correlation – Properties – Mean ergodic and cross ergodic process - Power spectral density – Cross spectral density – properties – Poisson process – Markov process – Markov chain – Classification of states of a Markov chain – Steady state distribution of a Markov chain. | | |

**Contact Periods:**
**Lecture: 45 Periods Tutorial: 30 Periods Total : 75 Periods**

**TEXT BOOKS :**

| AUTHOR NAME | TITLE OF THE BOOK | PUBLISHER,YEAR OF PUBLICATION |
|---|---|---|
| *Veerarajan T* | *Probability and Random Processes (with Queueing Theory and Queueing Networks)* | *McGraw Hill Education(India) Pvt Ltd., New Delhi, 4th Edition 2016* |

**REFERENCE BOOKS:**

| AUTHOR NAME | TITLE OF THE BOOK | PUBLISHER,YEAR OF PUBLICATION |
|---|---|---|
| *Gupta S.C and Kapoor V.K* | *Fundamentals of Mathematical Statistics* | *Sultan Chand & Sons, New Delhi, 2015* |
| *Gupta S.P* | *Statistical Methods* | *Sultan Chand & Sons, New Delhi, 2015* |
| *Kandasamy P, Thilagavathy K and Gunavathy K* | *Probability, Statistics and Random Processes* | *S.Chand& Co, Ramnagar, New Delhi, Reprint 2013* |
| *Yates and Goodman D.J* | *Probability and Stochastic Processes* | *John Wiley and Sons, Second Edition, New Delhi, 2005* |

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to

**CO1**: Understand probability axioms and calculate expected values through moment generating functions.

**CO2**: Understand probability distributions of discrete and continuous random variables and calculate coefficient of correlation, regression coefficients, multiple and partial correlation and regression plane.

**CO3**: Understand tests of sampling for large and small samples.

**CO4**: Acquire fluency in experimental design using criterion of ANOVA.

**CO5**: Understand stationary, ergodic, Markov processes and spectral densities.

**COURSE ARTICULATION MATRIX:**

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | H | H | M | - | - | - | - | - | - | M | - | - | - | - |
| **CO2** | H | H | M | - | - | - | - | - | - | - | - | - | - | L |
| **CO3** | H | H | - | - | - | - | - | - | - | M | - | - | H | H |
| **CO4** | H | H | M | - | - | - | - | - | - | M | M | - | H | H |
| **CO5** | H | H | - | - | - | M | - | - | - | - | - | - | M | M |
| **16BBS401** | H | H | M | - | - | M | - | - | - | M | M | - | M | - |

**L- Low , M-Moderate, H- High**

**16BES402** **FLUID MECHANICS** **CATEGORY: ES**

| L | T | P | C |
|---|---|---|---|
| 2 | 2 | 0 | 3 |

**PRE-REQUISITES: NIL**

**COURSE OBJECTIVES:**

- To understand Fluid properties dynamics of fluid flow.
- To gain knowledge about the flow measurement.
- To develop the energy balance equation for flow systems and to design fluidized bed reactors.
- To understand the mechanical operations for size reduction.

| | | |
|---|---|---|
| **UNIT I** | **INTRODUCTION** | **6 + 6 Periods** |
| Properties of fluids - Fluid statics, concept of shear stress, Newton's law of viscosity – Fluid behavior under shear - Newtonian and non-Newtonian fluids - Types of flow – Laminar, turbulent, steady, unsteady, non uniform and uniform flows – Compressible and incompressible fluids. | | |
| **UNIT II** | **FLUID DYNAMICS** | **6 + 6 Periods** |
| Continuity equation, Bernoulli's equation, boundary layer condition - Form drag, skin drag, drag coefficient – Laminar and turbulent flow through closed conduit - Velocity profiles, Pipes and pipe fittings, Darcy Wisbach equation - Head losses due to friction in pipes and fittings. | | |
| **UNIT III** | **FLUID FLOW MEASURMENT AND PUMPING EQUIPMENT** | **6 + 6 Periods** |
| Pressure measurement by manometers, U-tube, differential and inclined manometers - Flow meters - Orifice meter, Venturimeter, Pitot tube, Rota meter, Weirs and notches, hot wire anemometer, displacement meter, current meter, magnetic flow meter. Pumps - Types, selection and specifications, positive displacement pumps - Reciprocating pump, Rotary pumps - Centrifugal pumps - Characteristics curves of pumps - Fans, blowers and compressors. | | |
| **UNIT IV** | **FLUIDIZATION AND PACKED BEDS** | **6 + 6 Periods** |
| Mechanisms, types – Fluidized beds - Properties of fluidized beds - Continuous fluidization and application - Packed beds – Pressure drop, flooding and loading - Mixing & agitation | | |
| **UNIT V** | **MECHANICAL OPERATIONS** | **6 + 6 Periods** |
| Size reduction equipment – Operations and their classification, Energy and power requirements - Laws of crushing, open and closed circuit operations - Techniques of size analysis – Different methods for storage of solids - Conveyors and elevators. | | |

**Contact Periods:**
**Lecture: 30 Periods** **Tutorial : 30 Periods** **Total : 60 Periods**

**TEXT BOOKS:**

| AUTHOR NAME | TITLE OF THE BOOK | PUBLISHER,YEAR OF PUBLICATION |
|---|---|---|
| *McCabe Smith and Harriott* | *Unit Operations of Chemical Engineering* | *McGraw-Hill company, 1993* |
| *Geankoplis C.J.* | *Transport Processes and Unit Operations.* | *Prentice Hall of India, 3rd edition, 2002.* |
| *Frank M. White* | *Fluid Mechanics* | *McGraw-Hill company, 2015.* |

**REFERENCE BOOKS:**

| AUTHOR NAME | TITLE OF THE BOOK | PUBLISHER,YEAR OF PUBLICATION |
|---|---|---|
| *Coulson and Richardson's* | *Chemical Engineering. Vol I & II* | *Asian Books Pvt Ltd, 1998* |
| *Bansal R K* | *Fluid mechanics and Hydraulic machines 5th edition* | *Lakshmi publications (P) Ltd, New Delhi, 1997.* |

**COURSE OUTCOMES:**

Upon completion of the course, the students will be able to

**CO1**: Understand stress – strain relationship in fluids and analyse fluid flow problems.
**CO2**: To apply Bernouli principle and measure pressure drop in flow systems.
**CO3**: Describe the function and performance of flow metering devices.
**CO4**: Determine minimum fluidization velocity in fluidized bed.
**CO5**: Present characteristics of particulate solids, Principles of size reduction and screening, crushing and grinding equipment.

**COURSE ARTICULATION MATRIX:**

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | - | H | H | M | L | - | - | - | - | - | - | H | H | L |
| **CO2** | M | M | - | H | - | - | L | L | M | L | M | H | H | L |
| **CO3** | M | M | H | L | M | M | - | - | - | - | - | M | L | H |
| **CO4** | L | H | H | M | L | - | L | M | - | - | - | H | H | M |
| **CO5** | L | H | - | - | L | - | - | - | L | L | L | H | H | M |
| **16BES402** | L | H | H | M | L | M | L | M | M | L | M | H | H | M |

**L- Low , M-Moderate(Medium), H- High**

**16BPC403** **MOLECULAR BIOLOGY** **CATEGORY: PC**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**PRE-REQUISITES:**

16BPC304 - Cell Biology

**COURSE OBJECTIVES:**

* To learn the fundamental aspects of nucleic acids.
* To understand the principle and process of DNA replication, transcription and translation.
* To study the basics of regulation of gene activity, mutation and DNA repair.

| | | |
|---|---|---|
| **UNIT I** | **CLASSICAL & MOLECULAR GENETICS** | **8 Periods** |
| Linkage, crossing over, classical experiments – Hershey and Chase; Avery McLeod & McCarty. Conformation of DNA and RNA, classes of RNA. Organization of eukaryotic chromosome – cot value, Bacterial conjugation, transduction and transformation - Sexduction. | | |
| **UNIT II** | **DNA REPLICATION** | **10 Periods** |
| Rules of replication in all nucleic acid, enzymology, replication – Continuous, discontinuous. Replication in prokaryotes - D-loop and rolling circle mode of replication, replication of linear viral DNA. Replication of telomeres in eukaryotes. | | |
| **UNIT III** | **TRANSCRIPTION** | **10 Periods** |
| RNA polymerase, RNA replicase (Virus), Transcription in prokaryotes and eukaryotes, Inhibitors, features of promoters and enhancers, transcription factors, nuclear RNA splicing mechanisms – tRNA, rRNA, mRNA, ribozymes, RNA editing. | | |
| **UNIT IV** | **TRANSLATION** | **10 Periods** |
| Elucidation of genetic code, Salient features of genetic code - Wobble hypothesis, ribosomes – Prokaryotic & eukaryotic, protein synthesis, post translational processing, Protein targeting. | | |
| **UNIT V** | **MUTATION – REPAIR AND REGULATION OF GENE** | **7 Periods** |
| Regulation of genes – Replication, transcription & translation factors, Lac and trp operon. Mutation – Transition, transversion, artificial & natural mutation, suppressor mutation. Repair of DNA. | | |

**Contact Periods:**
**Lecture: 45 periods** **Total: 45 periods**

**TEXT BOOKS:**

| AUTHOR NAME | TITLE OF BOOK | PUBLISHER, EDITION, YEAR OF PUBLICATION |
|---|---|---|
| *David Friefelder* | *Molecular Biology* | *Narosa Publ. House.2nd edition, 1999* |

**REFERENCE BOOKS:**

| AUTHOR NAME | TITLE OF BOOK | PUBLISHER, EDITION, YEAR OF PUBLICATION |
|---|---|---|
| *Benjamin Lewin* | *Gene VII* | *Oxford University Press,7th edition, (2000).* |
| *Watson JD, Hopkins WH, Roberts JW, Steitz JA, Weiner AM* | *Molecular Biology of the Gene* | *McGraw Hill,2nd edition, (1986)* |

**COURSE OUTCOMES:**

Upon completion of the course, the students will be able to

**CO1:** Get familiarize with the biomolecules and their functions

**CO2:** Understand the fundamentals of classical & molecular genetics

**CO3:** Understand the regulatory mechanism of molecular biology

**CO4:** Solve molecular biology problems and to think analytically

**CO5:** Articulate applications of molecular biology in the modern world

**COURSE ARTICULATION MATRIX:**

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | H | - | - | - | - | - | - | - | - | - | - | - | H | L |
| **CO2** | H | - | - | - | - | - | - | - | - | - | - | - | H | M |
| **CO3** | L | M | H | - | - | - | - | - | - | - | - | - | H | M |
| **CO4** | - | H | M | - | M | - | - | - | - | - | - | - | M | H |
| **CO5** | - | L | H | - | M | - | - | - | - | - | - | M | M | H |
| **16BPC403** | H | H | H | - | M | - | - | - | - | - | - | M | H | H |

**L – Low, M – Moderate, H- High**

**16BPC404 BIOCHEMICAL THERMODYNAMICS CATEGORY: PC**

| L | T | P | C |
|---|---|---|---|
| 2 | 2 | 0 | 3 |

**PRE-REQUISITES:**

1. 16BES302 - Process Calculations

**COURSE OBJECTIVES:**

* To design & solve problem in realistic cases by applying thermodynamics concepts
* To estimate or locate necessary thermodynamic data
* To estimate thermodynamic properties of substances in gas and liquid states
* To understand about biochemical equilibrium and able to calculate the kinetics of biological systems

| UNIT I | THERMODYNAMIC LAW AND PROPERTIES OF FLUIDS | 6 + 6 Periods |
|---|---|---|
| Review of laws of thermodynamics and their applications; thermodynamic analysis of processes. Thermodynamic properties of fluids and their interrelationship: PVT behavior of pure substances; Equation of state; Generalized correlations and acentric factor; PVT behavior of mixtures; Thermodynamics charts; Estimation of thermodynamic properties. | | |
| **UNIT II** | **SOLUTION THERMODYNAMICS** | **6 + 6 Periods** |
| Partial molar properties; Chemical potential; Gibbs - Duhem equation; Ideal and non-ideal solutions; Fugacity and fugacity coefficient; Activity and activity coefficient; Excess properties of mixtures. | | |
| **UNIT III** | **PHASE EQUILIBRIA** | **6 + 6 Periods** |
| General criterion for equilibrium and their application; Stability constraints; Gibbs phase rule and its derivation for reacting and non-reacting systems; Vapour-liquid, liquid-liquid, and vapour-solid equilibrium for ideal and non-ideal systems. | | |
| **UNIT IV** | **CHEMICAL REACTION EQUILIBRIA** | **6 + 6 Periods** |
| Chemical equilibrium constants; Homogeneous and heterogeneous reactions; Standard Gibbs free energy change; Equilibrium conversion in single and multiple reactions. | | |
| **UNIT V** | **THERMODYNAMIC DESCRIPTION OF MICROBIAL GROWTH AND PRODUCT FORMATION** | **6 + 6 Periods** |
| Thermodynamics of microbial growth stoichiometry, maintenance, Calculation of the Operational Stoichiometry of a growth process including Heat using the Herbert – Pirt Relation for Electron Donor, thermodynamics and stoichiometry of Product Formation. | | |

**Contact Periods:**
**Lecture: 30 Periods Tutorial: 30 Periods Total : 60 Periods**

**TEXT BOOKS**

| AUTHOR NAME | TITLE OF BOOK | PUBLISHER, EDITION, YEAR OF PUBLICATION |
|---|---|---|
| *Smith J.M<br>Van Ness H.C<br>Abbott M.M* | *Introduction to Chemical Engineering Thermodynamics* | *McGraw-Hill, 7th edition,2005* |
| *Narayanan K.V* | *A Text Book of Chemical Engineering Thermodynamics* | *Prentice Hall of India, 2nd edition, 2013* |
| *Christiana D Smolke* | *The Metabolic Pathway Engineering Handbook Fundamentals* | *CRC Press Taylor & Francis 1st edition,2010* |

**REFERENCE BOOKS:**

| AUTHOR NAME | TITLE OF BOOK | PUBLISHER, EDITION, YEAR OF PUBLICATION |
|---|---|---|
| *Hougen O.A., Watson K.M., and Ragatz R.A* | *Chemical Process Principles Part II* | *John Wiley & Sons, 2nd edition. 2004* |
| *Sandler S.I* | *Chemical and Engineering Thermodynamics* | *John Wiley & Sons, 4th edition. 2006.* |

**COURSE OUTCOMES:**

Upon completion of the course, the students will be able to

**CO1:** Illustrate the application of thermodynamics in design & operation of process industries.
**CO2:** Design & solve problem in realistic cases by applying thermodynamics concepts.
**CO3:** Estimate or locate necessary thermodynamic data.
**CO4:** Estimate thermodynamic properties of substances in gas and liquid states
**CO5:** Interpret the phase equilibria concepts in multi-component systems
**CO6:** Understand about biochemical equilibrium and able to calculate the kinetics of biological systems.

**COURSE ARTICULATION MATRIX:**

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | M | M | - | - | - | - | L | M | L | L | - | M | H | H |
| **CO2** | H | H | H | - | H | - | - | - | M | M | - | M | H | H |
| **CO3** | L | M | - | L | M | - | - | - | - | - | - | L | L | H |
| **CO4** | M | M | M | L | - | - | - | - | L | L | - | L | L | M |
| **CO5** | M | M | M | M | M | - | - | - | L | L | - | L | L | M |
| **CO6** | - | M | L | M | H | - | - | - | - | - | - | M | M | H |
| **16BPC404** | M | M | M | M | H | - | L | M | L | L | - | M | H | H |

**L – Low, M – Moderate (Medium), H – High**

**16BPC405 ANALYTICAL TECHNIQUES IN BIOTECHNOLOGY CATEGORY: PC**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**PRE-REQUISITES:**

16BPC306 – Biochemistry

**COURSE OBJECTIVES:**

- To analyse the research findings and interpretation can be ascertained by the knowledge gained from this course.
- To understand the structural behavior of molecule using molecular spectroscopy.
- To inculcate knowledge on the various separation and purification methods.

| UNIT I | BASICS OF MEASUREMENT | 9 Periods |
|---|---|---|
| Classification of methods – Calibration of instrumental methods – Electrical components and circuits - Signal to noise ratio – Signal – Noise enhancement; Properties of electromagnetic radiations and their interaction with matter. | | |
| **UNIT II** | **MOLECULAR SPECTROSCOPY** | **9 Periods** |
| UV and visible light spectroscopy - Qualitative and Quantitative absorption Measurement, Beer-Lambert law, Spectrofluorimetry, IR spectroscopy, Raman spectroscopy, NMR spectroscopy, X-ray crystallography – Principle, instrumentation and applications; X-Ray Photoelectron Spectroscopy. | | |
| **UNIT III** | **ELECTROPHORESIS** | **9 Periods** |
| General principle of electrophoresis, support media (agarose and polyacrylamide gels), electrophoresis of proteins by SDS-PAGE, native PAGE, gradient gels, isoelectric focusing, two dimensional PAGE, electrophoresis of nucleic acids using agarose gel, sequencing gel, PFGE, FIGE, CHEF, capillary electrophoresis | | |
| **UNIT IV** | **CHROMATOGRAPHY** | **9 Periods** |
| Principles of chromatography, distribution coefficient, retention time, capacity factor, plate height and resolution, peak broadening and van Deemter plot, TLC and column chromatography, matrix materials, HPLC, ion exchange chromatography, gel exclusion chromatography and Gas chromatography | | |
| **UNIT V** | **THERMAL METHODS** | **9 Periods** |
| Differential thermal analysis techniques. Differential scanning calori metry - Instrumentation & application. Differential thermal analysis - Instrumentation & application, DTA curve. Thermogravimetry – Instrumentation & application, TG curve. | | |

**Contact Periods:**
**Lecture: 45 periods** **Total: 45 periods**

**TEXT BOOKS:**

| AUTHOR NAME | TITLE OF BOOK | PUBLISHER, EDITION, YEAR OF PUBLICATION |
|---|---|---|
| *Willard H.W., Merritt L.L., Dean J.A. & Settle F.A* | *Instrument Methods of Analysis* | *East West Publishers 6th ed.1988* |
| *Skoog, D.A. F. James Holler, and Stanky, R. Crouch* | *Instrumental Methods of Analysis* | *Cengage Learning, 6th edition2007* |

**REFERENCE BOOKS:**

| AUTHOR NAME | TITLE OF BOOK | PUBLISHER, EDITION, YEAR OF PUBLICATION |
|---|---|---|
| *Harrison ,R.G., Todd, P., Rudge, S.R. and Petrides* | *Bioseparations: Science and Engineering* | *B.B. Oxford University Press (2006).* |
| *Wilson K. and Walker J* | *Principles and Techniques of Biochemistry and Molecular Biology* | *Cambridge University Press (2005) 6th ed* |

**COURSE OUTCOMES:**

Upon completion of the course, the students will be able to

**CO1:** Understand the Basics of Measurement in instrumental methods
**CO2:** Impart knowledge on spectroscopic analytical methods
**CO3:** Inculcate knowledge on the separation of nucleic acids and proteins in molecular biology
**CO4:** Study the different chromatographic separation methods and their analysis.
**CO5:** Analyse the thermal behaviour of the bioproducts.

## COURSE ARTICULATION MATRIX:

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | M | H | M | - | - | - | - | - | L | L | - | L | H | L |
| **CO2** | L | L | H | - | - | - | L | - | L | L | - | - | H | M |
| **CO3** | M | L | H | - | - | - | L | - | - | - | - | L | L | M |
| **CO4** | M | L | H | - | - | - | L | L | - | - | - | - | H | M |
| **CO5** | L | H | M | - | - | - | L | - | - | - | - | - | M | L |
| **16BPC405** | M | L | H | - | - | - | L | L | L | L | - | L | H | M |

**L – Low, M – Moderate, H- High**

**16BPC406** **IMMUNOLOGY** **CATEGORY: PC**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**PRE-REQUISITES:**

1. 16BPC304 - Cell Biology

**COURSE OBJECTIVES:**

- To articulate the role of various cells and organs involved in immune responses and associated functions.
- To gain knowledge on the interaction between the immune system and pathogens.
- To develop the ability to identify issues in clinical immunology.

| | | |
|---|---|---|
| **UNIT I** | **CELLS AND ORGANS OF THE IMMUNE SYSTEM** | **6 Periods** |
| Innate and acquired immunity; cells of immune system, primary and secondary lymphoid organs. | | |
| **UNIT II** | **ANTIGENS AND ANTIBODIES** | **12 Periods** |
| Antigens: chemical and molecular nature; haptens; adjuvants; B and T-cell epitopes; antigenic determinants on antibodies; antibodies: structure and functions; antibodies: genes and generation of diversity; antigen-antibody reactions; monoclonal antibodies: principles and applications. | | |
| **UNIT III** | **CELLULAR RESPONSES** | **10 Periods** |
| Development, maturation, activation and differentiation of T-cells and B-cells; antigen presenting cells; major histocompatibility complex; antigen processing and presentation; regulation of T-cell and B-cell responses; cytokines | | |
| **UNIT IV** | **INFECTION AND IMMUNITY** | **8 Periods** |
| Immune responses to infections: immunity to viruses, bacteria, fungi and parasites; complement; immunosuppression, tolerance; allergy and hypersensitivity; vaccines. | | |
| **UNIT V** | **AUTOIMMUNITY AND TRANSPLANTATION IMMUNOLOGY** | **9 Periods** |
| Autoimmunity, Auto immune diseases: systemic and organ specific autoimmune disorders, proposed mechanisms for induction of Autoimmunity, Treatment of Autoimmune diseases; Types of grafts, Basis of Graft rejection, specificity and memory of graft rejection, Mechanisms involved in Graft rejections, Tests for HLA matching, General and specific immunosuppression therapies | | |

**Contact Periods:**
**Lecture: 45 periods** **Total: 45 periods**

**TEXT BOOKS:**

| AUTHOR NAME | TITLE OF BOOK | PUBLISHER, EDITION, YEAR OF PUBLICATION |
|---|---|---|
| *Kuby J* | *Immunology* | *WH Freeman & Co.5th edition2000.* |
| *Roitt I, Male, Brostoff.* | *Immunology* | *Mosby Publishers 6th edition2002.* |

**REFERENCE BOOKS:**

| AUTHOR NAME | TITLE OF BOOK | PUBLISHER, EDITION, YEAR OF PUBLICATION |
|---|---|---|
| *Chakaravarthy, A.K* | *(2006) Immunology and Immunotechnology* | *1st Edition (English) Oxford University Press India.* |

**COURSE OUTCOMES:**

Upon completion of the course, the students will be able to

**CO1:** Outline the basic components of immune system and their functions.

**CO2:** Illustrate various diagnostic methods based on antigen-antibody interaction

**CO3:** Describe principles and methods of various cellular immune responses

**CO4:** Demonstrate the state of immune system during infection

**CO5:** Find effective solutions for the treatment of autoimmune disorders and problem associated with organ transplantation

**COURSE ARTICULATION MATRIX:**

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | L | H | L | - | - | L | - | - | - | - | - | L | H | L |
| **CO2** | M | L | M | H | - | M | L | - | L | M | M | L | L | H |
| **CO3** | H | L | L | - | - | - | - | - | - | - | M | - | L | L |
| **CO4** | H | L | M | - | - | L | L | M | - | - | M | L | L | L |
| **CO5** | H | L | M | H | L | M | H | - | - | L | M | H | L | H |
| **16BPC406** | H | L | M | H | L | M | L | M | L | M | M | L | L | L |

**L – Low, M – Moderate, H- High**

**16BPC407** **MOLECULAR BIOLOGY LABORATORY** **CATEGORY: PC**

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 4 | 2 |

**PRE-REQUISITES:**

1. 16BPC308 – Microbiology Laboratory

**COURSE OBJECTIVES:**

- To provide hands on experience in performing basic molecular biology techniques.
- Introduce students to the theory behind in each technique and to describe common applications of each methodology in biological research.

| LIST OF EXERCISES |
|---|
| 1. Agarose gel electrophoresis for quality and quantity assessment. |
| 2. DNA quantification by UV spectroscopy. |
| 3. DNA Extraction from plant cells. |
| 4. DNA Extraction from animal cells. |
| 5. DNA Extraction from Bacterial cells. |
| 6. Plasmid Extraction from bacterial cell. |
| 7. DNA Extraction from Human blood. |
| 8. Molecular weight calculation using gel electrophoresis. |
| 9. RNA extraction. |
| 10. Denaturing gel electrophoresis for RNA. |

**Contact Periods:**
**Practical: 60 periods** **Total: 60 periods**

**REFERENCE BOOKS:**

| AUTHOR NAME | TITLE OF BOOK | PUBLISHER, EDITION, YEAR OF PUBLICATION |
|---|---|---|
| *Sambrook, Joseph and David W. Russell* | *The Condensed Protocols: From Molecular Cloning: A Laboratory Manual* | *Cold Spring Harbor, 4th edition, 2006* |

**COURSE OUTCOMES:**

Upon completion of the course, the students will be able to

**CO1:** Understand the principles underlying in the techniques of molecular biology.

**CO2:** Analyze the applications of these techniques.

**CO3:** Carry out lab experiments and interpret the results.

**CO4:** Take safety precautions on usage of hazardous chemicals in case of emergency.

**CO5**: Trouble shoot the problems while performing an experiment.

**COURSE ARTICULATION MATRIX:**

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | L | M | H | L | H | - | - | - | L | M | - | - | H | M |
| **CO2** | L | M | H | L | M | - | - | - | L | L | - | - | H | H |
| **CO3** | L | M | H | L | H | - | - | - | L | H | - | - | H | M |
| **CO4** | M | L | L | L | - | - | - | - | L | L | - | - | H | M |
| **CO5** | - | - | H | - | - | - | - | - | - | - | H | - | M | H |
| **16BPC407** | L | M | H | L | H | - | - | - | L | H | H | - | H | M |

**L – Low, M – Moderate, H- High**

**16BPC408 ANALYTICAL TECHNIQUES LABORATORY CATEGORY: PC**

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 4 | 2 |

**PRE-REQUISITES:**

1. 16BPC309 - Biochemistry Laboratory

**COURSE OBJECTIVES:**

- The students will be able to get familiar on different analytical techniques to employ their knowledge to solve the research problem.

| LIST OF EXERCISES |
|---|
| 1. Precision and Validity in an experiment. |
| 2. Validating Lambert-Beer's law using $KMnO_4$. |
| 3. Absorption spectrum of ferrous ions using absorption spectroscopy. |
| 4. Finding the concentration of the Iron content present in the tablet using absorption spectrometry. |
| 5. Finding the concentration of Na and Ca using flame photometer. |
| 6. Finding the Concentration of Phosphate content in soft drinks. |
| 7. Chromatography analysis using TLC. |
| 8. Column chromatographic analysis of chlorophyll. |
| 9. Finding the concentration of Na and Ca using atomic absorption spectrophotometer. |
| 10. Data interpretation of FTIR spectra and X-Ray Diffraction techniques |

**Contact Periods:**
**Practical: 60 periods** **Total : 60 periods**

**TEXT BOOKS:**

| AUTHOR NAME | TITLE OF BOOK | PUBLISHER, EDITION, YEAR OF PUBLICATION |
|---|---|---|
| *Skoog, D.A. F. James Holler, and Stanky, R. Crouch* | *Instrumental Methods of Analysis* | *Cengage Learning, 6th edition, 2007* |

**COURSE OUTCOMES:**

Upon completion of the course, the students will be able to

**CO1:** Understand the Lambert-Beers law and validation of Absorption spectroscopy.
**CO2:** Get familiarize with the working of UV-Visible spectroscopy and to find the concentration of organic compounds using absorption spectroscopy
**CO3:** Understand the working of Flame photometer and Atomic Absorption Spectrophotometer.
**CO4:** Impart knowledge on separation methods for bioproducts.
**CO5:** Understand the theory in the interpretation of FTIR spectrum and XRD pattern

**COURSE ARTICULATION MATRIX:**

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | M | M | H | L | H | - | - | - | L | M | - | - | H | M |
| **CO2** | L | M | H | L | M | - | - | - | L | L | - | - | H | H |
| **CO3** | L | H | M | L | H | - | - | - | L | M | - | - | H | M |
| **CO4** | L | M | L | L | H | - | - | - | L | L | - | - | M | M |
| **CO5** | L | L | H | L | H | - | - | - | L | L | - | - | H | H |
| **16BPC408** | L | M | H | L | H | - | - | - | L | L | - | - | H | M |

**L – Low, M – Moderate, H- High**

**16BPC409 CELL AND IMMUNOLOGY LABORATORY CATEGORY: PC**

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 4 | 2 |

**PRE-REQUISITES: NIL**

**COURSE OBJECTIVES:**

- To perform different staining techniques to identify blood cells and cell division using microscope
- To perform qualitative and quantitative analyses of antigens and antibodies and interpret the data based on pathological processes
- To work as a team to perform and analyze practical methods

**LIST OF EXERCISES**

1. Staining for different stages of mitosis in *Allium cepa* (Onion).
2. Identification of meiosis cell division in Grass hopper testis.
3. Identification of cells in a blood smear using Leishman stain.
4. Counting of cells using haemocytometer.
5. Osmosis and Tonicity.
6. Separation and Identification of Peripheral Blood Mononuclear Cells from blood and Analysis of Cell viability using Tryphan Blue stain.
7. Separation and preservation of serum from blood.
8. Agglutination reaction to determine blood group.
9. Immunodiffusion (Double diffusion - Ouchterlony method, radial immunodiffusion).
10. Immunoelectrophoresis.
11. Enzyme Linked Immuno Sorbent Assay (ELISA).

**Contact Periods:**
**Practical: 60 periods** **Total: 60 periods**

**REFERENCE BOOKS:**

| AUTHOR NAME | TITLE OF BOOK | PUBLISHER, EDITION, YEAR OF PUBLICATION |
|---|---|---|
| *De Robertis, E.D.P. and De Robertis, E.M.F* | *Cell and Molecular Biology* | *Lippincott Williams and Wilkins, Philadelphia, 8th edition, 2006.* |
| *Roitt, I* | *Essential Immunology* | *Blackwell Scientific, 9th edition, 1997.* |

**COURSE OUTCOMES:**

Upon completion of the course, the students will be able to

**CO1:** Identify the different specimens using microscope
**CO2:** Perform different staining techniques for the study of blood cells and cell division
**CO3:** Demonstrate various strategies of antigen-antibody interactions
**CO4:** Perform experiments to quantify immune molecules
**CO5:** Interpret the data obtained based on pathological processes

**COURSE ARTICULATION MATRIX:**

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | M | - | - | - | L | - | - | - | M | - | - | - | H | M |
| **CO2** | M | - | - | - | L | - | - | - | H | - | M | - | H | M |
| **CO3** | M | H | M | - | - | - | - | - | L | H | - | L | M | H |
| **CO4** | - | M | H | - | M | - | - | M | H | - | H | - | M | H |
| **CO5** | M | - | H | - | - | - | - | - | H | L | H | H | M | H |
| **16BPC409** | M | M | H | - | L | - | - | M | H | M | H | M | M | H |

**L – Low, M – Moderate, H- High**

**16BPC501 ENZYME ENGINEERING AND TECHNOLOGY CATEGORY: PC**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**PRE-REQUISITES:**

1. 16BPC306 – Biochemistry

**COURSE OBJECTIVES:**

* To inculcate the knowledge of enzyme catalytic reaction kinetics.
* To provide broad idea on production and industrial application of enzymes.

| UNIT I | INTRODUCTION TO ENZYMES | 6 Periods |
|---|---|---|
| Introduction of enzymes; Classification of enzymes; concept of active site and energetic s of enzyme substrate complex formation; Mechanisms of enzyme action – General catalysis and acid base catalysis; principles of catalysis – collision theory and transition state theory; Introduction to enzyme activity and specific activity. | | |
| **UNIT II** | **ENZYME KINETICS** | **12 Periods** |
| Kinetics of single substrate reactions - Michelis – Menten equation and Briggs Haldane equation; Estimation of Michelis – Menten parameters – Lineweaver-Burk plot- Eadie Hofstee plot and Hanes plot; Bisubstrate reactions – single displacement and ping pong mechanism; types of inhibition– Competitive- Uncompetitive- non competitive and substrate; Allosteric regulation of enzymes - Monod-Changeux-Wyman model. | | |
| **UNIT III** | **ENZYME IMMOBILIZATION** | **9 Periods** |
| Physical and chemical techniques for enzyme immobilization – adsorption- matrix entrapment- encapsulation- cross-linking and covalent binding; Applications of immobilized enzymes. | | |
| **UNIT IV** | **PURIFICATION AND CHARACTERIZATION OF ENZYMES FROM NATURAL SOURCES** | **9 Periods** |
| Production and purification of crude enzyme extracts from plant- animal and microbial sources – Methods of characterization of enzymes. | | |
| **UNIT V** | **ENZYME APPLICATIONS AND BIOSENSORS** | **9 Periods** |
| Application of enzymes in industries– Food-detergent- leather and wool; brewery ;healthcare and environment ; Enzyme electrodes and their application as biosensors in various industries – Calorimetric- potentiometric – amperometric - optic and immunosensors; Examples of biosensors. | | |

**Contact Periods:**
**Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**

**TEXT BOOKS:**

| AUTHOR NAME | TITLE OF BOOK | PUBLISHER, EDITION, YEAR OF PUBLICATION |
|---|---|---|
| *Trevor Palmer* | *Enzymes* | *Affiliated East West Press Pvt Ltd, New Delhi, 3rd edition, 2004* |
| *Harvey W. Blanch, Douglas S. Clark* | *Biochemical Engineering* | *Marcel Dekker Inc, 2nd edition , 2002.* |

**REFERENCE BOOKS:**


1. *James M. Lee,Biochemical Engineering, PHI, USA, 2nd edition, (1992).*
2. *James. E. Bailey & David F. Ollis, Biochemical Engineering Fundamentals, , McGraw Hill, 2nd edition,(1986)*


**COURSE OUTCOME:**

Upon completion of the course, the students will be able to

**CO1:** Understand the enzyme classification and catalysis mechanism.

**CO2:** Utilize the kinetics to study about various new enzymes.

**CO3:** Implement enzyme immobilization techniques for practical applications.

**CO4:** Utilize the knowledge in production and purification of enzymes for industrial needs.

**CO5:**Analyze the industrial importance of various enzymes.

**CO6:** Fabricate enzyme based biosensor based on the problems.

## COURSE ARTICULATION MATRIX:

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | M | L | L | - | - | - | - | - | L | L | - | L | H | L |
| **CO2** | L | M | H | - | - | - | L | - | L | L | - | - | H | M |
| **CO3** | L | M | H | - | - | - | L | - | - | - | - | - | H | M |
| **CO4** | L | L | L | - | M | - | L | L | - | - | - | - | M | H |
| **CO5** | L | L | H | - | M | - | L | - | - | - | - | - | M | H |
| **CO6** | L | H | H | - | - | - | M | - | H | - | - | - | L | H |
| **16BPC501** | L | H | H | - | M | - | L | L | H | L | - | L | H | H |

**L – Low, M – Moderate (Medium), H- High**

**16BES502 HEAT AND MASS TRANSFER OPERATIONS CATEGORY: ES**

| L | T | P | C |
|---|---|---|---|
| 2 | 2 | 0 | 3 |

**PRE-REQUISITES:**

1. 16BES402 Fluid Mechanics
2. 16BPC404 Biochemical Thermodynamics

**COURSE OBJECTIVES:**

- To understand the basic laws of heat transfer and to develop solutions for the problems involving steady state and transient heat conduction in simple geometries.
- To obtain numerical solutions for radiation heat transfer problems and to analyze the heat transfer efficiencies of any engineering systems involving heat exchange.
- To build a basic knowledge of mass transfer operations and separation processes carried out in the industries.
- To recognize the selection criteria for mass transfer process and equipment required by the industries.

| UNIT I | CONDUCTION AND CONVECTION | 6+6 Periods |
|---|---|---|
| Introduction – Conduction – Basic concepts of conduction in solids, liquids and gases – One and two dimensional heat conduction – Critical and optimum insulation thickness. Introduction to unsteady state heat transfer. Principles of convection – Equations of forced and free convection. | | |
| **UNIT II** | **RADIATION AND HEAT EXCHANGERS** | **6+6 Periods** |
| Basic laws of heat transfer by radiation – black body and gray body concepts – solar radiations – combined heat transfer coefficients by convection and radiation. Heat Transfer equipment – Double pipe, Shell & tube and Plate type heat exchanger. | | |
| **UNIT III** | **DIFFUSION** | **6+6 Periods** |
| Molecular and Turbulent diffusion – Diffusion coefficient and its dependence – Diffusion in multi-component gas mixtures – Diffusion in solids – Molecular, Knudsen &surface diffusion – Inter-phase mass transfer – Mass transfer coefficients – Mass transfer in fluidized bed reactor – flow past solids and boundary layers. | | |
| **UNIT IV** | **GAS - LIQUID AND VAPOUR - LIQUID OPERATIONS** | **6+6 Periods** |
| Gas-Liquid equilibrium – Henry's Law – Selection of solvents – Absorption in tray column – Graphical and analytical methods – Absorption in packed column – Design equation for packed column – HTU, NTU and HTEP concepts.<br>Vapor-Liquid equilibrium – Rayleigh's equation – Flash distillation and differential distillation for two component mixture – McCabe-Thiele method, Ponchon - Savarit Method – Bubble cap and sieve distillation column. | | |
| **UNIT V** | **LIQUID-LIQUID AND SOLID-LIQUID OPERATIONS** | **6+6 Periods** |
| Liquid-Liquid equilibria – Staged and continuous extraction – Solid-liquid equilibria – Leaching principles – Equipments for extraction and leaching. | | |

**Contact Periods:**
**Lecture: 30 Periods Tutorial: 30 Periods Practical: 0 Periods Total: 60 Periods**

**TEXT BOOKS:**

| AUTHOR NAME | TITLE OF BOOK | PUBLISHER, EDITION, YEAR OF PUBLICATION |
|---|---|---|
| *Yunus Cengel* | *Heat and Mass Transfer – Fundamentals & Applications* | *McGraw-Hill5th edition 2015.* |
| *Geankoplis C.J* | *Transport Processes and Unit Operations* | *Prentice Hall of India 4th edition 2003.* |

**REFERENCE BOOKS:**

1. *Incropera F.P. "Fundamentals of Heat and Mass Transfer", John Wiley, 7th edition. 2011.*
2. *McCabe W.L., Smith J.C, "Unit Operations in Chemical Engineering, McGraw-Hill, 7th edition. 2014.*
3. *Treybal R.E, "Mass Transfer Operations", McGraw-Hill, 3rd edition. 1981.*

**COURSE OUTCOME:**

Upon completion of the course, the students will be able to

**CO1:** Understand the basic laws of heat transfer & to develop solutions for the problem involving steady state & transient heat conduction in simple geometries.
**CO2:** Calculate heat transfer by conduction, convection & thermal radiation realistic cases.
**CO3:** Analyze & calculate heat transfer in systems involving several heat transfer mechanisms.
**CO4:** Understand the process of mass transfer and to relate the analogies of heat & momentum transfer.
**CO5:** Understand the designing of mass transfer equipment used in process industries.
**CO6:** Utilize the technological methods in design and troubleshooting of mass transfer operations in process industries.

