SAHRDAYA COLLEGE OF ENGINEERING & TECHNOLOGY
A CENTRE OF EXCELLENCE IN SCIENCE & TECHNOLOGY | MANAGED BY IRINJALAKUDA DIOCESAN EDUCATION TRUST
Approved by AICTE & Affiliated to APJ Abdul Kalam Technological University | Accredited by:
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# M. Tech

# Syllabus (2024)- Semester I to IV Discipline: Biotechnology

## Stream: Industrial Biotechnology

***(SHR/AC/Auto/Acad. Council/ M.Tech/3/Syll./IBT)***

*Recommended by Board of Studies on 30/8/2024*

*Approved by Academic Council on 31/8/2024*

# SEMESTER I

| 241TBT007 | INDUSTRIAL BIOTECHNOLOGY | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | Discipline Core 1 | 3 | 0 | 0 | 3 |

**Preamble:**

To study the application of studied biotechnology fundamentals in an industrial set up with an added emphasis of industrial bioproduction in India.

**Pre-requisites**: Nil

**Course Outcomes**: After the completion of the course, the student will be able to

| | |
|---|---|
| **CO 1** | Identify industrially relevant microorganisms and their isolation and screening techniques along with the substrates used for industrial fermentations. |
| **CO 2** | Explain the basic fermentations processes and the design of various industrially used bioreactors. |
| **CO 3** | Understand the methods and processes for industrial bio production of commonly used primary and secondary microbial metabolites. |
| **CO 4** | Relate the production of bio products in India with the case studies of ethanol and the corona virus vaccine by studying the process, problems and compare them to production in the global market. |

**Mapping of course outcomes with program outcomes**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 |
|---|---|---|---|---|---|---|---|
| **CO 1** | - | - | 2 | 2 | - | - | - |
| **CO 2** | - | - | 2 | 2 | - | - | - |
| **CO 3** | - | - | 3 | 3 | 2 | 2 | 2 |
| **CO 4** | - | 2 | 3 | 3 | 2 | 3 | 2 |

**Assessment Pattern**

| Bloom's Category | End Semester Examination |
|---|---|
| Apply | 30% |
| Analyse | 30% |
| Evaluate | 30% |
| Create | 10% |

**Mark distribution**

| Total Marks | CIE | ESE | ESE Duration |
|---|---|---|---|
| 100 | 40 | 60 | 2.5 hours |

**Continuous Internal Evaluation Pattern: 40 marks**

Micro/Course based project : 20 marks

Course based /Seminar/Quiz : 10 marks

Test paper, 1 no. : 10 marks

Test paper shall include minimum 80% of the syllabus.

**End Semester Examination Pattern: 60 marks**

The end semester examination will be conducted by the University. There will be two parts; Part A and Part B.

Part A will contain 5 numerical/short answer questions with one question from each module; having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions.

Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

**Model Question Paper**

**QP CODE:** **PAGES:**

**Reg No: _____ Name: __**

**SAHRDAYA COLLEGE OF ENGINEERING AND TECHNOLOGY**
**FIRST SEMESTER M. TECH DEGREE EXAMINATION, MONTH & YEAR**
**Course Code: 241TBT007**

Max. Marks: 60 Duration: 2.5 hrs.

**Industrial Biotechnology**

**PART – A**

Answer All the Questions.

One question from each module, having 5 marks for each question.

(5x 5 = 25)

1. Compare and contrast between submerged state, solid state and fed batch fermentations.
2. Under what process condition would you use a packed bed rector and when would you use a fluidised bed reactor. Give an example of an industrial product made using these reactors. Understand by the term GMP? State any five GMPs that should be practised in a food industry.
3. Explain the manufacture of single cell proteins and justify its industrial importance.
4. Name the commonly used strain and substrate used for penicillin manufacture in India. How is the downstream processing of this biopharmaceutical done today?
5. What is bioethanol and why is it of prime importance in reducing the fuel import bill of the Indian nation.

**PART – B**

Minimum one question from each module (Total seven questions)

Answer any five (5 x 7 = 35)

6. Differentiate between crude and synthetic media and their uses. Mention any five commonly used industrial media and the bioproduct they are used to manufacture.
7. With neat diagrams explain the working of a trickle reactor and cyclone reactors.
8. With a neat flow sheet explain the industrial manufacture of glutamic acid along with the biochemical pathways.
9. With a neat flow diagram explain the industrial production of citric acid in India and compare the same with the process used in Japan? What are the benefits and drawbacks of each?

10. How are bioplastics manufactured? Discuss the mode of bioplastic degradation as compared to that of regular plastics.
11. Discuss with a flow diagram the manufacture of Ethanol in India from molasses. Mention the strain used and the process parameters to be maintained. How do you get 99% ethanol from the 190 proof ethanol produced by fermentation?
12. Explain the type of Covid 19 vaccine produced by Serum India. How was it made? Discuss the global economic implications of India as a Covid19 vaccination manufacturing hub.

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## SYLLABUS

**Module 1 (8 hours)**

**Industrial Fermentation**: An overview, isolation, screening and selection of industrially important microorganisms, Crude and synthetic media; molasses, cornsteep liquor, sulphite waste liquor, whey, yeast extract and protein hydrolysates. Types of fermentation processes used in the industry - Solid-state and liquid-state (stationary and submerged) fermentations; batch, fed-batch (eg. baker's yeast) and continuous fermentations with examples.

**Module 2 (8 hours)**

**Industrial Bioreactors**: Design and components of basic fermentor, specialized fermentors for specific purposes – continuous, anaerobic, for gaseous nutrients, for treatment of wastes, trickle flow reactors, cyclone reactors, submerged types, tube reactors, bubble reactors, packed bed reactors, lab scale to pilot to industrial – Scale up process, online monitoring.

**Module 3 (8 hours)**

**Primary products of microbial production**: Single cell protein, amino acids (lysine and glutamic acid), production of citric acid by Koji process and submerged process production, nucleic acids. acetone-butanol fermentation, glycerol from yeasts and bacteria

**Module 4 (8 hours)**

**Secondary products of microbial metabolism**, Antibiotics (penicillin, tetracycline), alkaloids, taxol, Microbial polysaccharides (xanthan, dextran, alginate, gellan, cellulose, curdlan, pullulan, scleroglucan) and polyesters - bioplastics (polyhydroxyalkanoates)

**Module 5 (8 hours)**

**Industrial case studies**: Case Study of Covid 19 Vaccine Production in India- Types of Covid 19 Vaccines/ Scope and production methods and manufacturing companies. Industrial Economics of Covid 19 Vaccine Production in India for Global Markets. Advantages of India as a global vaccine manufacturing hub.

Case Study of Ethanol Production: Ethanol production from lignocellulosic waste (feedstocks to fermentable sugars-sugars, molasses, starches and cellulose) Ethanol production in India, Economics and Demand Industrial Process method and Process conditions. Product distillation and problems. Sugars to alcohol-Yeast, substrate range, substrate utilization. Ethanol tolerance. Use of Zymomonas mobilis and Clostridium for ethanol production-advantages and drawbacks. Biodiesel and use for ethanol in blending

**Course Plan**

| No | Topic | No. of Lectures |
|---|---|---|
| 1 | **Industrial Fermentation (8 hours)** | |
| 1.1 | Industrial Fermentation: An overview, isolation, screening and selection of industrially important microorganisms, | 2 |
| 1.2 | Crude and synthetic media; molasses, cornsteep liquor, sulphite waste liquor, whey, yeast extract and protein hydrolysates | 2 |
| 1.3 | Types of fermentation processes used in the industry - Solid-state and liquid-state (stationary and submerged) fermentations; batch, fed-batch (eg. baker's yeast) | 2 |
| 1.4 | Continuous fermentations with examples. | 2 |
| 2 | **Industrial Bioreactors (8 hours)** | |
| 2.1 | Design and components of basic fermentor | 2 |
| 2.2 | Specialized fermentors for specific purposes – continuous, anaerobic, for gaseous nutrients, for treatment of wastes, trickle flow reactors, cyclone reactors, submerged types, | 3 |
| 2.3 | Tube reactors, bubble reactors, packed bed reactors | 2 |
| 2.4 | Lab scale to pilot to industrial – Scale up process, online monitoring. | 1 |
| 3 | **Primary products of microbial production (8 hours)** | |
| 3.1 | Single cell protein, amino acids (lysine and glutamic acid) | 2 |
| 3.2 | Production of citric acid by Koji process and submerged process | 2 |
| 3.3 | Production, nucleic acids. acetone-butanol fermentation | 2 |
| 3.4 | Glycerol from yeasts and bacteria | 2 |
| 4 | **Secondary Products of microbial metabolism (8 hours)** | |
| 4.1 | Antibiotics (penicillin, tetracycline) | 2 |
| 4.2 | Microbial polysaccharides (xanthan, dextran, alginate, gellan, cellulose, curdlan, pullulan, scleroglucan) and polyesters | 3 |
| 4.3 | Alkaloids, taxol | 2 |
| 4.4 | Bioplastics (polyhydroxyalkanoates) | 1 |
| 5 | **Industrial case Studies (8 hours)** | |
| 5.1 | Case Study of Covid 19 Vaccine Production in India- Types of Covid 19 Vaccines/ Scope and production methods and manufacturing companies. Industrial Economics of Covid 19 Vaccine Production in India for Global Markets. Advantages of India as a global vaccine manufacturing hub. | 3 |

| | | |
|---|---|---|
| 5.2 | Case Study of Ethanol Production: Ethanol production from lignocellulosic waste (feedstocks to fermentable sugars-sugars, molasses, starches and cellulose) Ethanol production in India, | 2 |
| 5.3 | Economics and Demand Industrial Process method and Process conditions. Product distillation and problems. Sugars to alcohol-Yeast, substrate range, substrate utilization. Ethanol tolerance. Use of Zymomonas mobilis and Clostridium for ethanol production-advantages and drawbacks., | 2 |
| 5.4 | Biodiesel and use for ethanol in blending | 1 |

**Reference Books**


1. Stanbury, P.F and Whittacker; "Principles of Fermentation technology", Pergamon. Press Oxford
2. Michael L Shuler and Fikret Kargi., "Bioprocess Engg.: Basic concepts", Prentice Hall, New Delhi.
3. M.Yoong (Ed-in-Chief)., "*Comprehensive Biotechnology",* Vol 3 , Pergamon, Oxford.
4. B.D.Singh., "*Biotechnology- Expanding Horizons",* Kalyani Publishers ,NewDelhi.
5. H.K.Das., "*Text book of Biotechnology"* , Wiley Publications , New Delhi
6. Mukhopadhyay, Kunal., *"Applications of Biotechnology for Sustainable Development"*

| 241TBT008 | ADVANCED FERMENTATION TECHNOLOGY | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | Program core 1 | 3 | 0 | 0 | 3 |

**Preamble:**

After the completion of course advanced fermentation technology, students will acquire a thorough knowledge about the conventional fermentation technology & also the advancement in the corresponding sector.

