**NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY, GREATER NOIDA**
**(An Autonomous Institute)**

**Affiliated to**

**DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY UTTAR PRADESH, LUCKNOW**

# Evaluation Scheme & Syllabus

For

## B.Tech in Biotechnology (BT) Second Year

**(Effective from the Session: 2021-22)**

**NOIDA INSTITUTE OF ENGINEERING & TECHNOLOGY, GREATER NOIDA**
**(An Autonomous Institute)**

# B. TECH (BT)
## EVALUATION SCHEME
## SEMESTER-III

| Sl. No. | Subject Codes | Subject Name | Periods | | | Evaluation Scheme | | | | End Semester | | Total | Credit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | CT | TA | TOTAL | PS | TE | PE | | |
| **WEEKS COMPULSORY INDUCTION PROGRAM** | | | | | | | | | | | | | |
| 1 | ABT0304 | Bioinformatics | 3 | 1 | 0 | 30 | 20 | 50 | | 100 | | 150 | 4 |
| 2 | ABT0305 | Biophysics | 3 | 1 | 0 | 30 | 20 | 50 | | 100 | | 150 | 4 |
| 3 | ABT0301 | Biochemistry | 3 | 0 | 0 | 30 | 20 | 50 | | 100 | | 150 | 3 |
| 4 | ABT0302 | Cell Biology and Microbiology | 3 | 0 | 0 | 30 | 20 | 50 | | 100 | | 150 | 3 |
| 5 | ABT0303 | Genetics and Molecular Biology | 3 | 0 | 0 | 30 | 20 | 50 | | 100 | | 150 | 3 |
| 6 | ABT0306 | Plant and Animal Science | 3 | 0 | 0 | 30 | 20 | 50 | | 100 | | 150 | 3 |
| 7 | ABT0351 | Biochemistry and Biophysics Lab | 0 | 0 | 2 | | | | 25 | | 25 | 50 | 1 |
| 8 | ABT0352 | Cell Biology& Microbiology Lab | 0 | 0 | 2 | | | | 25 | | 25 | 50 | 1 |
| 9 | ABT0353 | Genetics & Molecular Biology Lab | 0 | 0 | 2 | | | | 25 | | 25 | 50 | 1 |
| 10 | ABT0359 | Internship Assessment-I | 0 | 0 | 2 | | | | 50 | | | 50 | 1 |
| 11 | ANC0301/ ANC0302 | Cyber Security*/ Environmental Science*(Non Credit) | 2 | 0 | 0 | 30 | 20 | 50 | | 50 | | 100 | 0 |
| 12 | | MOOCs** (For B.Tech. Hons. Degree | | | | | | | | | | | |
| | | **GRAND TOTAL** | | | | | | | | | | **1100** | **24** |

****List of MOOCs (Coursera) Based Recommended Courses for Second Year (Semester-III) B. Tech Students**

| S. No. | Subject Code | Course Name | University / Industry Partner Name | No of Hours | Credits |
|---|---|---|---|---|---|
| 1 | AMC0024 | Bioinformatic Methods I | University of Toronto | 20 | 1.5 |
| 2 | AMC0030 | Introduction to Genetics and Evolution | Duke University | 25 | 2 |

**PLEASE NOTE:-**

- **Internship (3-4 weeks) shall be conducted during summer break after semester-II and will be assessed during semester-III**
- ***Non Credit Course**

  *All Non Credit Courses (a qualifying exam) are awarded zero (0) credit.

  *Total and obtained marks are not added in the Grand Total.

**Abbreviation Used:-**

L: Lecture, T: Tutorial, P: Practical, CT: Class Test, TA: Teacher Assessment, PS: Practical Sessional, TE: Theory End Semester Exam., PE: Practical End Semester Exam.

**NOIDA INSTITUTE OF ENGINEERING & TECHNOLOGY, GREATER NOIDA**
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**B. TECH (BT)**
**Evaluation Scheme**
**SEMESTER IV**

| Sl. No. | Subject Codes | Subject Name | Periods | | | Evaluation Scheme | | | | End Semester | | Total | Credit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | CT | TA | TOTAL | PS | TE | PE | | |
| 1 | ABT0403 | Structural and Computational Biology | 3 | 1 | 0 | 30 | 20 | 50 | | 100 | | 150 | 4 |
| 2 | AASL0401 | Technical Communication | 2 | 1 | 0 | 30 | 20 | 50 | | 100 | | 150 | 3 |
| 3 | ABT0401 | Fermentation Engineering | 3 | 1 | 0 | 30 | 20 | 50 | | 100 | | 150 | 4 |
| 4 | ABT0404 | Green Biotechnology and Pollution Abetment | 3 | 0 | 0 | 30 | 20 | 50 | | 100 | | 150 | 3 |
| 5 | ABT0402 | Immunology &Immunotechology | 3 | 0 | 0 | 30 | 20 | 50 | | 100 | | 150 | 3 |
| 6 | ABT0405 | rDNA Technology | 3 | 0 | 0 | 30 | 20 | 50 | | 100 | | 150 | 3 |
| 7 | ABT0451 | Fermentation Engineering Lab | 0 | 0 | 2 | | | | 25 | | 25 | 50 | 1 |
| 8 | ABT0452 | Immunology &Immunotechology Lab | 0 | 0 | 2 | | | | 25 | | 25 | 50 | 1 |
| 9 | ABT0453 | Structural and Computational Biology Lab | 0 | 0 | 2 | | | | 25 | | 25 | 50 | 1 |
| 10 | ABT0459 | Mini Project | 0 | 0 | 2 | | | | 50 | | | 50 | 1 |
| 11 | ANC0402 / ANC0401 | Environmental Science*/ Cyber Security*(Non Credit) | 2 | 0 | 0 | 30 | 20 | 50 | | 50 | | 100 | 0 |
| | | MOOCs** (For B.Tech. Hons. Degree) | | | | | | | | | | | |
| | | **GRAND TOTAL** | | | | | | | | | | **1100** | **24** |

****List of MOOCs (Coursera) Based Recommended Courses for Second Year (Semester-IV) B. Tech Students**

| S. No. | Subject Code | Course Name | University / Industry Partner Name | No of Hours | Credits |
|---|---|---|---|---|---|
| 1 | AMC0047 | Fundamentals of Immunology: T Cells and Signaling | Rice University | 26 | 2 |
| 2 | AMC0048 | Genomics: Decoding the Universal Language of Life | University of Illinois at Urbana-Champaign | 36 | 3 |

**PLEASE NOTE:-**

- **Internship (3-4 weeks) shall be conducted during summer break after semester-IV and will be assessed during semester-V.**
- ***Non Credit Course**

  *All Non Credit Courses (a qualifying exam) are awarded zero (0) credit.
  *Total and obtained marks are not added in the Grand Total.

**Abbreviation Used:-**

L: Lecture, T: Tutorial, P: Practical, CT: Class Test, TA: Teacher Assessment, PS: Practical Sessional, TE: Theory End Semester Exam., PE: Practical End Semester Exam.

**NOIDA INSTITUTE OF ENGINEERING & TECHNOLOGY, GREATER NOIDA**

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**B. TECH (BT)**

**AICTE Guidelines in Model Curriculum:**

A student will be eligible to get Under Graduate degree with Honours only, if he/she completes the additional MOOCs courses such as Coursera certifications, or any other online courses recommended by the Institute (Equivalent to 20 credits). During Complete B.Tech. Program Guidelines for credit calculations are as follows.

1. For 6 to 12 Hours =0.5 Credit
2. For 13 to18 =1 Credit
3. For 19 to 24 =1.5 Credit
4. For 25 to 30 =2 Credit
5. For 31 to 35 =2.5 Credit
6. For 36 to 41 =3 Credit
7. For 42 to 47 =3.5 Credit
8. For 48 and above =4 Credit

For registration to MOOCs Courses, the students shall follow Coursera registration details as per the assigned login and password by the Institute these courses may be cleared during the B. Tech degree program (as per the list provided). After successful completion of these MOOCs courses, the students shall provide their successful completion status/certificates to the Controller of Examination (COE) of the Institute through their coordinators/Mentors only.

The students shall be awarded Honours Degree as per following criterion.

i. If he / she secures 7.50 as above CGPA.
ii. Passed each subject of that degree program in the single attempt without any grace.
iii. Successful completion of MOOCs based 20 credits.

| B.TECH. SECOND YEAR | | | |
|---|---|---|---|
| **Course Code** | **ABT0304** | **L T P** | **Credits** |
| **Course Title** | **Bioinformatics** | **3 1 0** | **4** |

**Course objective**

1. To understand the principles of analyzing biological data, building models and testing hypotheses using computer science algorithms.
2. This course is a survey of algorithms and tools in biological sequence analysis, genome-wide disease association, and precision medicine. Basic concept machine learning and its application in the analysis of biological data are also included in this course.
3. To understand a basic overview of various information repositories widely used in biological sciences; and tools for searching or querying those databases.
4. To build the foundation of sequence alignment techniques and find evolutionary connections.
5. To understand students to analyze mRNA expression annotations.

**Pre-requisites:**

**Course Contents / Syllabus**

| **UNIT-I** | **General Introduction:** | **7Hours** |
|---|---|---|

To study bioinformatics and its applications.Biological databases and tools: Nucleotide sequence databases, Protein sequence, structural and functional databases, Patent database, ***in silico***tools for rDNA technology.

| **UNIT-II** | **Database searching:** | **8Hours** |
|---|---|---|

BLAST and its types, Entrez, Ensembl-Biomart, Pairwise Sequence alignment: Pairwise alignment, Dynamic programing, Scoring Matrices, Gaps, Multiple sequence alignment: Dynamic and heuristic methods.

| **UNIT-III** | **Phylogenetic analysis:** | **8Hours** |
|---|---|---|

Relevance to inferences about evolution, introduction to molecular phylogeny, introduction, Types of Phylogenetic Trees, Methods and Applications. Bootstrap etc algorithm. Genome sequencing technologies and analysis methods; transcription factor regulation and motif finding.

| **UNIT-IV** | **Computational Epigenetics:** | **9Hours** |
|---|---|---|

Epigenetics and its role in transcription regulation, development, and diseases. Genomic variations and its associations: Linking genes, variations and diseases; Introduction to biomarkers and personalized medicine. Network biology and human diseases: Genome-wide association studies of humandiseases, Genome editing tools and applications to human diseases.

| **UNIT-V** | **Machine learning:** | **8Hours** |
|---|---|---|

Classification, Regression, SVM, Decision Trees, Artificial Neural Networks, Big Data in Biology. Molecular modeling (Homology and **Ab initio**) and validation (Procheck, verify 3D etc), Docking, Molecular dynamics, Energy calculations, Classical and semi-classical calculations, Quantum mechanical approaches.