**COURSE ARTICULATION MATRIX:**

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | H | M | L | - | - | - | - | - | H | L | - | L | H | H |
| **CO2** | H | - | H | M | M | - | - | - | H | M | - | M | H | H |
| **CO3** | M | M | H | M | M | - | M | - | H | M | - | M | L | H |
| **CO4** | L | L | M | M | M | - | - | - | M | L | - | L | L | M |
| **CO5** | M | M | M | M | M | - | M | L | M | M | - | M | L | M |
| **CO6** | M | L | M | L | L | - | - | M | M | M | M | M | M | H |
| **16BES502** | H | M | M | M | M | - | M | L | H | M | M | M | L | H |

**L – Low, M – Moderate (Medium), H- High**

**16BPC503** **BIOPROCESS PRINCIPLES** **CATEGORY: PC**

| L | T | P | C |
|---|---|---|---|
| 2 | 2 | 0 | 3 |

**PRE-REQUISITES:**

1. 16BPC303 Basics of Industrial Biotechnology

**COURSE OBJECTIVES:**

- To learn the basic principles of fermentation process.
- To understand the basic configuration and parts of a fermentor.
- To study the basics of metabolic stoichiometry and microbial kinetics in batch, fed-batch and continuous mode of operation.

| **UNIT I** | **OVERVIEW OF FERMENTATION PROCESSES** | **6+6 Periods** |
|---|---|---|
| Overview of fermentation industry, general requirements of fermentation processes, basic configuration of Fermentor and ancillaries, main parameters to be monitored and controlled in fermentation processes. | | |
| **UNIT II** | **RAW MATERIALS AND MEDIA DESIGN FOR FERMENTATION PROCESS** | **6+6 Periods** |
| Criteria for good medium, medium requirements for fermentation processes, carbon, nitrogen, minerals, vitamins and other complex nutrients, oxygen requirements, medium formulation of optimal growth and product formation, examples of simple and complex media, design of various commercial media for industrial fermentations – medium optimization methods- OFAT, PB , RSM.<br>**Case Study: Optimization of Amylase production by Plackett and Burman method.** | | |
| **UNIT III** | **STERILIZATION KINETICS** | **6+6 Periods** |
| Thermal death kinetics of microorganisms, batch and continuous heat sterilization of liquid media, filter sterilization of liquid media, sterilization of air, design of sterilization equipment for batch and continuous process. | | |
| **UNIT IV** | **METABOLIC STICHIOMETRY AND ENERGITICS** | **6+6 Periods** |
| Stoichiometry of cell growth and product formation – Elemental balances, degrees of reduction of substrate and biomass and available electron balances, Yield coefficients of biomass and product formation, Maintenance coefficients, energetic analysis of microbial growth and product formation, Oxygen consumption and heat evolution in aerobic cultures, Thermodynamic efficiency of growth. | | |
| **UNIT V** | **KINETICS OF MICROBIAL GROWTH AND PRODUCT FORMATION** | **6+6 Periods** |
| Modes of operation – batch, fed-batch and continuous cultivation, Simple unstructured kinetic models for microbial growth – Monod model, Growth of filamentous organisms and yeast, Product formation kinetics – Leudeking-Piret models, substrate and product inhibition on cell growth and product formation. | | |

**Contact Periods:**
**Lecture: 30 Periods** **Tutorial: 30 Periods** **Practical: 0 Periods** **Total: 60 Periods**

**TEXT BOOKS:**

| AUTHOR NAME | TITLE OF THE BOOK | PUBLISHER, EDITION, YEAR OF PUBLICATION |
|---|---|---|
| *Peter F. Stanbury, Stephen J. Hall & A. Whitaker,* | *Principles of Fermentation Technology* | *Science & Technology Books. 2007.* |
| *Shuler, Michael L. and FikretKargi* | *Bioprocess Engineering* | *Prentice Hall, 2008.* |
| *Doran M Pauline* | *Bioprocess Engineering Principles* | *Elsevier , 2 nd Edition, 2012.* |

**REFERENCE BOOK:**


1. *Bailey, James E. and David F. Ollis, "Biochemical Engineering Fundamentals", 2nd Edition. McGraw Hill, 1986.*
2. *Blanch H. W. and Clark D. S "Biochemical Engineering", 2nd Edition, CRC Press. 2007.*
3. *Rajiv Dutta, "Fundamentals of Biochemical Engineering", Springer, 2008.*
4. *GhasemD.Najafpour, "Biochemical Engineering and Biotechnology", Elsevier, 2007.*
5. *D.M. Himmelblau, "Basic principles and calculations in chemical engineering", 6th edition, Pearson education, 2006.*


**COURSE OUTCOME:**

Upon completion of the course in Bioprocess Principles graduates will be able to

**CO1:** Understand the general requirements of a fermentation process.

**CO2:** Understand the basic configuration of a fermentor and its ancillaries.

**CO3:** Demonstrate an ability to design good media.

**CO4:** Explain the sterilization kinetics and design the sterilization equipments for batch and continuous process.

**CO5:** Able to model microbial growth, substrate utilization and product formation.

**COURSE ARTICULATION MATRIX:**

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | M | M | L | L | L | - | - | - | - | - | - | L | L | L |
| **CO2** | H | H | H | M | M | - | - | H | M | - | - | - | L | H |
| **CO3** | H | H | H | H | H | - | M | - | M | - | - | M | L | M |
| **CO4** | H | H | H | H | M | - | L | - | L | - | - | M | L | M |
| **CO5** | H | H | H | H | - | - | L | - | L | - | - | M | L | H |
| **16BPC503** | H | H | H | H | M | - | L | - | L | - | - | M | L | M |

**L – Low, M – Moderate (Medium), H- High**

**16BPC504** **GENETIC ENGINEERING** **CATEGORY: PC**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**PRE-REQUISITES:**

1. 16BPC304 Cell Biology
2. 16BPC403 Molecular Biology

**COURSE OBJECTIVES:**

- To impart the knowledge on various components and techniques used in DNA manipulation
- To introduce basic knowledge to construct various recombinant proteins
- To describe techniques to analyze clones
- To introduce Transgenic Technology for animals.

| UNIT I | BASICS OF RECOMBINANT DNA TECHNOLOGY | 8 Periods |
|---|---|---|
| Role of genes within cells - Genetic elements that control gene expression in Prokaryotes and Eukaryotes – Repressors and Promoters – Methods of creating recombinant molecules - Restriction and modifying enzymes - Safety guidelines of recombinant DNA research. | | |
| **UNIT II** | **CREATION OF RECOMBINANT MOLECULES AND VECTORS** | **10 Periods** |
| Restriction mapping-Design of Linkers and Adaptors. Characteristics of plasmid and phage vectors, Prokaryotic and Eukaryotic expression vectors. Insect, Yeast and Mammalian vectors. | | |
| **UNIT III** | **CONSTRUCTION OF LIBRARIES** | **10 Periods** |
| Construction of cDNA and genomic libraries-Screening of libraries with DNA probes and antisera-Characterization of recombinant clones by Southern, Northern, Western – PCR analysis. | | |
| **UNIT IV** | **POLYMERASE CHAIN REACTION** | **10 Periods** |
| DNA amplification, primer synthesis – Taq polymerase – Types of PCR –Inverse PCR, Nested PCR, RACE PCR, RAPD-Taqman assay, Molecular beacons- site directed mutagenesis (Kunkel's Method) - Methods of nucleic acid sequencing: Sangers method. | | |
| **UNIT V** | **APPLICATIONS OF RECOMBINANT DNA TECHNOLOGY** | **7 Periods** |
| Applications of recombinant technology in Agriculture, Pharmaceutical industry and dicine – Knockout animals, Production of novel products, Antisense technology - Transgenic animals – Nuclear transfer eg. Dolly. | | |

**Contact Periods:**
**Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

**TEXT BOOKS:**

| AUTHOR NAME | TITLE OF BOOK | PUBLISHER, EDITION, YEAR OF PUBLICATION |
|---|---|---|
| *Old RW, Primrose SB* | *—Principles Of Gene Manipulation, An Introduction To Genetic Engineering* | *Blackwell Science Publications, 2013.* |

**REFERENCE BOOKS:**

1. *Ansubel FM, Brent R, Kingston RE, Moore DD, "Current Protocols In Molecular Biology", Green Publishing Associates, NY, 1988*
2. *Berger Sl, Kimmer AR, —Methods In Enzymology, Vol 152, Academic Press, 1987*

**COURSE OUTCOME:**

Upon completion of the course in students will be able to

**CO1:** Recall various components essential for Gene expression
**CO2:** Determine appropriate techniques for DNA manipulation.
**CO3:** Construct various recombinant proteins.
**CO4:** Analyze the clones.
**CO5:** Apply Genetic Engineering principles for the production of transgenics.

**COURSE ARTICULATION MATRIX:**

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | L | - | M | - | - | - | - | - | - | - | - | - | H | L |
| **CO2** | L | - | M | - | - | - | - | M | - | - | - | - | H | L |
| **CO3** | M | L | L | - | M | - | - | - | - | - | - | - | L | H |
| **CO4** | M | L | - | - | L | - | - | - | - | - | - | - | L | H |
| **CO5** | - | - | - | - | - | M | M | - | - | - | - | L | L | H |
| **16BPC504** | M | L | M | - | M | M | M | M | - | - | - | L | L | H |

**L – Low, M – Moderate (Medium), H- High**

**16BES507 CHEMICAL ENGINEERING LABORATORY CATEGORY: ES**

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 4 | 2 |

**PRE-REQUISITES:**

1. 16BES402 Fluid Mechanics
2. 16BPC502 Heat and Mass Transfer

**COURSE OBJECTIVES:**

- To understand the principles of flow rate measurement & hydrodynamics of the specialized reactor systems.
- To select the appropriate equipment for mechanical sizing & sieving operations.
- To analyze & calculate heat transfer efficiency in systems involving heat exchange processes.
- To understand the principles & kinetics of mass transfer operations.
- To operate & calculate the efficiency of the separation process equipment.

**LIST OF EXERCISES:**

**Fluid Mechanics:**

- Flow measurement using Venturimeter, Orificemeter for liquids.
- Studies on flow behavior and friction loss in Fluidized bed.

**Mechanical Operations:**

- Product size distribution analysis using Roll Crusher, Jaw Crusher.
- Product size distribution analysis using Ball Mill.

**Heat Transfer:**

- Performance analysis of Double pipe Heat Exchanger.
- Performance analysis of Shell & Tube Heat Exchanger.

**Mass Transfer:**

- Studies on Simple Distillation.
- Studies on Fractional Distillation.

**Unit Operations:**

- Calculations of filter and medium resistances in Leaf filter apparatus.
- Calculation of filter and medium resistances in Plate and Frame filter press.

**Contact Periods:**
**Lecture: 0 Periods Tutorial: 0 Periods Practical: 60 Periods Total: 60 Periods**

**REFERENCE BOOKS:**


1. *Yunus Cengel, "Heat and Mass Transfer – Fundamentals & Applications", McGraw-Hill, 5th edition. 2015.*
2. *Geankoplis C.J, "Transport Processes and Unit Operations", Prentice Hall of India, 4th edition. 2003.*

**COURSE OUTCOME:**

Upon completion of the course, the students will be able to

**CO1:** Understand the principles of flow rate measurement & hydrodynamics of the specialized reactor systems.

**CO2:** Select the appropriate equipment for mechanical sizing & sieving operations.

**CO3:** Analyze & calculate heat transfer efficiency in systems involving heat exchange processes.

**CO4:** Understand the principles & kinetics of mass transfer operations.

**CO5:** Operate & calculate the efficiency of the separation process equipment.

**COURSE ARTICULATION MATRIX:**

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | M | L | M | - | - | - | - | - | H | H | - | M | H | H |
| **CO2** | M | L | H | - | - | - | - | - | H | H | - | M | H | H |
| **CO3** | M | L | H | - | - | - | - | - | H | H | - | M | L | H |
| **CO4** | M | M | H | - | - | - | - | - | - | - | - | - | L | M |
| **CO5** | M | M | M | - | - | - | - | - | H | H | - | M | L | M |
| **16BES507** | M | L | H | - | - | - | - | - | H | H | - | M | L | H |

**L – Low, M – Moderate (Medium), H- High**

**16BPC508** **BIOPROCESS LABORATORY I** **CATEGORY: PC**

| | L | T | P | C |
|---|---|---|---|---|
| **PRE-REQUISITES: NIL** | **0** | **0** | **4** | **2** |

**COURSE OBJECTIVES:**

- To train the students on enzyme characterization.
- To familiarize the students on medium optimization techniques.
- To understand the microbial growth kinetics.
- To train the students on operation of fermentors.

**LIST OF EXERCISES:**

1. Enzyme kinetics – Determination of Michaelis xMenten parameters
2. Enzyme activity – Effect of Temperature
3. Enzyme activity – Effect of pH
4. Enzyme inhibition kinetics
5. Enzyme immobilization – Gel entrapment/ Cross linking
6. Medium optimization by Plackett-Burman design
7. Growth of bacteria - calculation of μ and Yield coefficient
8. Growth of yeast - calculation of μ and Yield coefficient.
9. Sterilization Kinetics
10. Preparation of bioreactor; utilities of bioreactor operation. (Batch, Fed-batch and continuous).

**Contact Periods:**
**Lecture: 0 Periods** **Tutorial: 0 Periods** **Practical: 60 Periods** **Total: 60 Periods**

**REFERENCE BOOKS:**


1. *Peter F. Stanbury, Stephen J. Hall & A. Whitaker, Principles of Fermentation Technology, Science & Technology Books. 2007.*
2. *Shuler, Michael L. and FikretKargi, "Bioprocess Engineering ", Prentice Hall, 2008.*
3. *Doran M Pauline "Bioprocess Engineering Principles" . 2nd Edition, Elsevier, 2012*
4. *Bailey, James E. and David F. Ollis, "Biochemical Engineering Fundamentals", 2nd Edition. McGraw Hill , 1986.*
5. *Blanch H. W. and Clark D. S "Biochemical Engineering" , 2nd Edition, CRC Press. 2007.*
6. *Ninfa. A.J, and D.P. Ballou , Fundamental Lab approaches for biochemistry and biotechnology, 2nd Edition, Oxford University press, UK, 1998.*


**COURSE OUTCOME:**

Upon completion of the course graduates will be able to

**CO1:** Understand enzyme kinetics and estimate MM parameters.
**CO2:** Learn the basic configuration of fermentor and its ancillaries.
**CO3:**Analyze and estimate the growth kinetics of bacteria and yeast.
**CO4:** Familiarize with medium optimization techniques.
**CO5:** Understand sterilization kinetics.

**COURSE ARTICULATION MATRIX:**

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | H | H | H | H | H | - | - | - | - | - | - | M | L | M |
| **CO2** | H | H | H | M | M | - | - | H | M | - | - | - | L | H |
| **CO3** | H | H | H | H | H | - | - | L | M | - | - | - | L | M |
| **CO4** | M | M | H | H | H | - | - | - | M | - | - | - | L | M |
| **CO5** | H | H | H | H | M | - | L | - | L | - | - | M | L | M |
| **16BPC508** | H | H | H | H | H | - | L | L | M | - | - | M | L | M |

**L – Low, M – Moderate (Medium), H- High**

**16BPC509 GENETIC ENGINEERING LABORATORY CATEGORY: PC**

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 4 | 2 |

**PRE-REQUISITES:**

1. 16BPC403 Molecular Biology
2. 16BPC407 Molecular Biology Laboratory
3. 16BPC504 Genetic Engineering

**COURSE OBJECTIVES:**

- To train in designing and conduction of experiments, analyze and interpret data.
- To train in isolating clones and express DNA of interest
- To impart practical knowledge in screening of clones using the appropriate molecular technique(s).

**LIST OF EXERCISES:**

1. Isolation and Quantification of plasmid DNA
2. Elution of DNA from agarose gels
3. Ligation of DNA into expression vectors
4. Competent Cell preparation
5. Transformation
6. Optimization of time of inducer for recombinant protein expression
7. SDS-PAGE
8. Western Blotting
9. PCR
10. RFLP and RAPD

**Contact Periods:**
**Lecture: 0 Periods Tutorial: 0 Periods Practical: 60 Periods Total: 60 Periods**

**TEXT BOOKS:**

| AUTHOR NAME | TITLE OF BOOK | PUBLISHER, EDITION, YEAR OF PUBLICATION |
|---|---|---|
| *Sambrook J, Russell DW* | *Molecular Cloning: A Laboratory Manual* | *Cold Spring Harbor Laboratory Press 4th edition, 2012.* |
| *Ansubel FM, Brent R, Kingston RE, Moore DD* | *Current Protocols In Molecular Biology* | *John Wiley & Sons 2012* |

**COURSE OUTCOME:**

Upon completion of the course, the students will be able to
CO 1: Isolate and quantify plasmids
CO 2: Separate and purify DNA fragments
CO 3: Prepare clones of interest
CO 4: Apply relevant molecular techniques to screen clones
CO 5: Express proteins of interest

**COURSE ARTICULATION MATRIX:**

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | - | - | H | - | - | - | - | - | - | - | - | - | H | H |
| **CO2** | M | - | H | - | - | - | - | - | - | - | - | - | L | H |
| **CO3** | M | - | H | - | - | - | - | - | - | - | - | - | L | H |
| **CO4** | - | - | H | - | H | - | - | - | M | - | - | - | M | H |
| **CO5** | - | - | H | - | - | - | - | - | - | - | - | - | M | H |
| **16BPC509** | M | - | H | - | H | - | - | - | M | - | - | - | M | H |

**L – Low, M – Moderate (Medium), H- High**

**16BPC601** **BIOSAFETY, BIOETHICS AND IPR** **CATEGORY: PC**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**PRE-REQUISITES:**
1.16B0C1Z1 - Human values

**COURSE OBJECTIVES:**
- To provide knowledge on various aspects of intellectual property.
- To learn application procedures for intellectual property.
- To learn concepts of bioethics and biosafety.

| | | |
|---|---|---|
| **UNIT I** | **BIOSAFETY** | **8 Periods** |
| Biosafety – Biotechnology development in India; levels of biosafety; Safety issues concerning biotechnological products; governing biosafety; Cartagena protocol on biosafety. | | |
| **UNIT II** | **INTELLECTUAL PROPERTY RIGHTS** | **10 Periods** |
| Introduction - Invention and Creativity - Intellectual Property (IP) - Importance - Protection of IPR - Basic types of property (i. Movable Property ii. Immovable Property and iii. Intellectual Property); IP - Patents - Copyrights and related rights - Trade Marks and rights arising from Trademark registration ;Definitions - Industrial Designs and Integrated circuits – Protection of Geographical Indications at national and International levels ;Application Procedures for IP . | | |
| **UNIT III** | **IPR – POLICIES** | **10 Periods** |
| International convention relating to Intellectual Property - Establishment of WIPO - Mission and Activities -History – General Agreement on Trade and Tariff (GATT). Indian Position Vs WTO and Strategies - Indian IPR legislations - commitments to WTO-Patent Ordinance and the Bill - Draft of a national Intellectual Property Policy - Present against unfair competition. | | |
| **UNIT IV** | **CASE STUDIES** | **8 Periods** |
| Case Studies on - Patents (Basumati rice, turmeric, Neem, etc.) - Copyright and related rights - Trade Marks – Industrial design – Geographic indications - Protection against unfair competition. | | |
| **UNIT V** | **BIOETHICS** | **9 Periods** |
| Bioethics – Disease prevention Vs right to privacy; patentability of DNA; preimplantation embryo diagnosi; Engineered organisms into environment;Genetic tests in diagnostics and therapy. | | |

**Contact Periods:**
**Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

**TEXT BOOKS:**

| AUTHOR NAME | TITLE OF BOOK | PUBLISHER, EDITION, YEAR OF PUBLICATION |
|---|---|---|
| *Singh K* | *Intellectual property rights on Biotechnology* | *BCIL, New Delhi* |
| *Joshi. R* | *Biosafety and Bioethics* | *Isha Books, New Delhi, 2006* |

**REFERENCE BOOKS:**


1. *Sasson A , Biotechnologies and Development ,UNESCO Publications, (1988).*
2. *Subbaram N.R ,Handbook of Indian Patent Law and Practice, , S. Viswanathan Printers and Publishers Pvt. Ltd., (1998)*


**COURSE OUTCOME:**

Upon completion of the course, the students will be able to

**CO1:** Understand different forms of IP.

**CO2:** Apply for patent for their innovations.

**CO3:** Gain knowledge on various governing bodies of IPR.

**CO4:** Follow the guidance on biosafety in their laboratory.

**CO5:** Understand the importance of bioethics in relation to GMO's and environmental release.

**CO6:** Analyse the IPR, biosafety and bioethics with respect to their innovation.

**COURSE ARTICULATION MATRIX:**

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | - | - | - | - | - | H | - | M | - | - | - | - | - | L |
| **CO2** | - | - | - | - | - | H | - | M | - | - | - | - | - | M |
| **CO3** | - | - | - | - | - | H | - | L | - | - | - | - | - | M |
| **CO4** | - | - | - | - | - | M | - | H | - | - | - | - | - | H |
| **CO5** | - | - | - | - | - | M | - | H | - | - | - | - | - | H |
| **CO6** | - | - | - | - | - | M | - | H | - | - | - | - | - | H |
| **16BPC601** | - | - | - | - | - | H | - | H | - | - | - | - | - | H |

**L – Low, M – Moderate (Medium), H- High**

**16BES602 CHEMICAL REACTION ENGINEERING CATEGORY: ES**

| L | T | P | C |
|---|---|---|---|
| 3 | 2 | 0 | 4 |

**PRE-REQUISITES:**

1. 16BES302- Process Calculations
2. 16BPC404- Biochemical Thermodynamics
3. 16BES502- Heat and Mass Transfer Operations

**COURSE OBJECTIVES:**

- Impart the basic concepts in reaction kinetics.
- Develop knowledge for design of ideal reactors
- Understand the practical aspects of Non-Ideal flow and multi parameter models.

| UNIT -I | KINETICS OF HOMOGENOUS REACTIONS | 9+6 Periods |
|---|---|---|
| Concentration and temperature dependent term of rate equation – searching for mechanism – predictability of reaction rate from theory; Interpretation of batch reactor data – constant volume and variable volume batch reactors – temperature and reaction rate - development of rate equations for different homogeneous reactions (up to second order reactions both reversible and irreversible reactions) . | | |
| **UNIT -II** | **REACTOR DESIGN** | **9+6 Periods** |
| Ideal batch reactors – steady state MFR & PFR – holding time for flow systems; Design for single reactions - performance equations for single reactors – size comparison of single reactors – MFR vs PFR for first and second order reactions – graphical comparison; multiple reactor systems-recycle and autocatalytic reactors. | | |
| **UNIT-III** | **MULTIPLE REACTIONS** | **9+6 Periods** |
| Design of reactors for multiple reactions - consecutive, parallel and mixed reactions - factors affecting choice-optimum yield and conversion-selectivity-reactivity and yield. | | |
| **UNIT- IV** | **NON IDEAL FLOW** | **9+6 Periods** |
| RTD of fluid in vessel – relationship between F,C& E curve – conversion from tracer information - non-ideal flow models – Dispersion model and Tanks in series Model- Multiparameter models – models for fluidized beds. | | |
| **UNIT –V** | **DESIGN FOR HETEROGENEOUS SYSTEMS** | **9+6 Periods** |
| Rate equations – contacting patterns for two phase systems; fluid particle reactions – unreacted core model for spherical particles of unchanging size – rate of reaction for shrinking spherical particles – determination of rate controlling step – application to design; reactions steps; resistances and rate equations; Fluid – Fluid reactions – rate equations. | | |

**Contact Periods:**
**Lecture: 45 Periods Tutorial: 30 Periods Practical: 0 Periods Total: 75 Periods**

**TEXT BOOKS:**

| AUTHOR NAME | TITLE OF BOOK | PUBLISHER, EDITION, YEAR OF PUBLICATION |
|---|---|---|
| *Levenspiel O* | *Chemical Reaction Engineering* | *3rd Edition, John Wiley,1999* |
| *Fogler H.S* | *Elements of Chemical Reaction Engineering* | *4th Edition, Prentice Hall India,2002* |

**REFERENCE BOOKS:**


1. *Missen R.W., Mims C.A., Saville B.A., "Introduction to Chemical Reaction Engineering and Kinetics". John Wiley & Sons, 1st Edition, 1999.*
2. *Froment. G.F., Bischoff K.B., "Chemical Reactor Analysis and Design", John Wiley and Sons, 3rd Edition, 2010.*
3. *James B.R., John G. E., "Chemical Reactor Analysis and Design Fundamentals", Nob Hill Publishers, 1stEdition, 2002*


**COURSE OUTCOME:**

Upon completion of the course, the students will be able to

**CO1:** Solve the kinetics of Homogeneous reactions

**CO2:** Develop design aspects for different ideal reactors

**CO3:** Familiarity with applications of multiple reactions in process industries

**CO4:** Demonstrate non ideal flow in chemical reactors

**CO5:** Design reactor for catalyzed reaction by understanding the heterogeneous chemical reactor system.

**COURSE ARTICULATION MATRIX:**

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | L | M | - | L | - | L | -- | L | - | - | L | - | M | - |
| **CO2** | L | M | L | - | L | L | -- | - | L | - | - | - | L | - |
| **CO3** | L | L | L | - | L | L | - | L | - | - | - | - | L | - |
| **CO4** | L | L | - | L | - | - | - | - | - | - | - | L | - | M |
| **CO5** | L | - | - | - | L | - | L | - | M | - | - | L | - | L |
| **16BES602** | L | L | L | L | L | L | L | - | M | - | - | L | M | L |

**L – Low, M – Moderate (Medium), H- High**

**16BPC603** **BIOINFORMATICS** **CATEGORY: PC**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**PRE-REQUISITIES:**

1. 16BES2Z5 – Programming in C

**COURSE OBJECTIVES:**

- To learn the basics of Unix commands and Perl programming.
- To understand the string alignment methods.
- To learn the methods to construct phylogenetic trees and structure prediction.

| **UNIT I** | **UNIX AND PERL PROGRAMMING** | **9 Periods** |
|---|---|---|
| Operating system –components, Linux OS-working environment ,basic UNIX commands - file, directory related commands ,pipes and filter; Perl – Introduction-data types, variables, operators, array operations, hashes, lists, control structures and file handling. | | |
| **UNIT II** | **BIOLOGICAL DATABASES** | **8 Periods** |
| Introduction to biological Databases, Primary databases – Nucleic acids – NCBI, EMBL, DDBJ. Proteins – PIR, swissprot; Secondary databases – prosite, PRINTS, profile, pfam; Structure classification databases – SCOP, CATH; Model organism databases- ribosomal RNA databases, virus pathogen resource; Metabolic pathway databases-KEGG. | | |
| **UNIT III** | **PATTERN MATCHING & MACHINE LEARNING** | **10 Periods** |
| Alignment -pair wise sequence alignment - local and global alignment , substitution matrices-PAM,BLOSUM; Dynamic programming , dotplot analysis; Database search tools - BLAST, FASTA ; Multiple sequence alignment –progressive alignment, iterative method ; Machine learning methods - Neural networks, Hidden Markov models. | | |
| **UNIT IV** | **PHYLOGENY** | **9 Periods** |
| Introduction to phylogeny terms; Molecular Clock theory –Jukes and Cantor model, Kimura's model; Phylogeny tree reconstruction methods- distance based-UPGMA, Neighbour Joining; Character based-Maximum Parsimony, Maximum Likelihood methods; Boot strapping techniques. | | |
| **UNIT V** | **STRUCTURE PREDICTION AND DRUG DESIGN** | **8 Periods** |
| 3D Structure prediction methods– Homology modeling, Threading, Ab-initio prediction; Micro array analysis –Principle and methods; Introduction to computer aided drug design (CADD). | | |

**Contact Periods:**
**Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

**TEXT BOOKS:**

| AUTHOR NAME | TITLE OF THE BOOK | PUBLISHER,YEAR OF PUBLICATION |
|---|---|---|
| *David. W. Mount* | *Bioinformatics genome and sequence analysis* | *Cold Spring House Lab publications, 2nd Edn,2004* |
| *Rastogi,S.C, Mendiratta.N Rastogi.P* | *Bioinformatics - Methods & Applications: Genomics, Proteomics and Drug Discovery* | *Prentice Hall of India Learning Pvt (Ltd), India, (Fourth Edition), 2013* |
| *Arthur Lesk* | *Introduction to Bioinformatics* | *Oxford University Press, (Second edition), 2002* |

**REFERENCE BOOKS:**

*1. Andreas D. Baxevanis, "Bioinformatics, A Practical Guide to the Analysis of Genes and Proteins", Third edition; Wiley-Interscience,2004.*

*2. David J. Parry-Smith, Dr Samiron Phukan, Teresa Attwood, "Introduction to Bioinformatics", Pearson Education India, 2007.*

*3. James Tisdall, "Beginning PERL for Bioinformatics", O'Reilly publishers, 2001.*

*4. Harshawardhan P Bal; "PERL programming for Bioinformatics"; Tata McGraw hill publications, 2003.*

**COURSE OUTCOMES:**

Upon completion of the course in Bioinformatics graduates will be able to

**CO1**: Gain expertise on Unix operating system commands and Perl programming.

**CO2:** Acquire knowledge on different biological databases.

**CO3**: Demonstrate an ability to align the macromolecular string by dynamic programming and heuristic methods.

**CO4**: Construct and interpret the phylogenetic trees.

**CO5**: Understand the methods for structure prediction of proteins and computer aided drug design.

**COURSE ARTICULATION MATRIX:**

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | L | M | - | H | M | - | - | - | M | - | - | - | M | L |
| **CO2** | L | M | - | M | M | - | - | - | - | - | - | - | L | - |
| **CO3** | L | L | L | M | H | - | L | - | - | - | - | - | L | - |
| **CO4** | M | M | - | H | M | - | - | - | L | - | - | - | M | M |
| **CO5** | L | M | - | H | M | - | - | - | M | - | - | - | M | H |
| **16BPC603** | L | M | L | H | M | - | L | - | M | - | - | - | M | M |

**L – Low, M – Moderate (Medium), H- High**

**16BPC604** **BIOPROCESS ENGINEERING** **CATEGORY: PC**

| L | T | P | C |
|---|---|---|---|
| 2 | 2 | 0 | 3 |

**PRE-REQUISITES:**

1. 16BPC501- Enzyme Engineering & Technology
2. 16BES502- Heat& Mass Transfer Operations
3. 16BPC503- Bioprocess Principles

**COURSE OBJECTIVES:**

- To acquire the knowledge on design, performance, stability analysis of bioreactors
- To learn about the bioreactors scale up methods.
- To understand the monitoring and control of bioprocess.
- To acquire knowledge about the fundamentals of modeling and simulations of bioprocess.
- To understand the kinetics of immobilized enzyme system.

| **UNIT I** | **DESIGN AND ANALYSIS OF BIOREACTORS** | **10+ 3 Periods** |
|---|---|---|
| Bioreactors- Types- Design considerations; Design and operation of novel bioreactors-airlift- bubble column- packed bed and fluidized bed reactors; Bioreactors for animal and plant cell culture; Stability analysis of bioreactors; Design of continuous sterilizer. | | |
| **UNIT II** | **BIOREACTOR SCALE – UP** | **10+4 Periods** |
| Oxygen transfer in bioreactors - microbial oxygen demands; Mass transfer coefficients ($k_La$)-determination methods; mass transfer correlations; Regime analysis of bioreactor processes; Scale up-geometric and dynamic similarities- criteria for bioreactors based on oxygen transfer- power consumption and impeller tip speed. | | |
| **UNIT III** | **MONITORING & CONTROL OF BIOPROCESSES** | **8+2 Periods** |
| Bioprocess monitoring- modes- On-line measurement of physico-chemical and biochemical parameters; Methods of on-line and off-line biomass estimation; microbial calorimetry; Flow injection analysis; Computer based data acquisition- LabView; Data interpretation – regression models-correlation coefficient. | | |
| **UNIT IV** | **MODELLING AND SIMULATION OF BIOPROCESSES** | **10 +4 Periods** |
| Structured models for analysis of various bioprocess – compartmental models, models of cellular energetics and metabolism, single cell models, plasmid replication and plasmid stability model; Dynamic simulation of batch - continuous and fed-batch system. | | |
| **UNIT V** | **BIOREACTOR CONSIDERATION IN ENZYME SYSTEMS** | **7 +2 Periods** |
| Analysis of film and pore diffusion effects on kinetics of immobilized enzyme reactions; formulation of dimensionless groups and calculation of effectiveness factors; Kinetics of immobilized enzyme reactors – packed bed and fluidized bed. | | |

**Contact Periods:**

**Lecture: 45 Periods** **Tutorial: 15 Periods** **Practical: 0 Periods** **Total: 60 Periods**

**TEXT BOOKS:**

| AUTHOR NAME | TITLE OF BOOK | PUBLISHER, EDITION, YEAR OF PUBLICATION |
|---|---|---|
| *James E. Bailey and David F. Ollis* | *Biochemical Engineering Fundamentals* | *McGraw Hill. 2nd Edition, 1986* |
| *Pauline.M. Doran* | *Bioprocess Engineering Principles* | *Elsevier, 2nd Edition, 2013.* |
| *Shuler and Kargi* | *Bioprocess Engineering* | *Prentice Hall, 2nd Edition, 2002.* |
| *Harvey W. Blanch and Douglas S. Clark* | *Biochemical Engineering* | *CRC Press, 2nd Edition, 1997* |

**REFERENCE BOOKS:**


1. *Shijie Liu, "Bioprocess Engineering-Kinetics, Biosystems, Sustaninability and Reactor Design", Elsevier, 2013.*
2. *James M. Lee, "Biochemical Engineering", Prentice Hall, 1992.*
3. *Anton Moser, Bioprocess Technology, Kinetics and Reactors, Springer Verlag.1998.*


**COURSE OUTCOMES:**

Upon completion of the course, the students will be able to

**CO1:** Design and analyze the performance of bioreactors.

**CO2:** Scale up the bioreactors based on various criteria.

**CO3:** Clearly understand the monitoring and control of bioprocess.

**CO4:** Perform modeling and simulations of bioprocess using software.

**CO5:** Understand the immobilized enzyme kinetics and apply for enzyme bioreactor design.

**COURSE ARTICULATION MATRIX:**

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | H | M | H | M | M | - | L | - | - | - | - | M | H | M |
| **CO2** | M | M | M | M | M | - | - | - | - | - | - | - | H | M |
| **CO3** | M | - | - | H | H | - | - | - | - | - | - | - | M | H |
| **CO4** | M | M | - | H | M | - | - | - | - | - | - | - | M | H |
| **CO5** | M | L | - | M | - | - | L | - | - | - | - | - | L | H |
| **16BPC604** | M | M | H | H | M | - | L | - | - | - | - | M | M | H |

**L – Low, M – Moderate (Medium), H- High**

**16BPC607 BIOINFORMATICS LABORATORY CATEGORY: PC**

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 4 | 2 |

**PRE-REQUISITIES:**
1.16BES2Z9 – Programming in C Laboratory

**COURSE OBJECTIVES:**
- To acquire knowledge on basics of Perl programming.
- To demonstrate an ability to utilize the tools such as BLAST, CLUSTAL, EMBOSS, PHYLIP etc.
- To predict and validate the 3D structure of protein using different methods.