**Pre-requisites**: Nil

**Course Outcomes:**

After the completion of the course the student will be able to

| | |
|---|---|
| **CO 1** | Generate interest on fermentation technology by learning the history and required basics of fermentation. |
| **CO 2** | Create awareness on raw materials by analysing the economics, availability and productivity of a wide spectrum of raw materials by using different case studies. |
| **CO 3** | Imbibe the idea of metabolic regulatory mechanism as a prerequisite to fermentation technology |
| **CO 4** | Familiarize the concept of Product development using recombinant technology |
| **CO 5** | Familiarize the commercial production mechanism of various biologically important products. |

**Mapping of course outcomes with program outcomes**

| | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** |
|---|---|---|---|---|---|---|---|
| **CO 1** | 2 | 2 | 2 | - | - | 2 | 2 |
| **CO 2** | 2 | 2 | 2 | 2 | 2 | 2 | 3 |
| **CO 3** | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| **CO 4** | 3 | 3 | 3 | 3 | 2 | 3 | 3 |
| **CO 5** | 3 | 3 | 3 | 3 | 3 | 2 | 3 |

**Assessment Pattern**

| **Bloom's Category** | **End Semester Examination** |
|---|---|
| Apply | 35% |
| Analyse | 35% |
| Evaluate | 15% |

| | |
|---|---|
| Create | 15% |

**Mark distribution**

| **Total Marks** | **CIE** | **ESE** | **ESE Duration** |
|---|---|---|---|
| 100 | 40 | 60 | 2.5 hours |

**Continuous Internal Evaluation Pattern**

Micro/Course based project : 20 marks

Course based /Seminar/Quiz : 10 marks

Test paper, 1 no. : 10 marks

Test paper shall include minimum 80% of the syllabus.

**End Semester Examination Pattern**

The end semester examination will be conducted by the University. There will be two parts; Part A and Part B.

Part A will contain 5 numerical/short answer questions with one question from each module; having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions.

Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

**Model Question Paper**

**QP CODE:** **PAGES:**

**Reg No: _____ Name: __**

**SAHRDAYA COLLEGE OF ENGINEERING AND TECHNOLOGY**
**FIRST SEMESTER M. TECH DEGREE EXAMINATION, MONTH & YEAR**
**Course Code: 241TBT008**

Max. Marks: 60 Duration: 2.5 hrs.

**Advanced Fermentation Technology**

**PART – A**

Answer All the Questions.

One question from each module, having 5 marks for each question.

(5x 5 = 25)

1. Demonstrate the emergence of fermentation technology with any one case study.
2. Discuss the business economics with the selection of raw material
3. Explain feedback inhibition and feedback repression
4. Relate advanced fermentation technology with recombinant technology by using any one example
5. Explain chemometrics (multi variate data analysis) for cell density.

**PART – B**

Minimum one question from each module (Total seven questions)

Answer any five (5 x 7 = 35)

6. Explain the industrial production of primary and secondary metabolites with suitable example
7. Demonstrate various fermentation techniques available based on the nature of culture medium
8. Explain the importance using nonconventional raw material instead of conventional by using proper example
9. (a) Explain raw material availability and pre-treatment of raw materials.
   (b) Explain Carbon catabolite repression & crab tree effect.
10. Explain the procedure for the generation of mutant for the production of specific metabolite with proper example
11. Demonstrate the production of L Tryptophan and acetic acid
12. Demonstrate the production of any one novel biopharmaceutical

## SYLLABUS

**Module 1 (8 hours)**

**Introduction to fermentation technology**: Interaction between Bio-chemical engineering, Microbiology and Biochemistry History and development of fermentation industry: Introduction to submerged and solid-state fermentation, Microbial culture selection for fermentation processes, Primary and Secondary metabolites, Media for industrial fermentations

**Module 2 (8 hours)**

**Raw materials**: Raw material availability, quality, processes and pre-treatment of raw materials. Major alcoholic raw materials. Applications of the nonconventional raw materials (cellulosic material and hydrocarbons).

**Module 3 (6 hours)**

**Regulatory mechanism**: Different regulatory mechanisms involved in controlling the catabolic and anabolic processes of microbes Induction, nutritional repression Carbon catabolite repression, crab tree effect Feedback inhibition and feedback repression.

**Module 4 (7 hours)**

**Procedures for developing mutants of the desired microbes**: Creation/procedures for developing mutants of the desired microbes with the stable capacity of producing desired metabolites. Isolation and preservation of different types of mutant's- induction resistant, feedback inhibition resistant. Concept for over production of primary and secondary metabolites.

**Module 5 (11 hours)**

**Details of the process, Parameters and materials**: Industrial manufacture of Antibiotics (Penicillin, streptomycin) Amino acid (L Tryptophan), Organic acids (Acetic acid) Novel biopharmaceuticals (vaccines) Microbial Transformations, Microbial leaching Real time data collection in fermentation technology-chemometrics (multi variate data analysis)

**Course Plan**

| No | Topic | No. of Lectures |
|---|---|---|
| 1 | **Introduction to fermentation technology (8 hours)** | |
| 1.1 | Interaction between Bio-chemical engineering, Microbiology and Biochemistry | 3 |
| 1.2 | History and development of fermentation industry: Introduction to submerged and solid-state fermentation, Microbial culture selection for fermentation processes | 3 |
| 1.3 | Primary and Secondary metabolites, Media for industrial fermentations | 2 |
| 2 | **Raw materials (8 hours)** | |
| 2.1 | Raw material availability, quality, processes and pre-treatment of raw materials. | 3 |
| 2.2 | Major alcoholic raw materials. | 3 |
| 2.3 | Applications of the nonconventional raw materials (cellulosic material and hydrocarbons). | 2 |
| 3 | **Regulatory mechanism (6 hours)** | |
| 3.1 | Different regulatory mechanisms involved in controlling the catabolic and anabolic processes of microbes Induction, nutritional repression | 2 |
| 3.2 | Carbon catabolite repression, crab tree effect | 2 |
| 3.3 | Feedback inhibition and feedback repression. | 2 |
| 4 | **Procedures for developing mutants of the desired microbes (7 hours)** | |
| 4.1 | Creation/procedures for developing mutants of the desired microbes with the stable capacity of producing desired metabolites. | 2 |
| 4.2 | Isolation and preservation of different types of mutant's- induction resistant, feedback inhibition resistant. | 2 |
| 4.3 | Concept for over production of primary and secondary metabolites. | 3 |
| 5 | **Details of the process, Parameters and materials (11 hours)** | |
| 5.1 | Industrial manufacture of Antibiotics (Penicillin, streptomycin) | 3 |
| 5.2 | Aminō acid (L Tryptophan), Organic acids (Acetic acid) | 3 |
| 5.3 | Novel biopharmaceuticals (vaccines)<br>Microbial Transformations, Microbial leaching | 2 |
| 5.4 | Real time data collection in fermentation technology-chemometrics (multi variate data analysis) | 3 |

**Reference Books**


1. Murray Moo –Young., "Comprehensive Biotechnology", Vol. 1 & III-latest ed.
2. Lel and Kotlers Richard J. Mickey., "Microbes and Fermentation", Oriffin Publication
3. Leland, N. Y., "Industrial Fermentations", Chemical Publishers.
4. Prescott and Dunn's., "Industrial Microbiology", 4 th, ed.
5. Rehm, Reed & Weinheim, Verlag-Chemie., "Biotechnology Series".
6. Aiba, Humphrey and Miller., "Biochemical Engg", Academic Press.

| 241EBT009 | BIOSEPARATION TECHNOLOGY | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | Program core 3 | 3 | 0 | 0 | 3 |

**Preamble:** Enable the students to learn the various industrial scale bio separations in the bioprocess industries

**Pre-requisites**: Nil

**Course Outcomes:** After the completion of the course the student will be able to

| | |
|---|---|
| **CO 1** | Analyse the biochemical characteristics of the bioproducts and comprehend the principle of separating insoluble solids from fermentation broth |
| **CO 2** | Distinguish different methods used in enrichment of biomolecules |
| **CO 3** | Design strategy for purification of bioproducts using chromatography |
| **CO 4** | Select the unit operations for polishing of bioproducts and have knowledge in industrial bioproduct purification |

**Mapping of course outcomes with program outcomes**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 |
|---|---|---|---|---|---|---|---|
| **CO 1** | - | - | - | 2 | 2 | - | - |
| **CO 2** | - | - | - | 2 | 2 | - | - |
| **CO 3** | - | - | - | 2 | 3 | - | - |
| **CO 4** | - | - | 2 | 3 | 3 | - | - |

**Assessment Pattern**

| Bloom's Category | End Semester Examination |
|---|---|
| Apply | 35% |
| Analyse | 50% |
| Evaluate | 15% |
| Create | |

**Mark distribution**

| Total Marks | CIE | ESE | ESE Duration |
|---|---|---|---|
| 100 | 40 | 60 | 2.5 hours |

**Continuous Internal Evaluation Pattern**

Micro/Course based project : 20 marks

Course based /Seminar/Quiz : 10 marks

Test paper, 1 no. : 10 marks

Test paper shall include minimum 80% of the syllabus.

**End Semester Examination Pattern**

There will be two parts; Part A and Part B.

Part A will contain 5 numerical/short answer questions with one question from each module; having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions.

Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

**Model Question Paper**

**QP CODE:** **PAGES:**

**Reg No: _____ Name: __**

**SAHRDAYA COLLEGE OF ENGINEERING AND TECHNOLOGY**
**FIRST SEMESTER M. TECH DEGREE EXAMINATION, MONTH & YEAR**
**Course Code: 241EBT009**

Max. Marks: 60 Duration: 2.5 hrs.

**Bio separation Technology**

**PART – A**

Answer All the Questions.

One question from each module, having 5 marks for each question.

(5x 5 = 25)

1. What are the characteristics of fermentation broth
2. Differentiate salting in and salting out with examples
3. Differentiate between GC-MS and LC-MS
4. List out the steps involved in the formation of crystals. Enumerate three applications of crystallization
5. Discuss about the purification of citric acid with a neat diagram

**PART – B**

Minimum one question from each module (Total seven questions)

Answer any five (5 x 7 = 35)

6. A continuous disc stack centrifuge is operated at 5000 rpm for separation of bakers' yeast. At a feed rate of 60 L min−1, 50% of the cells are recovered. For operation at constant centrifuge speed, solids recovery is inversely proportional to the flow rate
7. Elaborate on reversed miscellar extraction
8. Two proteins of molecular weights 2.5×105 and 1.0×104 were eluted out of a gel filtration columns at220ml and 300 ml respectively. Determine the molecular weight of a protein which elutes out a 270 ml from the column under the same conditions.
9. With a neat sketch explain the principle of freeze dryer and its applications
10. What are vaccines? With a neat diagram, explain the purification process of Hepatitis B Vaccine
11. Explain the principle of isoelectric focussing. Append a neat sketch.
12. Explain the working principle of a high-pressure homogenizer with the help of a neat sketch

## SYLLABUS

**Module I (8 hours)**

**Introduction to Bio separation Process and Removal of Insoluble:** Need for Bio separation, Economic Importance of Bio separation, RIPP scheme, Properties of Biomolecules, Characteristics of fermentation broth. Guidelines to recombinant protein purification-Affinity Tags. Cell disruption methods for intracellular products: Physical, chemical, mechanical and enzymatic methods. Removal of insoluble: Biomass and particulate debris separation techniques - flocculation - sedimentation - centrifugation and filtration methods.

**Module II (8 hours)**

**Isolation of Products**: Adsorption: Principles - Langumir - Freundlich isotherms - Extraction: Basics-Batch and continuous, aqueous two-phase extraction - supercritical extraction - in situ product removal - Precipitation: Methods of precipitation with salts - organic solvents and polymers - Membrane based separations: Microfiltration - ultra filtration - dialysis, Electrophoresis

**Module III (9 hours)**

**Purification of Bioproducts**: Basic principles of Chromatographic separations: GC-HPLC - gel permeation - ion- exchange -affinity - reverse phase and hydrophobic interaction chromatography - immunosorbent affinity chromatography, Electrophoretic separation techniques: capillary - isoelectric focusing-2D gel electrophoresis - Hybrid separation technologies: GC-MS and LC-MS.

**Module IV (7 hours)**

**Product Polishing: Crystallization**: Principles-Nucleation- Crystal growth-Kinetics-Batch crystallizers: Scale-up and design, Drying: Principles Water in biological solids- Heat and mass transfer- Drying equipments: description and operation-Vacuum shelf - rotary dryer-Freeze dryer-Spray dryer.

**Module V (8 hours)**

**Case Studies**: Purification of cephalosporin, aspartic acid, citric acid, vitamin B12, hepatitis B vaccine, Recombinant Streptokinase, Tissue plasminogen activator, Taq polymerase, Insulin and Monoclonal antibodies.

| Course Plan | | |
|---|---|---|
| No | Topic | No. of Lectures |
| 1 | **Introduction to Bio separation Process and Removal of Insoluble (8 hours)** | |
| 1.1 | Need for Bio separation, Economic Importance of Bio separation | 1 |
| 1.2 | RIPP scheme, Properties of Biomolecules, Characteristics of fermentation broth. | 1 |
| 1.3 | Guidelines to recombinant protein purification-Affinity Tags | 1 |
| 1.4 | Cell disruption methods for intracellular products: Physical, chemical, mechanical and enzymatic methods. | 2 |
| 1.5 | Removal of insoluble: Biomass and particulate debris separation techniques - flocculation - sedimentation - centrifugation and filtration methods. | 3 |
| 2 | **Isolation of Products (8 hours)** | |
| 2.1 | Adsorption: Principles - Langumir - Freundlich isotherms | 2 |
| 2.2 | Extraction: Basics- Batch and continuous, aqueous two-phase extraction - supercritical extraction - in situ product removal | 2 |
| 2.3 | Precipitation: Methods of precipitation with salts - organic solvents and polymers | 2 |
| 2.4 | Membrane based separations: Microfiltration - ultra filtration | 1 |
| 2.5 | Dialysis, Electrophoresis | 1 |
| 3 | **Purification of Bioproducts (9 hours)** | |
| 3.1 | Basic principles of Chromatographic separations: GC-HPLC - gel permeation - ion- exchange -affinity - reverse phase | 3 |
| 3.2 | hydrophobic interaction chromatography - immunosorbent affinity chromatography | 2 |
| 3.3 | Electrophoretic separation techniques: capillary - isoelectric focusing-2D gel electrophoresis | 2 |
| 3.5 | Hybrid separation technologies: GC-MS and LC-MS. | 2 |
| 4 | **Product Polishing: Crystallization (7 hours)** | |
| 4.1 | Principles-Nucleation- Crystal growth | 1 |
| 4.2 | Kinetics of Batch crystallizers | 1 |
| 4.3 | Scale-up and design | 1 |

| | | |
|---|---|---|
| 4.4 | Drying: Principles Water in biological solids- Heat and mass transfer | 2 |
| 4.5 | Drying equipments: description and operation-Vacuum shelf - rotary dryer-Freeze dryer-Spray dryer | 2 |
| 5 | **Case Studies (8 hours)** | |
| 5.1 | Purification of cephalosporin, aspartic acid, | 1 |
| 5.2 | citric acid, vitamin B12 | 1 |
| 5.3 | hepatitis B vaccine, Recombinant Streptokinase | 2 |
| 5.4 | Tissue plasminogen activator, Taq polymerase | 2 |
| 5.5 | Insulin and Monoclonal antibodies | 2 |

**Reference Books**

1. Harrison RG, Todd P, Rudge SR, Petrides DP., "Bio separations Science and Engineering", Oxford Press, 2003.
2. Richard W Baker., "Membrane Technology and applications" John Wiley & Sons Ltd., 2004.
3. McCabe, WL, Smith JC, Harriott P., "Unit Operation of Chemical Engineering", 6/e, McGraw Hill, New York, 2000.

| 241EBT100 | BIOPHARMACEUTICAL TECHNOLOGY | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | Program Elective 1 | 3 | 0 | 0 | 3 |

**Preamble:**

To educate the students with sufficient scientific information on the basic principles; for the production of biopharmaceutical products and therapeutic proteins. To enable students to design a product related to pharmaceutical industry

**Pre-requisites**: Nil

**Course Outcomes**: After the completion of the course, the student will be able to

| | |
|---|---|
| **CO 1** | Understand the discovery process of biopharmaceuticals |
| **CO 2** | Discern the production, processing, packaging and transport of drug molecules |
| **CO 3** | Ascertain the use of various therapeutic proteins, antibodies and vaccines |
| **CO 4** | To know the scale up processes and industrial production of therapeutic proteins |

**Mapping of course outcomes with program outcomes**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 |
|---|---|---|---|---|---|---|---|
| **CO 1** | 2 | - | 2 | 2 | - | 2 | - |
| **CO 2** | - | 2 | 2 | - | 2 | - | - |
| **CO 3** | - | - | 2 | 2 | 2 | - | 2 |
| **CO 4** | - | - | - | - | 2 | 2 | 2 |

**Assessment Pattern**

| Bloom's Category | End Semester Examination |
|---|---|
| Apply | 40% |
| Analyse | 25% |
| Evaluate | 25% |
| Create | 10% |

**Mark distribution**

| Total Marks | CIE | ESE | ESE Duration |
|---|---|---|---|
| 100 | 40 | 60 | 2.5 hours |

**Continuous Internal Evaluation Pattern: 40 marks**

| | |
|---|---|
| Micro/Course based project | : 15 marks |
| Course based /Seminar/Quiz | : 15 marks |
| Test paper, 1 no. | : 10 marks |

Test paper shall include minimum 80% of the syllabus.

**End Semester Examination Pattern: 60 marks**

The end semester examination will be conducted by the respective College. There will be two parts; Part A and Part B.

Part A will contain 5 numerical/short answer questions with one question from each module; having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions.

Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

**Model Question Paper**

**QP CODE:** **PAGES:**

**Reg No: _____ Name: __**

**SAHRDAYA COLLEGE OF ENGINEERING AND TECHNOLOGY**
**FIRST SEMESTER M. TECH DEGREE EXAMINATION, MONTH & YEAR**
**Course Code: 241EBT100**

Max. Marks: 60 Duration: 2.5 hrs.

**Biopharmaceutical Technology**

**PART – A**

Answer All the Questions.

One question from each module, having 5 marks for each question.

(5x 5 = 25)

1. What is the importance of preclinical trials in the drug discovery process?
2. What is GMP & GLP and why are they important?
3. How is antisense therapy used in modern health care? Give examples?
4. What is CART therapy?
5. CHO-derived cell lines are the preferred expression systems for biotherapeutics. Justify your answer with two suitable examples?

**PART – B**

Minimum one question from each module (Total seven questions)

Answer any five (5 x 7 = 35)

6. Discuss the role of regulatory authorities in bringing a drug molecule into the market with special emphasis on the global and Indian markets?
7. What are the challenges faced in the manufacture, stability, packaging and transport of therapeutic proteins?
8. Monoclonal antibodies are said to be the future molecule of the health care industry. Why?
9. What the significance of EGF, PDGF and VEGF in health and disease?
10. Describe the procedure of gene therapy with a schematic diagram?
11. What are (i) attenuated vaccines (ii) terta and pentavalent vaccines (iii) RNA vaccines. Give examples of each
12. What are the different types of media used in cell culture? Discuss the cell stability and significance of serum in maintaining cell lines

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## SYLLABUS

**Module 1 (7 hours)**

**Drug Discovery Process:** Sources of drugs: Plants, animals and microbes. Biopharmaceuticals: Current status and future prospectus. Approaches in drug design. Patenting in biotechnology. Role of regulatory authorities in the biopharmaceutical industry. Impact of genomics and related technologies in drug discovery. Delivery of biopharmaceuticals. Pre-clinical and clinical trials. Leading Indian biopharma companies.