**Course outcome: After completion of this course students will be able to**

| | | |
|---|---|---|
| CO 1 | Understanding the methodologies used for database searching, and determining the accuracies of database search. | |
| CO 2 | Understand basic algorithms used in Pairwise and Multiple alignments. | |
| CO 3 | To predict structure from sequence and subsequently testing the accuracy of predicted structures. | |
| CO 4 | To determine the protein function from sequence through analyzing data. | |
| CO 5 | To analyse and development of models for better interpretation of biological data to extract knowledge. | |

**Text books (Atleast3 )**


1. Bioinformatics: Sequence and Genome Analysis, David W Mount, Cold Spring Harbor Laboratory Press.
2. Essential Bioinformatics, JinXiong, Cambridge University Press; 1st edition 2006.

| | |
|---|---|
| **3.** Bioinformatics: methods and applications, S. C. Rastogi, PHI learning; 4th edition, 2013. | |
| **Reference Books (Atleast 3)** | |
| **1.** Jonathan Pevsner. Bioinformatics and Functional Genomics, 2nd Edition. ISBN: 978-0-470-08585-1 | |
| **2.** Greg Gibson and Spencer V. Muse. A Primer of Genome Science, Third Edition. ISBN:78-0-87893-309-9. | |
| **3.** The Dictionary of Genomics, Transcriptomics and Proteomics, Günter Kahl, WilleyVCH, 2015 | |
| **NPTEL/ Youtube/ Faculty Video Link:** | |
| **Unit 1** | |
| **Unit 2** | |
| **Unit 3** | |
| **Unit 4** | |
| **Unit 5** | |

| B.TECH. SECOND YEAR | | | |
|---|---|---|---|
| **Course Code** | **ABT0305** | **L T P** | **Credits** |
| **Course Title** | **Biophysics** | **3 1 0** | **4** |

**Course objective:** The objective of this course is to understand the biophysical, molecular and mechanistic basis of cellular functions and organism physiology and pathophysiology. Students would also be able to assimilate the recent research findings, advancement and development in the relevant subject.

| | |
|---|---|
| 1 | To understand the phenomena of water transport across cellular membranes. |
| 2 | To understand the electrical phenomena in excitable cells. |
| 3 | To gain a detailed understanding about membrane dynamics, ion channels and their importance in human health. |
| 4 | To learn the biophysical structure of Proteins and nucleic acids. |
| 5 | To understand the mechanism of cell dynamics. |

**Pre-requisites:** Basic Chemistry and Biology

**Course Contents / Syllabus**

| | | |
|---|---|---|
| **UNIT-I** | **Water transport across cell membranes:** | **6Hours** |

Concept of membrane permeablity, Diffusion, osmosis, tonicity, hydrostatic pressure and dialysis, Aquaporins and their roles. Regulation of cell volume.
Structural and functional classification of Biomolecules, Sterioisomerism in Biomolecules.

| | | |
|---|---|---|
| **UNIT-II** | **Electrical Phenomena:** | **8 Hours** |

Electrical Phenomena in Excitable Cells, Electrically Excitable Cells and their functions. Electrical Signals of Nerve Cells, The Ionic Hypothesis and Rules of Ionic Electricity,
Conduction disorders.

| | | |
|---|---|---|
| **UNIT-III** | **Ion Channels:** | **8 Hours** |

Membrane proteins and their functions, Interaction of membrane receptors and ligands, Channels and Transporters in Biological system, Functional Properties of Voltage-Gated Ion Channels, Ion pumping and Ion Channel rhodopsins and their use.

| | | |
|---|---|---|
| **UNIT-IV** | **Proteins and Nucleic acids:** | **8 Hours** |

Hierarchical Structure of Proteins, Torsional angles in proteins and nucleic acids, Protein stability and folding: thermodynamics and kinetics, Conformational Changes in proteins and DNA Molecules, A B and Z DNA, From DNA to RNA, The Biophysics of RNA.
Functional Design of Proteins, Molecular Chaperons, Thermodynamics of bi-molecular structures, Characterization of secondary structure using CD and X-ray crystallography.

| | | |
|---|---|---|
| **UNIT-V** | **Cell Dynamics** | **6 Hours** |

Cilia and Flagella: Structure and Movement, Molecular Motors: Kinesin, Dynein and Myosin,actin and intracellular movement, Microtubule structure.
Cell migration: Types and mechanism, Mechanobiology and its importance in human health.

**Course outcome: After completion of this course students will be able to**

| | **Course Outcomes** | **Bloom's Level** |
|---|---|---|
| CO 1 | Understand the phenomena of water transport across cellular membranes. | **KI, K2** |
| CO 2 | Learn about the electrical phenomena in excitable cells and understand its role in human physiology. | **K1, K2** |
| CO 3 | Learn the membrane dynamics, identify different types of ion channels and determine their importance in human health and thus understand the associated ongoing research in the field. | **K1, K2, K3** |
| CO 4 | Understand the conformational changes in DNA and protein and functional design of proteins. | **K1, K2,** |

| | | |
|---|---|---|
| CO 5 | Understand cellular dynamics and molecular motors involved in it. | **K1, K2,** |

**Text books**

1. The Biophysics of RNA. ACS Chem. Biol.200727440-444
2. Karp's Cell and molecular biology: Concepts and experiments, by Gerald Karp, Janet Iwasa, Wallace Marshall, ISBN: 978-1-118-88614-4

**Reference Books/Papers**

1. Membrane Organization and Dynamics , ISBN 978-3-319-66601-3
2. Principles of Biochemistry: A.L. Lehninger, Nelson and Cox, McMillan Worth Publishers.
3. Cox CD, Bavi N, Martinac B. Biophysical Principles of Ion-Channel-Mediated Mechanosensory Transduction. Cell Rep. 2019 Oct 1;29(1):1-12. doi: 10.1016/j.celrep.2019.08.075. PMID: 31577940

**NPTEL/ Youtube/ Faculty Video Link:**

| | |
|---|---|
| **Unit 1** | |
| **Unit 2** | |
| **Unit 3** | |
| **Unit 4** | |
| **Unit 5** | |

| B.TECH. SECOND YEAR | | | |
|---|---|---|---|
| **Course Code** | **ABT0301** | **L T P** | **Credits** |
| **Course Title** | **Biochemistry** | **3 0 0** | **3** |

**Course objective:** The objective of this course is to understand the biochemical, molecular and mechanistic basis of cellular functions and organism physiology and pathophysiology. Students would also be able to assimilate the recent research findings, advancement and development in the relevant subject.

| | |
|---|---|
| 1 | To learn about the role and importance of water, pH and buffers in biological processes. |
| 2 | To understand the chemistry and structure function of various types of carbohydrates along with their function and metabolism in body and to associate the same with biochemical basis of metabolic diseases. |
| 3 | To understand the chemistry and structure function of various types of lipids along with their function and metabolism in body and to associate the same with biochemical basis of metabolic diseases. |
| 4 | To Learn the basics of amino acids and protein structure and metabolism. |
| 5 | To analyse the structure and metabolism of nucleic acid and solve associated research problems. |

**Pre-requisites:** Basic Chemistry and Biology

**Course Contents / Syllabus**

| | | |
|---|---|---|
| **UNIT-I** | **Water, Buffers and Biochemical interactions:** | **6 Hours** |

Structure and properties of water, Ionization of water, Ph and buffers, buffering mechanism, Henderson-Hasselbalch equation, Buffering against pH Changes in Biological Systems: Phosphate buffer, Bicarbonate buffer, Chemical Bonds in biochemistry and their role in biological processes.

| | | |
|---|---|---|
| **UNIT-II** | **Carbohydrates** | **8 Hours** |

Classification of carbohydrates, Glycosidic bonds, Structure and function of carbohydrates, Ring structure and mutarotation. Glucose metabolism: Glycolysis & oxidation of Pyruvate, TCA cycle, Gluconeogenesis, Pentose Phosphate Pathway. Etiology of Diabetes.

| | | |
|---|---|---|
| **UNIT-III** | **Fatty acids and Lipids:** | **8 Hours** |

Structure and classification of fatty acids and lipids, nomenclature of lipids, Metabolism: Oxidation of fatty acids (beta oxidation, omega oxidation, alpha oxidation), carnitine shuttle, Biosynthesis of fatty acids. Electron transport chain and Oxidative phosphorylation.Etiology of Obesity.

| | | |
|---|---|---|
| **UNIT-IV** | **Amino acids and peptides:** | **6 Hours** |

Structure and classification, pKa and pI values of amino acids, Peptide bond, torsional angles in proteins-omega, phi and psi angle, Secondary structures: Alpha helix, beta sheets, Beta turns and Random coils, Ramachandran plot, Protein metabolism and function: Catabolism of proteins in body- deamination, transamination, Urea cycle, Glucose Alanine cycle; Overview of amino acid biosynthesis-Role of Glutamine.

| | | |
|---|---|---|
| **UNIT-V** | **Nucleic acids**: | **6 Hours** |

Purines and pyrimidines, Structure of nucleotides, Phosphodiester bond, Deoxyribonucleotides and ribonucleotides. Metabolism of Nucleotides: Purines & Pyrimidines synthesis: de Novo & salvage pathway, Conversion of nucleoside monophosphates to nucleoside triphosphates, Formation of deoxyribonucleotides. Catabolism & salvage of Purine and Pyrimidine nucleotides.

**Course outcome: After completion of this course students will be able to**

| | **Course Outcomes** | **Bloom's Level** |
|---|---|---|
| CO 1 | Comprehend the role and importance of water, pH and buffers in biological processes | **KI, K2** |
| CO 2 | Explain and associate the chemistry, structure of various types of carbohydrates with their function and metabolism in body and also will be | **K1, K2, K3** |

| | | |
|---|---|---|
| | able to apply the earned knowledge to understand the biochemical basis of metabolic diseases. | |
| CO 3 | Explain and associate the chemistry, structure of various types of lipids with their function and metabolism in body and also will be able to apply the earned knowledge to understand the biochemical basis of metabolic diseases. | **K1, K2, K3** |
| CO 4 | Learn the basics of amino acids and protein structure and metabolism; and apply the acquired knowledge in understanding and working with the associated techniques in research and industrial level. | **K1, K2, K6** |
| CO 5 | Identify and explain the structure and metabolism of nucleic acid and solve associated research problems with the help of acquired learning. | **K2, K3, K6** |

**Text books**

1. Principles of Biochemistry: A.L. Lehninger, Nelson and Cox, McMillan Worth Publishers.
2. Harper's Biochemistry-Rober K. Murray, Daryl K. Grammer, McGraw Hill, Lange Medical Books. 25th edition.
3. Biochemistry : S.C. Rastogi – Third Edition ; Tata McGraw Hill Education Pvt. Ltd. New Delhi.

**Reference Books**

1. Biochemistry: Stryer, W. H. Freeman
2. Biochemistry: Voet and Voet, John Wiley and Sons, Inc. USA
3. Biochemistry: Zubey, WCB.

**NPTEL/ Youtube/ Faculty Video Link:**

| | |
|---|---|
| **Unit 1** | https://www.youtube.com/watch?v=WhLrKCXxp08 |
| **Unit 2** | https://www.youtube.com/watch?v=OOc3zEgLLtk |
| **Unit 3** | |
| **Unit 4** | https://nptel.ac.in/courses/102/105/102105034/ |
| **Unit 5** | https://nptel.ac.in/courses/104/103/104103121/ |

| B.TECH. SECOND YEAR | | | |
|---|---|---|---|
| **Course Code** | **ABT0302** | **L T P** | **Credits** |
| **Course Title** | **Cell Biology and Microbiology** | **3 0 0** | **3** |

**Course objective:**

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|---|---|
| 1 | The course provides the students with a conceptual and experimental background in the broad discipline of cell and microbiology. The students will be introduced to the concept of Cell and major groups of microorganisms and their diversity in structure and functions and microbial interactions. Emphasis has been laid on bacterial growth, nutrition, control, metabolism, and genetics. The course also introduces the students to the scope and relevance of microbes in the field of medicine, agriculture, and industry. |

**Pre-requisites: Cell Biology**

**Course Contents / Syllabus**

| | | |
|---|---|---|
| **UNIT-I** | **Microscopy:** | **8L** |

Historical account of cell biology; Cell theory. Prokaryotic cell and it's ultrastructure. Eukaryotic cell- cell wall, cell membrane, cytoskeleton, nucleus, chloroplast, mitochondria, endoplasmic reticulum, Golgi bodies, ribosomes, lysosomes, vacuoles and centrosomes.

| | | |
|---|---|---|
| **UNIT-II** | **Cell cycle and division:** | **8L** |

Cell cycle and division - mitosis and meiosis. Cell Growth, Growth Kinetics, Cell- Cell Junction and Cell Signalling

| | | |
|---|---|---|
| **UNIT-III** | **History of Microbiology:** | **8L** |

History of Microbiology, Nutritional requirement of microorganisms, Types of Microorganisms, Preservation and Sterilization, Classification of bacteria and colony morphology, Structrue and classification of viruses, Lytic and Lysogenic cycles.

| | | |
|---|---|---|
| **UNIT-IV** | **Industrial Microbiology**: | **8L** |

Distribution of Microbes in Air and water, air sampling, Water treatment, Bacteriological analysis of water, Bioremediation. Biofertilizers, industrially important micro-organisms, secondary metabolites from micro-organisms, Microbiology of foods, Single cell Protein. Fermented food.

| | | |
|---|---|---|
| **UNIT-V** | **Medical Microbiology:** | **8L** |

Diseases caused bacteria, virus, fungi, and protozoans; Fungal diseases, Vaccines, Anti-microbial agents, Antibiotics and disinfectants, Cancer.