**LIST OF EXERCISES:**

1. Perl Programming
2. Biological Databases- Sequence Databases, Structure Databases, Specialized Databases; Data retrieval tools and methods; Database file formats.
3. Molecular visualization tools - Rasmol, Cn3D and Swiss PDB Viewer.
4. Pairwise alignment-dynamic programming – NEEDLE and Water; Dotplot analysis
5. Database similarity searching using Heuristic methods- BLAST, FASTA
6. Multiple sequence alignment- Clustal analysis
7. Protein sequence analysis -ExPASy proteomics tools
8. Construction of phylogenetic tree - Maximum Parsimony & Maximum Likelihood method, NJ,UPGMA method - PHYLIP program
9. Homology Modeling - Homology modeling using SPDBV
10. Model validation using Ramachandran plot, ProSA, Pro Check.

**Contact Periods:**
**Practical : 60 Periods** **Total: 60 Periods**

**TEXT BOOKS:**

| AUTHOR NAME | TITLE OF THE BOOK | PUBLISHER,YEAR OF PUBLICATION |
|---|---|---|
| *OrpitaBosu, Simminder Kaur Thukral* | *Bioinformatics Databases, Tools and Algorithms* | *Oxford University Press, Third edition, 2007.* |
| *K. Mani, N. Vijayaraj* | *Bioinformatics a Practical Approach* | *Aparna Publications,2004.* |

**COURSE OUTCOMES:**
Upon completion of course, the students will be able to
**CO1**: Acquire an ability to perform programming using PERL language.
**CO2**: Retrieve sequences from different biological databases.
**CO3**: Analyse pattern matching by pairwise and multiple sequence alignment
**CO4**: Able to construct phylogenetic tree by using distance based and character based methods
**CO5**: Able to predict and validate 3D structure of protein.

**COURSE ARTICULATION MATRIX:**

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | L | L | M | M | M | - | - | - | L | - | - | - | M | L |
| **CO2** | M | L | - | L | M | - | - | - | - | - | - | - | - | L |
| **CO3** | M | M | L | M | M | L | - | - | - | - | - | - | - | - |
| **CO4** | L | M | L | H | H | - | L | - | L | - | - | - | M | M |
| **CO5** | - | H | - | M | H | - | - | - | L | - | - | L | - | H |
| **16BPC607** | M | M | L | M | H | L | L | - | L | - | - | L | M | M |

**L – Low, M – Moderate (Medium), H- High**

**16BPC608 BIOPROCESS ENGINEERING LABORATORY CATEGORY: PC**

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 4 | 2 |

**PRE-REQUISITES:**

1. 16BPC508 – Bioprocess Laboratory –I

**COURSE OBJECTIVES:**

- To possess hands on experience to understand the basic concepts involved in the bioprocess engineering such as sterilization and growth kinetics
- To acquire the knowledge to determine RTD and heat, mass transfer rate in fermentation process
- To use MATLAB and Simulink tools for bioprocess simulations.

**LIST OF EXERCISES:**

1. Thermal death kinetics
2. Batch reactor kinetics – estimation of reaction rate constant
3. Estimation of mass transfer coefficient for starch hydrolysis by immobilized amylase enzyme in packed bed reactor
4. Estimation of $k_La$ – dynamic gassing method in batch fermenter
5. Estimation of $k_La$ – sulphite oxidation method
6. Estimation of $k_La$ – power correlation method
7. Residence time distribution in CSTR
8. Residence time distribution in PFR
9. Estimation of overall heat transfer coefficient in batch fermenter
10. Solving the bioreactor kinetic data using MATLAB
11. Solving the bioreactor kinetic data using Simulink

**Contact Periods:**
**Lecture: 0 Periods Tutorial: 0 Periods Practical: 60 Periods Total: 60 Periods**

**REFERENCE BOOKS:**


1. *Pauline.M. Doran, "Bioprocess Engineering Principles", Elsevier, 2nd Edition, 2013.*
2. *Shuler and Kargi, "Bioprocess Engineering", Prentice Hall, 2nd Edition, 2002*
3. *Cutlip, M.B., and Shacham, M. "Problem solving in chemical and biochemical engineering with POLYMATH, Excel, and MATLAB", Prentice Hall, 2008.*


**COURSE OUTCOMES:**

Upon completion of the course, the students will be able to

**CO1:** Design, analyze the growth kinetics in bioreactor and interpret the data meaningfully
**CO2:** Understand sterilization kinetics and its data interpretation
**CO3:** Estimate the residence time distribution in CSTR and PFR to demonstrate the non-ideality existence in reactors.
**CO4:** Calculate heat and mass transfer coefficients in fermentation process
**CO5:** Solve and simulate the bioreactor data using MATLAB and Simulink tools.

**COURSE ARTICULATION MATRIX:**

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | M | M | H | - | - | - | - | - | M | - | - | M | H | M |
| **CO2** | M | L | M | L | - | - | - | - | - | - | - | - | H | L |
| **CO3** | M | M | M | - | - | - | - | - | - | - | - | - | M | M |
| **CO4** | M | M | M | - | L | - | - | - | - | - | - | - | M | H |
| **CO5** | M | L | M | - | H | - | - | - | - | - | - | - | M | H |
| **16BPC608** | M | M | M | L | H | - | - | - | M | - | - | M | H | M |

**L – Low, M – Moderate (Medium), H- High**

**16BEE609 PERSONALITY AND SKILL DEVELOPMENT CATEGORY: EEC**

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 4 | 2 |

**PRE-REQUISITES:**

1. 16BEE307 Communication Skills and Technical Seminar.

**COURSE OBJECTIVES:**

* To develop a professional attitude
* To improve interpersonal and social skills

**LIST OF EXPERIMENTS:**

1. **PERSONAL COMMUNICATION** Day-to-day conversation
2. **SOCIAL COMMUNICATION** Telephone calls, Expressing opinions, Addressing a group
3. **GROUP COMMUNICATION** Debate, Panel discussion, Conducting meetings
4. **PUBLIC SPEAKING** Listening skills, Reading a speech, Writing a speech
5. **PRESENTATION SKILLS** Defending model/ hypothesis.
6. **EMPLOYABILITYSKILLS** Preparation for interview, mock interview

**Contact Periods:**
**Lecture: 0 Periods Tutorial: 0 Periods Practical: 60 Periods Total: 60 Periods**

**TEXT BOOKS:**

| AUTHOR NAME | TITLE OF BOOK | PUBLISHER, EDITION, YEAR OF PUBLICATION |
|---|---|---|
| *Richard Denny* | *Communication to Win* | *Kogan Page India Pvt. Ltd, 2008.* |
| *Jongewardm D &Seyer P C* | *Choosing Success (Transactional Analysis on the job)* | *John Wiley & Sons, 1978* |
| *Luthans F* | *Organisational Behaviour* | *McGraw-Hill 12th edition, 2010* |

**COURSE OUTCOME:**

Upon completion of the course, the students will be able to
**CO1**: Converse confidently in a personal and social gathering.
**CO2**: Competent in Group activities
**CO3**: Address a group or gathering
**CO4**: Present views and opinion
**CO5**: Effectively handle interviews
**CO6**: Improved interpersonal skills

**COURSE ARTICULATION MATRIX:**

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | - | - | - | - | - | - | - | - | H | M | - | - | L | H |
| **CO2** | - | - | - | - | - | - | - | - | H | M | - | - | L | H |
| **CO3** | - | - | - | - | - | - | - | - | M | H | - | - | L | H |
| **CO4** | - | - | - | - | - | - | - | - | M | H | - | - | M | H |
| **CO5** | - | - | - | - | - | - | - | - | - | H | - | - | L | H |
| **CO6** | - | - | - | - | - | - | - | - | H | M | L | - | L | H |
| **16BEE609** | - | - | - | - | - | - | - | - | H | H | L | - | L | H |

**L – Low, M – Moderate (Medium), H- High**

**16BHS701** **MANAGEMENT THEORY AND PRACTICE** **CATEGORY: HS**

*(Common to ECE Branch)*

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**PRE-REQUISITES: NIL**

**COURSE OBJECTIVES:**

- To gain a basic knowledge of business and management
- To plan for effective organization
- To communicate effectively and control

| UNIT I | BASICS OF MANAGEMENT THOUGHT | 9 Periods |
|---|---|---|
| Evolution of Management, definition, Levels, Principles, Differences with administration. Roles of Managers, Social Responsibility of Business, External environment of business, Management Ethics. | | |
| **UNIT II** | **PLANNING** | **9 Periods** |
| Types, Steps, Management by objectives, Strategic planning process, Decision-making - Types of decisions, Approaches to decision- making under uncertainity. | | |
| **UNIT III** | **ORGANIZING** | **9 Periods** |
| Formal, Informal organization- span of Management- Departmentation- Line, Staff authority, Decentralization and Delegation of authority- Effective organization and organization culture. | | |
| **UNIT IV** | **STAFFING AND LEADING** | **9 Periods** |
| Systems approach to staffing – Performance appraisal process and career strategy formulation, Leadership theories, Theories of motivation, Communication – Process, Barriers, Guidelines for effective communication – Electronic media in communication. | | |
| **UNIT V** | **CONTROLLING** | **9 Periods** |
| Process, Requirements for effective control – control techniques – Operations research for controlling, Overall and Preventive control. | | |

**Contact Periods:**
**Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

**TEXT BOOKS:**

| AUTHOR NAME | TITLE OF THE BOOK | PUBLISHER,YEAR OF PUBLICATION |
|---|---|---|
| *Harold Koontz, Weihrich* | *Essentials of Management* | *Tata McGrawHill, NewDelhi,2010* |
| *Tripathy P.C, Reddy P.N* | *Principles of Management* | *Tata McGrawHill, 2010* |

**REFERENCE BOOKS:**


1. Joseph Massie,"Essentials of Management",Prentice Hall of India,NewDelhi,2007.
2. Prasad, L.M.,"Principles and Practice of Management", Sultan Chand and Sons, NewDelhi, 2010.


**COURSE OUTCOMES:**

**CO 1:** Basic knowledge of business and management
**CO 2:** Ability to plan for effective organization
**CO 3:** Ability to communicate effectively and control

**COURSE ARTICULATION MATRIX:**

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | L | - | - | - | - | H | M | H | H | H | H | M | L | H |
| **CO2** | - | - | - | - | - | H | L | H | H | H | H | - | L | H |
| **CO3** | - | - | H | - | - | - | - | H | H | H | H | H | H | H |
| **16BHS701** | L | - | H | - | - | H | L | H | H | H | H | M | M | H |

**L – Low, M – Moderate (Medium), H- High**

**16BPC702** **DOWNSTREAM PROCESSING** **CATEGORY: PC**

| L | T | P | C |
|---|---|---|---|
| 2 | 2 | 0 | 3 |

**PRE-REQUISITES:**

1. 16BPC405- Analytical techniques in Biotechnology
2. 16BPC503- Bioprocess Principles
3. 16BPC604- Bioprocess Engineering

**COURSE OBJECTIVES:**

- Impart knowledge for various cell disruption methods
- Study the physical methods for separation of Bioproduct
- Learn the techniques involved for the isolation and extraction of bioproduct
- Study thevarious methods of chromatography used in protein purification

| UNIT –I | INTRODUCTION TO BIOSEPARATIONS | 6+2 Periods |
|---|---|---|
| Synthesis of biosepartion processes – Engineering analysis of biosepartaions – stages in downstream processing – process and product quality. Characteristics of biomolecules; Cell disruption for product release – mechanical, enzymatic and chemical methods- Pretreatment and stabilisation of bioproducts. | | |
| **UNIT –II** | **PHYSICAL METHODS OF SEPERATION** | **5+8 Periods** |
| Filtration principle – conventional and cross flow filtration – filter media – membrane fouling- rotary vacuum filtration – equipment details; sedimentation principle- sedimentation coefficient – sigma analysis –centrifugation – tubular and disk centrifuges – comparison and engineering analysis – ultracentrifugation – sedimentation at low accelerations – centrifugal elutriation- flocculation principle – electrical double layer, Schulze Hardy Rule – flocculation rate – flocculants. | | |
| **UNIT-III** | **PRODUCT ENRICHMENT** | **5+6 Periods** |
| Adsorption – Description of adsorption process and their application-Types of adsorption-nature of adsorbents-Adsorption equilibrium isotherm and its kinetics- Aqueous two-phase extraction principle – phase separation and portioning equilibria – counter current stage calculations –membrane separation – ultrafiltration and dialysis-precipitation of proteins by different methods – precipitate breakage and aging. | | |
| **UNIT- IV** | **PRODUCT PURIFICATION** | **5+5 Periods** |
| Chromatography principle-Column dynamics – plate models – chromatography column mass balance with negligible dispersion – calculation of elution profile – dispersion effects in chromatography – gradients and modifiers – adsorbent types – equipments and detectors – Principles of reverse phase- ion-exchange-size exclusion- hydrophobic interaction- bioaffinity and pseudo affinity chromatographic techniques. | | |
| **UNIT –V** | **PRODUCT FORMULATION** | **9+9 Periods** |
| Crystallization principle – batch crystallizers – process crystallization of proteins- drying principle – heat and mass transfer – dryers description and operations of vacuum shelf dryers- batch vacuum rotary dryers, freeze dryers and spray dryers. Design of drying systems. | | |

**Contact Periods:**
**Lecture: 30 Periods** **Tutorial: 30 Periods** **Practical: 0 Periods** **Total: 60 Periods**

**TEXT BOOKS:**

| AUTHOR NAME | TITLE OF BOOK | PUBLISHER, EDITION, YEAR OF PUBLICATION |
|---|---|---|
| *B. Sivasankar* | *Bioseparations: Principles and Techniques* | *1st Edition, Prentice-Hall of India Pvt.Ltd, 2007* |
| *P.A Belter, E.L Cussler Hu* | *Bioseparation –Downstream Processing for Biotechnology* | *1st Edition, Wiley Inter Science Publication, 2011* |
| *W.L. McCabe, J.C.Smith and P.Harriot,* | *Unit Operations In Chemical Engineering* | *7thEdition, McGraw-Hill Inc, 2013* |
| *Ghosh R* | *Principles of Bioseparation Engineering* | *1st Edition ,World Scientific Co. Ltd,2006* |

**REFERENCE BOOKS:**


1. *Roger G.Harrison, Paul Todd, Scott R.Rudge and Demetri P.Pterides, "Biosepartions Science and Engineering", Oxford University Press, 2nd Edition, 2003.*
2. *R.O. Jenkins, "Product Recovery In Bioprocess Technology – Biotechnology By Open Learning Series", Butterworth-Heinemann ,2nd Edition,1992.*
3. *Jansons. J.C and Ryden L. (Ed), "Protein purification-Principles, High Resolution Methods and Application". VCH Publications,3rd Edition1989*


**COURSE OUTCOME:**

Upon completion of the course, the students will be able to

**CO1:** Impart the skills in various cell disruption methods

**CO2**: Illustrate the solid-liquid unit operation involved in downstream processing

**CO3**: Gain the Knowledge of principles and working of different unit operations for the isolation and extraction of bio-products

**CO4**: Demonstrate the various methods of chromatography used in protein purification

**CO5**:Knowledge of different methods and industrial equipments used for the concentration purification and final polishing of bio-products at the industrial level

**COURSE ARTICULATION MATRIX:**

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | M | L | - | L | - | - | L | - | L | - | - | - | L | - |
| **CO2** | L | - | M | - | M | - | L | L | L | - | M | - | - | M |
| **CO3** | L | - | L | M | - | - | - | H | L | - | L | - | - | H |
| **CO4** | L | M | M | - | - | L | - | M | - | - | - | - | L | - |
| **CO5** | L | - | - | - | - | - | - | M | L | L | M | - | - | H |
| **16BPC702** | L | L | M | M | - | L | L | M | L | L | M | - | L | H |

**L – Low, M – Moderate (Medium), H- High**

**16BPC703** **PROTEIN ENGINEERING** **CATEGORY: PC**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**PRE-REQUISITIES:**
1.16BPC306 -Biochemistry

**COURSE OBJECTIVES:**
- To acquire knowledge on different bonds in protein and structure elucidation methods.
- To learn the various topologies of secondary, super secondary, tertiary and quaternary structures.
- To understand the relationship between protein structure and function using some models.
- To learn the fundamentals of protein engineering and design.

| UNIT I | BONDS IN PROTEIN & STRUCTURE ELUCIDATION | 9 Periods |
|---|---|---|
| Covalent, Ionic, Hydrogen, Hydrophobic and Vanderwaals interactions in protein structure. Elucidation of secondary structure- Circular di-chroism; Elucidation of tertiary structure protein structure using X-ray diffraction and Nuclear Magnetic Resonance (NMR). | | |
| **UNIT II** | **POST TRANSLATIONAL MODIFICATION AND PEPTIDE** | **9 Periods** |
| Amino acids - molecular properties (size, solubility, charge, pKa),Post translational modification-modification at N-terminus and C-terminus, Glycosylation; Determination of amino acid composition, peptide sequencing - automated edman method ,mass-spectrometry;Peptide synthesis, Peptide mapping. | | |
| **UNIT III** | **PROTEIN ARCHITECTURE** | **12 Periods** |
| Primary structure, Secondary structures-alpha helix, beta sheet and turns. Super-secondary structure: Alpha-turn-alpha, beta-turn-beta (hairpin), beta-sheets, alpha-beta-alpha, topology diagrams, Tertiary structure – types of different domains (α, β and α / β); α domain – Coiled coil structure and Four helix bundle; β domain – up and down, Greek key and jelly roll barrels; α / β domains – TIM barrel, Rossman fold and Horseshoe fold; Protein folding – role of molecular chaperones, protein disulphide isomerase and peptidylprolylcis-trans isomerase; Quaternary structure- Modular nature and formation of complexes. | | |
| **UNIT IV** | **STRUCTURE-FUNCTION RELATIONSHIP** | **9 Periods** |
| DNA binding proteins- prokaryotic transcription factors, Helix-Turn-Helix motif in DNA binding, *trp* repressor, Eucaryotic transcription factors, Zn fingers, helix-turn helix motifs in Homeodomain, Leucine zippers, Membrane proteins and receptors -Bacteriorhodopsin ,Photosynthetic reaction center, Immunoglobulins- IgG light chain and heavy chain architecture, Enzymes- Serine proteases. | | |
| **UNIT V** | **CASE STUDIES IN PROTEIN ENGINEERING** | **6 Periods** |
| Advantages - protein data base analysis – methods to alter primary structure of proteins, examples of engineered proteins, thermal stability of $T_4$-Lysozyme, recombinant insulin to reduce aggregation and inactivation;De-novo protein design – principles and examples. | | |

**Contact Periods:**
**Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

**TEXT BOOKS:**

| AUTHOR NAME | TITLE OF THE BOOK | PUBLISHER,YEAR OF PUBLICATION |
|---|---|---|
| *Voet D. and Voet G* | *Biochemistry* | *John Wiley and Sons, Fourth edition,2011* |
| *Branden C. and Tooze J* | *Introduction to Protein Structure* | *Garland Publishing, NY, USA, Second Edition, 1998.* |
| *Creighton T.E* | *Proteins: Structure and Molecular Properties* | *Freeman WH publishers, Second Edition, 1992* |

**REFERENCE BOOKS:**

*1.Lilia Alberghina ,Protein Engineering for Industrial Biotechnology, Lilia Alberghina, First edition, CRC*
*Press, 2003.*
*2.Stefan Lutz, Uwe Theo Bornscheuer , Protein Engineering Handbook volume1, First edition,Wiley-VCH Publications, 2008.*
*3.Moody P.C.E. and Wilkinson A.J., Protein Engineering, Infocusseries, IRL Press, OxfordUK, first edition, 1990.*

**COURSE OUTCOMES:**

Upon completion of the course, the students will be able to
**CO1**: Acquire knowledge about the bonds and energies in protein and elucidation of protein structure.
**CO2:** Understand the basics of post translational modification and peptide analysis.
**CO3**: Understand the architecture of proteins
**CO4**: Elucidate the structure function relationship of proteins
**CO5**: Understand the basics and steps involved in protein engineering

**COURSE ARTICULATION MATRIX:**

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | M | L | - | L | M | - | - | - | - | - | - | - | M | L |
| **CO2** | L | L | - | - | H | - | L | - | - | - | - | L | - | M |
| **CO3** | M | L | - | - | - | - | - | - | - | L | - | - | M | L |
| **CO4** | H | L | - | - | - | L | - | - | - | - | - | - | M | - |
| **CO5** | - | L | L | M | L | - | - | - | - | - | - | - | - | M |
| **16BPC703** | M | L | L | L | M | L | L | - | - | L | - | L | M | M |

**L – Low, M – Moderate (Medium), H- High**

**16BEE707** **MINI PROJECT** **CATEGORY: EEC**

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 8 | 4 |

**PRE-REQUISITES: NIL**

**COURSE OBJECTIVES:**

- To design the research work and research after review
- To analyze and interpret results using new tools
- To develop writing and presentation skills

| DESCRIPTION |
|---|
| * Students should do a separate mini project or part of their main project as mini project.<br>* Students can finalize their topic of specialization for their eighth semester project in seventh semester and do literature survey related to major project.<br>* At the end of the semester, a report has to be submitted. |

**Contact Periods:**
**Lecture: 0 Periods** **Tutorial: 0 Periods** **Practical: 120 Periods** **Total: 120 Periods**

**COURSE OUTCOMES:**
Upon completion of the course, the students will be able to
**CO1:** analyze the preliminary literature related to major project.
**CO2:** evaluate the experimental methods and hypothesis through available literature.
**CO3:** write the research thesis.
**CO4:** present the report to an audience.
**CO5:** defend the result outcomes to an audience.

**COURSE ARTICULATION MATRIX:**

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | H | H | M | M | - | H | M | M | - | - | - | H | H | M |
| **CO2** | M | H | H | M | M | M | - | - | M | - | M | - | H | M |
| **CO3** | L | - | - | - | - | - | - | - | M | H | - | - | M | M |
| **CO4** | - | - | - | - | - | - | - | - | M | H | - | - | M | M |
| **CO5** | - | - | - | - | - | L | - | - | - | H | M | - | M | H |

**L – Low, M – Moderate (Medium), H- High**

**16BPC708 DOWNSTREAM PROCESSING LABORATORY CATEGORY: PC**

**PRE-REQUISITES: NIL**

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 4 | 2 |

**COURSE OBJECTIVES:**

- Perform the different cell disruption methods
- perform different precipitation techniques to isolate the desired protein.
- Work as a team to perform final formulation and polishing of biomolecules.

**LIST OF EXERCISES:**

1. Solid liquid separation – centrifugation
2. Cell disruption techniques – ultrasonication
3. Cell disruption techniques – Mechanical method
4. Enzymatic method of cell disruption
5. Precipitation – ammonium sulphate precipitation
6. Membrane separation – Dialysis
7. Batch sedimentation
8. Aqueous two phase extraction
9. High resolution purification – ion exchange chromatography
10. Product polishing – gel filtration chromatography
11. Product polishing – spray drying, freeze drying (Lyophilization)

**Contact Periods:**
**Lecture: 0 Periods Tutorial: 0 Periods Practical: 60 Periods Total: 60 Periods**

**REFERENCE BOOKS:**

*1. RogerG.Harrison, Paul Todd, Scott R.Rudge and Demetri P.Pterides, "Biosepartions Science and Engineering", Oxford University Press,2nd Edition,2003*
*2. R.O. Jenkins, (Ed.),"Product Recovery In Bioprocess Technology – Biotechnology By Open Learning Series", Butterworth-Heinemann, 1st Edition, 1992.*

**COURSE OUTCOME:**

Upon completion of the course, the students will be able to
**CO1:** Impart the skills in various cell disruption methods
**CO2**: Illustrate the solid-liquid unit operation involved in downstream processing
**CO3**: Gain the Knowledge of principles and working of different unit operations for the isolation and extraction of bio-products
**CO4**: Demonstrate the various methods of chromatography used in protein purification
**CO5**: Knowledge of different methods and industrial equipments used for the concentration purification and final polishing of bio-products at the industrial level

**COURSE ARTICULATION MATRIX:**

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | M | L | - | L | - | - | L | - | L | - | - | - | H | L |
| **CO2** | L | - | M | - | M | - | L | L | L | - | M | - | L | H |
| **CO3** | L | - | L | M | - | - | - | H | L | - | L | - | L | L |
| **CO4** | L | M | M | - | - | L | - | M | - | - | - | - | L | L |
| **CO5** | L | - | - | - | - | - | - | M | L | L | M | - | L | H |
| **16BPC708** | L | L | M | M | - | L | L | - | L | - | M | - | L | L |

**L – Low, M – Moderate (Medium), H- High**

**16BEE803** **PROJECT WORK** **CATEGORY: EEC**

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 16 | 8 |

**PRE-REQUISITES:**

1. 16BEE707 – Mini Project

**COURSE OBJECTIVES:**

- To acquire knowledge to design and plan experiments
- To analyze and validate the obtained results.
- To draft a report and present research results.

**DESCRIPTION:**

The project should be done with the following criteria

1. Background of the study.
2. Hypothesis and rationale.
3. Plan of the study.
4. Designing of the experiment.
5. Validation.
6. Results and interpretation.
7. Discussion.
8. Conclusion and Significance of the study.
9. Outcomes and Summary.
10. Report preparation and Presentation (PPT).

Students are encouraged to publish their original results in Journals.

**Contact Periods:**
**Lecture: 0 Periods** **Tutorial: 0 Periods** **Practical: 300 Periods** **Total: 300 Periods**

**COURSE OUTCOMES:**

Upon completion of the course, the students will be able to

**CO1:** acquire practical knowledge on the selected area of biotechnology project..
**CO2:** identify, design and analyze the experiments in the systematic and ethical approach.
**CO3:** develop a project as an individual or in a team.
**CO4:** develop the communication skills for project presentation.
**CO5:** develop the writing skills for drafting the project report.

**COURSE ARTICULATION MATRIX:**

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | H | - | - | - | - | L | - | L | - | - | - | M | H | M |
| **CO2** | - | H | M | H | H | - | - | M | M | - | M | L | H | M |
| **CO3** | - | - | - | - | - | - | - | - | H | M | - | - | M | H |
| **CO4** | - | - | - | - | M | - | - | - | - | H | M | - | M | H |
| **CO5** | - | - | - | - | - | - | - | - | - | H | M | - | M | H |
| **16BEE803** | L | L | L | L | M | L | - | L | M | H | M | L | M | H |

**L – Low, M – Moderate (Medium), H- High**

**16BPEX01** **BIOFUELS** **CATEGORY: PE**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**PRE-REQUISITES:**

1. 16BPC303-Basic Industrial Biotechnology

**COURSE OBJECTIVES:**

- To understand the fundamental concepts in biofuels / bioenergy
- To learn the production mechanisms of different types of biofuels
- To obtain the knowledge related to processing technologies of biofuels
- To get familiarize the policies and guidelines available for the production of biofuels

| **UNIT I** | **ENERGY** | **8 Periods** |
|---|---|---|
| Introduction-resources-renewable and non-renewable resources (water, minerals, and energy) use and overexploitation; Classification and sources of energy; Problems relating demand and supply of various energy sources-Coal-Petroleum. | | |
| **UNIT II** | **MILESTONES IN BIOFUELS** | **9 Periods** |
| First generation biofuels-bioethanol – production mechanisms by microbes; Second generation biofuels-methane and hydrogen – production mechanisms by microbes; Factors affecting biogas yields; Third generation biofuels-biobutanol-biodiesel from algae; Fourth generation biofuels- solar to fuel method to produce biofuels. | | |
| **UNIT III** | **BIODIESEL AND BIOMETHANE** | **9 Periods** |
| Sources and processing of biodiesel (fatty acid methyl ester); Sources and characteristics of lipids for use as biodiesel feedstock and conversion of feedstock into biodiesel (transesterification); Biomethane or biogas-hydrolysis-anaerobic digestion - methanogenesis (acetoclastic, hydrogenotrophic) - rates of methane formation-one and two stage fermentation. | | |
| **UNIT IV** | **GASIFICATION & PYROLYSIS TECHNOLOGIES** | **10 Periods** |
| Gasification processes and the main types of gasifier designs-production of electricity by combining a gasifier with a gas turbine or fuel cell; Combined-cycle electricity generation with gas and steam turbines and generation of heat and steam; Fast pyrolysis technology to produce liquid bio oil or pyrolysis oil (synthetic oil) from biomass-refined to produce a range of fuels- chemicals and fertilizers. | | |
| **UNIT V** | **POLICIES AND FUTURE R&D OF BIOFUELS & BIOENERGY** | **9 Periods** |
| Analysis of both current and future Indian regulations - directives on biofuels and bioenergy; Evaluation of different production alternatives to produce bioenergy; Evaluation of current and future R&D needs-legal framework to support sustainable development and increased use of biofuels; Government policies and programs with regard to biofuels and investment opportunities worldwide. | | |

**Contact Periods:**
**Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

**TEXT BOOKS:**

| AUTHOR NAME | TITLE OF BOOK | PUBLISHER, EDITION, YEAR OF PUBLICATION |
|---|---|---|
| *Samir K. Khanal* | *Bioenergy Production: Principles and Applications* | *Wiley-Blackwell Publishing, 1st edition, 2016* |
| *David M. Mousdale* | *Biofuels: Biotechnology, Chemistry, and Sustainable Development* | *CRC Press Taylor and Francis group,1st edition, 2008* |
| *Gupta, Vijai Kumar; Tuohy, Maria G. (Eds.)* | *Biofuel Technologies Recent Developments* | *Springer, 1st edition, 2013* |

**REFERENCE BOOKS:**


1. *Robert C. Brown, "Biorenewable Resources: Engineering New Products from Agriculture", Wiley-Blackwell Publishing, 2nd edition, 2014.*
2. *Pogaku, Ravindra; Sarbatly, RosalamHj. (Eds.), "Advances in Biofuels", Springer, 2013.*
3. *Martin Kaltschmitt; Hermann Hofbauer. "Biomass Conversion and Biorefinery," Springer Publishing, 2008.*
4. *B Pandya, "Conventional Energy Technology - Fuels and chemical Energy " TMH(1987)*
5. *S.P. Sharma and Chander Mohan, "Fuels and Combustion", TMH, 1steditон, 1984*
6. *Kash Kori, C., "Energy resources, demand and conservation with special reference to India"TMH,, 1st edition, 1975.*


**COURSE OUTCOME:**

Upon completion of the course, the students will be able to

**CO1:** Understand the functions of cell and their structural organization
**CO2:** Describe the mechanisms and role of cell in immune system
**CO3:** Get familiarized biomolecules and human anatomy system
**CO4:** Illustrate the applications of microbes in industrial process
**CO5:** Apply the engineering concepts in biology

**COURSE ARTICULATION MATRIX:**

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | L | L | L | - | - | - | - | - | - | - | - | - | H | M |
| **CO2** | L | M | - | L | - | - | L | M | - | - | - | - | H | M |
| **CO3** | L | M | L | L | - | - | - | L | M | - | - | L | M | H |
| **CO4** | L | L | L | L | M | - | - | - | L | - | - | - | H | M |
| **CO5** | - | - | - | - | - | - | - | - | - | - | - | - | H | H |
| **16BPEX01** | L | M | L | L | M | - | L | M | M | - | - | L | H | M |

**L – Low, M – Moderate (Medium), H- High**

**16BPEX02** **BIOPOLYMER TECHNOLOGY** **CATEGORY: PE**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**PRE-REQUISITES:**

1. 16BPC604 - Bioprocess engineering

**COURSE OBJECTIVES:**

- To understand the different types of biopolymers in biomedical applications, environmental protection
- To apply bio surfactants in food industry and to examine the different properties and market analysis through case studies.

| UNIT I | INTRODUCTION | 9 Periods |
|---|---|---|
| Biopolymers - definition, Plant and Animal biopolymers- polynucleotide, polyamides, polysaccharides, polyisoprene, lignin, polyphosphate and polyhydroxyalkanoates. Application and chemical synthesis of super absorbent polymers-Polyethylene glycol, Polypropylene glycol, Polytetramethylene glycol, Polyglycerine. Bioplastics and environment, Commercial bioplastics. Natural fibers like silk, wool, flax, jute, linen, cotton, bamboo. Biocomposite- properties and applications. | | |
| **UNIT II** | **BIOPOLYMER TECHNOLOGY AND APPLICATIONS** | **9 Periods** |
| Industrial biopolymers: Production of polyphenol resins by the enzyme soybean peroxidase; Novel synthesis of Artificial Biopolymers in Biomedical Applications- An Overview, Hydrogel as potential Nano scale drug delivery system , Low cost foods and drugs using immobilized enzymes on Biopolymers, Physiochemical characteristics of biopolymers. Biodegradable polymers for medical purposes, Biopolymers in controlled release systems. Synthetic polymeric Membranes and their biological applications. | | |
| **UNIT III** | **BIOSURFACTANTS** | **9 Periods** |
| Biosurfactants: Source, characteristics and properties of Biosurfactants; Production of Biosurfactants via the fermentation and biotransformation routes; Production of Biosurfactants with immobilized cells; Integrated bioprocess for continuous production of Biosurfactants including downstream processing; Applications of Biosurfactants – Food Industry, Environmental Control. | | |
| **UNIT IV** | **MATERIAL TESTING AND ANALYTICAL METHODS** | **9 Periods** |
| An Overview of Available Testing Methods, Comparison of Test Systems for the Examination of the Fermentability of Biodegradable Materials, Evaluation of the properties of biopolymers to make good biomaterials; Tensile strength (both elasticity and breaking strength); Hydration, visco – elastic properties; viscosity. Criteria used in the evaluation of Biodegradable polymers – petridish screen – environmental chamber method – soil burial tests etc. | | |
| **UNIT V** | **CASE STUDIES** | **9 Periods** |
| Biopolymers: Synthesis from a simple biological monomer (i.e. Hyaluronate polymers); Dextran (used in chromatography columns); Rubberlike materials produced by bacteria and fungi – Polyhydroxybutyrate (PHB), Polycaprolactone (PCL), Xanthan gum; Production of a copolymer of PHB and PHV(Polyhydroxyvaleric acid), sold as Biopol by fermentation on *Alcaligeneseutrophus*; Biodegradable polymers | | |

**Contact Periods:**
**Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

**TEXT BOOKS:**

| AUTHOR NAME | TITLE OF BOOK | PUBLISHER, EDITION, YEAR OF PUBLICATION |
|---|---|---|
| *Emo Chiellini , Helena Gil* | *Biorelated Polymers: Sustainable Polymer Science and Technology* | *Springer, 2001* |
| *Johnson .R.M, L.Y. Mwaikambo and N. Tucker* | *Biopolymers* | *Rapra Technology, 2003* |

**REFERENCE BOOKS:**

1. NaimKosaric, Biosurfactants, Marcell Dekker Inc, 1993.

**COURSE OUTCOME:**

Upon completion of the course, the students will be able to

**CO1:** Employ the greener technologies to solve the environmental issues.

**CO2:** Familiar the different types of plant and animal derived biopolymers and their application as commercial bioplastics.