**Module 2 (8 hours)**

**Drug Manufacturing Process:** International pharmacopoeia- Manufacturing facility- Production of final product- Analysis of final product- Packaging and transport. Procedures and challenges in manufacturing biopharmaceuticals. Stabilization of biopharmaceutical products and finished product formulations.

**Module 3 (9 hours)**

**Therapeutic Proteins:** Cytokines: Interferons, interleukins & Tumor necrosis factor. Haematopoietic growth factors. Growth factors (EGF, PDGF, FGF,VEGF, TGF). Hormones of therapeutic interest. Blood products and therapeutic enzymes. Anticoagulants, anti-thrombotics. Nucleic acid therapeutics: Gene therapy, Antisense technology

**Module 4 (9 hours)**

**Therapeutic Antibodies and Vaccines:** Structure of Antibody. Production of polyclonal and monoclonal antibodies for therapy. Role of adjuvant. mAbs: The molecule of future Vaccine technology: Traditional vaccine preparation. Impact of genetic engineering in vaccine technology. Cancer vaccines. mRNA vaccines. Vaccine production: Challenges in production, packaging, transportation and storage.

**Module 5 (7 hours)**

**Industrial production of therapeutic proteins:** Cell Lines, Cell Culture, and Purification. Therapeutic recombinant protein production in plants: Challenges and opportunities. Developments in bioprocessing of recombinant proteins. Biosimilars: Advances and challenges

**Course Plan**

| No | Topic | No. of Lectures |
|---|---|---|
| 1 | **Drug Discovery Process (7 hours)** | |
| 1.1 | Sources of drugs: Plants, animals and microbes. | 2 |
| 1.2 | Biopharmaceuticals: Current status and future prospectus. Approaches in drug design. Patenting in biotechnology. | 2 |
| 1.3 | Role of regulatory authorities in the biopharmaceutical industry. | 1 |
| 1.4 | Impact of genomics and related technologies in drug discovery. Delivery of biopharmaceuticals. | 1 |
| 1.5 | Pre-clinical and clinical trials. Leading Indian biopharma companies. | 1 |
| 2 | **Drug Manufacturing Process (8 hours)** | |
| 2.1 | International pharmacopoeia- | 2 |
| 2.2 | Manufacturing facility- Production of final product- Analysis of final product- Packaging and transport. | 3 |
| 2.3 | Procedures and challenges in manufacturing biopharmaceuticals. | 2 |
| 2.4 | Stabilization of biopharmaceutical products and finished product formulations. | 1 |
| 3 | **Therapeutic Proteins (9 hours)** | |
| 3.1 | Cytokines: Interferons, interleukins & Tumor necrosis factor. | 2 |
| 3.2 | Haematopoietic growth factors. Growth factors (EGF, PDGF, FGF,VEGF, TGF). | 2 |
| 3.3 | Hormones of therapeutic interest. Blood products and therapeutic enzymes. Anticoagulants, anti-thrombotics. | 2 |
| 3.4 | Nucleic acid therapeutics: Gene therapy, Antisense technology | 3 |
| 4 | **Therapeutic Antibodies and Vaccines (9 hours)** | |
| 4.1 | Structure of Antibody. Production of polyclonal and monoclonal antibodies for therapy. | 1 |
| 4.2 | Role of adjuvant. mAbs: The molecule of future. | 2 |
| 4.3 | Vaccine technology: Traditional vaccine preparation. Impact of genetic engineering in vaccine technology. | 2 |
| 4.4 | Cancer vaccines. mRNA vaccines. | 2 |
| 4.5 | Vaccine production: Challenges in production, packaging, transportation and storage. | 2 |

| | | |
|---|---|---|
| 5 | **Industrial production of therapeutic proteins (7 hours)** | |
| 5.1 | Cell Lines, Cell Culture, and Purification. | 2 |
| 5.2 | Therapeutic recombinant protein production in plants: Challenges and opportunities. | 2 |
| 5.3 | Developments in bioprocessing of recombinant proteins. | 2 |
| 5.4 | Biosimilars: Advances and challenges | 1 |

**Reference Books**


1. Gary Walsh., "Biopharmaceuticals: Biochemistry & Biotechnology", 2nd Edition. Wiley Publications
2. David Aebisher ., " An Essential Guide to Biopharmaceuticals", Nova Publications.
3. Gary Walsh., "Biopharmaceuticals, an Industrial Perspective", 1st Edition Springer.
4. Jörg Knäblein., "Modern Biopharmaceuticals: Recent Success Stories", 1st Edition , Wiley Blackwell Publications.
5. Dr. Basanta Kumara Behera., "Biopharmaceuticals: Challenges and Opportunities", 1st Edition CRC Press.

| 241EBT001 | FOOD PROCESS TECHNOLOGY | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | Program elective 1 | 3 | 0 | 0 | 3 |

**Preamble:**To study the different properties of food materials, food processing operations involving the application and removal of heat, Microbiology involved in food processing, and different post-processing operations.

**Pre-requisites**: Nil

**Course Outcome:** After the completion of the course, the student will be able to

| | |
|---|---|
| **CO 1** | Understand the properties of food materials, the effect of processing on food properties, food safety, and good manufacturing practices. |
| **CO 2** | Apply food material processing at ambient temperature, and with the application of heat, different unit operations involved, mixing and analysis of equipment involved. |
| **CO 3** | Analyze the growth of microorganisms, shelf life, food processing by removal of heat, and application of membrane process. |
| **CO 4** | Understand different post-processing operations, material handling and storage operations. |

**Mapping of course outcomes with program outcomes**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 |
|---|---|---|---|---|---|---|---|
| **CO 1** | 2 | 2 | 2 | 2 | 2 | - | - |
| **CO 2** | 2 | 2 | 2 | 3 | 3 | 2 | - |
| **CO 3** | 2 | 2 | 2 | 3 | 3 | 2 | - |
| **CO 4** | 2 | 2 | 2 | 2 | 2 | 3 | 2 |

**Assessment Pattern**

| Bloom's Category | End Semester Examination |
|---|---|
| Apply | 35% |
| Analyse | 35% |
| Evaluate | 15% |
| Create | 15% |

**Mark distribution**

| Total Marks | CIE | ESE | ESE Duration |
|---|---|---|---|
| 100 | 40 | 60 | 2.5 hours |

**Continuous Internal Evaluation Pattern: 40 marks**

| | |
|---|---|
| Micro/Course based project | : 15 marks |
| Course based /Seminar/Quiz | : 15 marks |
| Test paper, 1 no. | : 10 marks |

Test paper shall include minimum 80% of the syllabus.

**End Semester Examination Pattern: 60 marks**

The end semester examination will be conducted by the respective College. There will be two parts; Part A and Part B.

Part A will contain 5 numerical/short answer questions with one question from each module; having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions.

Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

**Model Question Paper**

**QP CODE:** **PAGES:**

**Reg No: _____** **Name: _____**

**SAHRDAYA COLLEGE OF ENGINEERING AND TECHNOLOGY**
**FIRST SEMESTER M. TECH DEGREE EXAMINATION, MONTH & YEAR**
**Course Code: 241EBT001**

Max. Marks: 60 Duration: 2.5 hrs.

**Food Process Technology**

**PART – A**

Answer All the Questions.

One question from each module, having 5 marks for each question.

(5x 5 = 25)

1. Briefly describe the food safety attributes.
2. Give a brief description of pie and biscuit formers and confectionery molders
3. Discuss the non-thermal processing of food by the radio frequency electric fields.
4. Discuss the use of enzymes in food processing with examples.
5. Enumerate the different factors affecting the storage of food materials.

**PART – B**

Minimum one question from each module (Total seven questions)

Answer any five (5 x 7 = 35)

6. Discuss in detail the different physical attributes of food with its measurement method.
7. Enumerate the different types of driers used in the food industry. Explain anyone drier with a neat sketch.
8. Distinguish the single effect and multiple effect evaporators used in the food industry.
9. Differentiate between plate freezers and blast freezers, What are the applications of pasteurizer?
10. List the various equipment used for grading and sizing of food.
11. Give a brief account on the factors affecting the growth and survival of microorganisms in food.
12. Explain any two kinds of equipment used for freeze drying operation in food industry.

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## SYLLABUS

**Module 1 (8 hours)**

**Properties of foods**-, Rheological properties, Thermal properties, Electromagnetic properties, Biochemical properties, Sensory characteristics, main components in food, Nutritional quality. Measurement of color, flavor, consistency, viscosity, texture, and their relationship with food quality and composition. Effects of processing on nutritional properties Food safety, Good manufacturing practice and quality assurance, HACCP

**Module 2 (8 hours)**

**Basic food processing techniques**: Ambient-temperature processing- Raw material preparation, Cleaning, Removing contaminants and foreign bodies, Sorting, Grading, Peeling. Unit operations in food processing -Mechanical separations-Size reduction and classification. Mixing- Theory of solids mixing, Theory of liquids mixing, Equipment, Effect on foods Forming, Bread molders, Pie and biscuit formers, Confectionery molders.

**Module 3 (9 hours)**

**Processing by application of heat** – Blanching, Pasteurisation, Heat sterilization, Evaporation, distillation, extrusion, dehydration, baking and roasting, Frying, Heat processing Principle and applications of High pressure processing, Pulsed electric field processing, Infrared heating, Non-thermal processing by radio frequency electric fields, Osmotic dehydration, Application of ultrasound and irradiation, Ohmic heating, Microwave heating, Equipment and applications.