**Course outcome: After completion of this course students will be able to**

| | | |
|---|---|---|
| CO 1 | 1. Describe the detailed molecular structure and functioning of the key components of the cell, their culturing techniques and preservation methods. | K1 |
| CO 2 | 2. Compare and analyse various physical & chemical methods of controlling microbial growth. | K2 |
| CO 3 | 3. Acquire skills and knowledge on the role of beneficial microorganisms in environment | K1 |
| CO 4 | 4. Apply the knowledge and understanding of the nature and particular attributes of microorganisms as a basis for studies in the applied area of agricultural microbiology and Industrial microobiology. | K3 |
| CO 5 | 5. Understand the causes and consequences of medical microbiology in different disease and can comprehend the characteristics and origin of cancerous cells. | K1 |

**Text books (Atleast3 )**

**1.** Brock Biology of Microorganisms by Madigan, Martinko, Stahl andClark.

| | |
|---|---|
| 2. | Microbiology, M. Pelczar, E. Chan, N. Kreig, 5$^{th}$ed,MGH |
| 3. | General Microbiology by Dr. Rashmi Mishra, New Delhi Piblishers |
| **Reference Books (Atleast 3)** | |
| Prescott's Microbiology by Willey, Sherwood andWoolverton | |
| Ananthanarayan and Paniker's Textbook of Microbiology | |
| General Microbiology by Stanier, Ingraham, Wheelis andPainter. | |
| **NPTEL/ Youtube/ Faculty Video Link:** | |
| **Unit 1** | https://microbiologysociety.org/our-work/75th-showcasing-why-microbiology-matters/understanding-bacteria/bacteria-in-industry.html |
| **Unit 2** | https://www.scientistcindy.com/microbial-nutrition-and-growth.html<br>https://www.scientistcindy.com/microbial-nutrition-and-growth.html |
| **Unit 3** | https://www.waste2water.com/bioremediation-benefits-and-uses/ |
| **Unit 4** | https://www.youtube.com/watch?v=cjSE73S3Crs<br>https://www.youtube.com/watch?v=lm76h4h1R6k |
| **Unit 5** | https://study.com/articles/Medical_Microbiology_Careers_Job_Options_and_Requirements.html<br>https://www.youtube.com/watch?v=cvcsMeLGxf4 |

| B.TECH. SECOND YEAR | | | |
|---|---|---|---|
| **Course Code** | **ABT0303** | **L T P** | **Credits** |
| **Course Title** | **Genetics and Molecular Biology** | **3 0 0** | **3** |

**Course objective:** To provide students the knowledge about fundamentals of genetics, mutations and repair mechanism, evaluate genetic and allelic frequencies and get insight the chemistry of nucleic acids and genetic material replication, transcription, translation and molecular basis of gene regulations.

| | |
|---|---|
| 1 | To provide students the knowledge about fundamentals of genetics and to calculate and evaluate genetic and allelic frequencies. |
| 2 | To understanding types of mutations, detection of mutations and repair mechanism. |
| 3 | To learn the basic principle of genetic materials and their replication process in prokaryotes and eukaryotes. |
| 4 | To learn the basic principle of transcription, mRNA processing and translations. |
| 5 | Students enhance their knowledge about molecular basis of gene regulations. |

**Pre-requisites:** Basics of biotechnology, Remedial biology

**Course Contents / Syllabus**

| | | |
|---|---|---|
| **UNIT-I** | **Qualitative and Quantitative Genetics:** | **10 Hours** |

Fundamental principles of genetics, chi square test, gene interaction, multiple alleles, sex determination, sex linked inheritance, sex limited and sex, influenced inheritance, extra-chromosomal inheritance, Linkage, crossing over, recombination, gene mapping, two-point, three-point test crosses. Introduction to quantitative genetics, genotypic & allelic frequencies, calculating genotypic and allelic frequencies, Hardy-Weinberg equilibrium

| | | |
|---|---|---|
| **UNIT-II** | **Genetic Syndrome and Mutations:** | **10 Hours** |

Genetic Syndrome, Mutation and Types of Gene mutations- Base substitution and Frame shift mutations; Mutagens - Physical and chemical; Reverse mutation in bacteria; Techniques to detect mutations, DNA repair mechanism.

| | | |
|---|---|---|
| **UNIT-III** | **Genetic Material and DNA Replication:** | **7 Hours** |

Chemistry of Genetic Material, Discovery of DNA as genetic material, Experiments of Griffith; Avery, McCleod and; McCarthy, and Harshey and Chase. RNA as genetic material- Experiment of Fraenkel and Singer; Nucleic acids: structure of DNA, RNA, and Proteins, DNA Replication in prokaryotes and eukaryotes.

| | | |
|---|---|---|
| **UNIT-IV** | **Transcription, Translation and Genetic Code:** | **8 Hours** |

Transcription in prokaryotes and eukaryotes, Genetic code: Brief account, RNA processing, Translation in prokaryotes and eukaryotes.

| | | |
|---|---|---|
| **UNIT-V** | **Gene Expression and Gene regulation:** | **10 Hours** |

Gene regulation, positive regulation, negative regulation, attenuation, post-transcriptional regulation; Eukaryotic transcription factors, enhancers, silencers, insulators, Post-translational modification and protein stability.

**Course outcome: After completion of this course students will be able to**

| | | |
|---|---|---|
| CO 1 | Learn the fundamental principles of genetics and evaluate the genetic and allelic frequencies assumptions of Hardy-Weinberg equilibrium. | $K_1$, $K_4$ |
| CO 2 | Understanding the process of mutation types, and techniques to detect mutations, DNA repair mechanism | $K_2$ |
| CO 3 | Get insight into the genetic materials, replication process in genetic materials in prokaryotes and eukaryotes | $K_3$, $K_4$ |
| CO 4 | Get insight into the transcription, mRNA processing and translations. | $K_3$, $K_4$ |
| CO 5 | Evaluate the gene expression and its regulation mechanism in detail | $K_2$, $K_3$ |

**Textbooks:** 1. Molecular Biology of the Cell: Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walte; 6th edition New York: Garland Science; 2008.

| | |
|---|---|
| 2. Cell and Molecular Biology-Concepts and Experiments; Gerald Karp et al. John Wiley; 8th edition; 2015. | |
| 3. Lewin's GENES XII by Jocelyn E. Krebs Elliott S. Goldstein and Stephen T. Kilpatrick | |
| **References Books:** 1. Molecular Cell Biology, 8th edition (2016) by Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Anthony Bretscher, HiddePloegh, Angelika Amon and Kelsey C. Martin | |
| 2. Genetics a conceptual approach, 2nd Edition Benjamin A. Pierc WH freeman and, company, New York. Publisher | |
| 3.Latest/classic research articles and reviews relevant to various topics. | |
| | |
| **NPTEL/ Youtube/ Faculty Video Link:** | |
| **Unit 1** | https://www.youtube.com/watch?v=x3oR48DQCiQ<br>https://www.youtube.com/watch?v=ni5jyO0g1_w<br>https://www.youtube.com/watch?v=AzkXQBzZElE<br>https://www.youtube.com/watch?v=wrtLyLwt51o |
| **Unit 2** | https://www.youtube.com/watch?v=mCOMD291oBM&t=242s<br>https://www.youtube.com/watch?v=hxmkWNql2xU<br>https://www.youtube.com/watch?v=mDxpQGMVY54&t=3s |
| **Unit 3** | https://www.youtube.com/watch?v=vP8-5Bhd2ag<br>https://www.youtube.com/watch?v=4g6SDv83AjI<br>https://www.youtube.com/watch?v=yARVDFFGO60<br>https://www.youtube.com/watch?v=RngRezKfRXQ&t=67s<br>https://www.youtube.com/watch?v=EK3wauaZrnE |
| **Unit 4** | https://www.youtube.com/watch?v=RA9n0Enu5Gw<br>https://www.youtube.com/watch?v=TNKWgcFPHqw<br>https://www.youtube.com/watch?v=cXlv21NCGxQ<br>https://www.youtube.com/watch?v=EMDuf_kBJcs&t=79s<br>https://www.youtube.com/watch?v=KZBljAM6B1s |
| **Unit 5** | https://www.youtube.com/watch?v=qIwrhUrvX-k&t=62s<br>https://www.youtube.com/watch?v=J9jhg90A7Lw |

| B.TECH. SECOND YEAR | | | |
|---|---|---|---|
| **Course Code** | **ABT0306** | **L T P** | **Credits** |
| **Course Title** | **Plant and Animal Science** | **3 0 0** | **3** |

**Course objective:** To understand plant metabolism, plant development and their interaction with other organisms

| | |
|---|---|
| 1 | To understand the basics of plant structure and development. (K1) |
| 2 | To learn plant physiology. (K1) |
| 3 | To understand the different types of metabolisms in plants. (K3) |
| 4 | To understand the process of animal physiology (K1, K3) |
| 5 | To learn the reproduction ,events of sexual and asexual reproduction. (K1) |

**Pre-requisites:** The plant biology course deals with advanced aspects of plant biology such as physiology, development and anatomy. Students are expected to have knowledge of basic biology, because plants are a model system for research in molecular genetics, cell biology and biochemistry, plant biology and animal biology is an excellent course for students in these fields.

**Course Contents / Syllabus**

| | | |
|---|---|---|
| **UNIT-I** | **PLANT STRUCTURE AND DEVELOPMENT** | **8 hr** |
| Structural organization and function of plant cell, Growth and Division of The Cell, Morphogenesis and organogenesis in plants, programmed cell death, aging and senescence | | |
| **UNIT-II** | **PLANT PHYSIOLOGY:** | **8 hr** |
| Photosynthesis, Respiration and photorespiration, Nitrogen metabolism, Plant hormones, Sensory photobiology, Solute transport and photo assimilate translocation, Stress physiology | | |
| **UNIT-III** | **PLANT METABOLISM :** | **8 hr** |
| Control of metabolic pathways. Carbon assimilation: photosynthesis, photorespiration and sucrose transport; Non-photosynthetic generation of energy and precursors. Storage of carbon. Metabolism in plastids. Nitrogen, phosphorus, sulfur and iron assimilation; Movement of water and minerals. | | |
| **UNIT-IV** | **ANIMAL PHYSIOLOGY** | **8 hr** |
| Digestion-Alimentary canal and digestive glands, role of digestive enzymes, Breathing and respiration-Respiratory organs in animals, respiratory systems and mechanism of breathing and its regulations. Body fluids and circulation in animals. Excretory products and their elimination in animals. Chemical coordination and regulation in animals. | | |
| **UNIT-V** | **DEVELOPMENTAL BIOLOGY** | **8 hr** |
| Sexual and asexual reproduction in plants and animals, Events in sexual reproduction in animals and plants. Introduction to plant and animal fertilization, Seed formation and seed germination Pre fertilization and post fertilization events in animals, Gametogenesis, Embryo development in animals and plants, life history of model organisms like Drosophilla, House fly, Mosquito etc. | | |

**Course outcome: After completion of this course students will be able to**

| | | |
|---|---|---|
| CO 1 | Students will understand about the biology of plants. | (K1) |
| CO 2 | They will learn about plant physiology. | (K1) |
| CO 3 | Understand the different types of metabolisms in plants | (K3) |
| CO 4 | Learn the overall animal physiology | (K1, K3) |
| CO 5 | Understand the developmental biology in animals and plants. | (K1) |

**Textbooks:**

1. Plant Biology. Allison Smith et al. Garland Science, 2010.

2. Botany: An Introduction to Plant Biology, James D. Mauseth.

3. Biology of Plants by Peter H. Raven, Ray F. Evert, Susan E. Eichhorn, Hardcover: 875 pages, Publisher: W. H. Freeman

| **Reference Books:** | |
|---|---|
| 1. Plant Biology (with InfoTrac) by Thomas L. Rost, Michael G. Barbour, C. Ralph Stocking, Terence M. Murphy, Paperback: 568 pages, Publisher: Brooks Cole | |
| 2. Introductory Plant Biology by Kingsley R Stern, Jim Bidlack, Shelley Jansky, Hardcover: 640 pages, Publisher: McGraw-Hill Science/Engineering/Math | |
| 3. Introductory Botany: Plants, People, and the Environment by Linda R. Berg, Hardcover: 466 pages, Publisher: Brooks Cole | |
| **NPTEL/ Youtube/ Faculty Video Link:** | |
| **Unit 1** | https://www.youtube.com/watch?v=9UvlqAVCoqY |
| **Unit 2** | https://www.youtube.com/watch?v=RT-w2xHVl_E&list=PLs7Y2nGwfz4FL4ZJgONHsl1qp-AZPr3tJ |
| **Unit 3** | https://www.youtube.com/watch?v=IWgNA9ynfGs |
| **Unit 4** | https://www.youtube.com/watch?v=X3TAROotFfM<br>https://www.youtube.com/watch?v=X3TAROo<br>https://www.youtube.com/watch?v=SFzpZu-znCc<br>https://www.youtube.com/watch?v=3nB2RKW7oRs |
| **Unit 5** | https://www.youtube.com/watch?v=83AabzOGAZ4 |