**CO3:** Understand the properties of biosurfactants and their use in food industries.

**CO4:** Evaluate the tensile strength, hydration, viscoelastic properties using different testing methods.

**CO5:** Illustrate the synthesis and application of biopolymers in nanoscale drug delivery systems, as biomimetic materials and waste water treatment methods.

## COURSE ARTICULATION MATRIX:

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | M | H | L | - | L | L | M | - | - | - | - | - | H | M |
| **CO2** | M | M | L | - | M | L | H | - | - | - | - | - | L | M |
| **CO3** | L | L | M | - | L | L | H | - | - | - | - | - | M | H |
| **CO4** | M | M | L | - | H | L | L | - | - | - | - | - | M | L |
| **CO5** | L | M | H | - | L | L | H | - | - | - | - | - | M | H |
| **16BPEX02** | M | M | L | - | L | L | H | - | - | - | - | - | M | M |

**L – Low, M – Moderate (Medium), H- High**

**16BPEX03 INDUSTRIAL HAZARD MANAGEMENT CATEGORY: PE**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**PRE-REQUISITES: NIL**

**COURSE OBJECTIVES:**

- Identify and causes of various Hazards
- Enable the students to compare the hazards of chemicals with the permissible levels.
- Acquire knowledge about types of hazards arising out of physical, chemical and biological agents.
- Demonstrate various techniques involved in Hazard waste Management
- Recognize the issues related to environment and safety

| UNIT –I | PHYSICAL HAZARD | 6 Periods |
|---|---|---|
| Noise compensation aspects- noise exposure regulation-properties of sound-occupational damage-risk factors-sound measuring instruments- octave band analyzer- noise networks, noise surveys-noise control program- industrial audiometry - hearing conservation programs-vibration types and effects-instruments- surveying procedure- permissible exposure limit. | | |
| **UNIT –II** | **CHEMICAL HAZARD** | **10 Periods** |
| Recognition of chemical hazards-dust, fumes, mist, vapor, fog, gases, types, concentration-Exposure vs. Dose- TLV-Methods of Evaluation, process or operation description- Field Survey- Sampling methodology- Industrial Hygiene calculations- Comparison with OSHAS Standard. Air Sampling instruments- Types- Measurement Procedure- Instruments Procedure- Gas and Vapor monitors- dust sample collection devices- personal sampling. | | |
| **UNIT-III** | **BIOLOGICAL AND ERGONOMICAL HAZARDS** | **10 Periods** |
| Classification of Biohazardous agents–examples- bacterial agents- rickettsial and chlamydial agents-viral agents, fungal, parasitic agents, infectious diseases-Biohazard control program-employee health program-laboratory safety program-animal care and handling-biological safety cabinets-Work Related Musculoskeltal Disorders–carpal tunnel syndrome CTS-Tendon pain-disorders of the neck-back injuries. | | |
| **UNIT- IV** | **HAZARDOUS WASTE MANAGEMENT** | **10 Periods** |
| Hazardous waste management in India-waste identification- characterization and classification-technological options for collection-treatment and disposal of hazardous waste-selection charts for the treatment of different hazardous wastes-methods of collection and disposal of solid wastes- Health hazards-toxic and radioactive wastes-incineration and vitrification-hazards due to bio-process-dilution-standards and restrictions–recycling and reuse. | | |
| **UNIT -V** | **SAFETY MANAGEMENT** | **9 Periods** |
| Organising for safety- Health and Enviornment, Organisation -Structure, Function and responsibilities-Safety Committee : Structure and function-The competent person in relation to safety legislation - duties and responsibilities-Competence Building Technique (CBT), Concept for training-Employee participation in safety - Role of Trade union in safety, health and environment-Safety promotion and safety awards- safety-competitions- audio visual publication. | | |

**Contact Periods:**
**Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**

**TEXT BOOKS:**

| AUTHOR NAME | TITLE OF BOOK | PUBLISHER, EDITION, YEAR OF PUBLICATION |
|---|---|---|
| *S.P.Mahajan,* | *Pollution control in process industries* | *1st Edition, Tata McGraw Hill Publishing Company, New Delhi, 1993.* |
| *Krishnan N.V.* | *Safety Management in Industry* | *1st Edition,Jaico Publishing House, Bombay, 1997.* |

**REFERENCE BOOKS:**

1. *B.D. Singh, Biotechnology, Kalyani Publishers, 1st Edition,2003*

**COURSE OUTCOME:**

Upon completion of the course, the students will be able to

**CO1:** Identify and analyse various types of hazards present in physical, chemical, biological agents and ergonomical aspects in a process.

**CO2**: Identify and understand notifiable occupational diseases arising out of occupation and suggest methods for the prevention of such diseases.

**CO3**: Evaluate the safety performance of an organization

**CO4**: Gain the knowledge about the safety management

**CO5**: Identify and recognize issues related to Environment and safety

**COURSE ARTICULATION MATRIX:**

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | L | L | L | - | - | - | - | - | - | - | - | - | H | L |
| **CO2** | L | M | - | L | - | - | L | M | - | - | - | - | L | H |
| **CO3** | L | M | L | L | - | - | - | L | M | - | - | L | L | L |
| **CO4** | L | L | L | L | M | - | - | - | L | - | - | - | L | L |
| **CO5** | - | - | - | - | - | - | - | - | - | - | - | - | L | H |
| **16BPEX03** | L | M | L | L | - | - | - | M | L | - | - | L | L | L |

**L – Low, M – Moderate (Medium), H- High**

**16BPEX04** **FOOD PROCESS ENGINEERING** **CATEGORY: PE**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**PRE-REQUISITES:**

1. 16BPC305- Microbiology
2. 16BES402 – Fluid Mechanics
3. 16BES502 – Heat and Mass Transfer

**COURSE OBJECTIVES:**

* To enable the student to understand the chemistry and microbiology of aspects food.
* To gain knowledge in various aspects of food processing & its importance.

| UNIT I | BASICS OF FOOD CHEMISTRY AND MICROBIOLOGY | 9 Periods |
|---|---|---|
| Constituents of food- water – bound and unbound water activity, carbohydrate, lipids, proteins-organoleptic and textural characteristics; Bacteria, yeasts and molds – sources, types and species of importance in food processing and preservation; Fermented foods; Single cell protein. | | |
| **UNIT- II** | **FOOD PRESERVATION** | **10 Periods** |
| High Temperature - blanching, pasteurization, sterilization, evaporation, dehydration, distillation, baking, roasting, frying; Thermal death time relationships (D, Z and F values); Low Temperature - microbial activity at low temperature and methods – chilling, freezing; Irradiation; Chemicals preservation; Hurdle technology. | | |
| **UNIT- III** | **UNIT OPERATIONS IN FOOD PROCESSING** | **10 Periods** |
| Raw material preparation- cleaning, sorting, grading and peeling; Size reduction; Pumping; Mixing and forming; Separation and concentration – centrifugation, filtration, extraction, crystallization; Heat transfer–conduction, convection, radiation, extruders (Theory and equipment only); Large scale processing – meat, beverage, confectionary, dairy, fresh fruits and vegetables. | | |
| **UNIT- IV** | **FOOD PACKING** | **10 Periods** |
| Types of packaging material and containers; Interactions between packaging and foods; Controlling packaging atmosphere, Modified atmosphere packaging, Aseptic packaging, Active and intelligent packaging; Packing - meat, dairy, fresh fruits and vegetables, beverages and confectionaries; Food packaging closure and sealing system; Nutrition labelling and legislative requirements. | | |
| **UNIT -V** | **FOOD SAFETY AND QUALITY CONTROL** | **6 Periods** |
| Objectives, importance and functions of quality control; Food safety- definition, food laws and regulations - FSSAI, FDA; Grades and standards; Concept of codex almentarious/HACCP/ /ISO 9000 series etc; Food recalls. | | |

**Contact Periods:**
**Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

**TEXT BOOKS:**

| AUTHOR NAME | TITLE OF BOOK | PUBLISHER, EDITION, YEAR OF PUBLICATION |
|---|---|---|
| *Fellows P.J* | *Food Processing Technology: Principles and Practices* | *Woodhead Publishing, 4th edition, 2016* |
| *Robertoson G.L* | *Food Packaging: Principles and Practice* | *CRC Press, 3rd edition, 2016* |

**REFERENCE BOOKS:**

*1. Srinivasan Damodaran and Kirk L. Parkin., "Fennema's Food Chemistry", CRC Press, 5th edition. 2017.*

*2. Frazier W.C and Westoff D.C., "Food Microbiology", McGraw Hill, 5th edition. 2013.*

**COURSE OUTCOME:**

Upon completion of the course, the students will be able to

**CO1:**Understand the basic constituents of foods and their functional role

**CO2:**Describe the relationship between food and microorganism that basis for fermentation and preservation

**CO3:**Explain various preservation and packaging techniques for food product

**CO4:**Describe the operation principles involved in food processing

**CO5:**Sketch food quality, safety and regulations

## COURSE ARTICULATION MATRIX:

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | H | L | - | - | - | - | - | - | - | - | - | L | H | L |
| **CO2** | H | L | - | - | - | L | - | - | - | - | - | L | H | L |
| **CO3** | - | H | - | - | L | - | - | - | - | - | - | L | H | H |
| **CO4** | - | H | L | - | L | - | - | - | - | - | - | L | H | H |
| **CO5** | - | - | - | - | - | H | L | M | - | - | L | L | M | H |
| **16BPEX04** | H | H | - | - | L | L | L | - | - | - | - | L | H | - |

**L – Low, M – Moderate (Medium), H- High**

**16BPEX05** **MEDICAL BIOTECHNOLOGY** **CATEGORY: PE**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**PRE-REQUISITES:**
1. 16BPC305 Microbiology

**COURSE OBJECTIVES:**
- To understand the classification, diagnosis and therapy of pathogenic infections.
- To understand the concepts of stem cells and tissue engineering.
- To learn the importance of recombinant products and growth factors.

| UNIT I | MEDICALLY IMPORTANT INFECTIOUS ORGANISMS | 9 Periods |
|---|---|---|
| Classification of pathogenic microbes - *Leptospira*, *Brucella*, *Bacillus anthraces*; Medical Parasitology - Amoebiasis, Cryptoporidiosis, Giardiasis, Malaria, Toxoplasmosis; Viruses - Adenoviruses, Retroviruses; Medical Mycology - Superfical Mycoses, Subcutaneous Mycoses, | | |
| **UNIT II** | **DIAGNOSTICS** | **9 Periods** |
| Prenatal diagnosis - Invasive techniques, Amniocentesis, Fetoscopy; Non-invasive techniques – Ultrasonography; X-ray, Diagnosis using protein and enzyme markers, DNA/RNA based diagnosis; Hepatitis, HIV - CD 4 receptor; Microarray technology in cancer diagnosis. | | |
| **UNIT III** | **MODERN ADVANCES IN THERAPY** | **9 Periods** |
| Monoclonal Antibodies – Production, Targeted drug delivery using monoclonal antibodies; Detection and Therapy of Tuberculosis, Malaria, Acquired Immuno Deficiency Syndrome (AIDS), Cancer; Gene Therapy – types. | | |
| **UNIT IV** | **STEM CELL AND TISSUE ENGINEERING** | **9 Periods** |
| Embryonic and adult stem cells- Totipotent, pluripotent and multipotent cells, Testing and generation of embryonic stem cells - Potential uses of stem cells –cell based therapies; Biomaterials – Characterization, Host reactions, Extracellular matrix, Scaffolds, Artificial organs, Applications. | | |
| **UNIT V** | **PHARMACEUTICAL BIOTECHNOLOGY** | **9 Periods** |
| Vaccines- Preparation and testing, standardization and storage study; New generation of vaccines- Hepatitis, AIDS, Malaria. Production of recombinant pharmaceutical products –Biotechnologically derived products (therapeutic proteins)-Interferons, Interleukins, Insulin, Growth Hormones. Recombinant coagulation factors and thrombolytic agents, Somatostatin, Somatotropin, Peptide and protein drugs. | | |

**Contact Periods:**
**Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

**TEXT BOOKS:**

| AUTHOR NAME | TITLE OF BOOK | PUBLISHER, EDITION, YEAR OF PUBLICATION |
|---|---|---|
| *Judit Pongracz, Mary Keen Editors Judit Pongracz, Mary Keen* | *Medical Biotechnology Edition illustrated* | *Elsevier Health Sciences, 2009* |
| *Bernard R. Glick, Terry L. Delovitch, Cheryl L. Patten* | *Medical Biotechnology* | *ASM Press, Washington DC, 2014* |

**REFERENCE BOOKS:**


1. Albert Sasson , "Medical Biotechnology: Achievements, Prospects and Perceptions", United Nations University Press, 2005.
2. Yuan Kun Lee, "Microbial Biotechnology: Principles and Applications", World Scientific, 2nd Edition, 2006.


**COURSE OUTCOME:**

Upon completion of the course, the students will be able to

**CO1:** Understand the classification, diagnosis and therapy of pathogenic infections.
**CO2:** Exhibit knowledge on recent trends in diagnosis of various disorders.
**CO3:** Learn the production of monoclonal antibodies as diagnostic tools and therapeutic agents.
**CO4:** Exhibit knowledge on stem cells, tissue engineering and gene products.
**CO5:** Learn the types, preparation and testing of vaccines, recombinant products and growth factors

**COURSE ARTICULATION MATRIX:**

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | L | L | - | - | - | - | L | - | - | - | - | - | L | L |
| **CO2** | - | M | L | - | - | L | - | - | - | - | - | L | H | H |
| **CO3** | - | M | H | M | - | - | - | - | L | - | - | - | M | H |
| **CO4** | - | - | - | - | M | - | L | - | - | - | - | - | M | L |
| **CO5** | - | L | - | L | H | - | - | - | - | - | - | - | M | L |
| **16BPEX05** | L | M | H | M | H | L | L | - | L | - | - | L | M | L |

**L – Low, M – Moderate (Medium), H- High**

**16BPEX06** **MARINE BIOTECHNOLOGY** **CATEGORY: PE**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**PRE-REQUISITES:**

1. 16BPC305- Microbiology
2. 16BHS2Z4 – Environmental Science and Engineering

**COURSE OBJECTIVES:**

- To learn the basis of marine environment and various applications of marine organisms
- To equip the students in understanding of how biotechnology could be applied in finding solutions to marine problems

| | | |
|---|---|---|
| **UNIT I** | **INTRODUCTION TO MARINE ENVIRONMENT** | **10 Periods** |
| Marine ecosystem and its functioning - intertidal, estuarine, open ocean, deep sea; Biology of marine organisms- feeding and reproduction - Marine flora-Phytoplankton, seaweeds, sea grasses and mangroves; Marine fauna–Zooplankton; marine invertebrates -crustaceans & molluscs; Vertebrates and marine mammals - dolphins and whales. | | |
| **UNIT- II** | **BIOACTIVE COMPONENTS AND BIOMATERIALS FROM MARINE ENVIRONMENT** | **10 Periods** |
| Marine toxins – tetrodotoxins, conotoxins and ciguateratoxins; Marine enzymes-protease, lipase, chitinase, glucanase; Marine biominerals; Biopolymers-polysaccharides, chitin, marine collagens; GFP; Probiotics; antiviral and antimicrobial agents. | | |
| **UNIT- III** | **MARINE ENVIRONMENTAL BIOTECHNOLOGY** | **8 Periods** |
| Marine pollution – biology indicators (marine microbes, algae) – biodegradation and bioremediation – marine fouling and corrosion. | | |
| **UNIT- IV** | **AQUACULTURE TECHNOLOGY** | **8 Periods** |
| Important of coastal aquaculture – marine fishery resources – common fishing crafts and gears – aqua farm design and construction. | | |
| **UNIT -V** | **MANIPULATION TECHNIQUES** | **9 Periods** |
| Chromosome manipulation in aquaculture – hybridization; Ploidy induction; Gynogenesis, androgenesis and sex reversal in commercially important fishes. | | |

**Contact Periods:**
**Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

**TEXT BOOKS:**

| AUTHOR NAME | TITLE OF BOOK | PUBLISHER, EDITION, YEAR OF PUBLICATION |
|---|---|---|
| *Fingerman M, Nagabhushanam R, Thompson M.F* | *Recent advances marine biotechnology volume 2* | *Science Pub Inc 1999* |
| *Fingerman M, Nagabhushanam R, Thompson M.F* | *Recent advances marine biotechnology volume 3* | *Oxford & IBH Publishing company 1999* |

**REFERENCE BOOKS:**


1. *Pelcar M.J. Jr., Chan E.C.S and Kreig N.R., "Microbiology – Concepts And Applications",McGraw-Hill, 5th edition. 2001.*
2. *Joanne M. W, Sherwood L, Woolverton C.J., "Prescott's Microbiology", McGraw-Hill, 8th edition. 2011.*
3. *Kaiser M.J and Attrill M.J., "Marine Ecology: Process, Systems and Impacts", Oxford, 2nd edition. 2011.*

**COURSE OUTCOME:**

Upon completion of the course, the students will be able to

**CO1:**Learn the basic of ocean structure and characteristics

**CO2:**Explain the marine eco system

**CO3:**Describe the important microorganism in marine system

**CO4:**Understand importance of biotechnological solution for marine problems

**CO5:**Elaborate on various active compounds extract from marine organisms

**CO6:**Review on basic aqua culture methods

**COURSE ARTICULATION MATRIX:**

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | M | - | - | - | - | L | L | - | - | - | - | L | H | H |
| **CO2** | L | - | - | - | - | - | L | - | - | - | - | L | M | L |
| **CO3** | - | M | - | - | M | L | L | - | - | - | - | L | H | M |
| **CO4** | L | - | - | - | - | - | - | - | - | - | - | L | L | L |
| **CO5** | L | - | L | - | - | - | - | - | - | - | - | L | L | M |
| **CO6** | M | H | - | - | L | - | - | - | L | - | - | L | M | L |
| **16BPEX06** | L | M | - | - | L | - | L | - | L | - | - | M | H | - |

**L – Low, M – Moderate (Medium), H- High**

**16BPEX07** **PLANT BIOTECHNOLOGY** **CATEGORY: PE**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**PRE-REQUISITES:**

1. 16BPC403- Molecular biology
2. 16BPC504- Genetic Engineering

**COURSE OBJECTIVES:**

* To provide the basics of agrobacterium and applications of plant biotechnology
* To provide the fundamentals of plant cell culture and offer the knowledge about the micromanipulation and transgenic plants

| UNIT I | PLANT GENOMES AND PLANT TISSUE CULTURE | 9 Periods |
|---|---|---|
| Introduction-gene structure and gene expression-regulation, implication for plant transformation-heterologous promoters, genome size and organization, mitochondrial and chloroplast genome. Plant tissue culture-plasticity and totipotency, culture, environment, growth regulators, media regulators, culture types,plant regeneration. | | |
| **UNIT- II** | **PLANT TRANSFORMATION TECHNIQUES** | **9 Periods** |
| Introduction- Agrobacterium mediated gene transfer –Ti-plasmid-process of T-DNA transfer and integration, transformation in plant, Direct gene transfer methods, Binary vectors- basic features of vectors-optimization, clean gene technology, viral vectors- Gemini virus - cauliflower mosaic virus | | |
| **UNIT- III** | **TRANSGENIC PLANTS-HERBICIDE AND PEST RESISTANCE** | **9 Periods** |
| Herbicide resistance-use of herbicide in modern agriculture-strategies for engineering herbicide-resistance. Environmental impact, pest resistance-nature and scale of insect / pest damage to crop-GM strategies- Bt approach to insect resistance-copy nature strategy-insect resistant crops and food safety. | | |
| **UNIT- IV** | **PLANT DISEASE RESISTANCE AND STRESS TOLERANCE** | **9 Periods** |
| Introduction-plant-pathogen interactions-natural disease resistance pathways biotechnological approaches to disease resistance. Plant viruses- types-entry and replication transgenic approach- PDR Stress tolerance-abiotic stress-water deficit stress and various approaches for tolerance. | | |
| **UNIT- V** | **MOLECULAR FARMING AND GM CROPS FUTURE PROSPECTS** | **9 Periods** |
| Introduction-carbohydrates and lipids production-molecular farming of proteins, economic considerations for molecular farming.GM crops-current status-concerns about GM crops- regulations of GM crops and products-Greener genetic engineering. | | |

**Contact Periods:**
**Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

**TEXT BOOKS:**

| AUTHOR NAME | TITLE OF BOOK | PUBLISHER, EDITION, YEAR OF PUBLICATION |
|---|---|---|
| *Adrian Slater, Nigel W.Scott and Mark R.Fowler* | *Plant Biotechnology-The genetic manipulation of plants* | *Second edition Oxford University Press 2008* |
| *Ignacimuthu .S* | *Plant Biotechnology* | *Oxford and IBH Publishing Co Pvt. Ltd. New Delhi, 2003* |
| *Singh B.D* | *Text Book of Plant biotechnology* | *Kalyani Publishers, 1998.* |

**REFERENCE BOOKS:**


1. *Heldt H.W, "Plant Biochemistry & Molecular Biology", Oxford University Press, 1997.*
2. *Bhojwani S.S and Razdan M.K. Plant tissue culture: Theory and Practice", a revised edition, Elsevier science, 1996.*
3. *Dseke L.J, Kirakosyan a, Kanfman P.B, Warber S.L, Duke J.A and Brielmann H.L, "Natural Products from plants", second edition, Taylor and Francis groups, 2006.*
4. *Ignacimuthu S, "Plant biotechnology", Oxford Publishing co Pvt. Ltd, New Delhi, 1997.*


**COURSE OUTCOME:**

Upon completion of the course, the students will be able to

**CO1:**Apply the basic concepts of genetic engineering to establish plant tissue culture.

**CO2:**Gain knowledge about the significance of viral vectors in genetic transformation.

**CO3:**Understand GM strategies and BT approaches to develop pesticide and herbicide resistance plants.

**CO4:**Demonstrate plant-pathogen interactions and various approaches for resistances.

**CO5:** Understand the importance of Molecular Pharming

## COURSE ARTICULATION MATRIX:

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | H | M | - | - | - | - | - | - | - | - | - | - | H | - |
| **CO2** | H | M | - | - | - | - | - | - | - | - | - | - | M | - |
| **CO3** | H | L | - | - | - | H | - | M | - | - | - | - | M | H |
| **CO4** | H | M | - | - | - | - | - | - | - | - | - | - | M | - |
| **CO5** | H | M | - | - | - | - | - | - | - | - | - | - | H | - |
| **16BPEX07** | H | M | - | - | - | H | - | M | - | - | - | - | H | H |

**L – Low, M – Moderate (Medium), H- High**

**16BPEX08** **CANCER BIOLOGY** **CATEGORY: PE**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**PRE-REQUISITES:**

1. 16BPC304 - Cell Biology
2. 16BPC 403 - Molecular Biology

**COURSE OBJECTIVES:**

- To gain an appreciation of the complexity of cancer development process in cellular and molecular level.
- To understand the regulatory networks involved in the growth control and tissue organization.
- To understand the current strategies of cancer diagnosis, prevention and treatment.

| UNIT I | FUNDAMENTALS OF CANCER BIOLOGY | 9 Periods |
|---|---|---|
| Epidemiology of cancer: Environmental factors, Viruses, Life style habits, Mutations and DNA repair; Regulation of cell cycle , Modulation of cell cycle in cancer- pRb, p53; Forms and hallmarks of | | |
| **UNIT II** | **PRINCIPLES OF CARCINOGENESIS** | **9 Periods** |
| Theory of carcinogenesis- Chemical carcinogenesis, Physical carcinogenesis; X-ray radiation-mechanisms of radiation carcinogenesis; Epigenetics of cancer. | | |
| **UNIT III** | **PRINCIPLES OF MOLECULAR CELL BIOLOGY OF CANCER** | **9 Periods** |
| Cyclin dependent kinases; Tumor suppressor genes,Oncogenes, Virus and cancers- DNA viruses, Retroviruses; Growth factors related to transformation, Telomerases, Apoptosis – p53. | | |
| **UNIT IV** | **PRINCIPLES OF CANCER METASTASIS** | **9 Periods** |
| Clinical significances of invasion - Three step theory of invasion - Proteinases and tumour cell invasion - Angiogenesis: VEGF signaling. | | |
| **UNIT V** | **CANCER THERAPY** | **9 Periods** |
| Cancer screening and early detection - Detection using biochemical assays, Tumor markers; Advances in cancer detection, Different forms of therapy: Chemotherapy, Radiation th erapy, Immunotherapy, Molecular therapy, Use of signal targets towards therapy of cancer , Gene therapy. | | |

**Contact Periods:**
**Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

**TEXT BOOKS:**

| AUTHOR NAME | TITLE OF BOOK | PUBLISHER, EDITION, YEAR OF PUBLICATION |
|---|---|---|
| *Stella Pelengaris, Michael Khan* | *The molecular Biology of Cancer* | *Blackwell Publishing 1st edition2006.* |
| *Robert A. Weinberg* | *The Biology of Cancer* | *Garland Science 2nd edition 2014* |

**REFERENCE BOOKS:**


1. Dunmock N.J and Primrose S.B, "Introduction To Modern Virology'', Blackwell Scientific Publications, Oxford, 1988.
2. Franks L. M, Teich N. M, "An Introduction To Cellular and Molecular Biology of Cancer'',Oxford Univ. Press,Oxford Medical Publications, 1992.


**COURSE OUTCOME:**

Upon completion of the course, the students will be able to

**CO1:** Understand the epidemiology of carcinogenesis.

**CO2:** Understand the complex pathways and molecular switches involved in the transformation of a normal cell to a cancer cell.

**CO3:** Understand the stages of cancer leading to the movement of cancer cells throughout the body.

**CO4:** Develop knowledge on the current strategies of cancer diagnosis and treatment.

**CO5:** Summarize the importance of understanding cell biology in the study of cancer, its causes, its progression and its treatment.

**COURSE ARTICULATION MATRIX:**

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | L | L | - | - | L | L | - | - | - | - | - | L | L | L |
| **CO2** | - | - | - | L | L | - | - | - | - | - | - | - | H | M |
| **CO3** | - | - | - | L | L | - | - | - | - | | | - | L | M |
| **CO4** | - | H | - | - | - | M | H | H | H | - | - | - | L | H |
| **CO5** | - | M | M | - | - | - | H | L | H | - | - | - | L | H |
| **16BPEX08** | L | H | M | L | L | M | H | H | H | - | - | L | L | H |

**16BPEX09 ENVIRONMENTAL BIOTECHNOLOGY CATEGORY: PE**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**PRE-REQUISITES:**

1. 16BPC305- Microbiology
2. 16BHS2Z4 – Environmental Science and Engineering

**COURSE OBJECTIVES:**

- To enable the students to get familiar with the diverse microorganism present in the environment and their various roles in environmental safety.
- To furnish knowledge about various pollutants present in the environment.

| | | |
|---|---|---|
| **UNIT I** | **FUNDAMENTALS OF SOIL MICROBIOLOGY** | **9 Periods** |
| Microbial flora of soil; Growth and ecological adaptations of soil microorganisms; Interactions among soil microorganisms; Biogeochemical role of soil microorganisms. | | |
| **UNIT- II** | **BIODEGRADATION OF XENOBIOTIC COMPOUNDS** | **9 Periods** |
| Xenobiotics - persistence and biomagnifications; Types of recalcitrant xenobiotic compounds; Factors causing molecular recalcitrance; Microbial pathways for biodegradation of petroleum hydrocarbons – aliphatic, aromatic, polycyclic and chlorinated hydrocarbons; Biodegradation of pesticides and synthetic detergents. | | |
| **UNIT- III** | **WASTE WATER TREATMENT** | **9 Periods** |
| Characteristics of waste waters - physical, chemical and biological; Waste water treatment- biological method- suspended growth and biofilm processes; Design of activated sludge process; Ponds and lagoons; Trickling filters; Anaerobic wastewater treatment; Sludge digestion - design of anaerobic sludge digesters; Nutrient removal – nitrogen and phosphorus. | | |
| **UNIT- IV** | **INDUSTRIAL WASTE WATER MANAGEMENT** | **9 Periods** |
| Leather, pulp, pharmaceutical, dairy, textile and dye industries – production process, origin and characteristics of waste, waste minimization and treatment options; Solid waste management; Hazardous waste management. | | |
| **UNIT -V** | **DEVELOPMENTS PERTAINING TO ENVIRONMENTAL BIOTECHNOLOGY** | **9 Periods** |
| Case studies - bioleaching and biomining; Biofertilizers and biopesticides; Biofuel and biogas; Bioremediation; Biosensors; Production of bioelectricity from microbial fuel cell (MFC). | | |

**Contact Periods:**
**Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**

**TEXT BOOKS:**

| AUTHOR NAME | TITLE OF BOOK | PUBLISHER, EDITION, YEAR OF PUBLICATION |
|---|---|---|
| *Bruce E.R and Perry L.M* | *Environmental Biotechnology: Principle and Applications* | *McGraw Hill 2012* |
| *Mecalf & Eddy Inc, Tchobanoglous G, Burton F.L, Stensel H.D* | *Wastewater Engineering : Treatment Disposal Reuse* | *McGraw Hill 4th edition 2002* |
| *Connell D.W* | *Basic concepts of Environmental chemistry* | *CRC Press 2nd edition 2005* |

**REFERENCE BOOKS:**


1. *Scragg A. "Environmental Biotechnology", Oxford University press, 2nd edition. 2005.*
2. *Joanne M. W, Sherwood L, Woolverton C.J., "Prescott's Microbiology", McGraw-Hill, 8th edition. 2011.*


**COURSE OUTCOME:**

Upon completion of the course, the students will be able to

**CO1:** Understand various organism in soil and their roles in ecosystem management
**CO2:** Gain knowledge on various terms of pollutants and their accumulations
**CO3:** Review on xenobiotic compounds and their degradation pathway
**CO4:** Able to explain the characteristics and biological treatment of waste water
**CO5:** Analyze various industrial waste and their treatment process
**CO6:** Study on different applications of biotechnology for environmental problems

**COURSE ARTICULATION MATRIX:**

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | M | - | - | - | - | - | M | - | - | - | - | L | H | L |
| **CO2** | M | - | - | - | - | - | H | - | L | - | - | L | M | L |
| **CO3** | M | H | - | - | - | - | H | - | - | - | - | L | H | L |
| **CO4** | M | L | L | - | - | - | M | - | - | - | - | L | M | M |
| **CO5** | M | L | - | - | - | - | H | - | L | - | - | L | M | M |
| **CO6** | - | H | | L | L | L | H | - | - | - | - | L | H | M |
| **16BPEX09** | M | H | - | - | - | - | H | - | L | - | - | L | H | L |

**L – Low, M – Moderate (Medium), H- High**

**16BPEX10** **MOLECULAR PATHOGENESIS** **CATEGORY: PE**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**PRE-REQUISITES:**

1. 16BPC305 – Microbiology
2. 16BPC406 – Immunology

**COURSE OBJECTIVES:**

- To understand the principles of microbial pathogenesis, clinical importance of specific pathogens.
- To inculcate knowledge on recent outbreaks and their disease transmission.
- To understand the recent techniques to study the pathogens.

| UNIT I | BASICS OF MICROBIOLOGY AND IMMUNOLOGY | 9 Periods |
|---|---|---|
| Louis Pasteur's contributions - Robert Koch's postulates - early discoveries of microbial toxins, Vaccines and Antibiotics - Attributes & components of microbial pathogenesis, Host natural defense mechanism - humoral and cellular defense mechanisms – complements - inflammation process - general disease symptoms – Pathogen resistance to the defense mechanisms. | | |
| **UNIT II** | **PATHOGENESIS OF DISEASES** | **9 Periods** |
| Virulence factors - gene regulation in virulence of pathogens - labile & stable toxins; Vibrio Cholera - Cholera toxin - E. coli pathogens - ETEC – EPEC - EHEC - EIEC Hemolytic Uremic Syndrome - Shigella toxin - Plasmodium Life cycle - Antimalarials based on transport processes - Influenza virus - action of amantidine. | | |
| **UNIT III** | **RECENT DISEASE OUTBREAKS** | **9 Periods** |
| Clinical features and molecular mechanism of pathogenesis- Superficial mycoses- Dermatophytes- Intracellular stage-H1N1 ;HIV- Disease transmission of Chickengunya – Dengue. | | |
| **UNIT IV** | **EXPERIMENTAL STUDIES ON HOST PATHOGEN INTERACTIONS** | **9 Periods** |
| Virulence assays; cytopathic - cytotoxic effects. Criteria and tests in identifying virulence factors - attenuated mutants - signal transduction and host responses. | | |
| **UNIT V** | **MODERN APPROACHES TO CONTROL PATHOGENS** | **9 Periods** |
| Serotyping - Immuno and DNA based techniques - New therapeutic strategies based on life threatening pathogens - Vaccines - DNA, subunit and cocktail vaccines. Modern diagnosis based on highly conserved virulence factors . | | |

**Contact Periods:**
**Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

**TEXT BOOKS:**

| AUTHOR NAME | TITLE OF BOOK | PUBLISHER, EDITION, YEAR OF PUBLICATION |
|---|---|---|
| *Iglewski B.H and Clark V.L* | *Molecular basis of Bacterial Pathogenesis* | *Academic Press Ist Edition 1990.* |
| *Peter Williams, Julian Ketley& George Salmond* | *Methods in Microbiology : Bacterial Pathogenesis* | *Academic Press Ist Edition 1998* |

**REFERENCE BOOKS:**

1. *Recent reviews in Infect. Immun., Mol. Microbiol., Biochem. J., EMBO etc*
2. *Nester, Anderson, Roberts, Pearsall, Nester, "Microbiology: A Human Perspective", McGraw Hill, 3rd Edition, 2001.*
3. *Eduardo A. Groisman, "Principles of Bacterial Pathogenesis", Academic Press, 2001.*

**COURSE OUTCOME:**

Upon completion of the course, the students will be able to

**CO1:** Understand the basics of microbiology and the discovery.
**CO2:** Know how to analyse pathological condition in molecular level.
**CO3:** Acquire knowledge on the pathogenesis of recent outbreaks.
**CO4:** Learn basic molecular biology and experimental skills.
**CO5:** Study the modern approaches to control pathogens.