**Module 4 (8 hours)**

**Microbiology of food processing**: Factors affecting the growth and survival of microorganisms in food, chemical changes of foods caused by microorganisms, shelf life, determination of the presence of microorganisms and/or their products in Foods by various techniques, Fermentation and enzyme technology.
Processing by the removal of heat- Chilling, freezing, freeze-drying and freeze concentration. - Equipment and applications.

**Module 5 (7 hours)**

**Post processing operations**: Membrane processes in food processing.- Equipment used. Post-processing operations. Coating or enrobing, packaging, printing, Filling and sealing of containers, Materials handling, storage and distribution.

**Course Plan**

| No | Topic | No. of Lectures |
|---|---|---|
| 1 | **Basic properties of food materials (8 hours)** | |
| 1.1 | Rheological, Thermal, Electromagnetic, Biochemical properties, Sensory characteristics, main components in food, Nutritional quality. | 3 |
| 1.2 | Measurement of color, flavor, consistency, viscosity, texture, and their relationship with food quality and composition. Effects of processing on nutritional properties | 3 |
| 1.3 | Food safety, Good manufacturing practice and quality assurance, HACCP | 2 |
| 2 | **Basic food processing techniques (8 hours)** | |
| 2.1 | Raw material preparation, Cleaning Removing contaminants and foreign bodies, Sorting, Grading, Peeling | 2 |
| 2.2 | Mechanical separations-Size reduction and classification, Equipment | 3 |
| 2.3 | Mixing. Mixing Theory of solids mixing, liquid mixing, Equipment | 2 |
| 2.4 | Bread molders, Pie and biscuit formers, Confectionery molders | 1 |
| 3 | **Food Processing by application of heat (9 hours)** | |
| 3.1 | Blanching, Pasteurisation, Heat sterilization, Evaporation, distillation, extrusion, dehydration, baking and roasting, Frying | 3 |
| 3.2 | High pressure processing, Pulsed electric field processing, Infrared heating, Non-thermal processing by radio frequency electric fields, Osmotic dehydration, Equipment and applications | 3 |
| 3.3 | Application of ultrasound and irradiation, Ohmic heating, Microwave heating, Equipment and applications | 3 |
| 4 | **Microbiology of Food Processing (8 hours)** | |
| 4.1 | Factors affecting the growth and survival of microorganisms in food, chemical changes of foods caused by microorganisms, shelf life, determination of the presence of microorganisms and/or their products in Foods by various techniques | 3 |
| 4.2 | Fermentation and enzyme technology. | 2 |
| 4.3 | Processing by the removal of heat- Chilling, freezing, freeze-drying and freeze concentration. Equipment and applications. | 3 |
| 5 | **Post-processing operations (7 hours)** | |
| 5.1 | Membrane processes in food processing.- Equipment used | 1 |
| 5.2 | Coating or enrobing, packaging, printing, Filling and sealing of containers | 3 |
| 5.3 | Materials handling, storage and distribution | 3 |

**Reference Books**

1. P J Fellows., “Food Processing Technology: Principles and Practice”, 3/e, CRC Press, 2009.
2. B Sivasankar., “Food Processing and Preservation”, PHI Learning Pvt. Ltd., 2009.
3. Rao D G., “Fundamentals of Food Engineering”, PHI Learning Private Ltd., 2010.
4. R Paul Singh, Dennis R Heldman., “Introduction to Food Engineering”, 4/e, Elsevier, 2009.
5. Da-Wen Sun., “Emerging Technologies for Food Processing”, Elsevier, 2014.
6. PG Smith., “Introduction to Food Process Engineering”, 2/e, Springer, 2011.

| 241EBT002 | BIOMOLECULAR AND CELLULAR PROCESS TECHNOLOGY | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | Program Elective 1 | 3 | 0 | 0 | 3 |

**Preamble:**

Students are allowing to tailor the knowledge of biomolecular and cellular technology to suit their knowledge, interests and skills for the future research insight.

**Pre-requisites**: Nil

**Course Outcomes:**

After the completion of the course the student will be able to

| | |
|---|---|
| **CO 1** | Impart necessary concepts of biomolecules |
| **CO 2** | Identify the structure and key functions of enzymes and nucleic acids |
| **CO 3** | Integration and quantification approach towards cellular reactions and regulation of metabolic pathway |
| **CO 4** | Fundamentals of bioprocess technology and metabolic flux analysis in metabolic control analysis for increasing the productions. |
| **CO 5** | The student obtains advanced level knowledge in biomolecules and cellular process technology and bioprocess monitoring, a base for the higher research activity |

**Mapping of course outcomes with program outcomes**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 |
|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | - | - | - | 3 | 2 | 2 |
| **CO 2** | 2 | - | 2 | 2 | 3 | - | 3 |
| **CO 3** | 2 | - | - | - | 3 | - | - |
| **CO 4** | - | 2 | 2 | 2 | 3 | - | 3 |
| **CO 5** | - | 2 | 2 | 2 | 3 | - | 3 |

**Assessment Pattern**

| Bloom's Category | End Semester Examination |
|---|---|
| Apply | 35% |
| Analyse | 50% |
| Evaluate | 15% |
| Create | - |

**Mark distribution**

| Total Marks | CIE | ESE | ESE Duration |
|---|---|---|---|
| 100 | 40 | 60 | 2.5 hours |

**Continuous Internal Evaluation Pattern: 40 marks**

Micro/Course based project : 15 marks

Course based /Seminar/Quiz : 15 marks

Test paper, 1 no. : 10 marks

Test paper shall include minimum 80% of the syllabus.

**End Semester Examination Pattern: 60 marks**

The end semester examination will be conducted by the respective College. There will be two parts; Part A and Part B.

Part A will contain 5 numerical/short answer questions with one question from each module; having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions.

Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

**Model Question Paper**

**QP CODE:** **PAGES:**

**Reg No: _____** **Name: _____**

**SAHRDAYA COLLEGE OF ENGINEERING AND TECHNOLOGY**
**FIRST SEMESTER M. TECH DEGREE EXAMINATION, MONTH & YEAR**
**Course Code: 241EBT002**

Max. Marks: 60 Duration: 2.5 hrs.

**Biomolecular and Cellular Process Technology**

**PART – A**

Answer All the Questions.

One question from each module, having 5 marks for each question.

(5x 5 = 25)

1. Briefly explain general properties and functions of carbohydrates
2. Explain the Major class of enzymes with suitable examples
3. Explain the importance of bacterial strain typing.
4. What are the general criteria for Fermenter design?
5. What are the advanced technologies used for the purification of fermentation products?

**PART – B**

Minimum one question from each module (Total seven questions)

Answer any five (5 x 7 = 35)

6. Discuss the relationship between enzyme turnover number in terms of specific activity of enzymes
7. Explain the principles and specimen preparations of confocal microscopy
8. Differentiate solid state and submerged fermentations.
9. What are xenobiotic and the elimination of xenobiotic
10. Discuss the role of bacteria in degradation of polyaromatic compounds
11. Differentiate horizontal and vertical gel electrophoresis. Discuss the application of both.
12. Discuss some of the current practices in the bioprocess industries for the monitoring and control of important bioprocesses.

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## SYLLABUS

### Module I (7 hours)

**Fundamentals of Biomolecules** Carbohydrate – Classification, structure. General properties and functions of polysaccharides and complex carbohydrates. Lipids – Classification, structure, properties and functions of fatty acids, essential fatty acids, fats. Proteins – Peptide synthesis: chemical and Merrifield synthesis. Primary (peptide conformation, N- and C- terminal, peptide cleavage), Secondary (α-helix, β-sheet, random coil, Ramachandran plot), Tertiary and Quaternary structures of proteins.

### Module II (7 hours)

**Enzymes** – Historical perspective, classification (specific examples). Measurement and expression of enzyme activity, enzyme assay Definitions of IU, Katal, enzyme turnover and specific activity. Methods for isolation, purification and characterization of enzymes, tests for homogeneity of enzyme preparation. Nucleic acids – Structure and function of nucleotides. Primary, secondary and tertiary structure of nucleic acids. DNA forms and conformations, Denaturation of DNA.

### Module III (8 hours)

Microbial classification (Bacteria and Fungus). Bacterial strain typing, Microscopy - Bright field, Dark field, Phase contrast, Fluorescence microscopy and Confocal microscopy. Sterilization, nutritional requirements. Growth kinetics of bacteria, media for growing bacteria and fungi. Bacterial toxins – Classification, structure and mode of action of bacterial protein toxins. Viruses – General structure, properties and classification, phage typing.

### Module IV (8 hours)

Fundamentals of fermentation technology - Types of Fermentors, General criteria for fermentor design, Current practices in bioprocess technologies specific design criteria for mammalian cells, Plant and Microbial systems. Strategies for fermentation with recombinant organisms. Anaerobic and anaerobic fermentation processes. Solid state and submerged fermentation process. Case study for solid state and submerged fermentation process.