| B.TECH. SECOND YEAR | | | |
|---|---|---|---|
| **Course Code** | **ABT0351** | **L T P** | **Credit** |
| **Course Title** | **Biochemistry and Biophysics lab** | **0 0 2** | **1** |
| **Suggested list of Experiment** | | | |
| **Sr. No.** | **Name of Experiment** | | **CO** |
| 1 | To prepare solutions of given concentration in terms of 1) percentage, 2) molarity, 3) normality | | **K1** |
| **2** | To perform the titration of weak acid-weak base | | K1 |
| **3** | To test for the presence of sugar in a solution and differentiate between reducing sugar in the sample using Benedict's test, Fehling's test and Tollens's test. | | K2 |
| **4** | To perform quantitative analysis of carbohydrate using Phenol-Sulphuric acid method. | | K2 |
| **5** | To separate amino acids using paper/thin layer chromatography | | K3 |
| **6** | To quantify the nucleotide sample present in a sample using spectrophotometric method. | | K4 |
| **7** | To test the presence and quantify proteins in a given sample using Biuret method. | | **K4** |
| **8** | To study the working and principle of isoelectric focusing. | | K2,3,4 |
| **9** | To demonstrate osmosis, reverse osmosis and dialysis in biological membranes. | | K1 |
| **10** | To study thermal denaturation of biomolecules. | | K2 |
| **Course Outcome:** After completing the course, the student will gain the basic level of knowledge that is needed to start working in standard biochemistry laboratory at research or industrial level. | | | |
| CO 1 | **Prepare the solutions of any given concentrations.** | | **K5** |
| CO 2 | Qualitatively and quantitatively analyze the sample for the presence of Carbohydrates, lipids, nucleic acids and proteins | | **K6** |
| CO 3 | Understand the process of membrane transport by biological membranes. | | **K2** |
| CO 4 | Explain the working and principle of isoelectric focusing | | **K4, k5** |
| CO 5 | Understand the process of thermal denaturation of biomolecules. | | **K3, K4** |

| B.TECH. SECOND YEAR | | | |
|---|---|---|---|
| **Course Code** | **ABT0352** | **L T P** | **Credit** |
| **Course Title** | **Cell Biology and Microbiology lab** | **0 0 2** | **1** |
| **Suggested list of Experiment** | | | |
| **Sr. No.** | **Name of Experiment** | | **CO** |
| 1 | To identify the different types of cells, present in the leaf cross section. | | 1(K1) |
| **2** | To measure the length and breadth of the given cell sample by using micrometer | | 2(K3) |
| **3** | To identify the blood cell types in human blood smear | | 2(K3) |
| **4** | Media preparation, sterilization and disinfection | | 2(K3) |
| **5** | Preparation of Nutrient Agar Plate, slant and NA tube | | 2(K3) |
| **6** | Inoculation of microbes in NA Plate, NA Slant and NA Tube | | 2(K3) |
| **7** | Microbial simple and differential staining methods | | **3**(K1) |
| **8** | Isolation of Microbes from given soil sample | | 3(K1) |
| **9** | Isolation of pure culture and its preservation | | 2(K3) |
| **10** | Gram's staining | | **3**(K1) |
| **Lab Course Outcome:** | | | |
| CO 1 | Students will be aware of the conspicuous presence of microbes in the environment and their influence in our daily lives. as part of the food, soil, air environment, and disease development. | | |
| CO 2 | Students will be able to culture and study different types of Microorganism | | |
| CO 3 | The students will be excited to knowtheimmensediversityinthemicrobialworld,theirvariedinterorintra-community interactions and contribution to the biotech industry. | | |

| B.TECH. SECOND YEAR | | | |
|---|---|---|---|
| **Course Code** | **ABT0353** | **L T P** | **Credit** |
| **Course Title** | **Genetics and Molecular Biology Lab** | **0 0 2** | **1** |

**Suggested list of Experiment**

| Sr. No. | Name of Experiment | CO |
|---|---|---|
| **1** | Study of the life cycle of Drosophila melanogaster. | 1 |
| **2** | Study of polytene chromosome from insect salivary gland. | 1 |
| **3** | Study of mitosis in onion root tips. | 2 |
| **4** | How to calculate genotypic and allelic frequencies? | 2 |
| **5** | Observation of developmental mutants in Drosophila | 2 |
| **6** | Extraction of RNA from animal and plant tissues. | 4 |
| **7** | Extraction of plasmid DNA and calculation of concentration and purity. | 3 |
| **8** | Extraction of genomic DNA from animal cell and calculation of concentration and purity. | 3 |
| **9** | Estimation of size in bp of DNA using agarose gel electrophoresis. | 4 |
| **10** | Polyacrylamide gel electrophoresis and estimation of MW of proteins. | 3 |

**Course Outcome:**

| | |
|---|---|
| **CO 1** | Students able to demonstrate life cycle, polytene chromosome and importance of *Drosophila* fruit flies for genetic study. (K2) |
| **CO 2** | Students able to demonstrate different stages of mitosis, meiosis and Drosophila mutants ($K_1$,$K_2$) |
| **CO 3** | Students evaluate and calculate molecular weight of proteins and concentrations of DNA. (K3) |
| **CO 4** | Students will have enhanced their knowledge for doing extraction of RNA from animal and plant tissues ($K_1$,$K_2$) |

| B. TECH. SECOND YEAR | | | | | |
|---|---|---|---|---|---|
| **Course Code** | **ANC0301** | **L** | **T** | **P** | **Credit** |
| **Course Title** | **Cyber Security** | **2** | **0** | **0** | **0** |

**Course objective:**

Achieve knowledge about Security of Information system and Risk factors and examine security threats and vulnerability in various scenarios, understand concept of cryptography and encryption technique to protect the data from cyber-attackand provide protection for software and hardware.

**Pre-requisites:** Basics recognition in the domain of Computer Science.
Concept of network and operating system.
Commands of programming language.

## Course Contents / Syllabus

| UNIT-I | Introduction | 8 Hours |
|---|---|---|

Introduction to Information Systems: Types of Information Systems, Development of Information Systems, Need for Information Security, Threats to Information Systems, Information Assurance, Guidelines for Secure Password and WI-FI Security and social media and Windows Security, Security Risk Analysis, and Risk Management.

| UNIT-II | Application Layer Security | 8 Hours |
|---|---|---|

Data Security Considerations-Backups, Archival Storage and Disposal of Data,Security Technology-Firewall, Intrusion Detection, Access Control, Security Threats -Viruses, Worms, Trojan Horse,Bombs,Trapdoors,Spoofs, E-mail Viruses, Macro Viruses, Malicious Software,Network and Denial of Services Attack, Security,Threats to E-Commerce: Electronic Payment System, e- Cash, Issues with Credit/Debit Cards.

| UNIT-III | Secure System Development | 8 Hours |
|---|---|---|

Application Development Security, Architecture & Design,Security Issues in Hardware: Data Storage and Downloadable Devices, Mobile Protection,Security Threats involving in social media, Physical Security of IT Assets, Access Control, CCTV and Intrusion Detection Systems, Backup Security Measures.

| UNIT-IV | Cryptography And Network Security | 8 Hours |
|---|---|---|

Public key cryptography: RSA Public Key Crypto with implementation in Python,Digital Signature Hash Functions,Public Key Distribution.

Symmetric key cryptography: DES (Data Encryption Standard), AES (Advanced Encryption Standard), Secure hash algorithm(SHA-1).

Real World Protocols: Basic Terminologies, VPN, Email Security Certificates, Transport Layer Security, TLS, IP security, DNS Security.

| UNIT-V | Security Policy | 8 Hours |
|---|---|---|

Policy design Task, WWW Policies, Email based Policies, Policy Revaluation Process-Corporate Policies-Sample Security Policies,Publishing and Notification Requirement of the updated and new Policies.
Resent trends in security.

**Course outcome:** At the end of course, the student will be able to

| | | |
|---|---|---|
| CO 1 | Analyze the cyber security needs of an organization. | K4 |

| | | |
|---|---|---|
| CO 2 | Identify and examine software vulnerabilities and security solutions. | K1,K3 |
| CO 3 | Comprehend IT Assets security (hardware and Software) and performance indicators | K2 |
| CO 4 | Measure the performance and encoding strategies of security systems. | K3, K5 |
| CO 5 | Understand and apply cyber security methods and policies to enhance current scenario security. | K2, K3 |

## Text books:

1) Charles P. Pfleeger, Shari LawerancePfleeger, "Analysing Computer Security", Pearson Education India
2) V.K.Pachghare, "Cryptography and information Security", PHI Learning Private Limited, Delhi India
3) Sarika Gupta & Gaurav Gupta, Information Security and Cyber Laws, Khanna Publishing House
4) Michael E.Whitman and Herbert J Mattord "Principle of Information Security" Cengage

## Reference Books:

1) Schou, Shoemaker, "Information Assurance for the Enterprise", Tata McGraw Hill.
2) CHANDER, HARISH," Cyber Laws and It Protection", PHI Learning Private Limited,Delhi
3) V.K. Jain, Cryptography and Network Security, Khanna Publishing House, Delhi
4) William Stallings, Network Security Essentials: Applications and Standards, Prentice Hall, 4th edition, 2010

## E-books& E-Contents:

1) https://prutor.ai/welcome/
2) https://crypto.stanford.edu/cs155old/cs155-spring11/lectures/03-ctrl-hijack.pdf
3) https://cybermap.kaspersky.com/stats
4) https://www.fireeye.com/cyber-map/threat-map.html

## Reference Links:

1) https://crypto.stanford.edu/cs155old/cs155-spring11/lectures/03-ctrl-hijack.pdf
2) https://cs155.stanford.edu/lectures/03-isolation.pdf
3) http://uru.ac.in/uruonlinelibrary/Cyber_Security/Cryptography_and_Network_Security.pdf

## NPTEL/ Youtube/ Faculty Video Link:

1) https://www.youtube.com/watch?v=vv1ODDhXW8Q
2) https://www.youtube.com/watch?v=fQ3ESFfvchg&list=PLUtfVcb-iqn834VGI9faVXGIGSDXZMGp8
3) https://www.youtube.com/watch?v=iTVyKbDCJrA&list=PLgMDNELGJ1CbdGLyn7OrVAP-IKg-0q2U2
4) https://www.youtube.com/watch?v=1plMO7ChXMU&list=PLJ5C_6qdAvBFAuGoLC2wFGruY_E2gYtev
5) https://www.youtube.com/watch?v=_9QayISruzo

# B. TECH. SECOND YEAR

| Course Code | ANC0302 | L T P | Credits |
|---|---|---|---|
| Course Title | Environmental Science | 2 0 0 | 0 |

**Course objective:**

| | |
|---|---|
| 1 | To help the students in realizing the inter-relationship between man and environment. and help the students in acquiring basic knowledge about environment. |
| 2 | To develop the sense of awareness among the students about environment and its various problems. |
| 3 | To create positive attitude about environment among the student. |
| 4 | To develop proper skill required for the fulfilment of the aims of environmental education and educational evaluations |
| 5 | To develop the capability of using skills to fulfil the required aims, to realise and solve environmental problems through social, political, cultural and educational processes |

**Pre-requisites:** Basic knowledge of nature.

**Course Contents / Syllabus**

## UNIT-I Basic Principle of Ecology — 8 Hours

Definition, Scope and basic principles of ecology and environment. Ecosystem: Basic concepts, components of ecosystem. Food chains and food webs. Ecological pyramids, Energy flow in ecological systems, Characteristics of different ecosystems. Biogeochemical Cycles: Importance, gaseous and sedimentary cycles. Carbon, Nitrogen, Phosphorus and Sulphur Cycles.

Basic concepts of sustainable development, SDGs, Ecosystem services, UN Decade for Ecorestoration.

## UNIT-II Natural Resources and Associated Problems — 8 Hours

Natural resources and associated problems. Forest resources: Use and over-exploitation, deforestation. Timber extraction, mining, dams and their effects on forest and tribal people. Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources. Food resources: World food problems, changes caused by agriculture and over-grazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity.

Land resources: Land as a resource, land degradation, man induced landslides. Equitable use of resources for sustainable lifestyles.

Non-Renewable Energy Resources: Fossil fuels and their reserves, Nuclear energy, types, uses and effects, Renewable Energy Resources: hydropower, Solar energy, geothermal, tidal and wind energy, Biomass energy, biogas and its advantages.

## UNIT-III Biodiversity Succession and Non-Renewable Energy Resources — 8 Hours

Biodiversity and their importance, Threats to biodiversity, major causes, extinction's, vulnerability of species to extinction, IUCN threat categories, Red data book.

Strategies for biodiversity conservation, principles of biodiversity conservation in-situ and ex-situ conservation strategies Mega diversity zones and Hot spots, concepts, distribution and importance.

Succession: Concepts of succession, Types of Succession. Trends in succession. Climax and stability.