**COURSE ARTICULATION MATRIX:**

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | M | L | M | - | - | L | - | L | - | - | - | - | H | L |
| **CO2** | L | - | M | - | L | M | - | - | - | - | - | - | L | M |
| **CO3** | H | L | M | - | M | M | - | - | - | - | - | - | M | M |
| **CO4** | M | L | L | - | H | L | - | - | - | - | - | - | M | H |
| **CO5** | L | L | L | - | H | L | - | - | - | - | - | - | M | L |
| **16BPEX10** | M | L | M | - | H | L | - | L | - | - | - | - | M | M |

**L – Low, M – Moderate (Medium), H- High**

**16BPEX11** **NANOBIOTECHNOLOGY** **CATEGORY: PE**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**PRE-REQUISITES: NIL**

**COURSE OBJECTIVES:**

- To understand the fundamentals of nanotechnology, various form of nanomaterials, its properties and applications.
- To acquire knowledge about various methods of synthesis and characterization of nanoparticles.
- To understand the bionanomachinery in living cells for generating energy, motion, synthesizing biomolecules and to apply the knowledge to design bionanodevices.
- To understand and exploit the nanoparticles in biological applications.

| **UNIT I** | **INTRODUCTION** | **9 Periods** |
|---|---|---|
| Nano – definition; Fundamental science behind nanotechnology- electrons- atoms- ions- molecules- metals- biosystems; Nanobiotechnology –definition; Nanomaterials- types- Carbon nanomaterials (fullerene-grapheme- nanotubes; Characteristics and applications)- Quantum Dots and Wires; Metal nanoparticles - properties and applications | | |
| **UNIT II** | **METHODS OF NANOPARTICLES SYNTHESIS** | **9 Periods** |
| Nanoparticles fabrication- Top-down & bottom-up approaches- Physical- chemical- biological methods; Use of bacteria- fungi- actinomycetes and plants for nanoparticle synthesis; Magnetotactic bacteria for natural synthesis of magnetic nanoparticles- mechanism of formation. | | |
| **UNIT III** | **CHARACTERIZATION OF NANOPARTICLES** | **9 Periods** |
| Characterization of nanoparticles – AFM- SEM- TEM- STM- XRD- EDAX- FTIR – principle and applications. | | |
| **UNIT IV** | **NANOBIOMETRICS** | **9 Periods** |
| Introduction- Lipids as nanobricks and mortor- Self assembled monolayers; Nanoscale motors; Ion channel as sensors; DNA based nano-cubes and nano-hinges; Protein based nanomotors- bacteriorhodopsin. | | |
| **UNIT V** | **BIOMEDICAL APPLICATIONS OF NANOPARTICLES** | **9 Periods** |
| Biocompatible In-organic devices (Implant coating- stems and seeds); Chips for molecular diagnostics –DNA microarrays- Protein microarrays- lab on a chip; Nanoparticles for drug delivery; Nanovectors for gene therapy; Nanobiosensors; In-vivo diagnostics in molecular imaging. | | |

**Contact Periods:**
**Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

**TEXT BOOKS:**

| AUTHOR NAME | TITLE OF BOOK | PUBLISHER, EDITION, YEAR OF PUBLICATION |
|---|---|---|
| *Niemeyer and Mirkin* | *Nanobiotechnology: Concepts, Applications and Perspectives* | *Wiley-VCH, 2004.* |
| *Cao, G.* | *Nanostructures and Nanomaterials- Synthesis, properties and applications* | *Imperial College Press, 2004.* |
| *de la Fuente, J.M. and Grazu, V.* | *Nanobiotechnology", in: Fronteries in Nanoscience (Vol.4), R.E. Palmer (Ed),* | *Elsevier, 2012.* |

**REFERENCE BOOKS:**


1. *Yoseph, Bar-Cohen, "Biomimetics : Biologically Inspired Technologies", CRC Press, 2006.*
2. *Roszek, B., de Jong, W.H., Geertsma, R.E., "Nanotechnology in medical applications:state-of-the-art in materials and devices", 2005.*
3. *Kirkland, A.I., Hutchison, J.L., "Nanocharacterization", RSC Publishing, 2007.*


**COURSE OUTCOMES:**

Upon completion of the course, the students will be able to

**CO1:** understand the different types of nanomaterials, its properties and applications.
**CO2:** know about biological methods of nanoparticle synthesis
**CO3:** characterize the synthesized nanoparticles using different analytical techniques.
**CO4:** understand the bionanomachinery in living cells to design bionanodevices.
**CO5:** acquire knowledge about the biological applications of nanoparticles.

**COURSE ARTICULATION MATRIX:**

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | H | M | - | - | - | L | - | - | - | - | - | M | H | M |
| **CO2** | M | H | M | - | - | - | L | L | - | - | - | - | H | M |
| **CO3** | M | M | - | H | M | - | - | - | - | L | - | - | M | H |
| **CO4** | M | L | M | - | - | - | - | - | - | - | - | - | M | H |
| **CO5** | M | - | - | - | - | M | - | - | - | - | - | L | M | H |
| **16BPEX11** | M | M | M | H | M | M | L | L | - | L | - | M | M | H |

**L – Low, M – Moderate (Medium), H- High**

**16BPEX12** **ANIMAL BIOTECHNOLOGY** **CATEGORY: PE**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**PRE-REQUISITES:**

1. 16BPC305 – Microbiology
2. 16BPC406 - Immunology
3. 16BPC504 - Genetic Engineering

**COURSE OBJECTIVES:**

- To provide the basics and applications of animal cell culture.
- To inculcate knowledge about the micromanipulation technology and transgenic animal production.

| UNIT I | ANIMAL CELL CULTURE | 12 Periods |
|---|---|---|
| Introduction to basic tissue culture techniques - Equipment and instruments in ATC - Chemically defined and serum free media - Animal cell cultures - Maintenance and preservation - Various types of cultures - Suspension cultures, Continuous flow cultures, Immobilized cultures, Somatic cell fusion, Organ cultures. | | |
| **UNIT- II** | **ANIMAL DISEASES AND THEIR DIAGNOSIS** | **9 Periods** |
| Bacterial and viral diseases in animals - Monoclonal antibodies – Diagnosis - Molecular diagnostic techniques – PCR, *in-situ* hybridization, Northern blotting, Southern blotting, RFLP. | | |
| **UNIT- III** | **THERAPY OF ANIMAL DISEASES** | **10 Periods** |
| Recombinant cytokines – Therapeutic applications of monoclonal antibody - Vaccines - DNA, sub unit, cocktail vaccines - Gene therapy for animal diseases. | | |
| **UNIT- IV** | **MICROMANIPULATION OF EMBRYO** | **7 Periods** |
| Micromanipulation technology - equipment - enrichment of x and y bearing sperms from semen samples – Artificial insemination - Germ cell manipulations – *In vitro* fertilization -Embryo transfer - Micromanipulation technology and breeding of farm animals.. | | |
| **UNIT -V** | **TRANSGENIC ANIMALS** | **7 Periods** |
| Concepts of transgenic animal technology- Strategies for the production of transgenic and knock out animals– Significance in biotechnology - Stem cell cultures in production of transgenic animals. | | |

**Contact Periods:**
**Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

**TEXT BOOKS:**

| AUTHOR NAME | TITLE OF BOOK | PUBLISHER, EDITION, YEAR OF PUBLICATION |
|---|---|---|
| *Ranga M.M* | *Animal Biotechnology* | *Agrobios India Limited 2010.* |
| *R.Sasidhara* | *Animal Biotechnology* | *MJP Publishers, 2006* |

**REFERENCE BOOKS:**

*1.Masters J.R.W, "Animal Cell Culture: Practical Approach", Oxford University Press, 3rd Edition,2000*

**COURSE OUTCOME:**

Upon completion of the course, the students will be able to

**CO1:** Exploit the biomolecular techniques for the study and diagnosis of infective and parasitic animal diseases, as well as for the formulation of innovative biotechnological vaccines to be implemented in field of veterinary science.

**CO2:** Perceive and deduce the contemplative ethical problems subjective to testing protocols involving animals**.**

**CO3:** Demonstrate various diagnostic and therapeutic techniques for the identification andcuring of animal diseases.

**CO4:** Reckon and utilize the concept of gamete and embryo manipulation technology for the production of transgenic animals and cloning.

**CO5:** Acquire knowledge about the concept of transgenic animal production and its significance in biotechnology.

## COURSE ARTICULATION MATRIX:

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | L | H | - | - | - | - | - | - | - | - | - | - | H | L |
| **CO2** | - | - | - | - | - | M | - | H | - | - | - | - | L | H |
| **CO3** | M | H | M | - | - | - | - | - | - | - | - | - | M | M |
| **CO4** | M | M | M | - | - | L | - | M | - | - | - | - | H | M |
| **CO5** | H | M | M | - | - | L | M | M | - | - | - | - | H | L |
| **16BPEX12** | M | M | M | - | - | L | L | M | - | - | - | - | H | M |

**L – Low, M – Moderate (Medium), H- High**

**16BPEX13** **GENOMICS AND PROTEOMICS** **CATEGORY: PE**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**PRE-REQUISITES:**

1. 16BPC304 - Cell Biology
2. 16BPC403 - Molecular Biology
3. 16BPC504 - Genetic Engineering

**COURSE OBJECTIVES:**

- Provide basic knowledge of genomes and proteomes
- Introduce relevant tools for the analysis of genomes
- Describe methodologies of genomic and proteomic techniques

| UNIT I | OVERVIEW OF GENOMES OF BACTERIA, ARCHAEA AND EUKARYOTA | 9 Periods |
|---|---|---|
| Genome organization of prokaryotes and eukaryotes-Gene structure of Bacteria, Archaea and Eukaryotes-Human genome project-Introduction to functional and comparative genomics. | | |
| **UNIT II** | **PHYSICAL MAPPING TECHNIQUES** | **9 Periods** |
| Cytogenetic mapping-Radiation hybrid mapping-Fish-STS mapping-SNP mapping Optical mapping-Top down and bottom up approach-Linking and jumping of clones- Gap closure-Pooling strategies-Genome sequencing-Next Generation Sequencing. | | |
| **UNIT III** | **FUNCTIONAL GENOMICS** | **9 Periods** |
| Gene finding-Annotation-ORF and functional prediction-Subtractive DNA library screening-Differential display and representational difference analysis-SAGE. | | |
| **UNIT IV** | **PROTEOMICS TECHNIQUES** | **9 Periods** |
| Protein level estimation-Edman protein microsequencing-Protein cleavage-2 D gelelectrophoresis-metabolic labeling-Detection of proteins on SDS gels. Mass spectrometry principles of MALDI-TOF-Fourier Transform Ion Cyclotron Resonance Mass Spectrometer- Orbitrap Mass Analyzer, Tandem MS-MS-Peptide mass fingerprinting. | | |
| **UNIT V** | **PROTEIN PROFILING** | **9 Periods** |
| Post translational modification-Protein-protein interactions-Glycoprotein analysis-Phosphoprotein analysis. | | |

**Contact Periods:**
**Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

**TEXT BOOKS:**

| AUTHOR NAME | TITLE OF BOOK | PUBLISHER, EDITION, YEAR OF PUBLICATION |
|---|---|---|
| *Cantor and Smith* | *Genomics.* | *John Wiley & Sons, 1999.* |
| *Pennington and Dunn* | *Proteomics* | *Garland Science, 2001* |
| *T.A Brown* | *Genomes3* | *Garland Science,* 3rd edition, 2006. |

**REFERENCE BOOKS:**

1. *Primrose and Twyman, Principles of genome analysis and genomics, John Wiley & Sons, 3rd Edition 2003.*
2. *Liebler, Introduction to Proteomics, Humana Press, 2002*
3. *Hunt and Livesey, Functional Genomics, oxford University press, 2000.*

**COURSE OUTCOME:**

Upon completion of the course, the students will be able to

CO1: Understand the basic structure and organization of genomes of Prokaryotes.

CO2: Understand the basic structure and organization of genomes of Eukaryotes.

CO3: Have insight on basic organization of proteomes.

CO4: Analyze proteomes and genomes using the relevant tools.

CO5: Get familiarize with the principles of the methodologies of genomic and proteomic techniques.

**COURSE ARTICULATION MATRIX:**

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | H | - | - | - | - | - | - | - | - | - | - | - | H | L |
| **CO2** | H | - | - | - | - | - | - | - | - | - | - | - | H | L |
| **CO3** | H | - | - | - | - | - | - | - | - | - | - | - | H | L |
| **CO4** | M | H | H | - | H | - | - | - | - | - | - | - | L | H |
| **CO5** | M | H | M | - | H | - | - | - | - | - | - | M | L | H |
| **16BPEX13** | H | H | H | - | H | - | - | - | - | - | - | M | H | L |

**L – Low, M – Moderate (Medium), H- High**

**16BPEX14 MATHEMATICAL AND NUMERICAL METHODS FOR BIOTECHNOLOGY** **CATEGORY: PE**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

- This course introduces a range of numerical methods for the approximate solution of mathematical equations encountered in biochemical engineering.
- The methods are introduced in a problem specific context, such as Bioprocess engineering, Heat and Mass transfer and chemical reaction engineering.

| | | |
|---|---|---|
| **UNIT I** | **APPROXIMATIONS AND ERRORS & SOLUTION OF ALGEBRAIC EQUATIONS** | **10 Periods** |
| Types of Errors, Significant figures, Accuracy of Numbers, Precision, Error Propagation, Applications in Biochemical Engineering<br>Basic Properties of Equations, Relations between Roots and Coefficients, Descartes Rule of Sign, Synthetic Division of a Polynomial by a Linear Expression, Bracketing Methods (Bisection, Secant, Method of False Position or Regula Falsi, etc.), Convergence of Iterative Methods, Newton-Raphson Method for Non Linear Equations in Two Variables. | | |
| **UNIT II** | **SOLUTION OF LINEAR EQUATIONS** | **8 Periods** |
| Mathematical Background, Matrix inversion, Gauss Elimination, Gauss-Jordan Method, Gauss-Seidel Iteration Method, Jacobi's Method, Gauss-Seidel Method. | | |
| **UNIT III** | **CURVE FITTING & FINITE DIFFERENCES & INTERPOLATION** | **10 Periods** |
| Method of Least Squares, Fitting a Straight Line and a Polynomial, Fitting a Non-linear Function,<br>Finite Differences: Forward, Backward and Divided Differences Table, Central Differences, Newton's Forward, Backward and Divided Differences Interpolation Formula, Interpolation Polynomials, Lagrange Interpolation Formula, Inverse Interpolation, | | |
| **UNIT IV** | **NUMERICAL DIFFERENTIATION & INTEGRATION** | **8 Periods** |
| Differentiation Formula based on Tabulator at Equal and Unequal Intervals, Newton-Cotes Integration Formulas, Trapezoidal Rule and Simpson's 1/3 Rule. | | |
| **UNIT V** | **ORDINARY DIFFERENTIAL EQUATIONS** | **9 Periods** |
| Taylor's Series and Euler's Method, Modifications and Improvements in Euler's Method, Runge-Kutta 2nd Order & 4th Order Methods, Milne's Predictor-Corrector Methods, Boundary Value Problems, Parabolic, Applications in Biochemical Engineering. | | |

**Contact Periods:**
**Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**

**TEXT BOOKS:**

| AUTHOR NAME | TITLE OF THE BOOK | PUBLISHER,YEAR OF PUBLICATION |
|---|---|---|
| *Jain, M.K, Iyengar S.R.K and Jain R.K* | *Numerical Methods for Scientific and Engineering Computation* | *New Age International Publishers, 2007* |
| *Pushpavanam S* | *Mathematical Methods in Chemical Engineering.* | *Prentice Hall of India, 1998.* |
| *Alkis Constantinicles,* | *Numerical methods for chemical and Bioprocess engineers with MAT LAB applications* | *Prentice Hall India, 2002.* |

**REFERENCE BOOKS:**


1. *W. L. Luyben, "Process Modeling, Simulation and control for chemical engineers", McGraw Hill, 1990.*
2. *B.W. Bequette, "Process control modeling, Design and Simulation" Prentice Hall India, 2003.*

**COURSE OUTCOME:**

Upon completion of the course the graduates will be able to

**CO1**: Formulate a chemical engineering problem as a mathematical model, and select an appropriate solution method.

**CO2**: Analyze the accuracy of the numerical solution and identify alternate strategies and methods to achieve greater accuracy when it is needed.

**CO3**: Understand the basic algorithms for fitting curves to data.

**CO4**: Understand the basic algorithms for solution of and be able to solve numerical integration problems.

**CO5**: Select the appropriate software package to perform the numerical solution to a biochemical engineering problem.

**COURSE ARTICULATION MATRIX:**

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | - | H | H | L | M | - | - | - | - | - | - | L | H | L |
| **CO2** | M | M | - | H | - | - | L | L | M | L | L | H | H | L |
| **CO3** | M | L | H | L | M | M | - | - | - | - | - | M | L | H |
| **CO4** | L | H | H | L | M | - | H | M | - | - | - | L | H | M |
| **CO5** | L | H | - | - | M | - | - | - | L | M | L | H | L | M |
| **16BPEX14** | M | H | H | L | M | M | H | M | M | M | L | H | H | M |

**L – Low, M – Moderate (Medium), H- High**

**16BPEX15** **BIOENTREPRENEURSHIP** **CATEGORY: PE**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**PRE-REQUISITES:**

1. 16BHS1Z1 - Communication Skills in English
2. 16BHS2Z1 - Technical English
3. 16BEE307 - Communication Skills and Technical Seminar

**COURSE OBJECTIVES:**

- To enable the students to get familiarize with the different sources of opportunities and development of the skills to identify and analyze these opportunities for entrepreneurship and innovation.
- To develop entrepreneurial skills with an understanding of finance management, marketing strategies and ethical and legal issues related various business affairs.

| UNIT I | INTRODUCTION TO ENTREPRENEURSHIP | 9 Periods |
|---|---|---|
| Entrepreneurship Definition - Skills necessary for an Entrepreneur - Stages in entrepreneurship process - Role of entrepreneurship in economic development - Entrepreneurship- Innovation risk and failure - Bio entrepreneur | | |
| **UNIT II** | **BUSINESS MODELS AND FUNDING SOURCES** | **9 Periods** |
| Business models- Vertical model, Platform business model, Service business model from bio based companies, Product model - Grants and Funding sources - Initial public offering, Government Grants, Informal funding, Pre seed and seed, Business angels, Venture capital, Incubators, Private investors, Creative financing, Corporate partners. | | |
| **UNIT III** | **PROJECT PLANNING** | **9 Periods** |
| Start-up Idea – Customers - Competitors, Resources – Technology – Planning – People - Writing business proposal - Checklist for business proposal writing. | | |
| **UNIT IV** | **BIOBUSINESS DEVELOPMENT** | **9 Periods** |
| Location selection for business set up - Marketing Strategy - Financial management - Staff appointment and Management - Business Protection and Insurance – importance - Record Keeping and Accounting. | | |
| **UNIT V** | **LEGAL, ETHICAL AND SOCIAL OBLIGATIONS** | **9 Periods** |
| Legal, Ethical and Social issues involved in bio business management - Growth in Today's Marketplace -Case studies on real bio entrepreneurs- reason for success and failures. | | |

**Contact Periods:**
**Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

**TEXT BOOKS:**

| AUTHOR NAME | TITLE OF BOOK | PUBLISHER, EDITION, YEAR OF PUBLICATION |
|---|---|---|
| *Jogdand S.N* | *Entrepreneurship and Business of Biotechnology* | *Himalaya Publishing Home, 2007* |
| *Damian Hine, John Kapeleris and Edward Elgar* | *Innovation and Entrepreneurship in Biotechnology: An International Perspective, Concepts, Theories and Cases* | *Edward Elgar Publishing Ltd, 2006* |

**REFERENCE BOOKS:**

1. *Oliver R, "The coming biotech age: The business of biomaterials", New York, McGraw Hill, 2000.*
2. *Cynthia Robbins-Roth, "From Alchemy to IPO: The Business of Biotechnology", Basic Books, 2001.*

**COURSE OUTCOME:**

Upon completion of the course, the students will be able to

**CO1:** Develop an ability to communicate effectively, inculcate entrepreneurial skills leading to innovation and risk management.

**CO2:** Demonstrate an ability to grab business opportunity and to gain support from various funding sources for the venture.

**CO3:** Propose and develop appropriate business plan with an understanding of local and global business environment.

**CO4:** Understand the priority of business protection and to find an attractive market that can be reached economically.

**CO5:** Utilise critical thinking skills and apply ethical and legal understanding to business situations.

**CO6:** Desperately analyse the reasons for success and failures of the real bioentrepreneurs and gain knowledge in leading a profitable bio business.

## COURSE ARTICULATION MATRIX:

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | - | - | - | - | - | - | M | L | M | H | M | L | - | H |
| **CO2** | - | - | - | - | - | - | H | L | L | M | M | L | - | H |
| **CO3** | - | - | - | - | - | M | M | M | L | M | H | M | - | H |
| **CO4** | - | - | - | - | - | M | M | - | - | L | H | M | - | H |
| **CO5** | - | - | - | - | - | H | H | H | - | L | M | M | - | H |
| **CO6** | - | - | - | - | - | M | H | L | - | - | H | H | - | H |
| **16BPEX15** | - | - | - | - | - | M | M | M | L | L | M | M | - | H |

**L – Low, M – Moderate (Medium), H- High**

**16BPEX16** **IMMUNOTECHNOLOGY** **CATEGORY: PE**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**PRE-REQUISITES:**

1. 16BPC406 Immunology

**COURSE OBJECTIVES:**

- To find therapeutical solutions to health problems based on immunological principles
- To demonstrate use of various diagnostic kits to identify antigens at cellular and tissue levels
- To develop strategies to produce engineered immune molecules

| UNIT I | ANTIGENS | 6 Periods |
|---|---|---|
| Types of antigens, preparation of antigens for raising antibodies, handling of animals, adjuvants and their mode of action. | | |
| **UNIT II** | **ANTIBODIES & IMMUNODIAGNOSIS** | **12 Periods** |
| Monoclonal and polyclonal antibodies – production, Western blot analysis, immunoelectrophoresis, SDS-PAGE - purification and synthesis of antigens, ELISA-principle and applications, radio immuno assay (RIA) – principles and applications, non isotopic methods of detection of antigens-enhanced chemiluminescence assay. | | |
| **UNIT III** | **ASSESMENT OF CELL MEDIATED IMMUNITY** | **16 Periods** |
| Identification of lymphocytes and their subsets in blood using flow cytometry. Estimation of cytokines, macrophage activation, macrophage microbicidal assay, in-vitro experimentation to understand the pathogenesis and defense mechanisms. | | |
| **UNIT IV** | **IMMUNOPATHOLOGY** | **6 Periods** |
| Preparation and storage of tissues, identification of various cell types and antigens in tissues, isolation and characterization of cell types from inflammatory sites and infected tissues, immunocytochemistry – immunofluoresecence, immunoenzymatic technique, immuno electron microscopy. | | |
| **UNIT V** | **MOLECULAR IMMUNOLOGY** | **5 Periods** |
| Preparation of vaccines, application of recombinant DNA technology for the study of the immune system, production of anti idiotypic antibodies, catalytic antibodies, application of PCR technology to produce antibodies and other immune molecules, immunotherapy with genetically engineered antibodies – Tetramer. | | |

**Contact Periods:**
**Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

**TEXT BOOKS:**

| AUTHOR NAME | TITLE OF BOOK | PUBLISHER, EDITION, YEAR OF PUBLICATION |
|---|---|---|
| *Talwar G.P., and Gupta S.K* | *A hand book of practical and clinical immunology, vol. 1 & 2* | *2nd edition CBS Publications1992* |
| *Roitt, I* | *Essential Immunology* | *9th edition Blackwell Scientific1997* |

**REFERENCE BOOKS:**


1. *Roitt,I., Brostoff, J. and Male D. (2001) Immunology, 6th ed. Mosby.*
2. *Goldsby , R.A., Kindt, T.J., Osbome, B.A. and Kuby J. (2003) Immunology, 5th ed., W.H. Freeman, 2003*
3. *Weir, D.M. and Stewart, J. (1997) Immunology, 8th ed., Cheerchill, Linvstone, 1997.*

**COURSE OUTCOME:**

Upon completion of the course, the students will be able to

**CO1:** describe the preparation and use of antigens

**CO2:** demonstrate various diagnostic methods based on antigen-antibody interactions

**CO3:** critically analyze and assess health problems with immunological background

**CO4:** outline the state of pathogenesis of infectious diseases at cellular and tissue level based on immunopathology

**CO5:** define strategies for the production of engineered antibodies and design of vaccines.

**COURSE ARTICULATION MATRIX:**

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | M | - | - | - | - | M | - | H | - | M | - | - | H | M |
| **CO2** | M | M | H | - | M | - | - | M | L | M | M | M | M | H |
| **CO3** | M | H | H | M | H | H | M | H | M | L | H | H | M | H |
| **CO4** | M | L | M | - | M | L | M | L | - | M | L | L | H | M |
| **CO5** | L | M | H | H | H | H | H | H | H | M | H | H | L | H |
| **16BPEX16** | M | M | H | M | H | H | M | H | M | M | H | H | H | H |

**L – Low, M – Moderate (Medium), H- High**

**16BPEX17 BIOPHARMACEUTICAL TECHNOLOGY CATEGORY: PE**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

- To provide foundation and inform biopharmaceutical aspects in drug development.
- To gain knowledge in physiochemical properties, pharmacology and formulation of biopharmaceuticals.
- To learn the procedures in drug manufacturing and delivery systems.

| UNIT I | INTRODUCTION | 6 Periods |
|---|---|---|
| Pharmaceutical industry & development of drugs, Historical perspective of Biopharmaceutics, types of therapeutic agents , Generics and its advantages, Drugs and cosmetic act and regulatory aspects. | | |
| **UNIT II** | **DRUG ACTION, METABOLISM AND PHARMACOKINETICS** | **10 Periods** |
| Mechanism of drug action, physico-chemical principles of drug metabolism, barriers to distribution of drugs, pharmacokinetics. (ADME), pharmacokinetics - Zero, First, Second order reactions, compartment modeling, kinetics of protein – drug binding, bioavailability and bioequivalence, Biotransformation of drugs, Prodrugs. | | |
| **UNIT III** | **DOSAGE FORMS** | **13 Periods** |
| Classification of dosage forms (solid unit dosages – Tablets- types, manufacture and coating, capsules – preparation and coating; liquids – solutions, suspension; semi-solid – ointments, pastes, suppositories - laxatives; Parenterals), Analytical methods in drug product analysis, packing techniques, Radiopharmaceuticals. | | |
| **UNIT IV** | **BIOPHARMACEUTICAL PRODUCT DEVELOPMENT** | **7 Periods** |
| Reaction process for bulk drug manufacture - Penicillin, Streptomycin, vitamins (any two), vaccines, antibodies, insulin, interferons, recombinant proteins and growth hormones. | | |
| **UNIT V** | **DRUG DELIVERY** | **9 Periods** |
| Design and pharmacokinetic principles of controlled drug delivery systems, Oral, Parenteral controlled release systems, Transdermal, Ophthalmic drug delivery systems. | | |

**Contact Periods:**
**Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**

**TEXT BOOKS:**

| AUTHOR NAME | TITLE OF THE BOOK | PUBLISHER,YEAR OF PUBLICATION |
|---|---|---|
| *Gary Walsh* | *Pharmaceutical Biotechnology: Concepts and Applications* | *John Wiley and Sons, Fourth edition,2007* |
| *Remington's* | *Pharmaceutical Sciences* | *Mack publishing,1975* |
| *Leon Lachman et al* | *Theory and Practice of Industrial Pharmacy* | *Lea and Febiger, 3 Edition,1986.* |

**REFERENCE BOOKS:**


1. *Gareth Thomas. "Medicinal Chemistry". An introduction. John Wiley. 2000.*
2. *Katzung B.G. "Basic and Clinical Pharmacology", Prentice Hall of Intl. 1995.*
3. *Leon Lachman et al, "Theory and Practice of Industrial Pharmacy", 3 Edition, Lea and Febiger, 1986.*
4. *Brahmankar D M, Jaiswal S B, Biopharmaceutics and Pharmacokinetics A Treatise, Vallabh Publisher, (2008)*

**COURSE OUTCOME:**

Upon completion of the course in Biopharmaceutical Technology graduates will be able to

**CO1**: Perceive the pharmacological terms and drug development and its regulation.

**CO2**: Interpret the basic concepts of pharmacokinetics and drug metabolism.

**CO3**: Understand the forms of dosage, packing and contaminant analysis.

**CO4**: Enlighten the process involved in bulk drug manufacturing.

**CO5**: Discuss novel methods for production and delivery of biopharmaceuticals.

**COURSE ARTICULATION MATRIX:**

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | L | L | M | L | H | L | - | - | M | - | L | H | H | L |
| **CO2** | L | H | L | - | L | L | - | - | H | - | L | - | L | H |
| **CO3** | - | H | H | L | M | - | - | - | - | - | M | L | L | H |
| **CO4** | L | L | - | - | H | - | - | - | M | - | M | M | H | L |
| **CO5** | L | H | H | L | M | M | - | - | H | - | L | L | L | M |
| **16BPEX17** | L | H | H | L | M | L | - | - | H | - | L | L | L | H |

**L – Low, M – Moderate (Medium), H- High**

**16BPEX18 BIOPROCESS ECONOMICS AND PLANT DESIGN CATEGORY: PE**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**PRE-REQUISITES:**

1. 16BES502- Heat & Mass Transfer Operations
2. 16BPC604- Bioprocess Engineering

**COURSE OBJECTIVES:**

- To understand the basic engineering fundamentals that include process selection, design and flow sheet preparation for the particular bioprocess plant
- To develop knowledge to select plant location, layout, utilities and safety considerations that will help in installation procedures of new process plants
- To understand the basic concepts of cost estimation and profitability analysis of bioprocess plants.

| UNIT I | INTRODUCTION TO DESIGN PROJECT | 6 Periods |
|---|---|---|
| Introduction to Design – nature of design – Technical feasibility survey, Organization of project-process development – data acquisition – design data information of project – Project documentation – codes and standards. | | |
| **UNIT II** | **PROCESS DESIGN DEVELOPMENT** | **12 Periods** |
| Equipment selection and specifications - materials of construction – flow sheeting – piping and instrumentation – process safety and loss prevention- HAZOP analysis. | | |
| **UNIT III** | **GENERAL SITE CONSIDERATIONS** | **8 Periods** |
| Introduction – plant location and site selection – site layout- plant layout utilities – environmental considerations – waste management – visual impact – government regulations and other legal restrictions, community factors and other factors affecting investment and production costs – human resources. | | |
| **UNIT IV** | **COSTING AND PROJECT EVALUATION** | **12 Periods** |
| Introduction – Accuracy and purpose of capital cost estimates – fixed and working capital operating costs – estimation of purchased costs – inflation – rapid and factorial method of cost estimation, Lang factors - plant overheads – Administration, safety and other auxiliary services, payroll overheads, warehouse and storage facilities etc. | | |
| **UNIT V** | **ECONOMIC EVALUATION OF PROJECTS** | **7 Periods** |
| Cash flow diagrams – tax depreciation – discounted cash flow – rate of return – payback time - sensitivity analysis – computer methods for costing and project evaluation – accounting for uncertainty and variations for future development – Optimization techniques. | | |

**Contact Periods:**
**Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**

**TEXT BOOKS:**

| AUTHOR NAME | TITLE OF BOOK | PUBLISHER, EDITION, YEAR OF PUBLICATION |
|---|---|---|
| *Towler, G. and Sinnot, R.K.* | *Chemical Engineering Design Principles, Practice and Economics of Plant and Process Design* | *Butterworth Heinemann, 2nd Edition, 2013.* |
| *Sinnott.R.K, ,* | *Coulson & Richardson's Chemical Engineering, Series Vol-6* | *Butterworth Heinemann, 2nd Edition,2005* |
| *Peters and Timmerhaus, ,* | *Plant Design and Economics for Chemical Engineers* | *McGraw Hill, 5th Edition , 2003* |

**REFERENCE BOOKS:**


1. *Moran, S., "An Applied Guide to Process and Plant Design", Elsevier, 2015*
2. *Backhurst and Harker, "Process Plant Design",Butterworth-Heinemann, 2013*
3. *Baasal, W.D., "Preliminary Chemical Engineerings Plant Design", Springer, 1989.*


**COURSE OUTCOME:**

Upon completion of the course, the students will be able to

**CO1:** Understand the basics engineering fundamentals for project development and process design.

**CO2:** Design process equipment and consider safety, operability and other design constraints in bioprocess plant design.

**CO3:** Develop knowledge to select plant location, layout and utilities for new process plants

**CO4:** Calculate capital investment and operating costs for process plants

**CO5:** Understand the basic concepts of cost estimation and profitability analysis.

**COURSE ARTICULATION MATRIX:**

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | H | M | H | - | L | L | L | L | L | L | L | M | H | L |
| **CO2** | M | M | H | M | M | - | - | - | - | - | - | - | M | M |
| **CO3** | M | - | - | - | - | - | L | - | - | - | L | - | L | H |
| **CO4** | M | M | - | - | M | - | - | - | - | - | - | - | M | H |
| **CO5** | M | M | - | - | M | - | - | - | - | - | M | - | M | H |
| **16BPEX18** | M | M | H | M | M | L | L | L | L | L | L | M | M | H |

**L – Low, M – Moderate (Medium), H- High**

**16AOEX01** **NANOSCIENCE AND TECHNOLOGY** **CATEGORY: OE**

*(Common to All Branches)*

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**PRE-REQUISITES: NIL**

**COURSE OBJECTIVES:**

To Understand and analyze the concepts of Quantum confinement, Dimensional structures and Properties of nano systems

- To be familiar with various methods of synthesis of nano materials
- To analyze and understand the mechanical and electrical properties of nonmaterial and its applications
- To realize the importance of Nonporous materials and its applications
- To make the students to understand the fundamental aspects of properties leading to technology.

**UNIT I NANO SYSTEMS (9)**

Size effect and properties of nanoparticles - particle size - particle shape - particle density - melting point, surface tension, wettability - specific surface area and pore size – Properties of Individual nanoparticles. Quantum confinement in 3D, 2D, 1D and zero dimensional structures -Size effect and properties of nanostructures- Top down and Bottom up approach.