### Module V (10 hours)

**Bioprocess monitoring** - Isolation, characterization and production of secondary metabolites. Overview of downstream processing: centrifugation, filtration and chromatographic techniques. Secondary metabolite of Microbes, Secondary metabolite – Plants and Mammalian cells. Bioprocess monitoring and control: current practices in the bioprocess industries, advanced methodologies. Production of alcohols, antibiotics, steroids and enzymes Biotransformation, biomass & production of single cell protein. **Xenobiotics metabolism** – Biodegradation xenobiotics by microorganisms, Surfactants, polyaromatic hydrocarbons, dyes. Biodegradation of hydrocarbons, pesticides, role of Cytochrome P450 in detoxification.

| Course Plan | | |
|---|---|---|
| No | **Topic** | No. of Lectures |
| 1 | **Fundamentals of Biomolecules (7 hours)** | |
| 1.1 | Carbohydrate – Classification, structure. | 1 |
| 1.2 | General properties and functions of polysaccharides and complex carbohydrates. | 1 |
| 1.3 | Lipids – Classification, structure, properties and functions of fatty acids, essential and non-essential fatty acids, fats. | 1 |
| 1.4 | Proteins – Peptide synthesis: chemical and Merrifield synthesis. | 1 |
| 1.5 | Primary (peptide conformation, N- and C- terminal, peptide cleavage), | 1 |
| 1.6 | Secondary (α-helix, β-sheet, random coil, Ramachandran plot), | 1 |
| 1.7 | Tertiary and Quaternary structures of proteins. | 1 |
| 2 | **Enzymes and Nucleic acids (7 hours)** | |
| 2.1 | Enzymes – Historical perspective, classification (specific examples). | 1 |
| 2.2 | Measurement and expression of enzyme activity, enzyme assay | 1 |
| 2.3 | Definitions of IU, Katal, enzyme turnover and specific activity | 1 |
| 2.4 | Methods for isolation, purification and characterization of enzymes, tests for homogeneity of enzyme preparation. | 1 |
| 2.5 | Nucleic acids – Structure and function of nucleotides. | 1 |
| 2.6 | Primary, secondary and tertiary structure of nucleic acids. | 1 |
| 2.7 | DNA forms and conformations, Denaturation of DNA. | 1 |
| 3 | **Microbial Metabolism and Biochemistry (8 hours)** | |
| 3.1 | Microbial classification (Bacteria and Fungus) | 1 |
| 3.2 | Bacterial strain typing, | 1 |
| 3.3 | Microscopy - Bright field, Dark field | 1 |
| 3.4 | Phase contrast, Fluorescence microscopy and Confocal microscopy | 1 |

| | | |
|---|---|---|
| 3.5 | Sterilization, nutritional requirements | 1 |
| 3.6 | Growth kinetics of bacteria, media for growing bacteria and fungi | 1 |
| 3.7 | Bacterial toxins – Classification, structure and mode of action of bacterial protein toxins. | 1 |
| 3.8 | Viruses – General structure, properties and classification, phage typing. | 1 |
| 4 | **Cellular Process Technology (8 hours)** | |
| 4.1 | Fundamentals of fermentation technology - Types of Fermentors, | 1 |
| 4.2 | General criteria for fermentor design | 1 |
| 4.3 | Current practices in bioprocess technologies specific design criteria for mammalian cells. | 1 |
| 4.4 | Plant and Microbial systems. | 1 |
| 4.5 | Strategies for fermentation with recombinant organisms. | 1 |
| 4.6 | Anaerobic and anaerobic fermentation processes. | 1 |
| 4.7 | Solid state and submerged fermentation process. | 1 |
| 4.8 | Case study for solid state and submerged fermentation process | 1 |
| 5 | **Bioprocess monitoring (10 hours)** | |
| 5.1 | Bioprocess monitoring - Isolation, characterization and production of secondary metabolites. | 1 |
| 5.2 | Overview of downstream processing: centrifugation, filtration and chromatographic techniques. | 1 |
| 5.3 | Secondary metabolite from - Microbes | 1 |
| 5.4 | Secondary metabolite – Plants and Mammalian cells | 1 |
| 5.5 | Bioprocess monitoring and control: current practices in the bioprocess industries, advanced methodologies. | 1 |
| 5.6 | Production of alcohols, antibiotics, steroids and enzymes | 1 |
| 5.7 | Biotransformation, biomass & production of single cell protein. | 1 |
| 5.8 | Xenobiotics metabolism – Biodegradation xenobiotics by microorganisms, | 1 |

| | | |
|---|---|---|
| 5.9 | Surfactants, polyaromatic hydrocarbons, dyes. | 1 |
| 5.10 | Biodegradation of hydrocarbons, pesticides, role of Cytochrome P450 in detoxification. | 1 |

| 241EBT003 | ENVIRONMENTAL ENGINEERING | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | Program Elective1 | 3 | 0 | 0 | 3 |

**Preamble:** Acquaint the students to design and develop methods for the effective management of waste and protection of environment.

**Pre-requisites**: Nil

**Course Outcomes**

After the completion of the course the student will be able to

| | |
|---|---|
| **CO 1** | Explain water treatment methods. |
| **CO 2** | Explain sources and classification of wastewater |
| **CO 3** | Describe common methods of wastewater treatment. |
| **CO 4** | Explain aerobic and anaerobic biological processes. |
| **CO 5** | Design the management strategies for solid waste management |

**Mapping of course outcomes with program outcomes**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 |
|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | 3 | 2 | 2 | 2 | - | - |
| **CO 2** | - | - | - | 2 | 2 | - | - |
| **CO 3** | 3 | 3 | 2 | 2 | 2 | - | - |
| **CO 4** | 3 | - | 2 | 2 | 2 | - | - |
| **CO 5** | 3 | 3 | 2 | 3 | 2 | - | - |

**Assessment Pattern**

| Bloom's Category | End Semester Examination |
|---|---|
| Apply | 35% |
| Analyse | 50% |
| Evaluate | 15% |
| Create | |

**Mark distribution**

| Total Marks | CIE | ESE | ESE Duration |
|---|---|---|---|
| 100 | 40 | 60 | 2.5 hours |

**Continuous Internal Evaluation Pattern: 40 marks**

Micro/Course based project : 15 marks

Course based /Seminar/Quiz : 15 marks

Test paper, 1 no. : 10 marks

Test paper shall include minimum 80% of the syllabus.

**End Semester Examination Pattern: 60 marks**

The end semester examination will be conducted by the respective College. There will be two parts; Part A and Part B.

Part A will contain 5 numerical/short answer questions with one question from each module; having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions.

Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

**Model Question Paper**

**QP CODE:** **PAGES:**

**Reg No: _____** **Name: _____**

**SAHRDAYA COLLEGE OF ENGINEERING AND TECHNOLOGY**
**FIRST SEMESTER M. TECH DEGREE EXAMINATION, MONTH & YEAR**
**Course Code: 241EBT003**

Max. Marks: 60 Duration: 2.5 hrs.

**Environmental Engineering**

**PART – A**

Answer All the Questions.

One question from each module, having 5 marks for each question.

(5x 5 = 25)

1. Explain the major legislations and policies for the protection of the environment.
2. Describe the various methods used for the determination of organic content in water
3. Explain the difference between the attached growth and suspended growth systems for aerobic treatment of waste water.
4. Explain the sanitary landfill method of solid waste management
5. Explain the control measures used for air pollution

**PART – B**

Minimum one question from each module (Total seven questions)

Answer any five (5 x 7 = 35)

6. Explain the role of environmental engineers in the sustainable development of environment.
7. Explain the precipitation process used in waste water treatment
8. Explain Activated Sludge Process (ASP). Discuss the design aspects of ASP.
9. Discuss the methods for biomedical waste management
10. Explain 5R strategies used for waste minimization.
11. Discuss the methods for biomedical waste management
12. Discuss the ion exchange processes in detail

**********

**SYLLABUS**

**Module 1 (6 hours)**

**Introduction to Environmental Engineering**. Role of environmental engineers, Environmental legislations and regulations. Environmental regulatory bodies and policies. Significance of Environmental engineering in environmental change and sustainable development.

**Module 2 (9 hours)**

**Physico-chemical and Biological properties water**. Determination of organic matter in water-BOD, COD, Dissolved oxygen levels. Microbiology of waste water. Water quality standards, methods used for water conditioning, Precipitation processes, Water softening, Alum treatment and lime soda treatment, Ion-exchange processes, Boiler feed water treatment, Reverse osmosis, Desalination, Membrane purification, Application of nanotechnology for water purification.

**Module 3 (10 hours)**

**Properties of waste water**, Sources of waste water, Waste water sampling and analysis, Wastewater treatment-Stages, Pre-treatment, Primary treatment, Secondary treatment and Tertiary treatment. Pre-treatment methods- Screening, Grit removal, Oil removal, Equalisation, Neutralisation, Coagulation, Flocculation, and Sedimentation. Secondary treatment methods- Aerobic and anaerobic biological processes, Suspended and attached growth systems, activated sludge process (ASP), Design aspects for ASP, Sludge treatment and disposal, Trickling filter, Rotating biological contactors, Aerobic fluidized bed bioreactors. Anaerobic digestion- Stages, Anaerobic fluidized bed bioreactors, Design of Up-flow anaerobic sludge blanket (UASB) reactor. Tertiary treatment- Disinfection, filtration.

**Module 4 (7 hours)**

**Solid waste, sources and classification**. Solid waste management- Sanitary landfill, Incineration, Pyrolysis, Gasification, Composting- aerobic and anaerobic, Vermi-composting. Treatment and management of industrial waste from paper, textile, distillery, dairy and fermentation industries. Hazardous waste, classification and management of hazardous waste. Bio-medical waste-sources, sorting, treatment and disposal of biomedical wastes.

**Module 5 (8 hours)**

**Air pollution. Sources and classification of air pollution**. Environment effects due to air pollution, Control measures for the management of air pollution, Equipment used for air pollution control-settling chambers, cyclone separators, fabric filters, wet scrubbers, Electrostatic separators. Waste minimization strategies- Reduce, reuse and recycle concepts of waste minimization, Zero waste strategies, important aspects of treatment plant designing, Environmental impact assessment. Application of GIS in environmental engineering. Statistical methods and modelling used in environmental engineering