## UNIT-IV Pollution and Solid Waste Management — 8 Hours

Air pollution: sources of air pollution, Primary and secondary air pollutants. Origin and effects of SOX, NOX, Cox, CFC, Hydrocarbon, control of air pollution. Water pollution: sources and types of water pollution, Effects of water pollution, Eutrophication, Soil pollution: Causes of soil pollution, Effects of soil pollution, Major sources of and effects of noise pollution on health, Radioactive and thermal pollution sources and their effects on surrounding environment.

Solid waste disposal and its effects on surrounding environment, Climate change, global warming, acid rain, ozone layer depletion.

## UNIT-V Role of Community and Environmental Protection Acts — 8 Hours

Role of community, women and NGOs in environmental protection, Bioindicators and their role, Natural hazards, Chemical accidents and disasters risk management, Environmental Impact Assessment (EIA), Salient features of following Acts: a. Environmental Protection Act, 1986, Wildlife (Protection) Act, 1972.b. Water (Prevention and control of pollution) Act, 1974.c. Air (Prevention and control of pollution) Act, 1981. Forest (Conservation) Act, 1980.d. Wetlands (Conservation and Management) Rules, 2017; e. Chemical safety and Disaster Management law. F. District Environmental Action Plan. Climate action plans.

**Course outcome:** After completion of this course students will be able to

| | | |
|---|---|---|
| CO 1 | Understand the basic principles of ecology and environment. Ecosystem: Basic concepts, components of ecosystem., food chains and food webs. Ecological pyramids | K2 |
| CO 2 | Understand the different types of natural recourses like food, forest, minerals and energy and their conservation | K2 |
| CO 3 | Understand the importance of biodiversity, Threats of biodiversity and different methods of biodiversity conservation. | K2 |
| CO 4 | Understand the different types of pollution, pollutants, their sources, effects and their control methods | K3 |
| CO 5 | Understand the basic concepts of sustainable development, Environmental Impact Assessment (EIA) and different acts related to environment | K3 |

## Text books:


1. Brady, N.C. 1990. The nature and properties of Soils, Tenth Edition. Mac Millan Publishing Co., New York.
2. Botkin, D.B and Kodler E.A., 2000, Environmental Studies: The earth as a living planet. John Wiley and Sons Inc.
3. Rao M.N. and H.V.N. Rao, 1989: Air Pollution, Tata McGraw Hill Publishing Co. Ltd., New Delhi
4. Singh J.S., Singh S.P. and Gupta S.R., 2006, Ecology Environment and Resource Conservation, Anamaya Publishers, New Delhi.
5.Environmental Studies -Benny Joseph-Tata McgrawHill-2005
6. Environmental Studies- Dr. D.L. Manjunath, Pearson Education-2006.
7. Environmental studies- R, Rajagopalan -Oxford Pubtiotion2005.


## Reference Books:


1.Sodhi G.S. 2005, Fundamentals of Environmental Chemistry: Narosa Publishing House, New Delhi.
2.Dash, M.C. (1994), Fundamentals of Ecology, Tata Mc Graw Hill, New Delhi.
3. Sharma P. D. (1996). Environmental Biology, Rastogi Publications, Meerut.
4. Verma P.S. and V.K. Agarwal. (1985). Principles of Ecology. S. Chand and Company (Pub.), New Delhi.
5.Principles of Environmental Sciences and Engineering -P. Venugoplan Rao, Prenitice Hall of India.
6. Environmental Science and Engineering Meenakshi, Prentice Hall India.


## NPTEL/ Youtube/ Faculty Video Link:

| | |
|---|---|
| **Unit 1** | https://www.youtube.com/watch?v=T21OO0sBBfc, https://www.youtube.com/watch?v=qt8AMjKKPDohttps://www.youtube.com/watch?v=yAK-m91Nxrshttps://www.youtube.com/watch?v=ha_O-1uOWkk, https://www.youtube.com/watch?v=brF0RWJyx9w |
| **Unit 2** | https://www.youtube.com/watch?v=mOwyPENHhbc, https://www.youtube.com/watch?v=yqev1G2iy20, https://www.youtube.com/watch?v=_74S3z3IO_I, https://www.youtube.com/watch?v=jXVw6M6m2g0 |
| **Unit 3** | https://www.youtube.com/watch?v=GK_vRtHJZu4, https://www.youtube.com/watch?v=b6Ua_zWDH6U, https://www.youtube.com/watch?v=7tgNamjTRkk, https://www.youtube.com/watch?v=ErATB1aMiSU, https://www.khanacademy.org/science/high-school-biology/hs-ecology/hs-human-impact-on-ecosystems/v/conservation-and-the-race-to-save-biodiversity |
| **Unit 4** | https://www.youtube.com/watch?v=7qkaz8ChelI, https://www.youtube.com/watch?v=NuQE5fKmfME, https://www.youtube.com/watch?v=9CpAjOVLHII, https://www.youtube.com/watch?v=yEci6iDkXYw, https://www.youtube.com/watch?v=yEci6iDkXYw |
| **Unit 5** | https://www.youtube.com/watch?v=ad9KhgGw5iA, https://www.youtube.com/watch?v=nW5g83NSH9M, https://www.youtube.com/watch?v=xqSZL4Ka8xo, https://www.youtube.com/watch?v=WAI-hPRoBqs, https://www.youtube.com/watch?v=o-WpeyGlV9Y, https://www.youtube.com/watch?v=EDmtawhADnY |

| B.TECH SECOND YEAR | | | |
|---|---|---|---|
| **Course Code** | **ABT0403** | **L T P** | **Credits** |
| **Course Title** | **Structural and Computational Biology** | **3 1 0** | **4** |

**Course objective:**

| | |
|---|---|
| 1 | To enhance the knowledge about basic structure of DNA and RNA |
| 2 | To gain the information about different techniques used for protein analysis |
| 3 | To learn about the different application of protein structure |
| 4 | To enhance the knowledge about type of protein structure |
| 5 | To gain the information about usage of structural biology in future career |

**Pre-requisites:**

**Course Contents / Syllabus**

| | | |
|---|---|---|
| **UNIT-I** | **PROTEIN STRUCTURAL BIOLOGY:** | **8h** |

Protein sequences, sequence alignment; basic polypeptide stereochemistry, hierarchy in protein folds: secondary structure, tertiary structure, quaternary structure. Chaperones assisted protein production, Thermodynamics of protein stability. Effect of amino acid on protein structure.

| | | |
|---|---|---|
| **UNIT-II** | **PROTEIN STRUCTURE AND ANALYSIS:** | **8h** |

Principles of soluble and membrane protein purification, Phase diagram and separation, crystallization, Use of robotics in crystallization, Space groups and symmetry, structure determination; NMR sample preparation, Sample preparation for Cryo EM, Structure validation and best practices on the use of protein structures from protein data bank; Protein fold-function relationships, Protein Data Bank (PDB) and EM Data Bank, BioMagResBank (BMRB).

| | | |
|---|---|---|
| **UNIT-III** | **METHODS FOR ATOMIC-RESOLUTION STRUCTURE DETERMINATION**: | **8h** |

X-ray crystallography, solution- and solid-state NMR spectroscopy, Single particle Cryo Electron Microscopy, XRay Free-Electron Laser (XFEL). Anisotropy Use of Circular Dichroism, Steady-state and time-resolved fluorescence spectroscopy, FRET, Single molecule fluorescence, Electron Paramagnetic Resonance spectroscopy.

| | | |
|---|---|---|
| **UNIT-IV** | **DNA AND RNA STRUCTURES**: | **8h** |

DNA and RNA secondary structures (duplex, triplex, quadruplexes and aptamers), RNA secondary structure prediction.**Structure of Sugars and lipids**

| | | |
|---|---|---|
| **UNIT-V** | **STRUCTURAL DYNAMICS**: | **8h** |

Dynamics of Protein-RNA complexes; Structure and organizationof genomes. **Simulations**: Protein functional dynamics, Protein dynamics studies by MD simulations;Protein dynamics studies by biophysical techniques.

**Course outcome: After completion of this course students will be able to**

| | | |
|---|---|---|
| CO 1 | gain an understanding of the basic science of Protein and Nucleic Acid (DNA and RNA) structure, including first principles of physical interactions that maintain proteins and the mechanisms that make them intact. | |
| CO 2 | Understand about the different techniques and experimental approaches that represent the state-of-the-art and are widely used in the study of proteins. | |
| CO 3 | Understand the different applications of protein structure. | |
| CO 4 | Offered a learning environment that should make the understanding of protein structure. | |
| CO 5 | Understand the relevance of structural biology and its application to their future careers. | |

**Text books (Atleast3 )**

| | |
|---|---|
| Biophysical Chemistry vol I, II and III by Charles R. Canter and Paul R. Shimmel. | |
| Structure and Mechanism in Protein Science by Alan Fersht | |
| Proteins: Structures and Molecular Properties, by Thomas E. Creighton | |
| **Reference Books (Atleast 3)** | |
| Introduction to Protein Structure by Branden and Tooze, Garland Science; 2nd edition 1999. | |
| Principles of nucleic acid structure, by Stephen Neidle. | |
| RNA Sequence, Structure, and Function: Computational and Bioinformatic Methods by Walter L. Ruzzo, Jan Gorodkin, Springer 2014. | |
| **NPTEL/ Youtube/ Faculty Video Link:** | |
| **Unit 1** | https://www.youtube.com/watch?v=6ROBp57G2ZI |
| **Unit 2** | https://www.youtube.com/watch?v=RkuvqFfNAis |
| **Unit 3** | https://www.youtube.com/watch?v=Tqz9s-2MLwg |
| **Unit 4** | https://www.youtube.com/watch?v=0lZRAShqft0 |
| **Unit 5** | https://www.youtube.com/watch?v=6Udqou3vmng |

# B. TECH. SECOND YEAR

| Course Code | AASL0401 | L T P | Credit |
|---|---|---|---|
| Course Title | Technical Communication | 2 1 0 | 3 |

**Course objective:**

| | |
|---|---|
| 1 | To help the students develop communication and critical thinking skills necessary for securing a job, and succeeding in the diverse and ever-changing workplace of the twenty first century |
| 2 | To enable students to communicate effectively in English at the workplace. |

**Pre-requisites:**

- The student must have a good degree of control over simple grammatical forms and some complex grammatical forms of English language.
- The student should be able to speak English intelligibly.

## Course Content / Syllabus

| UNIT-I | Introduction to Technical Communication and Reading | 4 Hours |
|---|---|---|

- Fundamentals of technical communication
- Role of technical communication
- Reading Comprehension - central idea, tone, and intention
- Critical reading strategies

| UNIT-II | Technical Writing 1 | 5 Hours |
|---|---|---|

- Characteristics of technical writing; technical vocabulary, etymology
- Business letters /emails – types, format, style and language
- Notices, agenda and minutes
- Job application, CV and resume

| UNIT-III | Technical Writing 2 | 5 Hours |
|---|---|---|

- Technical reports – types & formats
- Structure of a report
- Technical Proposal - structure and types
- Technical/ Scientific paper writing

| UNIT-IV | Public Speaking | 5 Hours |
|---|---|---|

- Components of effective speaking (emphasis on voice dynamics)
- Seminar and conference presentation
- Conducting/ participating in meetings
- Appearing for a job interview
- Mobile etiquettes

| UNIT-V | Manuscript Preparation | 5 Hours |
|---|---|---|

- Short report writing
- Copy editing and referencing
- Developing writing style – Jargons, Abbreviations
- Ethical writing

**Course outcome:** At the end of the course the students will be able to Levels.

| | | |
|---|---|---|
| CO 1 | Comprehend the fundamental principles of technical communication with special reference to reading. | K2 |

| | | |
|---|---|---|
| CO 2 | Write various kinds of professional correspondence. | K5 |
| CO 3 | Recognise and produce different kinds of technical documents. | K2 |
| CO 4 | Apply effective speaking skills to communicate at the workplace. | K3 |
| CO 5 | Demonstrate their understanding of various ethical concerns in written communication. | K3 |

**Textbook:**

1. Technical Communication – Principles and Practices by Meenakshi Raman & Sangeeta Sharma, Oxford Univ. Press, 2016, New Delhi.