**UNIT II SYNTHESIS OF NANOMATERIALS (9)**

Sol-Gel Process - Self assembly - Electrodeposition - Spray Pyrolysis - Flame Pyrolysis – Metal Nanocrystals by Reduction - Solvothermal Synthesis - Chemical Vapor Deposition (CVD) – Metal Orgonic Chemical Vapor Deposition (MOCVD).Ball Milling - Inert Gas Condensation Technique (IGCT) – Thermal evaporation – Pulsed Laser Deposition (PLD) – DC/RF Magnetron Sputtering - Molecular Beam Epitaxy (MBE) – Melt Spinning process.

**UNIT III MECHANICAL AND ELECTRICAL PROPERTIES (9)**

Nanoscale Mechanics - Introduction – Mechanical properties – Density Considered as an Example Property – The Elasticity of Nanomaterials – Elasticity of Bulk Nanomaterials –Plastic Deformation of Nanomaterials - The Physical Basis of Yield Strength – Crystals and Crystal Plasticity – From Crystal Plasticity to Polycrystal Plasticity.

Introduction - Energy Storage Basics - General Information: Electrical Energy Storage Devices and Impact of Nanomaterials – Batteries – Capacitors - Electrochemical Properties of Nanoscale Materials - Aerogels and Structure-Directed Mesoporous and Macroporous Solids - Nanoparticles - Nanotubes, Nanowires, and Nanorolls

**UNIT IV NANOPOROUS MATERIALS (9)**

Nanoporous Materials – Silicon - Zeolites, mesoporous materials – nano membranes and carbon nanotubes - AgX photography, smart sunglasses and transparent conducting oxides- Hydrophobic & Hydrophilic materials – molecular sieves – nanosponges.

**UNIT V NANOTECHNOLOGY APPLICATIONS (9)**

Applications of nanoparticles, quantum dots, Nanotubes and nanowires for nanodevice fabrication – Single electron transistors, coulomb blockade effects in ultra-small metallic tunnel junctions - nanoparticles based solar cells and quantum dots based white LEDs – CNT based transistors – principle of Dip Pen Lithography.

**Contact Periods:**

**Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**

**REFERENCE BOOKS:**


1. *G. Timp. Editor, "**Nanotechnology**" AIP press, Springer-Verlag, New York, 1999*
2. *Hari Singh Nalwa, Editor, **"Nanostructured materials and Nanotechnology''**, Concise Edition, Academic Press, USA (2002).*
3. *Guozhong Gao, "**Nanostructures & Nanomaterials: Synthesis, Properties & Applications"**, Imperial College Press (2004).*
4. *K. T. Ramesh, "**Nanomaterials : Mechanics and Mechanisms"**, Springer 2009.*
5. *Kenneth J. Klabunde, "**Nanoscale materials in chemistry"**, John Wiley & Sons, 2001.*
6. *Hari Singh Nalwa,Editor, "**Hand book of Nanostructured Materials and Technology''**, Vol.1-5, Academic Press, USA (2000).*
7. *"**Hand book of Nanoscience, Engineering and Technology"** (The Electrical Engineering handbook series), Kluwer Publishers, 2002*
8. *N John Dinardo, Weinheim, "**Nanoscale characterization of surfaces & interfaces"**, Cambridge: Wiley-VCH, 2nd ed., 2000*
9. *G. Cao, "**Nanostructures & Nanomaterials: Synthesis, Properties &Applications"**, Imperial College Press, 2004.*
10. *J.George, "**Preparation of Thin Films"**, Marcel Dekker, Inc., New York. 2005.*


**COURSE OUTCOME**

**CO1:** Analyze the particle size, particle shape, particle density, Size effect and properties of nanostructures.[Familiarity]

**CO2:** Acquire knowledge in various methods of synthesis of Nano materials. [Application]

**CO3:** Analyze the Elasticity of Nanomaterials , Electrical Energy Storage Devices and Aerogels. Assessment]

**CO4:** Acquire knowledge in Zeolites, mesoporous materials, nano membranes and carbon nanotubes.[Familiarity]

**CO5:** Apply various nano materials to the LED, Transistor Applications. [Usage and Assessment]

**COURSE ARTICULATION MATRIX:**

| CO/ PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | - | H | - | M | - | L | - | - | - | - | - | - | - | - | - |
| **CO2** | M | - | - | L | H | - | - | - | - | - | - | - | - | - | - |
| **CO3** | - | H | - | - | L | - | M | - | - | - | - | - | H | - | - |
| **CO4** | H | - | - | M | - | L | - | - | - | - | - | - | - | H | - |
| **CO5** | L | - | H | - | - | - | M | - | - | - | - | M | - | - | H |

**L – Low, M – Moderate (Medium), H – High**

**16AOEX02 MATERIAL CHARACTERIZATIONS CATEGORY: OE**

*(Common to All Branches)*

**PRE-REQUISITES: NIL** L T P C

**COURSE OBJECTIVES:** 3 0 0 3

- To Understand and analyze the concepts of Thermo gravimetric analysis, Differential thermal analysis and Differential thermal analysis.
- To be familiar with various methods of microscope
- To analyze and understand the working principle of SEM, FESEM, EDAX, and HRTEM
- To realize the importance of Electrical methods and its limitations
- To understand the fundamental aspects and properties of spectroscopy techniques.

**UNIT I THERMAL ANALYSIS (9)**

Introduction – thermo gravimetric analysis (TGA) – instrumentation – determination of weight loss and decomposition products – differential thermal analysis (DTA)- cooling curves - differential scanning calorimetry (DSC) – instrumentation – specific heat capacity measurements – determination of thermo mechanical parameters .

**UNIT II MICROSCOPIC METHODS (9)**

Optical Microscopy: optical microscopy techniques – Bright field optical microscopy – Dark field optical microscopy - phase contrast microscopy - fluorescence microscopy - confocal microscopy - digital holographic microscopy - oil immersion objectives - quantitative metallography - image analyzer.

**UNIT III ELECTRON MICROSCOPY AND OPTICAL CHARACTERISATION (9)**

SEM- FESEM- EDAX,- HRTEM: working principle and Instrumentation – sample preparation – Photoluminescence – light – matter interaction – instrumentation – electroluminescence – instrumentation – Applications.

**UNIT IV ELECTRICAL METHODS (9)**

Two probe and four probe methods- van der Pauw method – Hall probe and measurement – scattering mechanism – C-V, I-V characteristics – Schottky barrier capacitance – impurity concentration – electrochemical C-V profiling – limitations.

**UNIT V SPECTROSCOPY (9)**

Principles and instrumentation for UV-Vis-IR, FTIR spectroscopy, Raman spectroscopy, ESR, NMR, NQR, ESCA and SIMS- proton induced X-ray Emission spectroscopy (PIXE) – application – mass spectroscopy.

**Contact Periods:**
**Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**

**REFERENCE BOOKS:**


1. *Stradling, R.A; Klipstain, P.C;* ***"Growth and Characterization of semiconductors"****, Adam Hilger, Bristol,1990.*
2. *Belk, J.A;* ***"Electron microscopy and microanalysis of crystalline materials"****, Applied Science Publishers, London, 1979.*
3. *Lawrence E.Murr,* ***"Electron and Ion microscopy and Microanalysis principles and Applications"****, Marcel Dekker Inc., New York, 1991*

4. *D.Kealey & P.J.Haines, **"Analytical Chemistry"**, Viva Books Private Limited, New Delhi, 2002.*
5. *G. Gao, **"Nanostructures and Nanomaterials"**, Imperial College Press, London, 2006*
6. *Y. Gogotsi, **"Nanomaterials Handbook"**, CRC Taylor and Francis, New York, 2006*
7. *Banwell, **"Fundamentals of Molecular Spectroscopy"**, Tata McGraw-Hill, 1994.*

**COURSE OUTCOME**

**CO1**: Analyze the properties of TGA,DTA and DSC.[Assessment]
**CO2:** Acquire knowledge in various types of microscopes. [Familiarity]
**CO3:** Analyze the working principle and Instrumentation of SEM, FESEM, EDAX, and HRTEM [Familiarity]
**CO4:** Acquire knowledge in I-V and C-V characteristics. [Application]
**CO5:** Analyze the Principles and instrumentation of Spectroscopy methods. [Familiarity]

**COURSE ARTICULATION MATRIX:**

| CO/ PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | - | H | - | - | M | M | L | - | - | - | - | - | H | - | - |
| **CO2** | H | M | M | - | - | - | L | - | - | - | - | L | - | - | - |
| **CO3** | - | H | M | M | L | - | - | - | - | - | - | - | - | H | - |
| **CO4** | M | H | - | L | M | - | - | - | - | - | - | - | - | - | H |
| **CO5** | - | M | H | - | L | M | - | - | - | - | - | L | - | - | - |

**L – Low, M – Moderate (Medium), H – High**

**16AOEX03 ELECTROCHEMICAL TECHNOLOGY CATEGORY: OE**

*(Common to All Branches)*

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**PRE-REQUISITES: NIL**

**COURSE OBJECTIVES:**

- This course aims at making Mechanical Engineers know about Electrochemical principles applied in manufacturing of Chemical products, fabrication of metals, metallurgy and corrosion studies

**UNIT – I (9)**

Fundamental concepts, electron transfer, mass transfer, adsorption, electro-catalysis, phase formation in electrode reaction, assessment of cell voltage, costing of electrolytic process, performance and figure of merit. Typical cell designs. Laboratory data and scale-up.

**UNIT – II (9)**

Chlor-alkali industry-concept of brine electrolysis, chlorine cell technology, the production of NaOH. Water electrolysis, sodium chlorate, hydrogen peroxide, ozone, cuprous oxide, and synthesis of metal salt via anodic dissolution, Organic electro synthesis-dimerization of acrylonitrile, indirect electrosynthesis

**UNIT – III (9)**

The extraction, refining and production of metal–electro-winning, cementation, electro-refining, Electro-deposition of metal powders. Corrosion and its control-thermodynamics and kinetics of corrosion reactions, corrosion problems in practice, corrosion prevention and control, corrosion problems in electrolytic processing, corrosion measurement and monitoring

**UNIT – IV (9)**

Metal finishing-electroplating, electroless plating, conversion coatings, electroforming, electrochemical etching. Batteries and fuel cells-battery characteristics, battery specifications, evaluation of battery performance, battery components. Fuel cells.

**UNIT – V (9)**

Water purification, effluent treatment and recycling of industrial process stream-metal ion removal and recovery, treatment of liquors containing dissolved chromium, electrolytic method of phase separation, flue gas desulphurization, electrodialysis. Electrochemical sensor and monitoring techniques, polarographic to anodic stripping voltammetry, ion selective electrode, electrochemical biosensors.

**Contact Periods:**
**Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**

**TEXT BOOKS:**

*1. Derek Pletcher and Frank C Walsh, **"Industrial Electrochemistry"**, 2nd edition, Chapman & Hall, UK, 1990*
*2.A.T.Kuhn, **"Industrial Electrochemistry"**, Elsevier Publishers, 1972*

**REFERENCE BOOKS:**

*1. C.L. Mantell, **"Chemical Engineering Series – Industrial Electrochemistry"**, McGraw Hill Co., Inc. London, 1958*
*2.Ullmann's **"Encyclopedia of Industrial Chemistry"**, John Wiley & Sons, Vol.6, pp: 399 - 481, 2003.*
*3.Krik–"**Othmer Encyclopedia of Chemical Technology"**, 4th edition, Vol: I., Pp938 –1025 (1991)*
*4.N.M.Proutand J.S.Moorhouse**, "Modern Chlo-Alkali Technology"**, Vol. IV, Elsevier Applied Science, London, 1990*

**COURSE OUTCOMES**

Students after the completion of this course:

**CO1:** Students will be able to understand the electrodic processes and design cell requirements

**CO2:** Students can apply the electrolysis principle in manufacture of materials required for regular use.

**CO3:** Students will be able to apply their technical skill in metallurgy.

**CO4:** Students will be able to acquire knowledge in all metal finishing techniques.

**CO5:** Students will gain knowledge in solving the problems of corrosion of equipment and battery systems.

**COURSE ARTICULATION MATRIX:**

| CO/ PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | L | H | M | M | H | L | - | - | - | - | - | - | H | - | - |
| **CO2** | L | M | H | L | H | L | - | - | - | - | - | - | - | M | - |
| **CO3** | H | L | H | M | M | H | - | - | - | - | - | - | - | M | - |
| **CO4** | M | L | L | L | M | H | - | - | - | - | - | - | M | L | - |
| **CO5** | L | M | H | L | H | M | - | - | - | - | - | - | - | M | L |
| **16AOEX03** | M | M | M | L | H | M | - | - | - | - | - | - | L | L | L |

**L – Low, M – Moderate (Medium), H – High**

**16AOEX04** **POLYMER TECHNOLOGY** **CATEGORY:OE**

*(Common to All Branches)*

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**PRE-REQUISITES: NIL**

**COURSE OBJECTIVES:**

* This course is aimed to make Mechanical Engineers apply their skills in identifying the types of polymers and their properties applicable to plastics and rubber processing.

**UNIT – I CHEMISTRY OF HIGH POLYMERS (9)**

Monomers, functionality, degree of polymerizations, classification of polymers, glass transition, melting transition, criteria for rubberiness, polymerization methods: addition and condensation; metallocene polymers and other newer techniques of polymerization, copolymerization, block and graft copolymers, techniques for copolymerization-bulk, solution, suspension and emulsion.

**UNIT – II SYNTHESIS AND PROPERTIES (9)**

Commodity and general purpose thermoplastics: PE, PP, PS, PVC, Polyesters, Acrylic, PU polymers. Engineering Plastics: Nylon, PC, ABS, Fluoropolymers - Thermosetting polymers: PF, MF, UF, Epoxy, Unsaturated polyester. Natural and synthetic rubbers: Recovery of NR hydrocarbon from latex, SBR, Nitrile, CR, CSM, EPDM, IIR, BR, Silicone, TPE.

**UNIT – III POLYMER TECHNOLOGY (9)**

Polymer compounding-need and significance, different compounding ingredients for rubber and plastics, cross-linking and vulcanization,. Compression molding, transfer molding, injection molding, blow molding, reaction, injection molding, extrusion, pultrusion, calendaring, rotational molding, thermoforming, rubber processing in two-roll mill, internal mixer.

**UNIT – IV POLYMER BLENDS AND COMPOSITES (9)**

Difference between blends and composites, their significance, choice of polymers for blending, blend miscibility-miscible and immiscible blends, FRP, particulate, long and short fibre reinforced composites.

**UNIT – V POLYMER TESTING (9)**

Mechanical-static and dynamic tensile, flexural, compressive, abrasion, endurance, fatigue, hardness, tear, resilience, impact, toughness. Conductivity-thermal and electrical, dielectric constant, dissipation factor, power factor, electric resistance, surface resistivity, volume resistivity, swelling, ageing resistance, environmental stress cracking resistance.

**Contact Periods:**

**Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**

**REFERENCE BOOKS:**


*1. F.W. Billmeyer, Jr.,* ***"Textbook of polymer science"****, Wiley - Interscience, N.Y.(1971)*

*2. G.Odian ,* ***"Principles of polymerization"****, , Wiley – Interscience (1981)*

*3. Gowarikar V.R. and others ,* ***"Polymer science"****, Wiley Eastern (1986).*

*4. Fenner R.T.,* ***"Principles of polymer processing"****, Chemical publishing N.Y. (1979)*

**COURSE OUTCOMES**

Students after the completion of this course:

**CO1:** Will be able to identify different types of polymers by structure and behaviour, properties and their method of polymerisation.

**CO2:** Will be able to apply various processes of fabrication of plastics and rubber.

**CO3:** Will be able to distinguish polymer blends and composites and understand their specific applications.

**CO4:** Will be able to test the polymer specimens for mechanical properties applicable for various end uses.

**CO5:** Will be able to test the polymer specimens for electrical properties applicable for various end uses.

**COURSE ARTICULATION MATRIX:**

| CO/ PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | M | H | L | L | M | H | - | - | - | - | - | - | M | - | - |
| **CO2** | L | L | H | M | H | L | - | - | - | - | - | - | H | L | - |
| **CO3** | M | M | L | L | M | L | - | - | - | - | - | - | - | M | - |
| **CO4** | L | L | M | M | M | H | - | - | - | - | - | - | - | M | L |
| **CO5** | - | H | L | L | H | M | - | - | - | - | - | - | - | H | - |
| **16AOEX04** | L | M | M | L | M | M | - | - | - | - | - | - | L | M | L |

**L – Low, M – Moderate (Medium), H – High**

**16COEX05 DISASTER MANAGEMENT AND MITIGATION CATEGORY: OE**

*(Common to All Branches)*

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**PRE-REQUISITES: NIL**

**COURSE OBJECTIVES:**

- To give knowledge about basics of Disaster Management.
- To impart knowledge about Hazards and Vulnerability.
- To give knowledge about mitigation and preparedness.
- To teach about Response and Recovery.
- To impart knowledge about the participants involved in the disaster management activity.

**UNIT - I INTRODUCTION (08)**

Disaster throughout history, History of disaster management, Capacity by demand, UN International strategy for disaster reduction, the Hyogo framework for action, Post 2015 framework, Disaster trends.

**UNIT – II HAZARDS AND RISK VULNERABILITY (10)**

Hazard Identification and Hazard Profiling, hazard analysis, Types of hazards- Natural and technologicalComponents of Risk- likelihood and Consequence, Trends and Computation of likelihood and Consequence. Risk Evaluation – purpose, Risk Acceptibility, Alternatives, Personnel. Political/ social, Economic. vulnerability-Physical Profile, Social Profile, Environmental Profile, Economic Profile. Factors Influncing Vulnerability, risk Perception.

**UNIT - III MITIGATION AND PREPAREDNESS (08)**

Mitigation - types of mitigation ,Obstacles in mitigation, Assessment and selection of Mitigation options, Emergency response capacity as , Incorporating Mitigation into development and relief projects

Prepareness- Government Preparedness, Public Preparedness, Media as a public educator. Obstacles to public education and preparedness.

**UNIT - IV RESPONSE AND RECOVERY (09)**

Response the Emergency- Pre disaster, post disaster, Provision of water, food and shelter, volunteer management , command , control and coordination

Recovery- short term and long term recovery .components of recovery- planning, coordination, information, money and supplies, allocation of relief funds, personnel. Types of recovery- Government, Infrastructure, Debris removal disposal and processing, environment, housing, economic and livelihood, individual, family and social recovery- special considerations in recovery.

**UNIT – V PARTICIPANTS (10)**

Governmental Disaster management agencies- Fire, law, emergency management, Emergency medical service, Millitary and other resources. Structures- local, regional, national. Bilateral assistance and its types. Types of national agencies involved in international disaster management. Political implications of bilateral assistance.

Non Governmental Organizations – operations, NGO/ Millitary coordination, standard of conduct. The role of Private sector and academia.

Multilateral organizations - UN agencies and progammes, Regional &Inernationalorganaisations. International Financial Institutions- the world bank, IMF, ADB, IADB. Special considerations.

**Contact Periods:**
**Lecture: 45 Periods Tutorial:0 Periods Practical:0 Periods Total: 45 Periods**

**Text Book**

*1 .Damon P. Coppola, **"Introduction to International Disaster management"**, Elsevier publication, 2015.*

**REFERENCE BOOKS:**

*1. Brassard, Caroline, Giles, David W., Howitt, Arnold M., **"Natural Disaster Management in the Asia-Pacific"**, Policy and Governance.*

*2. **"Disaster Management"**, Global Challenges and Local Solutions, Universities Press, 2009.*

*3. Jack Pinkowski, **"Disaster Management Handbook"**, CRC Press,January 22, 2008.*

*4. **Disaster Management Guidelines**, GOI-UNDP Disaster Risk Reduction Programme (2009-2012).*

**COURSE OUTCOMES**

**CO1:** Able to get knowledge about basics of Disaster management.
**CO2:** Able to impact knowledge about Hazards and vulnerability
**CO3:** Able to know about Mitigation and preparedness.
**CO4:** Able to attain knowledge about response and recovery.
**CO5:** Able to learn about the participants involved in the disaster management activity.

**COURSE ARTICULATION MATRIX:**

| CO/ PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 | PSO 4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | - | L | - | - | L | L | - | L | - | - | - | - | - | - | - | L |
| **CO2** | L | H | - | M | L | M | - | - | - | - | - | L | L | - | - | L |
| **CO3** | L | L | - | - | H | M | - | - | - | - | - | L | L | - | - | L |
| **CO4** | L | M | - | L | L | M | M | - | - | - | - | - | - | - | - | L |
| **CO5** | - | M | - | L | L | M | - | - | - | - | - | - | - | - | - | L |
| **16COEX05** | L | M | - | L | L | M | M | - | - | - | - | L | L | - | - | L |

**L – Low, M – Moderate (Medium), H – High**

**16COEX06** **ENVIRONMENTAL MANAGEMENT** **CATEGORY:OE**

*(Common to All Branches)*

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**PRE-REQUISITES:**

* 16BES2Z4 – Environmental Science and Engineering

**COURSE OBJECTIVES:**

* To understand the importance of nature and study about the water, air and soil pollution control as well as solid waste management.

**UNIT – I NATURE AND SCOPE OF ENVIRONMENTAL PROBLEMS (09)**

Environment and sustainable development – Natural and human environmental disturbances – Global warming –acid rain – ozone depletion – effects and control - climate change conventions – Kyoto protocol – India's efforts for Environmental protection – Public policy and role of NGO's.

**UNIT – II WATER POLLUTION AND CONTROL (09)**

Fresh water and its pollution – Natural processes – sources and pollutants – pollution due to industrial, agricultural and municipal wastes – effects on streams - limitations of disposal by dilution – BOD consideration in streams – Oxygen Sag Curve – Strategies for sustainable water management – Marine environment and its management – Water acts.

**UNIT – III AIR AND NOISE POLLUTION (09)**

Pollutant emissions - sources and sink – effects of air pollution on human health, vegetation and climate– Global effects – prevention and control of air pollution – Control of particulates – Air pollution surveys and sampling – Air quality monitoring - Air Act – Management of air pollution – Sound level – Effect of noise on people – Environmental noise control- noise pollution rules, 2000.

**UNIT – IV SOLID WASTE MANAGEMENT AND SOIL POLLUTION (09)**

Sources – Characteristics – Quantities – Collection methods – Processing and disposal techniques – Onsite Handling, storage and processing – sanitary landfill – Incineration and pyrolysis – Composting – aerobic and anaerobic of compositing – Recycling and reuse of solid wastes – Hazardous wastes – Definition – Sources & types only – Integrated system for waste management – The Basel convention Land use and degradation – Management problems – strategies for sustainable land management – soil pollution –wetland conservation.

**UNIT – V ENVIRONMENTAL MANAGEMENT SYSTEM (09)**

Terminology – installation and common motives of EMS – Environmental standards – ISO 14000 (Series) – basic principles – Environmental Audit – Environmental Impact assessment - Trade rules and environmental protection– Practices for Waste Minimisation and Cleaner Production.

**Contact Periods:**

**Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**

**TEXT BOOKS:**

*1. N.K.Uberoi,* ***"Environmental Management",*** *Excel Books, New Delhi (2006).*

2. *Rao,* ***"Air Pollution"****, Tata McGraw-Hill Education, 01-Jun-1988*

**REFERENCE BOOKS:**

1. *S.Vigneahwaran,M.Sundaravadivel and D.S.Chaudhary* ***, "Environmental Management"****, SCITECH*

*Publications(India) Pvt.Ltd, Chennai & Hyderabad (2004).*

*2. Technobanoglous,* ***"Environmental Management"****, McGraw Hill Book Company (2006).*

**COURSE OUTCOME:**

**CO1:** Students exposed to know common issues related with environment.

**CO2:** Students able to know the sources, causes and effects of water pollution.

**CO3:** Able to attain knowledge related with air and noise pollution.

**CO4:** Able to understand the various management techniques of solid waste and soil Pollution.

**CO5:** Able to aquire knowledge on Environmental Management Systems.

**COURSE ARTICULATION MATRIX:**

| CO/ PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 | PSO 4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | M | L | - | - | - | - | M | - | - | - | - | - | L | H | - | L |
| **CO2** | L | M | - | - | L | - | H | - | - | - | - | L | H | H | L | L |
| **CO3** | L | M | - | - | L | - | H | - | - | - | - | L | H | H | L | L |
| **CO4** | L | M | - | - | L | - | H | - | - | - | - | L | H | H | L | L |
| **CO5** | M | L | - | - | - | - | M | - | - | - | - | - | L | H | L | L |
| **16COEX06** | L | M | - | - | L | - | H | - | - | - | - | L | H | H | L | L |

**L – Low, M – Moderate (Medium), H – High**

**16COEX07 TOWN PLANNING AND ARCHITECTURE CATEGORY: OE**

*(Common to All Branches)*

| | L | T | P | C |
|---|---|---|---|---|
| **PRE-REQUISITES: NIL** | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

- Students are introduced the basics of Town Planning and Architecture

**UNIT – I TOWN PLANNING (09)**

History of evolution of towns - Town and environment – Planning acts – land use classification – Transportation network - Climate, humidity, wind and radiation - Surveys and Data collection - Residential neighborhoods - Industrial areas - Public Buildings - Housing and Slum clearance.

**UNIT – II BUILDING RULES AND GUIDELINES (09)**

General – Zoning regulations – Regulations regarding layouts or subdivisions – Building regulations – Rules for special types of buildings – Floor space index – minimum plot size and building front age – Open spaces – Minimum standard dimensions of building elements – Provision for lighting and ventilation – Provision for means of access – Provision for urban growth.

**UNIT – III BASIC ELEMENTS OF ARCHITECTURE (09)**

Introduction of Architecture – Definition – Mass and space visual emotional effects of geometric forms and their derivatives– The sphere, the cube, the pyramid, the cylinder and cone – The aesthetic qualities of Architecture – Proportion, scale, balance, symmetry, rhythm and axis – contrast in form – Harmony – Consideration of comfort factors acoustics, lighting, ventilation and thermal aspects.

**UNIT – IV PRINCIPLES OF ORIENTATION AND PLANNING OF BUILDINGS (09)**

General – factors affecting orientation – sun – Wind – Rain – Orientation criteria for Indian conditions – Principles governing the theory of Planning – General requirements of site and building – Functional planning of buildings.

**UNIT – V ELEMENTS OF INTERIOR DESIGN (09)**

General – Decorative Materials – Cement Bonded Board (BISON PANEL), Water proof cement paint, Industrial glazing and Roofing, unit masonry, plaster and dry wall, Wall surface materials, Effect of colour on architecture – Home furnishing– plans in rooms.

**Contact Periods:**

**Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**

**TEXT BOOKS:**

*1.S.C.Rangwala, **"Elements of Town Planning"**, McGraw Hill, London, 2006.*

*2.Biswas Hiranmay,**"Principles of Town Planning and Architecture"**, VAYU Education of India, 2012.*

**REFERENCE BOOKS:**

*1. V.S.Pramar, **'Design fundamentals and architecture'** Lakshmi Publishers, 2003.*

*2. Hiraskar, **"Fundamentals in town planning"** Khanna Publishers, 2005.*

**COURSE OUTCOME:**

**CO1:** Students will be able to know about the basics of town planning and building rules.
**CO2:** Students will be able to gain knowledge on building rules & regulations.
**CO3:** Students able to apply the architectural principles in the area of Civil Engineering.
**CO4:** Students will be able to do planning of various buildings.
**CO5:** Students will be able to understand about interior design of buildings.

**COURSE ARTICULATION MATRIX:**

| CO/ PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 | PSO 4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | - | - | - | M | - | - | - | - | - | - | - | L | - | L | - | - |
| **CO2** | - | - | - | - | - | - | M | - | - | - | L | L | - | - | - | - |
| **CO3** | - | L | - | L | - | - | - | - | - | M | - | - | L | - | - | - |
| **CO4** | - | L | - | L | - | - | - | - | - | M | - | - | - | - | - | - |
| **CO5** | - | M | - | - | - | - | - | L | - | - | - | H | - | - | - | - |
| **16COEX07** | - | L | - | L | - | - | L | L | - | M | L | L | L | L | - | - |

**L – Low, M – Moderate (Medium), H – High**

**16MOEX08 TOTAL QUALITY MANAGEMENT FOR ENGINEERS CATEGORY: OE**

*(Common to All Branches except production)*

| | L | T | P | C |
|---|---|---|---|---|
| **PRE-REQUISITES: NIL** | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES**

- To impart knowledge to develop a product with the required quality at a reasonable price and to satisfy the requirements under various quality standards

**UNIT – I QUALITY CONCEPTS (9)**

Definition of quality, dimensions of quality, quality planning, quality costs concepts – basic concepts of total quality management, principles of TQM, leadership concepts – quality council, quality statements, strategic planning- steps in strategic planning- Deming philosophy, barriers in TQM implementation, benefits of TQM.

**UNIT – II TQM PRINCIPLES (9)**

Contribution of TQM Gurus – customer perception of quality – retention, employee involvement – motivation, empowerment, performance appraisal, continuous process improvement – Juran trilogy, PDSA cycle, 5S concept, kaizen, supplier partnership – supplier rating – performance measures- Malcom Balridge National Quality Award.

**UNIT – III STATISTICAL PROCESS CONTROL (9)**

Seven old and new tools of quality – statistical fundamentals – population and sample – normal curve – control charts for variables ,attributes and its applications- process capability – concept of six sigma.

**UNIT – IV TOOLS AND TECHNIQUES (9)**

Benchmarking needs and benefits – benchmarking process – quality function deployment (QFD) – house of quality – Taguchi quality loss function – total productive maintenance (TPM) – pillars of TPM – Failure Mode Effective Analysis (FMEA) – Failure rate- types of FMEA – stages of FMEA-case studies.

**UNIT – V QUALITY SYSTEMS (9)**

Introduction to ISO 9000 and other quality system – ISO 9001:2015 quality system – elements – implementation of quality system – documentation – quality auditing – QS 9000, ISO 14000 – concept, requirements and benefits- integrating ISO 14000 with ISO 9000 – OSHSAS 18001,Implementation of TQM in manufacturing industry.

**Contact Periods:**

**Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**

**TEXT BOOKS:**


*1. Dale H.Besterfield, et al., **"Total Quality Management",** Pearson Education, 2008.*

*2. Subburaj Ramasamy, **"Total Quality Management",** Tata McGraw Hill, 2008.*

*3.Vilas S.Bagad, "Total Quality Management", TECHNICAL PUBLICATIONS, 2017.*

**REFERENCE BOOKS:**

*1. James R.Evans & William M.Lidsay,* ***"The Management and Control of Quality",****Thomson Learning, 2002.*

*2. Feigenbaum.A.V.* ***"Total Quality Management",*** *McGraw-Hill, 1991.*

*3. Zeiri,****"Total Quality Management for Engineers"*** *Wood Head Publishers, 1991*

*4. P.N.Mukherjee****"Total Quality Management"****,PHI Publishers,2006*

*5. John.L Hradesky* ***"Total Quality Management Hand book"*** *McGraw-Hill, 1995.*

**COURSE OUTCOMES**

On completion of this course, students will be able to

- **CO1:** apply the principle of strategic planning, Deming philosophy and leadership concepts in industries.
- **CO2:** apply the principle of TQM in industries.
- **CO3:** apply the principle of statistical process control in industries.
- **CO4:** select appropriate quality tools to meet industrial requirements.
- **CO5:** implement appropriate quality standards for industries.

**COURSE ARTICULATION MATRIX:**

| CO/ PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | L | H | - | - | M | - | - | L | L | - | L | L | M | L | M |
| **CO2** | L | H | - | - | M | - | - | L | L | - | L | L | M | L | M |
| **CO3** | L | H | - | - | M | - | - | L | L | - | L | L | M | L | M |
| **CO4** | L | H | - | - | M | - | - | L | L | - | L | L | M | L | M |
| **CO5** | L | H | - | - | M | - | L | L | L | - | L | L | M | L | M |
| **16MOEX08** | L | H | - | - | M | - | L | L | L | - | L | L | M | L | M |

**L – Low, M – Moderate (Medium), H – High**

**16MOEX09** **COMPOSITE MATERIALS** **CATEGORY:OE**

*(Common to all Branches)*

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**PRE-REQUISITES:**

16BBS2Z3 Material Science

**COURSE OBJECTIVES:**

- To impart the fundamentals of composite materials with different reinforcement, matrix materials and comprehend the types of manufacturing methods for advance composite materials to meet various engineering requirements.

**UNIT –I INTRODUCTION TO COMPOSITE MATERIALS (9)**

Types and characteristics of composite materials-Mechanical 154odelling-Basic terminology and Manufacture of laminated fiber-Reinforced composite materials-Current and potential advantages-Applications of composite materials.

**UNIT – II REINFORCEMENT AND MATRICES (9)**

Different types of fibers-Properties and applications of fibers-Roll of matrix-Matrix materials, Selection of matrix-Thermoset matrix-Thermoplastic matrix, Fiber architecture – Natural Fibers.

**UNIT –III DESIGN OF COMPOSITE STRUCTURES (9)**

Elements of Design-Steps in design process- Elements of analysis in design-Analysis iterations-Design analysis stages-Material selection-Configuration selection-Laminate joints-Design requirements and design failure criteria.

**UNIT –IV MANUFACTURING OF ADVANCED COMPOSITES (9)**

Bag-Molding process-Compression molding-Pultrusion-Filament winding-Liquid composite molding processes-Resin film infusion-Elastic reservoir molding-Tube rolling-Forming methods for thermoplastic matrix composites.

**UNIT – V METAL, CERAMIC AND CARBON MATRIX COMPOSITES (9)**

Metal matrix composites – Manufacturing processes – Ceramic matrix composites- Mechanical properties – Manufacturing processes – Carbon matrix composites – Fabrication methods – Applications.

**Contact Periods:**

**Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**

**TEXT BOOKS:**

*1.Krishnan K., Chawla **"Composite Materials Science and Engineering"**, Springer (India) Private Limited, 2011*

*2.P.K.Mallick, **"Fiber Reinforced Composite materials, Manufacturing and Design"**, CRC Press,Taylor and Francis Group, Boca Raton,London,Newyork 2010*

**REFERENCE BOOKS:**

*1. A.K.Bhargava,* ***"Engineering Materials: Polymers, ceramics and composites"****, Pentice Hall of India Limited, 2010.*

*2. Hyer M., Stress Analysis of Fiber –* ***"Reinforced Composite Materials"****, Tata McGraw Hill, 1998.*

*3. Madhujit Mukhopadhyay ,* ***"Mechanics of Composite Materials and Structures "****, Universities Press (India) Private Limited, 2009.*

*4. Robert M.Jones,* ***"Mechanics of Composite Materials"****, Taylor & Francis Group, 2010.*

*5. Web Portal: Composite Materials {Nptel .Mechanical Engineering}*

**COURSE OUTCOMES:**

On completion of this course, students will be able to

CO1: understand the mechanics and behaviour of reinforced composite materials for specific applications and developing composite materials for sustainability

CO2: formulate different types of reinforcement and matrices to develop new composite material for the various application

CO3: design and manufacture post processing methods of composite structures and capable to perform various analysis

CO4: execute different methods of manufacturing advanced composites to meet the innovate demand in engineering.

CO5: fabricate metal matrix, ceramic matrix and carbon matrix composite for various engineering application to meet the societal demand.

**COURSE ARTICULATION MATRIX:**

| CO/ PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | H | M | H | - | - | M | M | - | - | - | L | - | H | - | L |
| **CO2** | H | M | M | M | M | - | L | - | - | - | M | - | M | M | - |
| **CO3** | M | M | M | M | - | L | M | - | - | - | L | - | L | M | - |
| **CO4** | M | M | M | L | - | H | L | - | L | - | M | - | M | L | - |
| **CO5** | L | L | - | L | - | M | L | - | - | - | - | L | M | M | - |
| **16MOEX09** | M | M | M | L | L | M | L | - | L | - | L | L | M | L | L |

**L – Low, M – Moderate (Medium), H – High**

**16MOEX10** **AUTOMOBILE ENGINEERING** **CATEGORY:OE**

*(Common to all Branches)*

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**PRE-REQUISITES:**

1. 16MPC502 Thermal Engineering
2. 16MPC603 Design of Transmission systems

**COURSE OBJECTIVES:**

- The learners are able to visualize the scope of Automobile Engineering.