**Course Plan**

| No | Topic | No. of Lectures |
|---|---|---|
| 1 | **Introduction to environmental engineering. Role of environmental engineers (6 hours)** | 1 |
| 1.1 | Environmental legislations and regulations | 1 |
| 1.2 | Environmental regulatory bodies and policies | 2 |
| 1.3 | Significance of Environmental engineering in environmental change and sustainable development. | 2 |
| 2 | **Physico-chemical and biological properties water (9 hours)** | 1 |
| 2.1 | Determination of organic matter in water-BOD, COD, Dissolved oxygen levels | 1 |
| 2.2 | Microbiology of waste water | 2 |
| 2.3 | Water quality standards, methods used for water conditioning | 1 |
| 2.4 | Precipitation processes, Water softening, Alum treatment and lime soda treatment | 1 |
| 2.5 | Ion-exchange processes, Boiler feed water treatment | 1 |
| 2.6 | Reverse osmosis, Desalination, Membrane purification | 1 |
| 2.7 | Application of nanotechnology for water purification. | 1 |
| 3 | **Properties of waste water, Sources of waste water, Waste water sampling and analysis (10 hours)** | 1 |
| 3.1 | Wastewater treatment-Stages, Pre-treatment, Primary treatment, Secondary treatment and Tertiary treatment | 2 |
| 3.2 | Pre-treatment methods- Screening, Grit removal, Oil removal, Equalisation, Neutralisation, Coagulation, Flocculation, and Sedimentation | 1 |
| 3.3 | Secondary treatment methods- Aerobic and anaerobic biological processes, Suspended and attached growth systems | 1 |
| 3.4 | Activated sludge process (ASP), Design aspects for ASP, Sludge treatment and disposal | 1 |

| | | |
|---|---|---|
| 3.5 | Trickling filter, Rotating biological contactors, Aerobic fluidized bed bioreactors | 1 |
| 3.6 | Anaerobic digestion- Stages, Anaerobic fluidized bed bioreactors, | 2 |
| 3.7 | Design of Up-flow anaerobic sludge blanket (UASB) reactor. Tertiary treatment- Disinfection, filtration. | 1 |
| 4 | **Solid waste, sources and classification (7 hours)** | 1 |
| 4.1 | Solid waste management- Sanitary landfill, Incineration, Pyrolysis, Gasification | 1 |
| 4.2 | Composting- aerobic and anaerobic, Vermi-composting | 1 |
| 4.3 | Treatment and management of industrial waste from paper, textile, distillery, dairy and fermentation industries | 2 |
| 4.4 | Hazardous waste, classification and management of hazardous waste | 1 |
| 4.5 | Bio-medical waste-sources, sorting, treatment and disposal of biomedical wastes | 1 |
| 5 | **Air pollution. Sources and classification of air pollution. Environment effects due to air pollution (8 hours)** | 1 |
| 5.1 | Control measures for the management of air pollution, Equipments used for air pollution control-settling chambers, cyclone separators, fabric filters, wet scrubbers, Electrostatic separators | 1 |
| 5.2 | Waste minimization strategies- Reduce, reuse and recycle concepts of waste minimization, Zero waste strategies | 1 |
| 5.3 | Important aspects of treatment plant designing, Environmental impact assessment | 2 |
| 5.4 | Application of GIS in environmental engineering | 2 |
| 5.5 | Statistical methods and modelling used in environmental engineering | 1 |

**Reference Books**

1. Susan J Masten., “Principles of Environmental Engineering and Science”, McGraw-Hill Higher Education, 2004.
2. Metcalf and Eddy., “Wastewater Engineering, Treatment and Reuse”, Tata McGraw Hill, New Delhi, 2003.
3. C S Rao., “Environmental Pollution Control Engineering”, New Age International, 2007.

4. W W Nazaroff, Lisa Alvarez-Cohen., “Environmental Engineering Science”, Wiley, 2001.
5. Sawyer C N, McCarty P L, Parkin G F., “Chemistry for Environmental Engineering”, Tata McGraw-Hill, New Delhi, 2003.

| 241EBT004 | ENZYME ENGINEERING AND TECHNOLOGY | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | Program Elective 1 | 3 | 0 | 0 | 3 |

**Preamble:**

Enzymes, also called biocatalysts, are widely used in various industrial applications, especially in the manufacturing of bulk chemicals and pharmaceuticals. Enzyme engineering is the process of improving the efficiency of an already available enzyme or the formulation of an advanced enzyme activity by altering its amino acid sequence or biochemical reaction rates . This subject allows one to gain a better awareness of how the structure of an enzyme influences its properties and a better interpretation of the many engineering aspects.

**Pre-requisites**: Nil

**Course Outcomes:**

After the completion of the course the student will be able to

| | |
|---|---|
| **CO 1** | Analyse the structure and properties of an enzyme |
| **CO 2** | Evaluate the kinetics and mechanism of enzyme mediated reactions |
| **CO 3** | Quantify bio-catalytic reactions using enzyme assays |
| **CO 4** | Examine the regulatory mechanisms for mediating enzyme activity |
| **CO 5** | Apply bio-catalytic mechanisms for practical applications |

**Mapping of course outcomes with program outcomes**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 |
|---|---|---|---|---|---|---|
| **CO 1** | 2 | 2 | 2 | 2 | 2 | 2 |
| **CO 2** | 2 | 3 | 2 | 2 | 2 | 2 |
| **CO 3** | 2 | 3 | 3 | 3 | 2 | 3 |
| **CO 4** | 2 | 2 | 2 | 2 | 2 | 2 |
| **CO 5** | 2 | 2 | 2 | 3 | 2 | 3 |

**Assessment Pattern**

| Bloom's Category | End Semester Examination |
|---|---|
| Apply | 10 |
| Analyse | 20 |
| Evaluate | 60 |
| Create | 10 |

**Mark distribution**

| Total Marks | CIE | ESE | ESE Duration |
|---|---|---|---|
| 100 | 40 | 60 | 2.5 hours |

**Continuous Internal Evaluation Pattern: 40 marks**

Micro/Course based project : 15 marks

Course based /Seminar/Quiz : 15 marks

Test paper, 1 no. : 10 marks

Test paper shall include minimum 80% of the syllabus.

**End Semester Examination Pattern: 60 marks**

The end semester examination will be conducted by the respective College. There will be two parts; Part A and Part B.

Part A will contain 5 numerical/short answer questions with one question from each module; having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions.

Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

**Model Question Paper**

**QP CODE:** **PAGES:**

**Reg No: _____** **Name: _____**

**SAHRDAYA COLLEGE OF ENGINEERING AND TECHNOLOGY**
**FIRST SEMESTER M. TECH DEGREE EXAMINATION, MONTH & YEAR**
**Course Code: 241EBT004**

Max. Marks: 60 Duration: 2.5 hrs.

**Enzyme Engineering and Technology**

**PART – A**

Answer All the Questions.

One question from each module, having 5 marks for each question.

(5x 5 = 25)

1. Give a brief account on the nomenclature and classification of enzymes
2. Discuss the significance of MM kinetic constants
3. Signify the importance of Zymography and the use of isotopes in enzyme assays
4. What is Damkohler Number? Explain its significance.
5. Signify the importance of genetic engineering in enzyme technology

**PART – B**

Minimum one question from each module.Answer any five (5 x 7 = 35)

6. (a) Elaborate the proximity and orientation effects in enzymes
   (b) Explain the various interactions that assist biocatalysis using enzymes
7. (a) Discuss the linear plots of MM equation.
   (b) Describe the various mechanisms involved in an enzyme catalysed reaction
8. Describe the principle of any purification technique used industrially for enzyme purification. Also, provide details on interpreting purification using databases.
9. Discuss the industrial and pharmaceutical perspectives of Inhibition, Cooperation and Allostery with suitable examples
10. What are synthetic enzymes? Explain the prospects of the same in diagnostic applications
11. Aspergillus sp is a common fungal source used for enzyme synthesis"- Substantiate the statement and provide a brief overview of the isolation procedures
12. What are synthetic enzymes? Explain the prospects of the same in diagnostic applications

**********

## SYLLABUS

**MODULE 1 (8 hours)**

**Enzyme Catalysis- A Perspective**: Enzyme Nomenclature and Classification; Enzyme Specificity; Origins of enzyme catalytic power- proximity and orientation effects, role of electrostatics and metal ions, acid-base and covalent catalysis, transition state binding and stabilization; Enzyme structure and catalysis- basics, structural motif vs domain, Ramachandran Plot, SCOP structural Classification and CATH Database.

**MODULE 2 (6 hours)**

**Enzyme Kinetics and Measurements**: MM Kinetics and Linear transforms of MM Kinetics; Significance of MM Constants; Investigating Enzyme mechanisms through kinetics; Deriving rate equations for complex equilibria- Algebraic Method, King Altman Procedure, Net Rate Constant Method, Other Methods; Assigning Kinetic Mechanisms- Ordered, Random and Ping Pong Mechanisms.

**MODULE 3 (10 hours)**

**Quantification of Catalysis**: Enzyme Units, Specific Activity, Turn over number; Fungi, bacteria and Plants as sources for enzyme; Enzyme Purification and Characterization; Interpreting a purification Table- Criteria of Enzyme Purity; Enzyme Assays- Detection and Estimation Methods; Isotopes in Enzymology; Zymography

**MODULE 4 (8 hours)**

**Regulation of Enzyme Activity**: Industrial and pharmaceutical perspectives of Inhibition, Cooperation, Allostery, Iso-enzymes and covalent modifications; ; Kinetics of Enzyme Inhibition; Enzyme Deactivation; Mass Transfer Effects: Diffusion, crowding and Enzyme Efficiency.

**MODULE 5 (8 hours)**

**Applied Biocatalysis**: Applications in medicine-diagnostic enzymes, therapeutic enzymes, Enzymes as reagents in clinical chemistry, Enzymes and inborn errors, Industrial applications of enzymes; Applications in genetic engineering/ gene editing. Synthetic Enzyme: Ribozymes, Catalytic antibodies, Enzyme engineering (Protein engineering). Enzyme Immobilization; Immobilization of enzymes and their applications, Kinetics of immobilized enzymes. Biosensors