**Reference Books:**


1. Personality Development and Soft Skills by Barun K Mitra, Oxford Univ. Press, 2012, New Delhi.
2. Spoken English- A Manual of Speech and Phonetics by R K Bansal & J B Harrison, Orient Blackswan, 2013, New Delhi.
3. Business Correspondence and Report Writing by Prof. R C Sharma & Krishna Mohan, Tata McGraw Hill & Co. Ltd., 2001, New Delhi.
4. Practical Communication: Process and Practice by L U B Pandey; A.I.T.B.S. Publications India Ltd.; Krishan Nagar, 2014, Delhi.
5. Modern Technical Writing by Sherman, Theodore A (et.al); Apprentice Hall; New Jersey; USA.
6. A Textbook of Scientific and Technical Writing by S D Sharma; Vikas Publication, Delhi.
7. Skills for Effective Business Communication by Michael Murphy, Harvard University, USA.
8. A Complete Guide to Write Right by Agarwal, Deepa. Scholastic, 1st edition.
9. Technical writing and communication, R S Sharma, V.P. Publication, 1st edition.
10. Business Communication for Managers by Payal Mehra, Pearson Publication, Delhi.

## B. TECH SECOND YEAR

| Course Code | ABT0401 | L T P | Credits |
|---|---|---|---|
| Course Title | Fermentation Engineering | 3 1 0 | 4 |

**Course objective:**

| | |
|---|---|
| 1 | To gain the knowledge about sterilization process in bioprocess. (K1) |
| 2 | To enhance the knowledge about different fermentation processes. (K1, K3) |
| 3 | To gain the information about various process that control the formation of product. (K1, K3) |
| 4 | To enhance the knowledge about products related to fermentation (K3) |
| 5 | To learn about the optimization process for alcoholics and pharma products (K2, K3) |

**Pre-requisites: Knowledge of microbiology**

**Course Contents / Syllabus**

| UNIT-I | FERMENTATION AND ITS REQUIREMENT: | 8h |
|---|---|---|

Introduction to submerged and solid state fermentation, Microbial culture selection for fermentation processes. Primary and Secondary metabolites, sterilization process, media for industrial fermentation

| UNIT-II | TYPE OF FERMENTATION PROCESSES: | 8h |
|---|---|---|

Batch, Fed-batch, continuous, Construction of fermenters, Basic function of fermenters, Design, and operation, scale up of fermentation, Instrumentation and control, Aeration and agitation, introduction to bioreactors.

| UNIT-III | MECHANISM BEHIND METABOLIC REACTION: | 8h |
|---|---|---|

Different regulatory mechanisms involved in controlling the catabolic and anabolic processes of microbes. Induction, nutritional repression, carbon catabolite repression, crabtree effect, feedback inhibition and feedback repression.

| UNIT-IV | FERMENTATION AND FOOD: | 8h |
|---|---|---|

Raw material availability, quality, processes and pretreatment of raw materials: Alcoholic beverages and IMFL/distilled spirits. Mushroom cultivation, Oriented Fermented Products, soy sauce, pickles, fermented milks & cheeses, Idli, Dosa, Dhokla.

| UNIT-V | FERMENTATION AND ITS APPLICATION IN INDUSTRY: | 8h |
|---|---|---|

Details of the process, parameters and materials -for the industrial manufacture of Antibiotics (βlactum), Solvents (acetone, ethanol) Amino acid (Lysine), Organic acids (Citric acid), Ind. Enzymes (Protease/Amylase) and Biopharmaceuticals (Insulin/Interferon etc.)

**Course outcome: After completion of this course students will be able to**

| | | |
|---|---|---|
| CO 1 | understand sterilization techniques and estimate the sterilization time | K1 |
| CO 2 | understand the Bath culture, Fed-Batch and continuous fermentation. | K1, K2 |
| CO 3 | understand the different regulatory mechanism during product formation | K1, K3 |
| CO 4 | understand the production process of fermented products | K3 |
| CO 5 | understand the production process of alcohols, antibiotics and organic acids. | K2,K3 |

**Text books (Atleast3 )**


1. Murray Moo -Young , Comprehensive Biotechnology, Vol. 1 & III-latest ed.

2. Microbes & Fermentation, A. Lel and Kotlers Richard J. Mickey, Oriffin Publication

3. Industrial Fermentations- Leland, N. Y. Chemical Publishers.

| **Reference Books (Atleast 3)** | |
|---|---|
| 1. Murray Moo -Young , Comprehensive Biotechnology, Vol. 1 & III-latest ed. | |
| 2. Microbes & Fermentation, A. Lel and Kotlers Richard J. Mickey, Oriffin Publication | |
| 3. Industrial Fermentations- Leland, N. Y. Chemical Publishers. | |
| **NPTEL/ Youtube/ Faculty Video Link:** | |
| **Unit 1** | https://www.youtube.com/watch?v=hT--rx6pG5E |
| **Unit 2** | https://www.youtube.com/watch?v=3qkaONqqDbo |
| **Unit 3** | https://nptel.ac.in/courses/102/105/102105058/ |
| **Unit 4** | https://www.youtube.com/watch?v=D6mRPgvAEOc |
| **Unit 5** | https://www.youtube.com/watch?v=H0ZZWXSH7OE |

| B.TECH SECOND YEAR | | | |
|---|---|---|---|
| **Course Code** | **ABT0404** | **L T P** | **Credits** |
| **Course Title** | **Green Biotechnology and Pollution Abetment** | **2 0 0** | **2** |

| **Course objective:** | |
|---|---|
| 1 | To gain knowledge about wastewater treatment processes. |
| 2 | To enhance knowledge about biological degradation of xenobiotic compounds |
| 3 | To learn about the usage of enzyme and its importance in waste treatment |
| 4 | To learn about the various biological processes for remediation of pollutant |
| 5 | To gain information about potential use of waste to produce energy |

**Pre-requisites:**

**Course Contents / Syllabus**

| **UNIT-I** | **BIOLOGICAL WASTE TREATMENT:** | **8h** |
|---|---|---|

Biological Waste Treatment: Biological wastewater treatment: Principles and design aspects of various waste treatment methods with advanced bioreactor configuration: Solid waste management: landfills, recycling and processing of organic residues, minimal national standards for waste disposal.

| **UNIT-II** | **BIODEGRADATION OF XENOBIOTIC COMPOUNDS:** | **8h** |
|---|---|---|

Biodegradation of Xenobiotic Compounds: Xenobiotic compounds–Definition, examples and sources. Biodegradation- Introduction, effect of chemical structure on biodegradation, recalcitrance, co metabolism and biotransformation. Factors affecting biodegradation, microbial degradation of hydrocarbons.

| **UNIT-III** | **BIOTRANSFORMATION'S AND BIOCATALYSTS:** | **8h** |
|---|---|---|

Biotransformation's and Biocatalysts: Basic organic reaction mechanism- Common prejudices against enzymes, advantages & disadvantages of biocatalysts, isolated enzymes versus whole cell systems, biocatalytic application, catalytic antibodies; stoichiometry.

| **UNIT-IV** | **BIOREMEDIATION AND BIORESTORATION:** | **8h** |
|---|---|---|

Bioremediation and Biorestoration: Introduction and types of bio-remediation, bioremediation of surface soil and sludge, bioremediation of subsurface material, Insitu and Ex-situ technologies, phytoremediation-restoration of coal mines a case study. Biorestoration: reforestation through micropropagation, use of mycorrhizae in reforestation, use of microbes for improving soil fertility, reforestation of soils contaminated with heavy metals.

| **UNIT-V** | **ECO-FRIENDLY BIOPRODUCTS FROM RENEWABLE SOURCES:** | **8h** |
|---|---|---|

Eco-Friendly Bioproducts from Renewable Sources: Fundamentals of composting process: scientific aspects and prospects of biofuel production: bioethanol, biohydrogen and biodiesel; biofertilizers and biopesticides. Biotechnology in Environment Protection: Current status of biotechnology in environment protection and its future, release of genetically engineered organisms in the environment.

**Course outcome: After completion of this course students will be able to**

| | | |
|---|---|---|
| CO 1 | understand design aspect of various waste treatment processes | |
| CO 2 | describe the use of biotechnological processes to handle xenobiotic compounds. | |
| CO 3 | understand importance of enzymes and its utilization in waste treatment. | |
| CO 4 | to describe the use of biotechnological processes to protect the environment | |
| CO 5 | identify potential biomass sources for renewable energy generation. | |

**Text books (Atleast3 )**


1. “Environmental Biotechnology” by Bhattacharya B C and Banerjee R
2. “Environmental Biotechnology: Basic Concepts and Applications” by Indu Shekhar Thakur
3. “Environmental Biotechnology” by V Kumaresan and N Arumugam


**Reference Books (Atleast 3)**


1. “Environmental Biotechnology: Concepts and Application” by Jordening H J and Winter J

| | |
|---|---|
| 2. “Environmental Biotechnology: Theory and Application” by Evans G M and Furlong J C | |
| 3. “Microbiology” by Pelczar M J | |
| **NPTEL/ Youtube/ Faculty Video Link:** | |
| **Unit 1** | https://www.youtube.com/watch?v=Jj16iZ6unBQ |
| **Unit 2** | https://www.youtube.com/watch?v=6RHXbQBkXrY |
| **Unit 3** | https://www.youtube.com/watch?v=QNOivQcSjWc |
| **Unit 4** | https://www.youtube.com/watch?v=oRBeBZcUies |
| **Unit 5** | https://www.youtube.com/watch?v=xAms3Q_3pXg |

| B.TECH SECOND YEAR | | | |
|---|---|---|---|
| **Course Code** | **ABT0402** | **L T P** | **Credits** |
| **Course Title** | **Immunology and Immunotechnology** | **3 0 0** | **3** |

**Course objective:** The purpose of the Immunology and immune technology course is to provide students, undergraduate level knowledge of the immune response and its involvement in health and disease, the process of vaccination and application of technology in immunology and immunotherapy.

| | |
|---|---|
| 1 | **To gain a comprehensive about the basic components and functionalities of the immune system.** |
| 2 | **To understand the Antigen and Antibody structure and function and the associated technologies.** |
| 3 | **To understand the technical aspect of immunological reactions and their use in scientific research.** |
| 4 | **To learn about various ways of regulation of immune response; and critically evaluate the regulatory mechanisms and their importance in human health.** |
| 5 | **To associate the immunological mechanisms with various kinds of human diseases and health conditions.** |

**Pre-requisites:**

**Course Contents / Syllabus**

| | | |
|---|---|---|
| **UNIT-I** | **OVERVIEW OF THE IMMUNE SYSTEM:** | **8** |

Introduction to immunity and immune system, Cells and Molecules of the immune system, Haematopoiesis, Characteristics and players of innate and adaptive immunity, Humoral and Cell mediated immune response, Primary and Secondary lymphoid organs, Structure, function and application of cytokines, Inflammation-features and Inflammatory response, Pro-inflammatory and anti-inflammatory cytokines, T &B cell maturation, activation and differentiation.

| | | |
|---|---|---|
| **UNIT-II** | **ANTIGEN AND ANTIBODY STRUCTURE: ANTIGENS:** | **8** |

Characteristics and types of Antigens, Factors affecting the immunogenicity, Haptens and adjuvants, Epitopes, Characteristics of T&B cell epitopes.

**Antibodies**: Structure, functions and characteristics of different classes of antibodies, Antigenic Determinants on Immunoglobulins,Generation of antibody diversity, Somatic hyper-mutation, Monoclonal and polyclonal antibodies and their commercial preparation, Hybridoma technology

| | | |
|---|---|---|
| **UNIT-III** | **IMMUNO-TECHNIQUES AND IMMUNIZATION:** | **8** |

Antigen and antibod**y** interactions, cross reactivity, precipitation reactions, Immunological techniques: serological techniques, Immuno-diffusion assay, ELISA, Immuno-blotting, RIA, western blotting. ELISPOT assay, Immuno-Histochemistry, Flow Cytometry, FACS sorting, Immuno-precipitation.