**UNIT – I INTRODUCTON TO AUTOMOTIVES (9)**

An overview of different types of automobiles and their power sources. Specifications, Performance Parameters, Quality standards, Trends in automobile design

**UNIT – II POWER SOURCE FEATURES (9)**

Reciprocating Engine systems, Rotary Engine systems, Gas Turbine systems, Hybrid systems – Pollutant emissions and their control; Catalytic converter systems, Electronic Engine management systems

**UNIT – III TRANSMISSION, SUSPENSION AND BRAKING SYSTEMS (9)**

Clutch system, Gear box system, propeller shafting, differential, axles, wheels and tyres and Preliminaries of suspension systems

**UNIT – IV AUXILIARY SYSTEMS (9)**

Electrical and electronic systems, safety systems, Heating, Ventilation, and Air Conditioning (HVAC) systems, Vehicle Thermal Management System and vehicle body design features.

**UNIT – V TESTS, SERVICE AND MAINTENANCE (9)**

Engine Tuning, vehicle maintenance, engine and Chassis Dynamometry Pollutants and emissions Check, Wind Tunnel Tests, preliminaries of engine and vehicle testing.

**Contact Periods:**

**Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**

**TEXT BOOKS:**

*1. Dr. Kirpal Singh, **"Automobile Engineering Vol. I & II"**, Standard Distributors Publishers, 2012.*

*2. R.B.Gupta, **"Automobile Engineering"** Sathya Prakashan, New Delhi, 2006.*

**REFERENCE BOOKS:**

*1. William H.Crouse, **"Automotive Mechanics"**, McGraw Hill Book Co. 2004.*

*2. K.K. Ramalingam, **"Automobile Engineering – theory and Practice"** SciTech Publications, 2001.*

*3. Joseph Heinter **"Automobile Mechanics Principles and Practice"** Affiliated East West Press, 1997.*

*4. Jain K.K. and Asthana. R.B, **"Automobile Engineering"** Tata McGraw Hill Publishers, New Delhi, 2002.*

*5. Heinz Heisler, **"Advanced Engine Technology"** SAE International Publications USA, 1998.*

**COURSE OUTCOMES:**

On completion of this course, learners will be able to:

CO1: Identify the different components in an automobile.

CO2: Clearly understand different auxiliary and transmission systems.

CO3: Explain the working of various parts like engine, transmission, clutch, brakes

CO4: Understand the environmental implications of automobile emissions

CO5: Develop a strong base for understanding future developments in the automobile industry

**COURSE ARTICULATION MATRIX:**

| CO/ PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | M | M | M | L | H | M | M | M | L | L | L | H | M | M | H |
| **CO2** | H | M | H | H | M | H | L | L | L | M | M | L | H | M | H |
| **CO3** | M | M | M | L | M | H | M | L | L | M | H | L | H | H | M |
| **CO4** | H | M | H | M | H | M | H | H | M | M | H | L | L | L | H |
| **CO5** | M | L | L | L | M | H | M | | L | H | H | H | H | M | H |
| **16MOEX10** | M | M | M | M | H | H | M | L | L | M | M | M | M | M | H |

**L – Low, M – Moderate (Medium), H – High**

**16EOEX11 RENEWABLE ENERGY SOURCES AND TECHNOLOGY CATEGORY:OE**

*(Common to all Branches)*

| | L | T | P | C |
|---|---|---|---|---|
| **PRE-REQUISITES: NIL** | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVE:**

- To elucidate the technologies used for generation and utilization of power from renewable energy resources.

**UNIT – I SOLAR ENERGY ( 9)**

Solar radiation, solar spectra-latitude and longitude, Declination angle, solar window, cosine law, seasonal variations, hour angle, calculation of angle of incidence, angstroms equation and constants, Photo voltaic: p-n junctions. Solar cells, PV systems, Standalone, Grid connected solar power – Types of solar thermal collectors – Flat and concentrating collectors, solar thermal applications – water heaters, dryers, stills, refrigeration, air-conditioning, solar pond, central receiver power generation.

**UNIT – II WIND ENERGY ( 9)**

Wind energy – Basic principle of wind energy conversion system, wind data and energy estimation, site selection, components of wind energy conversion systems, design consideration of horizontal axis wind mill- merits and limitations- application

**UNIT – III BIOMASS ENERGY ( 9)**

Biomass, sources of biomass, thermo-chemical and bio-chemical conversion of biomass – Pyrolysis, gasification, combustion and fermentation. Gasifiers – Up draft, downdraft and fluidized bed gasifier. Digesters- Fixed and floating digester biogas plants, economics of biomass power generation.

**UNIT – IV OCEAN AND GEOTHERMAL ENERGY ( 9)**

Ocean energy resources – Principles of ocean thermal energy conversion systems – ocean thermal power plants – Principles of ocean wave energy conversion and tidal energy conversion – Difference between tidal and wave power generation, Economics of OTEC.
Definition and classification of Geothermal resources, Utilization for electricity generation and direct heating, Wellhead power generating units. Overview of micro and mini hydel power generation

**UNIT – V RENEWABLE ENERGY POLICIES ( 9)**

Renewable energy policies - Feed-in tariffs, portfolio standards, policy targets, tax incentives, and biofuels mandates. International policies for climate change and energy security. Economic analysis and comparisons, Life cycle analysis, financial analysis, cost of conserved energy, and externalities. Cost assessment of supply technologies versus energy- Efficiency.

**Contact Periods:**

**Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**

**TEXT BOOKS:**

*1.Rao. S. And Dr. Pamlekar B.B,* ***"Energy Technology",*** *Khanna Publishers, Second Ed. 1997*
*2.Pai and Ramaprasad,* ***"Power Generation through Renewal sources",*** *Tata McGraw Hill – 1991*

**REFERENCE BOOKS:**

*1.Rai , G.D., "**Non Conventional sources of Energy**", Khanna Publishers , IV Ed.,2009*

*2.Bansal NK, Kleeman and Meliss, M "**Renewable Energy Sources and Conversion Techniques**", Tata McGraw Hill, 1996*

*3.Roland Wengenmayr, Thomas Buhrke, **"Renewable energy: Sustainable energy concepts for the future"**, Wiley-VCH, 1st edition, 2008.*

**COURSE OUTCOME:**

**CO1:** Realize the need for utilizing the energy from clean and Sustainable energy resources.

**CO2:** Describe the principles of operation of the broad spectrum of renewable energy Technologies

**CO3:** Analyze energy technologies from a systems perspective.

**CO4:** Articulate the technical challenges for each of the renewable sources

**CO5:** Create solutions for alternate energy issues

**CO6:** Discuss economic, technical and sustainability issues involved in the integration of renewable energy systems

**COURSE ARTICULATION MATRIX:**

| CO/ PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | H | M | M | M | M | M | M | - | - | L | L | L | H | M | M |
| **CO2** | H | H | M | M | M | M | M | L | - | L | L | L | H | H | H |
| **CO3** | H | M | M | M | M | M | M | M | - | - | L | L | M | H | H |
| **CO4** | M | H | M | L | M | H | M | M | - | L | L | L | H | H | H |
| **CO5** | M | H | H | H | M | M | M | M | - | L | L | L | M | H | M |
| **CO6** | H | M | M | M | M | M | M | - | H | H | L | L | M | H | M |
| **16EOEX11** | H | H | M | M | M | M | M | L | L | L | L | L | H | H | H |

**L – Low, M – Moderate (Medium), H – High**

**16EOEX12** **SMART GRID TECHNOLOGY** **CATEGORY:OE**

*(Common to all Branches)*

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**PRE REQUISITES: NIL**

**COURSE OBJECTIVE:**

* To gain knowledge on the fundamentals of smart grid technologies, its architecture and its managements. Also the students should learn many of the challenges facing the smart grid as part of its evolution.

**UNIT – I SMARTGRIDS: MOTIVATION, STAKES AND PERSPECTIVES ( 9)**

Introduction – Information and Communication technologies serving the electrical system – Integration of advanced technologies – Definitions of Smart Grids – Objectives addressed by the Smart Grid concept – Socio-economic and environmental objectives – Stakeholders involved the implementation of the Smart Grid concept – Research and scientific aspects of the Smart Grid – Smart Grids from the customer's point of view.

**UNIT – II INFORMATION AND COMMUNICATION TECHNOLOGY ( 9)**

Data Communication, Dedicated and shared communication channels, Layered architecture and protocols, Communication technology for smart grids, standards for information Exchange, Information security for the smart grid – Cyber Security Standards – IEEE1686 – IEC62351.

**UNIT – III SENSING AND MEASUREMENT ( 9)**

Synchro Phasor Technology-Phasor Measurement Unit, Smart metering and demand side integration-Communication infrastructure and protocol for smart metering-Data Concentrator, Meter Data Management System. Demand side Integration-Services, Implementation and Hardware Support of DSI.

**UNIT – IV CONTROL AND AUTOMATION ( 9)**

Distribution automation equipment – Substation automation equipments: current transformer, potential transformer, Intelligent Electronic Devices, Bay controller, Remote Terminal Unit. Distribution management systems – SCADA: 160odelling and analysis tools, applications

**UNIT- V REGULATION OF SMARTGRIDS AND ENERGY STORAGE SYSTEMS ( 9)**

Regulation and Economic models-Evolution of the value chain-The emergence of a business model for smart grids-Regulation can assist in the emergence of Smart Grids-The standardization of Smart Grids-Energy Storage Technologies-Methods-Batteries, Flow Battery, Fuel Cell and Hydrogen Electrolyser, Flywheel, Super-Conducting magnetic energy storage system, Super Capacitor.

**Contact Periods:**

**Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**

**TEXT BOOKS:**

*1.Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage,* ***"Smart Grid Technologies and applications",*** *John Wiley Publishers Ltd., 2012.*

*2.Nouredine Hadjsaid, JeanClaude Sabonnadiere,* ***"Smart Grids****",Wiley Publishers Ltd., 2012.*

*3.Lars T. Berger, Krzysztof Iniewski,* ***"Smart Grid applications, Communications and Security",*** *John Wiley Publishers Ltd., 2012.*

**Reference Books :**

*1.Yang Xiao,* ***"Communication and Networking in Smart Grids",*** *CRC Press Taylor and Francis Group,2012.*

*2.Caitlin G. Elsworth,* ***"The Smart Grid and Electric Power Transmission",*** *Nova Science Publishers Inc, August 2010*

**COURSE OUTCOME:**

**CO1:** Develop and demonstrate the various aspects of the smart grid, including Technologies, Components, Architectures, Applications

**CO2:** Design a smart grid and to meet the needs of a utility, including Meeting a utility's objectives, helping to adopt new technologies into the grid

**CO3:** Creating a framework for knowledgeable power engineers to operate the grid more effectively

**CO4:** Transfer the available information from any part of the power system to centralized control centre.

**CO5:** Handle the smart meter, sensors and intelligent devices to measure the electrical quantity.

**CO6:** Control the Electrical quantity from remote place.

**COURSE ARTICULATION MATRIX:**

| CO/ PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | - | - | - | L | L | M | H | L | M | M | M | H | M | H | M |
| **CO2** | L | L | M | M | M | M | M | L | M | M | M | M | M | M | H |
| **CO3** | - | - | - | M | M | M | M | M | M | M | M | H | M | M | M |
| **CO4** | L | - | - | M | M | M | H | - | M | M | M | H | M | H | H |
| **CO5** | M | - | L | M | M | M | M | - | M | M | M | M | M | M | M |
| **CO6** | L | L | M | L | M | M | L | - | M | M | M | M | M | M | M |
| **16EOEX12** | L | L | L | M | M | M | M | L | M | M | M | H | M | M | M |

**L – Low, M – Moderate (Medium), H – High**

**16LOEX13 PRINCIPLES OF COMMUNICATION CATEGORY:OE**

*(Common to all Branches)*

| | L | T | P | C |
|---|---|---|---|---|
| **PRE-REQUISITES: NIL** | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

- To understand the concepts of analog communication
- To gain the fundamental knowledge of digital communication
- To be familiar with the fundamentals of satellite and optical communication

**UNIT- I AMPLITUDE MODULATION ( 9)**

Introduction to communication systems- Electromagnetic spectrum – Principle of amplitude modulation – AM envelope – frequency spectrum and bandwidth – modulation index and percentage of modulation –AM power distribution–AM generation and-detection – square law modulator- envelope detector.

**UNIT – II ANGLE MODULATION ( 9)**

Frequency modulation and phase modulation- FM and PM waveforms – phase deviation and modulation index – frequency deviation and percentage of modulation – Frequency analysis of angle modulated waves- Bandwidth requirements for Angle modulated waves – generation and detection of FM – Armstrong modulator- Foster Seely Discriminator.

**UNIT – III PULSE MODULATION ( 9)**

Sampling and Quantization – Pulse Amplitude modulation- Pulse width modulation –Pulse position modulation- Pulse code modulation- PCM transmitter and receiver – Signal to Quantization noise ratio – Differential Pulse Code Modulation – Delta modulation – Adaptive Delta modulation

**UNIT – IV DIGITAL COMMUNICATION ( 9)**

Introduction – ASK, FSK,PSK- transmitter and receiver – QPSK transmitter and receiver – M ary PSK – Error probability in PSK, FSK.

**UNIT –V SATELLITE AND OPTICAL COMMUNICATION ( 9)**

Satellite Communication Systems-Transmitter and receiver- Kepler's Law –LEO and GEO Orbits – GEO Stationary orbit–Optical Communication Systems– Transmitter and receiver-Sources and Detectors- Types of Optical Fiber – Losses.

**Contact Periods:**

**Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**

**TEXT BOOKS:**

1. *Wayne Tomas*i, "***Advanced Electronic Communication Systems",*** 6/e, Pearson Education, 2007.

2. *Simon Haykin, "**Communication Systems**", 4th Edition, John Wiley & Sons., 2008.*

**REFERENCE BOOKS:**


1. *H.Taub,D L Schilling ,G Saha , "**Principles of Communication**"3/e,2007.*
2. *B.P.Lathi, "**Modern Analog And Digital Communication systems",** 3/e, Oxford University Press, 2007*
3. *Blake, "**Electronic Communication Systems",** Thomson Delmar Publications, 2002.*
4. *B.Sklar, "**Digital Communication Fundamentals and Applications" 2/e** Pearson Education 20 07.*


**COURSE OUTCOMES:**

Upon completion of this course, the students will have the :

**CO1.** Basic knowledge of amplitude modulation systems
**CO2.** Basic knowledge of angle modulation systems
**CO3.** Fundamental knowledge of digital communication systems
**CO4.** Understanding of digital transmission techniques
**CO5.** Fundamental knowledge of satellite communication system
**CO6.** Fundamental knowledge of optical communication system

**COURSE ARTICULATION MATRIX:**

| CO/ PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | M | M | M | - | - | - | - | - | - | - | - | L | M | L | - |
| **CO2** | M | M | M | - | - | - | - | - | - | - | - | L | M | L | - |
| **CO3** | M | M | M | - | - | - | - | - | - | - | - | L | L | L | - |
| **CO4** | M | M | M | - | - | - | - | - | - | - | - | L | M | L | - |
| **CO5** | M | M | M | - | - | - | - | - | - | - | - | L | L | L | - |
| **CO6** | M | M | M | - | - | - | - | - | - | - | - | L | M | M | - |
| **16LOEX13** | M | M | M | - | - | - | - | - | - | - | - | L | M | L | - |

**L – Low, M – Moderate (Medium), H – High**

**16LOEX14 MICROCONTROLLERS AND ITS APPLICATIONS CATEGORY:OE**

*(Common to all Branches)*

| | L | T | P | C |
|---|---|---|---|---|
| **PRE-REQUISITES: NIL** | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

- To gain knowledge on basics of microcontrollers
- To get exposure to programming of microcontroller 8051
- To acquire knowledge on interfacing of peripherals with 8051 and PIC microcontrollers.
- To get exposure on applications of microcontrollers

**UNIT – I INTRODUCTION TO MICROCONTROLLER (9)**

Microprocessors and Microcontrollers – CISC and RISC – Fundamentals of Assembly language Programming – Instruction to Assembler – C Programming for Microcontrollers – Compiler and IDE – Introduction to Embedded systems – Architecture 8051 family – PIC 18FXXX – family – Memory organization

**UNIT – II PROGRAMMING OF 8051 MICROCONTROLLER (9)**

Instruction set – Addressing modes – I/O Programming-Timer/Counter – Interrupts – Serial communication of 8051.

**UNIT – III PROGRAMMING OF PIC18FXXX MICROCONTROLLER (9)**

Instruction set – Addressing modes – I/O Programming-Timer/Counter – Interrupts – Serial communication, CCP, ECCP PWM programming of PIC18FXXX.

**UNIT – IV PERIPHERAL INTERFACING (9)**

Interfacing of Relays, Memory, key board, Displays – Alphanumeric and Graphic, RTC, ADC and DAC, Stepper motors and DC Motors, $I^2C$, SPI with 8051 and PIC family.

**UNIT – V MICROCONTROLLER APPLICATIONS (9)**

Pulse measurement-measuring frequency, pulse width measurement –Speed control of DC Motor-Speed control of Stepper Motor-Traffic Light Controller and Washing Machine Controller.

**Contact Periods:**

**Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**

**Text Books:**

*1.Kenneth J.Ayala., **"The 8051Microcontroller",** 3rd Edition, Thompson Delmar Learning, 2007, New Delhi.*

*2. John B. Peatman, "**PIC programming"**, McGraw Hill International, USA, 2005.*

**REFERENCE BOOKS:**

*1.Muhammad Ali Mazidi and Janice GillispicMazdi, "**The 8051 Microcontroller and Embedded Systems**" Pearson Education, Inc 2006.*

*2.John B. Peatman, "**Design with Micro controllers"**, McGraw Hill International, USA, 2005*

*3.James W. Stewart, **"The 8051 Micro controller hardware, software and interfacing**", regents Prentice Hall, 2003.*

*4.David Calcutt, Fred Cowan, Hassan Parchizadeh, "**8051 Microcontroller An Application Based Introduction"**, Elsevier Publication, 1st edition,2004.*

*5.Krishna Kant, "**Microprocessor and Microcontrollers**" Eastern company edition, Prentice Hall of India, New Delhi, 2007.*

**COURSE OUTCOMES:**

Upon completion of this course the student will:

**CO1:** Acquire knowledge on the basics of microcontroller

**CO2:** Exposure to 8051 microcontroller Programming

**CO3:** Exposure to PIC microcontroller Programming

**CO4:** Able to interface peripherals with microcontrollers

**CO5:** Get exposure to the applications of microcontrollers

**CO6:** Able to design microcontroller based systems

**COURSE ARTICULATION MATRIX:**

| CO/ PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | M | H | M | - | - | - | - | - | - | - | - | L | L | M | - |
| **CO2** | M | H | M | - | - | - | - | - | - | - | - | M | M | M | - |
| **CO3** | M | H | M | - | - | - | - | - | - | - | - | M | M | M | - |
| **CO4** | M | H | M | - | - | - | - | - | - | - | - | M | M | M | - |
| **CO5** | M | H | M | - | - | - | - | - | - | - | - | M | M | M | - |
| **CO6** | H | H | H | - | - | - | - | - | - | - | - | M | H | H | - |
| **16LOEX14** | H | H | M | - | - | - | - | - | - | - | - | M | M | M | - |

**L – Low, M – Moderate (Medium), H – High**

**16NOEX15 INDUSTRIAL AUTOMATION SYSTEMS CATEGORY: OE**

*(Common to all Branches)*

| | L | T | P | C |
|---|---|---|---|---|
| **PRE-REQUISITES: NIL** | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES**

- To elaborate the basic concept of automation and the components required for automation.
- To introduce the concept and programming of programmable logic controllers and distributed control system which is used for process automation.
- To outline the basic concepts of SCADA technology.

**UNIT – I INTRODUCTION TO AUTOMATION (9)**

Automation overview – requirement of automation systems – architecture of industrial automation system – power supplies and isolators –relays – switches –transducers – sensors –seal-in circuits – industrial bus systems : modbus and profibus.

**UNIT – II AUTOMATION COMPONENTS (9)**

Sensors for temperature – pressure – force – displacement – speed – flow- level – humidity and Ph measurement. Actuators – process control valves – power electronic drives DIAC- TRIAC – power MOSFET – IGBT. Introduction to DC and AC servo drives for motion control

**UNIT- III PROGRAMMABLE LOGIC CONTROLLERS (9)**

PLC Hardware – PLC programming – ladder diagram – sequential flow chart – PLC communication and networking – PLC selection – PLC installation – Advantages – Application of PLC to process control industries and Robotics.

**UNIT – IV DISTRIBUTED CONTROL SYSTEM (DCS) (9)**

Overview of DCS – DCS hardware – DCS software configuration – DCS communication – DCS supervisory computer tasks – DCS integration with PLC and Computers

**UNIT – V SCADA (9)**

Introduction – Supervisory Control and Data Acquisition Systems (SCADA) – SCADA HMI Essentials – SCADA Components – SCADA Configuration and Software – HMI hardware and software.

**Contact Periods:**

**Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**

**TEXT BOOKS:**


1. *John.W. Webb Ronald A Reis, "**Programmable Logic Controllers – Principles and Applications**", Prentice Hall Inc., 5th Edition, 2003.*
2. *M. P. Lukcas, "**Distributed Control Systems",** Van Nostrand Reinhold Co., 1986.*


**REFERENCE BOOKS:**


*1. Bela G Liptak, **"Process software and digital networks – Volume 3",** 4th Edition, CRC press, 2012.*

*2. Frank D. Petruzella, "**Programmable Logic Controllers**", 5th Edition, McGraw Hill, 2016.*

*3. Huges T, "**Programmable Logic Controllers**", ISA press, 1994*

*4. Romily Bowden, "**HART application guide and the OSI communication foundation**", 1999*

*5. Krishna Kant, "**Computer Based Industrial Control**" Second edition, Prentice Hall of India, New Delhi, 2010*

**COURSE OUTCOMES:**

On completion of this course, the students will be able to

**CO1:** Elaborate the basic architecture of automation systems

**CO2:** Describe the various sensors and actuators involved in industrial automation

**CO3:** Construct ladder logic diagram using PLC basic functions, timer and counter functions for simple applications

**CO4:** Illustrate the functionary components and supervisory control of DCS with relevant diagrams.

**CO5:** Describe the basics of SCADA technology

**COURSE ARTICULATION MATRIX:**

| CO/ PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | H | H | M | M | L | L | L | H | L | M | L | L | H | L | L |
| **CO2** | H | H | H | H | L | L | L | H | L | M | L | L | H | L | L |
| **CO3** | H | H | M | M | L | L | M | H | L | M | L | L | H | L | L |
| **CO4** | H | H | H | H | L | L | L | H | L | M | L | L | H | L | L |
| **CO5** | H | H | M | M | M | L | L | H | L | M | L | L | H | L | L |
| **16NOEX15** | H | H | M | M | L | L | L | H | L | M | L | L | H | L | L |

**L – Low, M – Moderate (Medium), H – High**

**16NOEX16 MEASUREMENTS AND INSTRUMENTATION CATEGORY:OE**

*(Common to all Branches)*

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**PRE-REQUISITES:**

* 16NPC305 Sensors and Transducer

**COURSE OBJECTIVES**

* To study about the electrical parameter measuring instruments.
* To familiarize about the measurement techniques for power and energy.
* To gain knowledge about potentiometer and instrument transformers.
* To learn about the working of different analog and digital instruments.
* To study about display and recording devices.

**UNIT – I MEASUREMENT OF ELECTRICAL PARAMETERS (9)**

Types of ammeters and voltmeters: PMMC Instruments, Moving Iron Instruments, Dynamometer type Instruments – Resistance measurement: Wheatstone bridge, Kelvin double bridge and Direct deflection methods. Measurement of Inductance: Maxwell-Wien Bridge, Hay's bridge and Anderson Bridge – Measurement of Capacitance: Schering Bridge.

**UNIT – II POWER AND ENERGY MEASUREMENTS (9)**

Electro-dynamic type wattmeter: Theory and its errors – LPF wattmeter – Phantom loading – Single phase Induction type energy meter – 3 phase induction energy meter and phase measurement– Calibration of wattmeter and Energy meters – Synchroscope.

**UNIT – III POTENTIOMETERS AND INSTRUMENT TRANSFORMERS (9)**

D.C. Potentiometers: Student type potentiometer, Precision potentiometer – A.C. Potentiometers: Polar and Coordinate types – Applications – Instrument Transformer: Construction and theory of Current Transformers and Potential Transformers.

**UNIT – IV ANALOG AND DIGITAL INSTRUMENTS (9)**

Wave analyzers – Signal and function generators – Distortion factor meter – Q meter – Digital voltmeter and multi-meter – Microprocessor based DMM with auto ranging and self diagnostic features – Frequency measurement.

**UNIT – V DISPLAY AND RECORDING DEVICES (9)**

Cathode ray oscilloscope: Classification, Sampling and storage scopes – LED, LCD and dot matrix displays – X-Y recorders – Magnetic tape recorders –Digital Data Recording –Digital memory waveform recorder – Data loggers.

**Contact Periods:**

**Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**

**TEXT BOOKS:**

*1.Kalsi. H.S, "**Electronic Instrumentation**", Tata McGraw-Hill, New Delhi, 2010*

*2.Sawhney.A.K, "**A Course in Electrical & Electronic Measurements & Instrumentation**", Dhanpat Rai and Co., New Delhi, 2010*

**REFERENCE BOOKS:**


*1.Northrop. R.B, "**Introduction to Instrumentation and Measurements**", Taylor & Francis, New Delhi, 2008.*

*2. Carr.J.J, "**Elements of Electronic Instrumentation and Measurement**", Pearson Education India, New Delhi, 2011.*

*3. David A.Bell, "**Electronic Instrumentation and Measurements**", PHI, New Delhi.*

*4. Copper. W.D and Hlefrick.. A.D, "**Modern Electronic Instrumentation and Measurement Technique"** 5th Edition, Prentice Hall of India, 2002.*


**COURSE OUTCOMES:**

On completion of this course, the students will be able to

**CO1:** Compare the working principles, merits and demerits of different types of electrical instruments and can understand about different instruments that are used for Measurement purpose.

**CO2:** Understand how different bridge networks are constructed and balanced for finding the values of resistance, capacitance and inductance.

**CO3:** Apply knowledge of electronic instrumentation for measurement of electrical quantities.

**CO4:** Apply the principles and practices for instrument design and development to real world problems.

**CO5:** Select a suitable measuring instrument for a given application.

**CO6:** Pursue higher studies and do research activities in the field of measurement and instrumentation.

**COURSE ARTICULATION MATRIX:**

| CO/ PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | H | H | M | H | M | H | M | L | H | M | H | H | H | M | H |
| **CO2** | H | M | M | M | H | H | H | M | H | L | H | H | H | H | M |
| **CO3** | H | H | M | H | M | H | M | L | H | M | H | H | H | H | H |
| **CO4** | H | H | M | H | M | H | M | L | H | M | H | H | H | M | H |
| **CO5** | H | H | M | H | M | H | M | L | H | M | H | H | H | M | M |
| **CO6** | H | H | M | H | M | H | M | L | H | M | H | H | M | H | M |
| **16NOEX16** | H | H | M | H | M | H | M | L | H | M | H | H | H | H | H |

**L – Low, M – Moderate (Medium), H – High**

**16SOEX17** **ENTERPRISE JAVA** **CATEGORY:OE**

*(Common to all Branches)*

| | L | T | P | C |
|---|---|---|---|---|
| **PRE-REQUISITES: NIL** | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES**

Upon completion of this course, the students will be familiar with:

- Basic programming constructs in java to develop simple object oriented programs
- Enterprise Architecture types and features of Java EE platform
- JEE foundation concepts like Enterprise java bean,JSP and JSF
- Distributed Programs and methods to connect with database.
- Java Web services

**UNIT- I INTRODUCTION TO JAVA (9)**

Introduction to object oriented programming-Features of Java – Data types, variables and arrays – Operators – Control statements – Classes and Methods – Inheritance. Packages and Interfaces – Exception Handling – Multithreaded Programming – Input/Output – Files – Utility Classes – String Handling – Networking –Applet class – Event Handling.

**UNIT –II INTRODUCTION TO ENTERPRISE JAVA (9)**

Challenges of Enterprise application Development - Platform for enterprise Solutions – J2EE Application Scenario – J2EE Platform Technologies –J2EE Multi-Tier Architecture – J2EE Architecture Approaches – Model-View-Controller Architecture – J2EE Design Patterns – Designing the Sample Application – Choosing Application Tiers – Choosing Local or Distributed Architecture – Architecture of the Sample Application

**UNIT- III ENTERPRISE JAVA FOUNDATION (9)**

Enterprise Java Beans –Business Logic and Business Objects. – Enterprise Beans as J2EE Business Objects - Entity Beans - Session Beans – Message-Driven Beans –Transaction support in EJB-Security support in EJB –Java Server Pages – Directive Elements – Scripting Elements - Action Elements-Expression Language-JSP Standard Tag Library – Java Server Page Online Store – JavaServer Faces – Life Cycle – Resource Management.

**UNIT –IV INTERCONNECTIVITY (9)**

Concept of JDBC – JDBC Driver types- Database Connection – Associating JDBC Bridge with the database – Statement Objects –Resultset – Transaction Processing – RMI- Network File-Locking Server –Java Mail API and Java Activation Framework – send ,receive, retrieve and delete email message – Java Message Service – JMS Fundamentals –Components of a JMS program –JMS architecture –JMS-Based Alarm System - JNDI – Naming and Directories – Naming Operations

**UNIT –V WEB SERVICES (9)**

SOAP Basics – Java API for XML Messaging – Creating a SOAP Attachment – Accessing a SOAP Attachment – Universal Description, Discovery and Integration (UDDI)- UDDI Architecture – UDDI Application Programming Interface – Inquiry Application Programming Interface – Publishing Application Programming Interface –JAXR – JAXR client – Publishing a service to an XML Registry – Removing a published service from an XML Registry- WSDL – Inside WSDL- WSDL and SOAP – RESTFul Web services – REST Approach – Java API for RESTful Web service

**Contact Periods:**
**Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**

**TEXT BOOKS:**


*1.Herbert Schildt, "**Java The Complete Reference**" , 9th Edition. Tata McGraw- Hill Edition. 2014.*

*2.Stephen Asbury and Scott R. Weiner "**Developing Java Enterprise Applications",** second edition Wiley Publishing.1999.*

*3.Antonio Goncalves "**Beginning Java™ EE 6 Platform with GlassFish™ 3From Novice to Professional**" Apress 2009.*

*4.Jim Keogh, "**The Complete Reference J2EE** " ,Tata McGraw –Hill 2002*


**REFERENCE BOOKS:**


*1.John Brock, Arun Gupta, Geertjan Wielenga "**Java Server Programming Java EE 7 (J2EE 1.7) – Black Book**" McGraw Hill, 2015.*

*2.Inderjeet Singh, Beth Stearns, Mark Johnson, and the Enterprise Team "**Designing Enterprise Applications with the J2EE™ Platform**", Second Edition Addison Wesley, 2002.*


**COURSE OUTCOMES**

Upon completion of this course, the students will be able to:

**CO1:** Write simple java programs using fundamental concepts of java like control structures, inheritance, packages,interfaces,multithreaded programming and exception handling**. [Usage]**

**CO2:** Write java program for Networking using applets**.[Usage]**

**CO3:** Describe and use the client/server and distributed architectures in a programming environment**.[Usage]**

**CO4:** Use EJB, JSPand JFC technology in developing enterprise applications.**[Usage]**

**CO5:** Apply Java interconnectivity techniques like JDBC, RMI, Java Mail, JMS , JNDIin developing enterprise applications**.[Usage]**

**CO6:** Explain the roles XML,JAXR, SOAP, WSDL and UDDI in the architecture of Web Services ***[Familiarity]***

**CO7:** Develop applications using RESTful web services **[Assessment**].

**COURSE ARTICULATION MATRIX:**

| CO/ PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 | PSO 4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | H | L | H | L | H | - | L | - | - | - | - | M | L | H | L | H |
| **CO2** | H | M | H | M | H | - | L | - | - | - | - | M | M | H | L | H |
| **CO3** | H | L | H | L | H | - | L | - | - | - | - | M | L | H | H | H |
| **CO4** | M | L | M | L | H | - | L | - | - | - | - | M | M | H | H | H |
| **CO5** | H | L | H | L | H | - | M | - | - | - | - | M | L | H | H | H |
| **CO6** | M | L | M | L | H | - | L | - | - | - | - | L | M | H | H | H |
| **CO7** | H | L | H | L | H | - | M | - | - | - | - | M | M | H | H | H |
| **16SOEX17** | H | L | H | L | H | - | L | - | - | - | - | M | M | H | H | H |

**L – Low, M – Moderate (Medium), H – High**

**16SOEX18** **CYBER SECURITY** **CATEGORY:OE**

*(Common to all Branches)*

| | L | T | P | C |
|---|---|---|---|---|
| **PRE-REQUISITES: NIL** | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

Upon completion of this course, the students will be familiar with:

- Cybercrime and cyber offenses.
- Cybercrime using mobile devices.
- Tools and methods used in cybercrime.
- Legal perspectives of cybercrime.
- Fundamentals of computer forensics.

**UNIT- I INTRODUCTION TO CYBERCRIME AND CYBEROFFENSES (9)**

Cybercrime and Information Security – Classifications of Cybercrimes – The Legal Perspectives – Cybercrime and the Indian ITA 2000 – A Global Perspective on Cybercrimes - Plan of Attacks – Social Engineering – Cyberstalking – Cybercafe and Cybercrimes – Botnets – Attack Vector.

**UNIT- II CYBERCRIME: MOBILE AND WIRELESS DEVICES (9)**

Proliferation of Mobile and Wireless Devices – Trends in Mobility – Credit Card Fraudsin Mobile and Wireless Computing Era – Security challenges posed by mobile devices – registry setting for mobile devices – authentication service security – attacks on mobile/cell phones – Organizational measures for handling mobiles.

**UNIT –III TOOLS AND METHODS USED IN CYBERCRIME (9)**

Proxy Servers and Anonymizers – Phishing – Password Cracking – Keyloggers – Spywares –Virus and Worms – Trojan Horses and Backdoors – Steganography – DoS and DdoS Attacks – SQL Injection – Attacks on Wireless Networks.

**UNIT –IV CYBERCRIMES AND CYBERSECURITY: THE LEGAL PERSPECTIVES (9)**

Cyberlaws- The Indian Context – The Indian IT Act – Challenges to Indian Law and Cybercrime Scenario in India - Consequences of Not Addressing the Weakness in Information Technology Act – Digital Signatures and the Indian IT Act - Amendments to the Indian IT Act – Cybercrime and Punishment.

**UNIT –V UNDERSTANDING COMPUTER FORENSICS (9)**

Digital Forensics – Forensics Analysis of E-Mail – Network Forensics – Forensics and Steganography – Forensics and Social Networking Sites – Challenges in Computer Forensics – Data Privacy Issues – Forensics Auditing – Antiforensics

**Contact Periods:**

**Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**

**Text Book**

*1.Nina Godbole and Sunit Belapur,* ***"Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives"****, Wiley India Publications, April, 2011*

**REFERENCE BOOKS:**


*1.Robert Jones,* ***"Internet Forensics: Using Digital Evidence to Solve Computer Crime",*** *O'Reilly Media, October, 2005.*

*2.Chad Steel,* ***"Windows Forensics: The field guide for conducting corporate computer investigations"****, Wiley India Publications, December, 2006.*


**COURSE OUTCOMES**:

Upon completion of this course, the students will be able to:

**CO1:** Explain the fundamental concepts of cybercrime and cyberoffenses. **[Familiarity]**

**CO2**: Describe the cybercrimes occurred in mobile and wireless devices. **[Familiarity]**

**CO3**: Elaborate the methods used in cybercrime. **[Familiarity]**

**CO4**: Explain the laws for cybercrime and its respective punishments. **[Familiarity]**

**CO5**: Explain the forensics Analysis of E-Mail, Network and Social Networking Sites**[Familiarity]**

**COURSE ARTICULATION MATRIX:**

| CO/ PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 | PSO 4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | M | M | M | M | L | H | L | M | - | - | - | H | H | L | M | M |
| **CO2** | M | M | M | M | M | H | M | M | - | - | - | M | H | H | M | M |
| **CO3** | H | L | L | L | L | H | H | L | - | - | - | H | H | H | L | L |
| **CO4** | H | M | M | M | M | H | H | H | - | - | - | M | H | H | L | L |
| **CO5** | H | M | M | M | M | L | H | L | - | - | - | H | H | H | M | M |
| **16SOEX18** | H | M | M | M | M | H | H | M | - | - | - | H | H | H | M | M |

**L – Low, M – Moderate (Medium), H – High**

**16SOEX19** **NETWORK ESSENTIALS** **CATEGORY:OE**

*(Common to all Branches)*

| | L | T | P | C |
|---|---|---|---|---|
| **PRE-REQUISITES: NIL** | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

Upon completion of this course, the students will be familiar with:

- Basic taxonomy and terminology of the computer networking
- Wireless networking
- Addressing and Routing
- Routing protocols
- Troubleshooting and security issues.

**UNIT -I INTRODUCTION (9)**

Introduction to Computer Networks - Goals and advantages of Computer Networks - Network Topologies – Basic networking devices – Protocols – the need for a layered architecture - The OSI Model and the TCP/IP reference model – the Ethernet LAN – Home Networking – Assembling an office LAN – Testing and Troubleshooting a LAN – Physical layer cabling: Twisted pair and Fiber optics

**UNIT -II WIRELESS NETWORKING (9)**

Importance of Wireless Networking – IEEE 802.11 Wireless LANs – Bluetooth- WIMAX – RFIDs – Securing the Wireless LANs – Configuring a Point to Multipoint Wireless LAN – Interconnecting network LANs – Switch, Bridges and Routers. Interconnecting LANs with the router, Configuring the network interface-Auto negotiation.

**UNIT -III ADDRESSING AND ROUTING FUNDAMENTALS (9)**

IPv4 and IPv6 addressing – Subnet masks – CIDR blocks – configuration of a router – Console port connection - user EXEC mode – Privileged EXEC mode - Configuration of a switch – Static VLAN configuration - Spanning Tree protocol – Network Management – Power over Ethernet.

**UNIT- IV ROUTING PROTOCOLS (9)**

Static Vs Dynamic Routing Protocols – Distance vector Routing – Link State Routing – Hybrid Routing – Configuring RIP - Network Services – DHCP , DNS - Analyzing Internet Traffic.

**UNIT -V TROUBLESHOOTING AND NETWORK SECURITY (9)**

Analyzing Computer Networks – FTP data packets – Analyzing Campus Network data traffic – Troubleshooting the router and switch interface, Troubleshooting fiber optics – Intrusion – DOS – Security software and hardware.

**Contact Periods:**

**Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**

**TEXT BOOKS:**

*1.Jeffrey S.Beasley Piyasat Nilkaew, "**Network Essentials**", 3rd Edition, Pearson, 2012.*

*2.Larry L. Peterson and Bruce S. Davie, "**Computer Networks, A Systems Approach**", Morgan Kaufmann Publishers Inc, 5th edition 2011.*

**REFERENCE BOOKS:**

*1. Behrouz A.Ferouzan, "**Data Communications and Networking"**, 5th edition, Tata McGraw-Hill, 2012.*

*2. Andrew S. Tanenbaum, "**Computer networks**"s, PHI, 5th edition 2011.*

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to:

- **CO1:** Identify topologies and types of Computer Networks **[Familiarity]**
- **CO2:** Enumerate the layers of the OSI model and TCP/IP and Explain the functions of each layer **[Familiarity]**
- **CO3:** Identify and Compare types of cabling for data communication **[Usage]**
- **CO4:** Explain the significance of wireless networks **[Familiarity]**
- **CO5:** Configure a Wireless LAN **[Assessment]**
- **CO6:** Configure router and a switch **[Assessment]**
- **CO7:** Describe basic routing algorithms and network services. **[Usage]**
- **CO8:** Troubleshoot the router and switch interface **[Usage]**
- **CO9:** Analyze Campus Network data traffic **[Usage]**

**COURSE ARTICULATION MATRIX:**

| CO/ PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 | PSO 4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | M | M | H | H | H | L | L | H | H | H | H | H | M | H | H | M |
| **CO2** | H | H | H | H | H | L | L | H | H | H | H | H | M | H | H | M |
| **CO3** | L | L | L | L | H | L | L | H | L | L | L | H | M | H | H | M |
| **CO4** | L | H | M | M | H | L | L | H | H | M | L | H | L | H | H | L |
| **CO5** | H | H | H | M | H | L | L | H | H | H | M | H | M | H | H | M |
| **CO6** | H | H | H | M | H | L | L | H | H | M | L | H | M | H | H | M |
| **CO7** | H | H | H | H | H | L | L | H | H | H | M | H | M | H | H | M |
| **CO8** | H | H | H | H | H | L | L | H | H | M | L | H | M | H | H | M |
| **CO9** | H | H | H | H | H | L | L | H | H | H | M | H | M | H | H | M |
| **16SOEX19** | M | H | H | M | H | L | L | H | H | L | M | H | M | H | H | M |

**L – Low, M – Moderate (Medium), H – High**

**16IOEX20** **PROGRAMMING IN PYTHON** **CATEGORY:OE**

*(Common to all Branches)*

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**PRE-REQUISITE:** NIL

**COURSE OBJECTIVES:**

Upon completion of this course the students will be Familiar with:

- Data types and variables declaration
- Control statements, Functions and the use of basic programming.
- Operations on list and dictionary
- File and Exception handling.
- Object oriented programming and GUI development.

**UNIT -I INTRODUCTION (9)**

Introduction to Python - Setting up Python in OS – Python IDLE(write- edit- run- and save programs) – Strings - Numbers – Variables – simple I/O - Getting user input– Using String method–Converting values.

**UNIT -II CONTROL STATEMENTS AND FUNCTIONS (9)**

Control statements – Random number generator- Branching and loops – Range functions- Functions – User defined functions- passing parameters- return function- working with global variables and constants.

**UNIT -III LISTS AND DICTIONARIES (9)**

Lists – create- index- slice a list- Add and delete elements from a list- Append- Sort and reverse a list- nested sequences- Dictionaries – Create- add- delete from a Dictionary- Operations associated with pairs of data.

**UNIT -IV FILES AND EXCEPTIONS (9)**

Files – Read from text files- Write to text files- Read and write more complex data- Exceptions – Intercept and handle errors during program's execution.

**UNIT -V OBJECT ORIENTED PROGRAMMING AND GUI (9)**

Object oriented programming – Create objects of different classes in the same program- objects communication- complex object creation- derive new classes- existing class extension- override method- GUI – GUI toolkit- create and fill frames- create buttons- text entries and text boxes- create check buttons and radio buttons - case study – create a web page using GUI functionality

**Contact Periods:**

**Lecture: 45 Periods Tutorial:0 Periods Practical:0 Periods Total: 45 Periods**

**TEXT BOOKS:**


1. *Y. Daniel Liang* ***"Introduction to Programming Using Python",*** *Pearson, 2013.*
2. *Charles Dierbach* ***"Introduction to Computer Science Using Python: A Computational Problem-Solving Focus"****, Wiley Publications, 2012.*

**REFERENCE BOOKS:**

*1.Michael Dawson "**Python Programming for the Absolute Beginner"**, Premier Press, 2003.*

**COURSE OUTCOMES**

Upon completion of this course the students will be able to:

**CO1:** Use various data types.[**Understand**]

**CO2:** Handle the arrangement of data elements in Lists and Dictionary structures.[**Analyze**]

**CO3:** Use control statements and functions. [**Understand**]

**CO4:** Handle exceptions and perform file operations**. [Understand]**

**CO5:** Develop application using object oriented programming and GUI. [**Analyze**]

**COURSE ARTICULATION MATRIX:**

| CO/ PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | M | L | - | L | L | - | L | L | - | - | L | - | L | L |
| **CO2** | M | L | - | L | L | - | L | L | - | - | L | - | L | L |
| **CO3** | M | M | L | M | L | - | L | L | - | - | L | - | M | L |
| **CO4** | M | M | L | M | L | - | M | M | - | - | L | - | M | L |
| **CO5** | M | M | L | M | L | - | M | M | - | - | M | L | M | L |
| **16IOEX20** | M | M | L | M | L | - | L | L | - | - | L | L | M | L |

**L – Low, M – Moderate (Medium), H – High**

**16IOEX21** **BIG DATA SCIENCE** **CATEGORY: OE**

*(Common to all Branches)*

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**PRE-REQUISITES: NIL**

**COURSE OBJECTIVES:**

Upon completion of this course, the students will be familiar with,

- Big Data and its characteristics
- Technologies used for Big Data Storage and Analysis
- Mining larger data streams
- Concepts related to Link analysis and handle frequent data sets

**UNIT- I THE FUNDAMENTALS OF BIG DATA (9)**

Understanding Big Data-Concepts and Technology-Big Data Characteristics-Types of data-Case Study-Business Motivation and Drivers for Big Data Adoption- Planning Considerations-Enterprise Technologies and Big Data Business Intelligence- OLTP-OLAP-Extract Transform Load-Data Warehouses-Data Mart-Traditional and Big Data BI-Case Study

**UNIT -II BIG DATA STORAGE AND PROCESSING (9)**

Big Data Storage Concepts- Clusters-File systems and Distributed File Systems-NoSQL- Sharding - Replication -Sharding and Replication-CAP Theorem-ACID-BASE-Case Study- Big Data Processing Concepts- Parallel Data Processing-Distributed Data Processing-Hadoop-Processing Workloads-Cluster-Processing in Batch mode-Processing in Real Time mode-Case study

**UNIT -III BIG DATA STORAGE AND ANALYSIS TECHNOLOGY (9)**

Big Data Storage Technology: On-Disk Storage devices-NoSQL Databases-In-Memory Storage Devices-Case study, Big Data Analysis Techniques: Quantitative Analysis-Qualitative Analysis-Data Mining-Statistical Analysis-Machine Learning-Semantic Analysis-Visual Analysis-Case Study

**UNIT -IV MINING DATA STREAMS (9)**

The stream data model – Sampling data streams – counting distinct elements in a stream – Estimating moments. Finding similar items – Applications of nearest neighbor search – shingling of documents - similarity preservation – locality sensitive hashing- distance measures – methods for high degree similarity.

**UNIT -V LINK ANALYSIS AND FREQUENT ITEMSETS (9)**

Link analysis – Page rank – Efficient computation of a page rank – topic sensitive page rank – link spam –Frequent datasets – the market basket model – A-Priori algorithm – handling larger datasets in main memory –limited pass algorithm – counting frequent items in a stream

**Contact Periods:**

**Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**

**TEXT BOOKS:**


1. *Thomas Erl, WajidKhattak, and Paul Buhler," **Big Data Fundamentals Concepts, Drivers & Techniques"**, Prentice Hall,2015*
2. *AnandRajaraman and Jeffrey David Ullman, **"Mining of Massive Datasets**", Cambridge University Press, 2012.*

**REFERENCE BOOKS:**


1.Paul Zikopoulos, Chris Eaton, ***"Understanding Big Data: Analytics for Enterprise Class Hadoop and Streaming Data"***, *McGraw Hill, 2011.*

2.Frank J Ohlhorst, ***"Big Data Analytics: Turning Big Data into Big Money",*** *Wiley and SAS Business Series, 2012.*


**COURSE OUTCOMES**

Upon completion of this course, the students will be able to,

**CO1:** Understand the Big Data and usage in Enterprise Technologies. [Understand]

**CO2:** Store and Process Big Data using suitable Processing Methods[Understand]

**CO3:** Handle Big Data using appropriate analysis Techniques. [Analyse]

**CO4:** Mine larger data streams using suitable algorithms. [Understand]

**CO5:** Rank pages and handle large data sets efficiently [Analyse]

**COURSE ARTICULATION MATRIX:**

| CO/ PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | H | L | M | L | H | L | - | - | - | - | - | - | M | L |
| **CO2** | M | - | - | - | H | - | - | L | - | - | - | L | M | L |
| **CO3** | - | H | - | - | H | - | - | - | - | - | - | L | M | L |
| **CO4** | M | H | M | - | M | - | - | - | - | - | - | L | M | L |
| **CO5** | L | M | H | - | - | - | - | - | - | - | - | L | M | L |
| **16IOEX21** | M | M | M | L | H | L | - | L | - | - | - | L | M | L |

**L – Low, M – Moderate (Medium), H – High**

**16IOEX22 OBJECT ORIENTED PROGRAMMING USING C++ CATEGORY:OE**

*(Common to all Branches)*

| | L | T | P | C |
|---|---|---|---|---|
| **PRE-REQUISITES: NIL** | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

Upon completion of this course, the students will be familiar with,

- Fundamentals of object oriented programming
- Classes and objects
- Concepts of overloading and type conversions
- Inheritance and Polymorphisms
- Files, templates and exception handling

**UNIT -I PRINCIPLES OF OBJECT ORIENTED PROGRAMMING (9)**

Basic concepts- benefits – applications of object oriented programming – beginning with C++ - tokens – expressions and control structures – C++ stream classes – Formatted and Unformatted I/O operations. Managing output with manipulators.

**UNIT -II CLASSES AND OBJECTS (9)**

Introduction – specifying class – defining member functions – memory allocation constructors and destructors:- parameterized- copy – default -dynamic and multiple constructors – destructors

**UNIT -III FUNCTIONS AND TYPE CONVERSIONS (9)**

Introduction – function prototyping call by reference – return by reference – inline function – recursion – friend function – function overloading – operator overloading – manipulation of strings using operators – type conversions

**UNIT -IV INHERITANCE AND POLYMORPHISM (9)**

Defining derived classes – single, multiple, multilevel, hierarchical and hybrid inheritance – virtual base classes – abstract base classes – nesting of classes - pointers – pointers to objects – this pointer – pointers to derived classes – virtual functions – pure virtual functions virtual constructors and destructors.

**UNIT -V FILES AND TEMPLATES (9)**

Classes for file stream operations – opening and closing a file – detecting EOF – open file modes – file pointers and their manipulations – sequential I/O operations – updating and error handling of file. Class and function template – template with multiple parameters – overloading, member function and non-type template arguments-Exception handling.

**Contact Periods:**

**Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**

**TEXT BOOKS:**

*1.E.Balagurusamy **"Object oriented Programming with C++"** McGraw Hill Education Ltd,6th Edition 2013.*

**REFERENCE BOOKS:**

*1.R.Rajaram **"Object Oriented Programming and C++"** New Age International 2nd edition , 2013*

*2.K.R. Venugopal,Rajkumar,T. Ravishankar**"Mastering C++"** , Tata McGraw Hill Education,2nd edition, 2013*

*3.Yashavant P. Kanetkar**" Let us C++"** BPB Publications , 2nd edition 2003.*

**COURSE OUTCOMES**

Upon completion of this course, the students will be able to,

**CO1**: Understand the principles of object oriented programming [Understand]

**CO2**: Develop programs using classes and objects.[Analyze]

**CO3**: Use functions and type conversions in programs. [Understand]

**CO4**: Apply inheritance and polymorphism to develop applications. [Analyze]

**CO5**: Use files, templates and handle exceptions. [Understand]

**COURSE ARTICULATION MATRIX:**

| CO/ PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | M | H | H | M | M | - | M | M | - | - | M | - | M | M |
| **CO2** | M | H | H | H | M | - | M | M | - | - | M | - | H | M |
| **CO3** | M | H | H | H | M | - | M | M | - | - | M | - | H | M |
| **CO4** | M | H | H | H | M | L | M | M | - | - | M | - | H | M |
| **CO5** | M | H | H | H | M | - | M | M | - | - | M | - | H | M |
| **16IOEX22** | M | H | H | H | M | L | M | M | - | - | M | - | H | M |

**L – Low, M – Moderate (Medium), H – High**

**16BOEX23** **COMPUTATIONAL BIOLOGY** **CATEGORY:OE**

*(Common to all Branches)*

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**PRE-REQUISITES: NIL**

**COURSE OBJECTIVES:**

- Understand the basic concepts and role of computation in biological analysis
- Familiarize with sequence alignment methods
- Understand the machine learning tools used for biological analysis

**UNIT -I BASICS OF BIOLOGY (9)**

Biomolecules of life:Structure and Composition of DNA, RNA & Protein.Protein Structure basics-Primary, Secondary and tertiary Structure of protein

**UNIT -II BIOLOGICAL DATABASES (9)**

Concept of Relational database, Data archiving, Data mining, Primary databases-NCBI,EMBL,DDBJ; Structure databases-PDB

**UNIT -III SEQUENCE ANALYSIS (9)**

Pairwise alignment tools-Dot matrix analysis, Dynamic programming-Smith waterman and Needleman wunsch algorithm ,Heuristic methods- BLAST,FASTA;Multiple sequence alignment methods-Progressive alignment(Clustal)

**UNIT -IV STRUCTURE ANALYSIS AND DRUG DESIGN (9)**

Protein secondary prediction-Chou fasman method, GOR method; Tertiary structure prediction-Homology modelling, Introduction to Computer aided drug design.

**UNIT -V MACHINE LEARNING (9)**

Genetic Algorithm, Neural networks,Artificial Intelligence, Hidden markov model -application in bioinformatics

**Contact Periods:**

**Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**

**TEXT BOOKS:**

*1.David W. Mount,* ***"Bioinformatics: Sequence and Genome Analysis"****, Cold Spring Harbor Laboratory Press, Second Edition, 2004.*

*2.Arthur M. Lesk,* ***"Introduction to Bioinformatics",****Oxford University Press, 2008.*

*3.Pierre Baldi, Soren Brunak ,* ***"Bioinformatics: The machine learning approach"*** *MIT Press, 2001*

**REFERENCE BOOKS:**

*1.Andrew R. Leach, "****Molecular Modeling Principles And Applications",*** *Second Edition, Prentice Hall, 2001.*

*2.Baxevanis A.D. and Oullette, B.F.F,* ***"A Practical Guide to the Analysis of Genes and Proteins",*** *2nd ed., John Wiley, 2002*

*3.David L. Nelson ,Michael M. Cox ,* ***"Lehninger Principles of Biochemistry"****, Sixth edition, Freeman, W. H. & Co. Publisher,2012.*

**COURSE OUTCOMES**

Upon completion of the Computational Biology course, the students will be able to

CO1:Understand basic structure of Biological macromolecules

CO2:Acquire the knowledge of biological databases

CO3:Ability to perform pair wise and multiple sequence alignment

CO4:Ability to predict the secondary and tertiary structure of proteins.

CO5:Understand the machine learning approaches in computational biology

**COURSE ARTICULATION MATRIX:**

| CO/ PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | M | M | L | L | - | L | - | - | M | - | - | - | M | - |
| **CO2** | M | L | L | L | - | - | - | - | L | - | - | L | L | - |
| **CO3** | L | - | L | - | - | M | - | - | L | - | - | L | - | M |
| **CO4** | M | M | L | M | M | - | - | - |  | - | - | - | L | L |
| **CO5** | - | M | - | H | H | M | L | - | M | - | - | - | L | M |
| **16BOEX23** | L | L | L | L | L | L | L | - | L | - | - | L | L | L |

**L – Low, M – Moderate (Medium), H – High**

**16BOEX24** **BIOLOGY FOR ENGINEERS** **CATEGORY:OE**

*(Common to all Branches)*

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**PRE-REQUISITES: NIL**

**COURSE OBJECTIVES:**

To enable the students

- To understand the basic functions of the cell and their mechanisms in transport process
- To get familiarize human anatomy and physiology
- To learn about microbes, immune system and biomolecules
- To know the concepts of applied biology

**UNIT -I BASICS OF CELL BIOLOGY (9)**

An Overview of cells – Origin and evolution of cells. Cell theory, Classification of cells – prokaryotic cells and eukaryotic cells. Structure of prokaryotic and eukaryotic cells and their organelles. Comparison of prokaryotic and eukaryotic cells, Transport across membranes – diffusion - active and passive diffusion.

**UNIT -II BASICS OF MICROBIOLOGY (9)**

Classification of microorganism, Microscopic examination of microorganisms, Structural organization and multiplication of bacteria, viruses, algae and fungi, Microorganism used for the production of penicillin, alcohol and vitamin B-12.

**UNIT- III HUMAN ANATOMY AND PHYSIOLOGY (9)**

Basics of human anatomy, tissues of the human body: epithelial, connective, nervous and muscular, Nervous system, Respiratory System, Circulatory system and Digestive system.

**UNIT- IV BIO MOLECULES AND IMMUNE SYSTEM (9)**

Introduction to Biochemistry, Classification, structure and properties of carbohydrates, proteins, lipids and nucleic acids. Innate and acquired immunity, Types of immune responses.

**UNIT -V APPLIED BIOLOGY FOR ENGINEERS (9)**

Overview of biosensors- glucometer applications-medicine, Microarray analysis to diagnose the cancer, Microbial production of biofuels, Applications of stem cells.

**Contact Periods:**

**Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**

**TEXT BOOKS:**

*1.Darnell J, Lodish H, Baltimore D,* ***"Molecular Cell Biology",*** *W.H.Freeman; 8th edition,2016*

*2.Pelczar MJ, Chan ECS and KreinNR****,"Microbiology"****, Tata McGraw Hill, 5th edition, New Delhi.2001.*

*3.WulfCruger and AnnelieseCruger,* ***"A Textbook of Industrial Microbiology"****, Panima Publishing Corporation, 2nd Edition, 2000.*

**REFERENCE BOOKS:**

*1.David L. Nelson and Michael M Cox,* ***"Lehninger's Principles of Biochemistry"****, Macmillan Worth Publisher, 4th edition, 2004.*

*2.Brain R.Eggins ,* ***"Chemical Sensors and Biosensors"****, John Wiley & Sons, 2002*

*3.Anton Moser,* ***"Bioprocess Technology, Kinetics and Reactors"*** *Springer, Berlin (Verlag),1998*

*4.Kuby J,* ***"Immunology"****, WH Freeman & Co., 2000.*

**COURSE OUTCOMES**

Upon completion of the course, the students will be able to

**CO1:** Understand the functions of cell and their structural organization

**CO2:** Describe the mechanisms and role of cell in immune system

**CO3:** Get familiarized biomolecules and human anatomy system

**CO4:** Illustrate the applications of microbes in industrial process

**CO5:** Apply the engineering concepts in biology

**COURSE ARTICULATION MATRIX:**

| CO/ PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | L | L | L | - | L | M | - | L | - | L | M | L | L | L |
| **CO2** | L | - | L | L | L | M | M | - | L | L | L | L | L | L |
| **CO3** | L | L | - | - | L | L | L | L | L | - | L | L | L | L |
| **CO4** | L | - | L | - | L | - | - | L | - | L | L | L | L | M |
| **CO5** | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **16BOEX24** | L | L | L | L | L | L | L | L | L | L | L | L | L | L |

**L – Low, M – Moderate (Medium), H – High**

**16BOEX25 FUNDAMENTALS OF BIOENGINEERING CATEGORY:OE**

*(Common to all Branches)*

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**PRE-REQUISITES: NIL**

**COURSE OBJECTIVES:**

- To make the students aware of the overall industrial bioprocess.
- To understand the basic configuration and parts of a fermentor.
- To study the production of primary and secondary metabolites.
- To understand the production of modern biotechnology products.

**UNIT – I INTRODUCTION TO INDUSTRIAL BIOPROCESS (9)**

Fermentation - Bacterial, Fungal and Yeast, Biochemistry of fermentation. Traditional and Modern Biotechnology - A brief survey of organisms, processes, products. Basic concepts of Upstream and Downstream processing in Bioprocess.

**UNIT – II FERMENTATION INDUSTRY (9)**

Overview of fermentation industry, Basic configuration of Fermentor and ancillaries, main parameters to be monitored and controlled in fermentation processes. Types of fermentation – Solid state, submerged, batch, continuous, fed batch fermentation methods.

**UNIT – III PRODUCTION OF PRIMARY METABOLITES (9)**

A brief outline of processes for the production of some commercially important organic acids - Citric acid, lactic acid ,acetic acid; amino acids - glutamic acid, phenylalanine; ethanol.

**UNIT – IV PRODUCTION OF SECONDARY METABOLITES (9)**

Study of production processes for various classes of secondary metabolites: Antibiotics: beta lactams – penicillin and cephalosporin; aminoglycosides – streptomycin; macrolides - erythromycin, vitamin - B9, B12

**UNIT – V PRODUCTS THROUGH MODERN BIOTECHNIQUES (9)**

Production of industrial enzymes - proteases, amylases, lipases; Production of single cell protein from wastes; biopreservatives – Bacterosin; biopolymers - xanthan gum and PHA. Industrial uses of enzymes in detergents, beverage and food.

**Contact Periods:**

**Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**

**TEXT BOOKS:**


*1.Peter F. Stanbury, Stephen J. Hall & A. Whitaker,* ***"Principles of Fermentation Technology"****, Science & Technology Books. 1995.*

*2.Presscott, S.C. and Cecil G. Dunn,* ***"Industrial Microbiology"****, Agrobios (India), 2005.*

*3.Casida, L.E.* ***"Industrial Microbiology"****, New Age International (P) Ltd, 1968.*

**REFERENCE BOOKS:**


1.Crueger, W and AnnelieseCrueger, Biotechnology: ***"A Textbook of Industrial Microbiology"***, Panima Publishing Corporation, Edition 2, 2003

2.Sathyanarayana, U., ***"Biotechnology"***, Books and Allied (P) Ltd. Kolkata, 2005

3.Ratledge C and Kristiansen B. ***"Basic Biotechnology"***, Cambridge University Press, second Edition, 2001.

4.Michael J. Waites. ***"Industrial Microbiology:*** An Introduction", Blackwell Publishing,2001.


**COURSE OUTCOMES**

**CO1:** Upon completion of the course in Bioprocess Principles graduates will be able to understand the basics of industrial bioprocess.

**CO2:** Explain the principle of a fermentation process and the chronological development of fermentation industry.

**CO3:** Understand the basic configuration of a fermentor and its ancillaries.

**CO4:** Learn the production of various primary and secondary metabolites.

**CO5:** Understand the production of biotechnological products.

**COURSE ARTICULATION MATRIX:**

| CO/ PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | M | H | H | - | - | - | - | - | - | - | - | - | M | - |
| **CO2** | H | M | - | - | - | - | - | - | - | - | - | - | - | - |
| **CO3** | H | H | H | M | M | M | - | L | H | - | - | - | - | H |
| **CO4** | H | L | L | - | - | L | - | L | - | - | - | - | - | H |
| **CO5** | H | M | H | L | M | - | - | L | - | - | - | - | - | H |
| **16BOEX25** | H | M | M | L | L | L | - | L | L | - | - | - | L | M |

**L – Low, M – Moderate (Medium), H – High**

**16BOC1Z1** **HUMAN VALUES I** **Category : OC**

*(Common to all branches)*

L T P C

1 0 0 1

**PRE-REQUISITES: NIL**

**COURSE OBJECTIVES:**

- Essential complementarily between 'values' and 'skills' to ensure sustained happiness and prosperity which are the core aspirations of all human beings.
- The development of a Holistic perspective among students towards life, profession and happiness based on a correct understanding of the Human reality and the rest of existence, which forms the basis of Value based living in a natural way.
- The plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually satisfying human behaviour and mutually enriching interaction with nature.

**UNIT I** **INTRODUCTION TO VALUE EDUCATION** **5 Periods**

Introduction- Need, Basic Guidance, Content and Process for Value Education- Basic human Aspirations – Prosperity and happiness – Methods to fullfill human aspirations - Understanding and living in harmony at various levels.

**UNIT II** **HARMONY IN THE HUMAN BEING** **5 Periods**

Coexistence – Happiness and convenience – Appraisal of Physical needs – Mental and Physical health – Human relationship – Mutual Trust and Respect.

**UNIT III** **ETHICS** **5 Periods**

Morals, Values and Ethics - Integrity - Work Ethics - Service Learning - Civic Virtue – Caring – Sharing - honesty- Courage – Empathy – Self Confidence -Ethical Human Conduct- Basis for humanistic Education, Constitution and universal order – Competence in professional ethics – Strategy for transition from the present state to Universal human order.

**Contact Periods:**

**Lecture: 15 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 15 Periods**

**TEXT BOOKS:**

| **AUTHOR NAME** | **TITLE OF BOOK** | **PUBLISHER, YEAR OF PUBLICATION** |
|---|---|---|
| *R.R. Gaur, R. Singal, G.P. Bangaria* | *Foundation Course in Human Values and Professional Ethics, 2009* | *Excel Book Private Ltd., New Delhi.* |

**REFERENCE BOOKS:**

| AUTHOR NAME | TITLE OF BOOK | PUBLISHER, YEAR OF PUBLICATION |
|---|---|---|
| *S. K. Chakraborty and Dabangshu Chakraborty* | *Human Values and Ethics: Achieving Holistic Excellence* | *ICFAI University Press, 2006.* |
| *A.N. Tripathy* | *Human Values* | *New Age International publishers, 2003.* |
| *M. Govindarajan, S. Natarajan and V.S. Senthil kumar* | *Engineering Ethics(including human values)* | *Eastern Economy Edition, Printice Hall of India Ltd., 2004.* |
| *E.G. Seebauer and Rober. L. Berry* | *Fundamentals of Ethics for Scientists and Engineers* | *Oxford University Press, 2000.* |

**COURSE OUTCOMES:**

Upon completion of the course, the students will be able to

**CO1:** Start exploring themselves, get comfortable to each other and to the teacher and start finding the need and relevance for the course.

**CO2:** See that their practice in living is not in harmony with their natural acceptance most of the time and able to refer to their natural acceptance to remove this disharmony.

**CO3:** Aware of their activities like understanding, desire,thought and selection and start finding their focus of attention at different moments.

**CO4:** Able to see that respect is right evaluation and only right evaluation leads to fulfillment in relationship.

**CO5:** Develop an understanding of the whole existence and interconnectedness in nature.

**16BOC202 HUMAN VALUES AND PROFESSIONAL ETHICS Category : OC**

*(Common to all branches)*

L T P C
1 0 0 1

**PRE-REQUISITES: NIL**

**COURSE OBJECTIVES:**

- Engineering Ethics and Human Values
- Social responsibility of an Engineer
- Ethical dilemma while discharging duties in Professional life.

**UNIT I ENGINEERING ETHICS 5 Periods**

Senses of Engineering Ethics -variety of moral issues – types of inquiry – moral dilemmas – moral autonomy – Kohlberg's Theory – Gilligen's Theory – Consensus and contraversy – Models of Professional roles – theories about right actions – Self interest – customs and religion – uses of ethical theories – Valuing time-cooperation-commitment.

**UNIT II ENGINEERING AS SOCIAL EXPERIMENTATION 5 Periods**

Engineering as experimentation – engineers as responsible experimenters – codes of ethics – a balanced outlook on law – the challenger case study - engineers as managers – consulting engineers - Moral leadership .

**UNIT III SAFETY, RESPONSIBLITIES, RIGHTS AND GLOBAL ISSUES 5 Periods**

Safety and risk – assessment of safety and risk – risk benefit analysisand reducing risk – the three mile island and chernobyl case studies.– Environmental ethics – computer ethics – weapons development- Multinational corporations - engineers as expert witnesses and advisors.

**Contact Periods:**

**Lecture:15 Periods Tutorial:0 Periods Practical: 0 Periods Total: 15 Periods**

**TEXT BOOKS:**

| AUTHOR NAME | TITLE OF BOOK | PUBLISHER, YEAR OF PUBLICATION |
|---|---|---|
| *Mike Martin and Roland Schinzinger* | *Ethics in Engineering* | *McGraw Hill, New York,1996.* |
| *M. Govindarajan,S. Natarajan and V.S. Senthil kumar* | *Engineering Ethics (including human values)* | *Eastern Economy Edition, Printice Hall of India Ltd., 2004.* |

**REFERENCE BOOKS:**

| AUTHOR NAME | TITLE OF BOOK | PUBLISHER, YEAR OF PUBLICATION |
|---|---|---|
| *Charles D.Fleddermann* | *Engineering Ethics* | *Pearson Education, 2004.* |
| *Edmund G Seebauer and Robert L. Berry* | *Fundamentals of Ethics for Scientists and Engineers, 2001* | *Oxford University Press* |
| *Charles E. Harris, Michael S. Protchard and Michael J. Rabins* | *Engineering Ethics – Concepts and Cases* | *Thomson Learning, 2000.* |
| *John R. Boatright* | *Ethics and Conduct of Business* | *Pearson Education,2003.* |

**COURSE OUTCOMES:**

Upon completion of the course, the students will be able to

**CO1:** Understand and appreciate Human values, exhibit self confidence and develop good character

**CO2:** Sense engineering ethics, professional roles and valuing time, co-operation and commitment

**CO3:** Understand and practise code of ethics.

**CO4:** Assess safety and risk and capable of doing risk benefit analysis.

**CO5:** Develop and exhibit moral leadership qualities in exercising Engineering Consultations without compromising envionmental, legal and ethical issues

**16BOC003** **YOGA FOR YOUTH EMPOWERMENT** **Category: OC**

*(Common to all branches)*

| L | T | P | C |
|---|---|---|---|
| 1 | 0 | 0 | 1 |

**PRE-REQUISITES:NIL**

**COURSE OBJECTIVES:**

- To familiarise with the various Yoga.
- To impart the knowledge asanas.
- To be able to analyse the benefit of yoga.

**UNIT I ASTANGA YOGA** **5 Hours**

Yama – Niyama – PratipakshaBhavanam -Asana:Meditative and Cultural. Pranayama – Benefits of Pranayama, Nadishuddiand Pranayama, Duration and time for Pranayama Practice, Gradation of Pranayama, Yukta and Ayukta Pranayama, Nadishuddi.

**UNIT II ASANAS** **5 Hours**

Tadasana -Trikonasana -Ekpadasana -Utkatasana -Pratnasana -Bujangasana-Chakrasana -Vajrasana -Sukasana -Savasana

**UNIT III KRIYA** **5 Hours**

Kriyas – Satkriya-Neti, Dhauti, Basti, Nauli, Trataka-Jalneti –Sutraneti-Vamanadauti -Trataka -Kaphalbhati -Moolashoodana.

**Contact Periods:**
**Lecture : 15 Periods** **Total : 15 Periods**

**TEXT BOOKS:**

| AUTHOR NAME | TITLE OF BOOK | PUBLISHER, EDITION, YEAR OF PUBLICATION |
|---|---|---|
| *Taimini, I.K* | *Glimpses into the Psychology of Yoga* | *Theosophical Publishing House,4th edition, 1973* |

**COURSE OUTCOME**

Upon completion of the course, the students will be able to

**CO1:** enable the student to have good health.
**CO2:** practice mental hygiene.
**CO3:** possess emotional stability