Active immunization, passive immunization, Antibodies in diagnostics Vaccines and their types.

| | | |
|---|---|---|
| **UNIT-IV** | **MHC AND REGULATION OF IMMUNE RESPONSE:** | **8** |

Structure and Function of MHC molecules, Antigen presenting cells, Exogenous and Endogenous pathways of antigen processing and presentation, Germinal centre, Plasma Cells, BCR signelling,

Complement system and pathways, immune tolerancenegative/positive selection, TCR rearrangement, co-stimulatory molecules. T cell subtypes: Th1, Th2, Th17, Tregs etc. Memory B and T cell responses, Immune checkpoints: PD1, CTLA4, TIM3 etc. CD4 and CD8 receptors.

| | | |
|---|---|---|
| **UNIT-V** | **IMMUNITY AND DISEASES:** | **8** |

Immunity without infection: autoimmunity, hypersensitivity, Transplantation immunologyhost vs graft reaction Design of recombinant antibodies, Immuno-therapy in cancer, checkpoint therapy. Immunity against infectious diseases (virus, bacteria and protozoan), AIDS, Immune response in plants- an Overview

**Course outcome: After completion of this course students will be able to**

| | | |
|---|---|---|
| CO 1 | **Identify and explain in a detail about the basic components and functionalities of the immune system.** | **K1, K2** |
| CO 2 | **Identify and explain antigen and antibody structure and function, thus will be able to understand the associated scientific and industrial research and** | **K1, K2** |

| | | |
|---|---|---|
| | **technologies.** | |
| CO 3 | **Understand the technical aspect of immunological reactions and their application in scientific research.** | **K2, K3** |
| CO 4 | **Describe various ways of regulation of immune response; and thus, will be able to critically evaluate the regulatory mechanisms and their importance in human health.** | **K1, K2, K6** |
| CO 5 | **Associate the immunological mechanisms with various kinds of human diseases and health conditions.** | **K3** |

**Text books**

1. Immunology by Kuby (Free man publication)
2. Immunology and immunotechnology by Ashim k. Chakravarty (Oxford university Press)
3. Basic Immunology by Abul K. **Abbas** and Andrew H. **Lichtman**, Saunders, 2001.

**Reference Books**

1. Cellular and molecular immunology, by Abul **Abbas**, Andrew Lichtman, and Jordan Pober. W. B. Saunders.
2. Immunobiology - the immune system in health and disease, by Charles **Janeway**, Jr. and Paul Travers. Garland Publishing, Inc. Fifth edition, 2001.
3. Immunology by Ivan **Roitt**, Jonathan Brostoff, and David Male. Mosby, London. 6th edition, 2001.

**NPTEL/ Youtube/ Faculty Video Link:**

| | |
|---|---|
| **Unit 1** | https://www.youtube.com/watch?v=LSYED-7riNY<br>https://www.youtube.com/watch?v=4cpzrcp5M7Q<br>https://www.youtube.com/watch?v=k9QAyP3bYmc |
| **Unit 2** | https://www.youtube.com/watch?v=C_GRI3fxUWw |
| **Unit 3** | https://www.youtube.com/watch?v=exfSgIBA4MU |
| **Unit 4** | https://www.youtube.com/watch?v=w21r7FfIpRI |
| **Unit 5** | https://www.youtube.com/watch?v=b6XbuS34TGo |

| B. TECH SECOND YEAR | | | |
|---|---|---|---|
| **Course Code** | **ABT0405** | **L T P** | **Credits** |
| **Course Title** | **rDNA Technology** | **3 0 0** | **3** |

**Course Objectives:**

1. It is intended to impart basic undergraduate-level knowledge in the area of molecular biology and recombinant DNA technology.
2. The student would be able to understand the working details of the cloning of a gene
3. They would also be able to assimilate recent research findings, advancement and development in the rDNA technology.
4. The use of virtual lab and computational tools would enable them to perform in silico cloning of the selected DNA.
5. To learn about various screening and selection methods of recombinants.

**Pre-requisites:** Students should know about basic concept of nucleic acids and molecular biology

**Course Contents / Syllabus**

| | | |
|---|---|---|
| **UNIT-I** | **BASIC PRINCIPLES OF RDNA TECHNOLOGY**: | **8** |

Introduction to recombinant DNA technology and its uses, Restriction enzymes: Class I, II & III restriction enzymes, Nomenclature, Isoschizomers, Heterohypekomers, Unit of restriction enzymes, Restriction digestion: partial and complete, Star activity; Homopolymer tailing, Synthetic Linkers, Adaptors; Roles of DNA ligase, T4 DNA polymerase, Alkaline phosphatase, Reverse transcriptase in cloning

| | | |
|---|---|---|
| **UNIT-II** | **VECTORS:** | **8** |

cloning, expression, and promoter less vectors Plasmids; Bacteriophages; Phage as a cloning vector: Advantage of using phage lambda vector, M13 mp vectors; PUC19 and Bluescript vectors, Phagemids; Lambda vectors, Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Animal Virus derived vectors; Expression vectors; Baculovirus and pichia vectors system, Plant based vectors, Ti and Ri as vectors, Yeast vectors, Shuttle vectors

| | | |
|---|---|---|
| **UNIT-III** | **THE POLYMER CHAIN REACTION:** | **8** |

PCR based methods, Amplification of DNA using PCR, Principle & applications of PCR: RT PCR, Inverse PCR, Nested PCR, Multiplex PCR, Anchored PCR, RACE, DD-RTPCR, Degenerate PCR TA cloning, Real time PCR, Primer design; Fidelity of thermostable enzymes; DNA polymerases

| | | |
|---|---|---|
| **UNIT-IV** | **TECHNIQUES IN RDNA TECHNOLOGY:** | **8** |

Gene bank / Genomic library and cDNA library construction; Overview of techniques for recombinant selection and screening: Functional and nutritional complementation, Colony/ plaque hybridization, Blotting techniques, Plus-Minus screening, Immunological screening, HART, HAT

| | | |
|---|---|---|
| **UNIT-V** | **SCREENING AND SELECTION OF RECOMBINANTS:** | **8** |

Preparation of bacterial competent cells, Transformation of ligated (recombinant) DNA in selected host (e.g. Bacterial host), Screening of recombinant bacterial colonies using colony PCR, Rapid DNA and RNA sequencing techniques: Sanger method, Maxam and Gilbert procedure, automated DNA sequencing, pyrosequencing; Genomics: High throughput Sequencing: shot gun cloning, Clone contig cloning, Microarray, Purification and selected characterization (spectroscopic) of the purified recombinant proteins

**Course outcome: After completion of this course students will be able to**

| | | |
|---|---|---|
| CO 1 | Understand the basic concept and procedure of gene cloning and the role of enzymes and vectors used for genetic manipulation and genetic engineering | K1, K2, K3, K4 |
| CO 2 | Acquired theoretical knowledge of vectors, their different types and applications in genetic engineering. | K1, K2, K3 |
| CO 3 | Have knowledge of PCR technique, their different types and applications. | K2, K3, K4 |
| CO 4 | Getting detailed knowledge of construction of gene libraries and their screening methods. | K2, K3, K5 |
| CO 5 | Understand the basic concept of genetic engineering techniques for selection of recombinants. | K1, K5, K6 |

**Text books (Atleast3 )**

| | |
|---|---|
| 1. Winnacker, Ernst L. (1987), From genes to clones: introduction to gene technology [Gene und Klone] (in German), Horst Ibelgaufts (trans.), Weinheim, New York: VCH, ISBN 0-89573-614-4. | |
| 2. Genetic Engineering by Dr Smita Rastogi & Dr Neelak Pathak, Oxford University Press | |
| 3. Genetic Engineering, Priciples& Practice by Sandhya Mitra, McGraw Hill Education. | |
| **Reference Books (Atleast 3)** | |
| 1. Principles of Gene Manipulation and Genomics, Primrose & Twyman. | |
| 2. Molecular Biology of the Cell. 4th edition. Alberts B, Johnson A, Lewis J, et al. New York: Garland Science; 2002. | |
| 3. Modern Genetic Analysis. Griffiths AJF, Gelbart WM, Miller JH, et al. New York: W. H. Freeman; 1999. | |
| **NPTEL/ Youtube/ Faculty Video Link:** | |
| **Unit 1** | https://www.youtube.com/watch?v=Yh9w_fyvpUk |
| **Unit 2** | https://www.youtube.com/watch?v=VXkw_U6mJpc |
| **Unit 3** | https://www.youtube.com/watch?v=BIIWlZqWxKg |
| **Unit 4** | https://www.youtube.com/watch?v=CgXtJ4ooaUU<br>https://www.youtube.com/watch?v=OK7_ReXhVaQ |
| **Unit 5** | https://www.youtube.com/watch?v=YnF1b_Kqf88<br>https://www.youtube.com/watch?v=BIIWlZqWxKg |

| B.TECH SECOND YEAR | | | |
|---|---|---|---|
| **Course Code** | **ABT0451** | **L T P** | **Credit** |
| **Course Title** | **Fermentation Engineering Lab** | **0 0 2** | **1** |

| **Suggested list of Experiment** | | |
|---|---|---|
| **Sr. No.** | **Name of Experiment** | CO |
| 1 | To understand the controlling and functioning of fermenter. | CO4 |
| **2** | Production of antibiotic using the concept of fermentation. | CO1 |
| **3** | Citric acid production by (a) solid state and (b) submerged fermentation. | CO3 |
| **4** | Microbial production of enzymes by (a) solid state and (b) submerged fermentation | CO4 |
| **5** | Fermentative production of Ethanol using Saccharomyces cerevisiae. | CO2 |
| **6** | Production of wine via Fermentation. | CO2 |
| **7** | Microbial production of Biopolymer using suitable Strain. | CO3 |
| **8** | Computer modelling and optimization of one product form fermentation. | CO4 |
| **9** | Production of fermentative food (Idli). | CO5 |
| **10** | Up scaling a fermentative process from lab scale to pilot scale. | CO2 |

| **LCourse Outcome:** | |
|---|---|
| CO 1 | At the end of the course the student will be able design and optimize the process for the production for antibiotic. (k2, k3) |
| CO 2 | At the end of the course the student will be able design and optimize the process for the production for alcohols. |
| CO 3 | At the end of the course the student will be able design and optimize the process for the production for organic acid and other products. |
| CO 4 | At the end of the course the student will be able understand the control and working of mechanism of fermenter |

| B.TECH SECOND YEAR | | | |
|---|---|---|---|
| **Course Code** | **ABT0452** | **L T P** | **Credit** |
| **Course Title** | **Immunology and Immunotechnology Lab** | **0 0 2** | **1** |
| **Suggested list of Experiment** | | | |
| **Sr. No.** | **Name of Experiment** | | **CO** |
| **1** | To identify the blood cells/ immune cell with the help of leishman stain. | | **1** |
| **2** | To determine the blood group and Rh factor of given blood | | 2 |
| **3** | To perform single radial immunodiffusion | | 3 |
| **4** | To perform double immunodiffusion | | 3 |
| **5** | To perform counter current immune electrophoresis | | 3 |
| **6** | To perform Sand-witch ELISA | | 4 |
| **7** | To determination of binding affinity of antigen-antibody complex. | | **1** |
| **8** | To Isolate and perform microscopic visualization of T-cells and B-cells | | 1 |
| **9** | To perform western blotting. | | 5 |
| **10** | Histological examination of immune organs. | | **5** |
| **LCourse Outcome: After completion of the course, the student will be able to understand the principle behind the techniques based on Antigen- Antibody reactions and also gain the basic know-how to work in a core- immunology research lab.** | | | |
| CO 1 | Identify different types of immune cells from blood | | |
| CO 2 | Determine blood type and rh factor | | |
| CO 3 | Perform immunodiffusion reactions | | |
| CO 4 | Understand the principle of and perform ELISA . | | |
| CO5 | Learn the principle of FACS and Western blotting. | | |

| B.TECH SECOND YEAR | | | |
|---|---|---|---|
| **Course Code** | **ABT0453** | **L T P** | **Credit** |
| **Course Title** | **Structural and Computational Biology Lab** | **0 0 2** | **1** |

**Suggested list of Experiment**

| Sr. No. | Name of Experiment | CO |
|---|---|---|
| 1 | Finding patterns in genomes. | |
| **2** | Implementation of motif finding algorithms. | |
| **3** | Identifying various regions around genes using Genome browsers | |
| **4** | Browsing genetic variation databases such as dbSNP, ClinVar. | |
| **5** | Finding disease variation association using GWAS Catalog. | |
| **6** | Basic machine learning using WEKA tool. | |
| **7** | Accessing databases from NCBI. | |
| **8** | Extracting protein and nucleotide sequences from NCBI. | |
| **9** | Pairwise and Multiple sequence alignment. | |
| **10** | Analysis of target-ligand interaction by molecular docking. | |

| **L Course Outcome:** | |
|---|---|
| CO 1 | Basic algorithms used in Pairwise and Multiple alignments |
| CO 2 | Understanding the methodologies used for database searching, and determining the accuracies of database search |
| CO 3 | Prediction of structure from sequence and subsequently testing the accuracy of predicted structures |
| CO 4 | Determine the protein function from sequence through analysis of data |
| CO 5 | Analysis and development of models for better interpretation of biological data to extract knowledge |

| B. TECH. SECOND YEAR | | | |
|---|---|---|---|
| **Course Code** | **ANC0402** | **L T P** | **Credits** |
| **Course Title** | **Environmental Science** | **2 0 0** | **0** |

**Course objective:**

| | |
|---|---|
| 1 | To help the students in realizing the inter-relationship between man and environment. and help the students in acquiring basic knowledge about environment. |
| 2 | To develop the sense of awareness among the students about environment and its various problems. |
| 3 | To create positive attitude about environment among the student. |
| 4 | To develop proper skill required for the fulfilment of the aims of environmental education and educational evaluations |
| 5 | To develop the capability of using skills to fulfil the required aims, to realise and solve environmental problems through social, political, cultural and educational processes |

**Pre-requisites:** Basic knowledge of nature.

**Course Contents / Syllabus**

| | | |
|---|---|---|
| **UNIT-I** | **Basic Principle of Ecology** | **8 Hours** |

Definition, Scope and basic principles of ecology and environment. Ecosystem: Basic concepts, components of ecosystem. Food chains and food webs. Ecological pyramids, Energy flow in ecological systems, Characteristics of different ecosystems. Biogeochemical Cycles: Importance, gaseous and sedimentary cycles. Carbon, Nitrogen, Phosphorus and Sulphur Cycles.

Basic concepts of sustainable development, SDGs, Ecosystem services, UN Decade for Ecorestoration.

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| **UNIT-II** | **Natural Resources and Associated Problems** | **8 Hours** |

Natural resources and associated problems. Forest resources: Use and over-exploitation, deforestation. Timber extraction, mining, dams and their effects on forest and tribal people. Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources. Food resources: World food problems, changes caused by agriculture and over-grazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity.

Land resources: Land as a resource, land degradation, man induced landslides. Equitable use of resources for sustainable lifestyles.

Non-Renewable Energy Resources: Fossil fuels and their reserves, Nuclear energy, types, uses and effects, Renewable Energy Resources: hydropower, Solar energy, geothermal, tidal and wind energy, Biomass energy, biogas and its advantages.

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| **UNIT-III** | **Biodiversity Succession and Non-Renewable Energy Resources** | **8 Hours** |

Biodiversity and their importance, Threats to biodiversity, major causes, extinction's, vulnerability of species to extinction, IUCN threat categories, Red data book.

Strategies for biodiversity conservation, principles of biodiversity conservation in-situ and ex-situ conservation strategies Mega diversity zones and Hot spots, concepts, distribution and importance.

Succession: Concepts of succession, Types of Succession. Trends in succession. Climax and stability.

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| **UNIT-IV** | **Pollution and Solid Waste Management** | **8 Hours** |

Air pollution: sources of air pollution, Primary and secondary air pollutants. Origin and effects of SOX, NOX, Cox, CFC, Hydrocarbon, control of air pollution. Water pollution: sources and types of water pollution, Effects of water pollution, Eutrophication, Soil pollution: Causes of soil pollution, Effects of soil pollution, Major sources of and effects of noise pollution on health, Radioactive and thermal pollution sources and their effects on surrounding environment.

Solid waste disposal and its effects on surrounding environment, Climate change, global warming, acid rain, ozone layer depletion.

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| **UNIT-V** | **Role of Community and Environmental Protection Acts** | **8 Hours** |

Role of community, women and NGOs in environmental protection, Bioindicators and their role, Natural hazards, Chemical accidents and disasters risk management, Environmental Impact Assessment (EIA), Salient features of following Acts: a. Environmental Protection Act, 1986, Wildlife (Protection) Act, 1972.b. Water (Prevention and control of pollution) Act, 1974.c. Air (Prevention and control of pollution) Act, 1981. Forest (Conservation) Act, 1980.d. Wetlands (Conservation and Management) Rules, 2017; e. Chemical safety and Disaster Management law. F. District Environmental Action Plan. Climate action plans.

**Course outcome:** After completion of this course students will be able to

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|---|---|---|
| CO 1 | Understand the basic principles of ecology and environment. Ecosystem: Basic concepts, components of ecosystem., food chains and food webs. Ecological pyramids | K2 |
| CO 2 | Understand the different types of natural recourses like food, forest, minerals and energy and their conservation | K2 |
| CO 3 | Understand the importance of biodiversity, Threats of biodiversity and different methods of biodiversity conservation. | K2 |
| CO 4 | Understand the different types of pollution, pollutants, their sources, effects and their control methods | K3 |
| CO 5 | Understand the basic concepts of sustainable development, Environmental Impact Assessment (EIA) and different acts related to environment | K3 |

## Text books:


1. Brady, N.C. 1990. The nature and properties of Soils, Tenth Edition. Mac Millan Publishing Co., New York.
2. Botkin, D.B and Kodler E.A., 2000, Environmental Studies: The earth as a living planet. John Wiley and Sons Inc.
3. Rao M.N. and H.V.N. Rao, 1989: Air Pollution, Tata McGraw Hill Publishing Co. Ltd., New Delhi
4. Singh J.S., Singh S.P. and Gupta S.R., 2006, Ecology Environment and Resource Conservation, Anamaya Publishers, New Delhi.
5.Environmental Studies -Benny Joseph-Tata McgrawHill-2005
6. Environmental Studies- Dr. D.L. Manjunath, Pearson Education-2006.
7. Environmental studies- R, Rajagopalan -Oxford Pubtiotion2005.


## Reference Books:


1.Sodhi G.S. 2005, Fundamentals of Environmental Chemistry: Narosa Publishing House, New Delhi.
2.Dash, M.C. (1994), Fundamentals of Ecology, Tata Mc Graw Hill, New Delhi.
3. Sharma P. D. (1996). Environmental Biology, Rastogi Publications, Meerut.
4. Verma P.S. and V.K. Agarwal. (1985). Principles of Ecology. S. Chand and Company (Pub.), New Delhi.
5.Principles of Environmental Sciences and Engineering -P. Venugoplan Rao, Prenitice Hall of India.
6. Environmental Science and Engineering Meenakshi, Prentice Hall India.


## NPTEL/ Youtube/ Faculty Video Link:

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|---|---|
| **Unit 1** | https://www.youtube.com/watch?v=T21OO0sBBfc, https://www.youtube.com/watch?v=qt8AMjKKPDohttps://www.youtube.com/watch?v=yAK-m91Nxrshttps://www.youtube.com/watch?v=ha_O-1uOWkk, https://www.youtube.com/watch?v=brF0RWJyx9w |
| **Unit 2** | https://www.youtube.com/watch?v=mOwyPENHhbc, https://www.youtube.com/watch?v=yqev1G2iy20, https://www.youtube.com/watch?v=_74S3z3IO_I, https://www.youtube.com/watch?v=jXVw6M6m2g0 |
| **Unit 3** | https://www.youtube.com/watch?v=GK_vRtHJZu4, https://www.youtube.com/watch?v=b6Ua_zWDH6U, https://www.youtube.com/watch?v=7tgNamjTRkk, https://www.youtube.com/watch?v=ErATB1aMiSU, https://www.khanacademy.org/science/high-school-biology/hs-ecology/hs-human-impact-on-ecosystems/v/conservation-and-the-race-to-save-biodiversity |
| **Unit 4** | https://www.youtube.com/watch?v=7qkaz8ChelI, https://www.youtube.com/watch?v=NuQE5fKmfME, https://www.youtube.com/watch?v=9CpAjOVLHII, https://www.youtube.com/watch?v=yEci6iDkXYw, https://www.youtube.com/watch?v=yEci6iDkXYw |
| **Unit 5** | https://www.youtube.com/watch?v=ad9KhgGw5iA, https://www.youtube.com/watch?v=nW5g83NSH9M, https://www.youtube.com/watch?v=xqSZL4Ka8xo, https://www.youtube.com/watch?v=WAI-hPRoBqs, https://www.youtube.com/watch?v=o-WpeyGlV9Y, https://www.youtube.com/watch?v=EDmtawhADnY |

# B. TECH. SECOND YEAR

| Course Code | ANC0401 | L T P | Credit |
|---|---|---|---|
| Course Title | Cyber Security | 2 0 0 | 0 |

**Course objective:**

Achieve knowledge about Security of Information system and Risk factors and examine security threats and vulnerability in various scenarios, understand concept of cryptography and encryption technique to protect the data from cyber-attackand provide protection for software and hardware.

**Pre-requisites:** Basics recognition in the domain of Computer Science.
Concept of network and operating system.
Commands of programming language.

## Course Contents / Syllabus

| UNIT-I | Introduction | 8 Hours |
|---|---|---|

Introduction to Information Systems: Types of Information Systems, Development of Information Systems, Need for Information Security, Threats to Information Systems, Information Assurance, Guidelines for Secure Password and WI-FI Security and social media and Windows Security, Security Risk Analysis, and Risk Management.

| UNIT-II | Application Layer Security | 8 Hours |
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Data Security Considerations-Backups, Archival Storage and Disposal of Data, Security Technology-Firewall, Intrusion Detection, Access Control, Security Threats -Viruses, Worms, Trojan Horse, Bombs, Trapdoors, Spoofs, E-mail Viruses, Macro Viruses, Malicious Software, Network and Denial of Services Attack, Security, Threats to E-Commerce: Electronic Payment System, e- Cash, Issues with Credit/Debit Cards.

| UNIT-III | Secure System Development | 8 Hours |
|---|---|---|

Application Development Security, Architecture & Design, Security Issues in Hardware: Data Storage and Downloadable Devices, Mobile Protection, Security Threats involving in social media, Physical Security of IT Assets, Access Control, CCTV and Intrusion Detection Systems, Backup Security Measures.

| UNIT-IV | Cryptography And Network Security | 8 Hours |
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Public key cryptography: RSA Public Key Crypto with implementation in Python,Digital Signature Hash Functions,Public Key Distribution.

Symmetric key cryptography: DES (Data Encryption Standard), AES (Advanced Encryption Standard), Secure hash algorithm(SHA-1).

Real World Protocols: Basic Terminologies, VPN, Email Security Certificates, Transport Layer Security, TLS, IP security, DNS Security.

| UNIT-V | Security Policy | 8 Hours |
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Policy design Task, WWW Policies, Email based Policies, Policy Revaluation Process-Corporate Policies-Sample Security Policies, Publishing and Notification Requirement of the updated and new Policies.
Resent trends in security.

**Course outcome:** At the end of course, the student will be able to

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| CO 1 | Analyze the cyber security needs of an organization. | K4 |
| CO 2 | Identify and examine software vulnerabilities and security solutions. | K1,K3 |

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| CO 3 | Comprehend IT Assets security (hardware and Software) and performance indicators | K2 |
| CO 4 | Measure the performance and encoding strategies of security systems. | K3, K5 |
| CO 5 | Understand and apply cyber security methods and policies to enhance current scenario security. | K2, K3 |

**Text books:**

5) Charles P. Pfleeger, Shari LawerancePfleeger, "Analysing Computer Security", Pearson Education India
6) V.K.Pachghare, "Cryptography and information Security", PHI Learning Private Limited, Delhi India
7) Sarika Gupta & Gaurav Gupta, Information Security and Cyber Laws, Khanna Publishing House
8) Michael E.Whitman and Herbert J Mattord "Principle of Information Security" Cengage

**Reference Books:**

5) Schou, Shoemaker, "Information Assurance for the Enterprise", Tata McGraw Hill.
6) CHANDER, HARISH," Cyber Laws and It Protection", PHI Learning Private Limited,Delhi
7) V.K. Jain, Cryptography and Network Security, Khanna Publishing House, Delhi
8) William Stallings, Network Security Essentials: Applications and Standards, Prentice Hall, 4th edition, 2010

**E-books& E-Contents:**

5) https://prutor.ai/welcome/
6) https://crypto.stanford.edu/cs155old/cs155-spring11/lectures/03-ctrl-hijack.pdf
7) https://cybermap.kaspersky.com/stats
8) https://www.fireeye.com/cyber-map/threat-map.html

**Reference Links:**

4) https://crypto.stanford.edu/cs155old/cs155-spring11/lectures/03-ctrl-hijack.pdf
5) https://cs155.stanford.edu/lectures/03-isolation.pdf
6) http://uru.ac.in/uruonlinelibrary/Cyber_Security/Cryptography_and_Network_Security.pdf

**NPTEL/ Youtube/ Faculty Video Link:**

6) https://www.youtube.com/watch?v=vv1ODDhXW8Q
7) https://www.youtube.com/watch?v=fQ3ESFfvchg&list=PLUtfVcb-iqn834VGI9faVXGIGSDXZMGp8
8) https://www.youtube.com/watch?v=iTVyKbDCJrA&list=PLgMDNELGJ1CbdGLyn7OrVAP-IKg-0q2U2
9) https://www.youtube.com/watch?v=1plMO7ChXMU&list=PLJ5C_6qdAvBFAuGoLC2wFGruY_E2gYtev
10) https://www.youtube.com/watch?v=_9QayISruzo