**Course Plan**

| No | Topic | No. of Lectures |
|---|---|---|
| 1 | **Enzyme Catalysis- A Perspective ( 8hours)** | |
| 1.1 | Enzyme Nomenclature and Classification; Enzyme Specificity | 2 |
| 1.2 | Catalysis: proximity and orientation effects | 2 |
| 1.3 | Role of electrostatics and metal ions, acid-base and covalent catalysis, transition state binding basics, structural motif vs domain and stabilization | 2 |
| 1.4 | Ramachandran Plot, SCOP structural Classification and CATH Database. | 2 |
| 2 | **Enzyme Kinetics and Measurements ( 6 hours)** | |
| 2.1 | MM Kinetics and Linear transforms of MM Kinetics; Significance of MM Constants | 2 |
| 2.2 | Deriving rate equations for complex equilibria- Algebraic Method, King Altman Procedure, Net Rate Constant Method, Other Methods | 2 |
| 2.3 | Assigning Kinetic Mechanisms- Ordered, Random and Ping Pong Mechanism | 2 |
| 3 | **Quantification of Catalysis (10 hours)** | |
| 3.1 | Enzyme Units, Specific Activity, Turn over number | 2 |
| 3.2 | Fungi, bacteria and Plants as sources for enzyme | 2 |
| 3.3 | Enzyme Purification and Characterization; Interpreting a purification Table- Criteria of Enzyme Purity | 2 |
| 3.4 | Enzyme Assays- Detection and Estimation Methods; | 2 |
| 3.5 | Isotopes in Enzymology; Zymography | 2 |
| 4 | **Regulation of Enzyme Activity (8 hours)** | |
| 4.1 | Kinetics of Enzyme Inhibition- Industrial and pharmaceutical perspectives of Inhibition | 2 |

| | | |
|---|---|---|
| 4.2 | Cooperation, Allostery, Isoenzymes and covalent modifications | 2 |
| 4.3 | Enzyme Deactivation And Kinetics | 2 |
| 4.4 | Mass Transfer Effects: Diffusion, crowding and Enzyme Efficiency. | 2 |
| 5 | **Applied Biocatalysis (8 hours)** | |
| 5.1 | Applications in medicine-diagnostic enzymes, therapeutic enzymes, Enzymes as reagents in clinical chemistry, | 2 |
| 5.2 | Industrial applications of enzymes; Applications in genetic engineering/ gene editing | 2 |
| 5.3 | Synthetic Enzyme: Ribozymes, Catalytic antibodies, Enzyme engineering (Protein engineering). | 1 |
| 5.4 | Immobilization; Immobilization of enzymes and their applications | 1 |
| 5.5 | Biosensors | 2 |

**Reference Books**

1. S. M. Bhatt., "Enzymology and Enzyme Technology", 2011.
2. N.S. Punekar., "ENZYMES: Catalysis, Kinetics and Mechanisms", 2018.
3. Modern Biocatalysis Advances towards Synthetic Biological Systems- 2018

| | | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| **241EBT005** | **APPLIED BIOSTATISTICS** | **Program Elective1** | **3** | **0** | **0** | **3** |

**Preamble:** To impart basic concepts of probability and statistical techniques for applying hypothesis in real life problems

**Pre-requisites**: Nil

**Course Outcome**: After the completion of the course the student will be able to

| | |
|---|---|
| **CO 1** | Understand the basic concepts of probability |
| **CO 2** | Apply probability distribution in their field |
| **CO 3** | Use statistical techniques for analysing biological data |
| **CO 4** | Apply the hypothesis test in real life problems |
| **CO 5** | Use various technique of ANOVA in bio statistics |

**Mapping of course outcomes with program outcomes**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 |
|---|---|---|---|---|---|---|---|
| **CO 1** | - | - | - | 2 | 2 | - | - |
| **CO 2** | 2 | - | - | 2 | - | 2 | - |
| **CO 3** | 3 | 2 | 2 | 2 | - | - | - |
| **CO 4** | - | - | - | 3 | - | - | - |
| **CO 5** | - | - | - | 2 | - | - | - |

**Assessment Pattern**

| Bloom's Category | End Semester Examination |
|---|---|
| Apply | 35% |
| Analyse | 50% |
| Evaluate | 15% |

| | |
|---|---|
| Create | |

**Mark distribution**

| **Total Marks** | **CIE** | **ESE** | **ESE Duration** |
|---|---|---|---|
| 100 | 40 | 60 | 2.5 hours |

**Continuous Internal Evaluation Pattern: 40 marks**

Micro/Course based project : 15 marks

Course based /Seminar/Quiz : 15 marks

Test paper, 1 no. : 10 marks

Test paper shall include minimum 80% of the syllabus.

**End Semester Examination Pattern: 60 marks**

The end semester examination will be conducted by the respective College. There will be two parts; Part A and Part B.

Part A will contain 5 numerical/short answer questions with one question from each module; having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions.

Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

**Model Question Paper**

**QP CODE:** **PAGES:**

**Reg No: _____** **Name: _____**

**SAHRDAYA COLLEGE OF ENGINEERING AND TECHNOLOGY**
**FIRST SEMESTER M. TECH DEGREE EXAMINATION, MONTH & YEAR**
**Course Code: 241EBT005**
**Applied Biostatistics**

Max. Marks: 60 Duration: 2.5 hrs.

**PART – A**

Answer All the Questions.

One question from each module, having 5 marks for each question.

(5x 5 = 25)

1. A random variable X has the following probability distribution

| X | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|
| P(x) | a | 3a | 5a | 7a | 9a | 11a | 13a | 15a | 17a |

i) Determine the value of "a" ii) $p(x<3)$ iii) $P(2\leq X<5)$ iv) what is the smallest value of x for which $P(x \leq x) > 0.5$

2. Telephone calls arrive at an exchange according to the Poisson process at a rate $\lambda = 2$/min. Calculate the probability that exactly two calls will be received during each of the first 5 minutes of the hour.
3. Two random variables have the regression lines with equations $3x + 2y = 26$ and $6x + y = 31$. Find the mean values and the corelation coefficient between X & Y
4. 4A coin was tossed 400 times and returned heads 216 times. Test the hypothesis that the coin is unbiased
5. What are the assumptions underlying ANOVA. Discuss its uses

**PART – B**

Minimum one question from each module (Total seven questions)

Answer any five (5 x 7 = 35)

6. A die is tossed twice. A success is "getting 1 or 6" on a toss. Find the mean and variance of the number of successes
7. The mileage which car owners get with a certain kind of radial tire is a random variable having an exponential distribution with mean 20,000 KMS. Find the probability that one of these tires will last i) at least 10,000 KMS ii) Atmost 10,000 KMS

8. Fit the curve of the form $Y = AB^x$ for the following data

| X | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| Y | 8.3 | 15.4 | 33.1 | 65.2 | 127.4 |

9. Find the coefficient of correlation for the following data

| X | 10 | 14 | 18 | 22 | 26 | 30 |
|---|---|---|---|---|---|---|
| Y | 18 | 12 | 24 | 6 | 30 | 36 |

10. A random sample of size 16 has 53 as mean. The sum of squares of the deviation from the mean is 135. Can this sample be regarded as taken from the population having 56 as mean? Use t- test with level of significance 5 %
11. The following table gives the number of accidents in a city during a week. Find whether the accidents are uniformly distributed over a week.

| **Day** | **Sun** | **Mon** | **Tue** | **Wed** | **Thu** | **Fri** | **Sat** | **Total** |
|---|---|---|---|---|---|---|---|---|
| No. of Accident | 13 | 15 | 9 | 11 | 12 | 10 | 14 | 84 |

12. The three drying techniques for curing a glue were studied and the following times were obtained:

| Formula A | 13 | 10 | 8 | 11 | 8 | |
|---|---|---|---|---|---|---|
| Formula B | 13 | 11 | 14 | 14 | | |
| Formula C | 4 | 1 | 3 | 4 | 2 | 4 |

At $\alpha = 0.001$, test the hypothesis that the average times for the three formulas are same

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## SYLLABUS

**Module I (8 hours)**

**Probability & Random Variables:** Sample spaces – Events - Axiomatic approach to probability - conditional probability - addition theorem - Multiplication theorem - Random variables - discrete and continuous - Distribution function - Expectation with properties – Mean – Variance.

**Module II (8 hours)**

**Standard Distributions**: Discrete Distribution-Binomial, Poisson And Geometric Distribution-Continuous Distribution-Exponential, Gamma And Normal Distribution - Simple Properties - Bivariate Distribution - Conditional And Marginal Distribution

**Module III (8 hours)**

**Correlation, Regression & Curve Fitting:** Correlation coefficient - Properties - Rank correlation - Regression equations - curve fitting by the method of least squares - fitting curves of the - ax+b, ax^2 +bx+c, ab^x and ax^b - Bivariate correlation- application to biotechnologists

**Module IV (8 hours)**

**Testing of Hypothesis:** Concept of sampling - Methods of sampling - sampling distributions and Standard Error - Small samples and large samples - Test of hypothesis - Type I, Type II Errors - Critical region - large sample tests for proportion and mean - Exact test based on normal, t, F and chi-square distribution -Test for goodness of fit.

**Module V (8 hours)**

**Design of Experiments**: Basic principles of experimentation - Analysis of variance - one-way, Two-way classifications- Randomized block design and Latin square design

**Course Plan**

| No | Topic | No. of Lectures |
|---|---|---|
| 1 | **Probability & Random Variables (8 hours)** | |
| 1.1 | Sample spaces- Events | 1 |
| 1.2 | Axiomatic approach to probability | 1 |
| 1.3 | Conditional probability | 1 |
| 1.4 | Addition theorem, multiplication theorem | 1 |
| 1.5 | Random Variables, discrete and continuous | 1 |
| 1.6 | Distribution function, Expectation with properties | 1 |
| 1.7 | Mean | 1 |
| 1.8 | Variance | 1 |
| 2 | **Standard Distributions (8 hours)** | |
| 2.1 | Discrete Distribution | 1 |
| 2.2 | Binomial, Poisson and Geometric Distribution- | 2 |
| 2.3 | Continuous Distribution-Exponential, | 1 |
| 2.4 | Gamma And Normal Distribution | 1 |
| 2.5 | Simple Properties | 1 |
| 2.6 | Bivariate Distribution | 1 |
| 2.7 | Conditional And Marginal Distribution | 1 |
| 3 | **Correlation, Regression & Curve Fitting (8 hours)** | |
| 3.1 | Correlation coefficient - Properties | 1 |
| 3.2 | Rank correlation | 1 |
| 3.3 | Regression equations | 1 |

| | | |
|---|---|---|
| 3.4 | Curve fitting by the method of least squares | 1 |
| 3.5 | Fitting curves of the form ax+b | 1 |
| 3.6 | Fitting curves of the form $ax^2+bx+c$ $ab^x$ | 1 |
| 3.7 | Fitting curves of the form $ax^b$ - | 1 |
| 3.8 | Bivariate correlation- application to bíotechnologists | 1 |
| 4 | **Testing of Hypothesis (8 hours)** | |
| 4.1 | Concept of sampling | 1 |
| 4.2 | Methods of sampling - sampling distributions and Standard Error | 2 |
| 4.3 | Small samples and large samples | 1 |
| 4.4 | Test of hypothesis - Type I, Type II Errors - | 1 |
| 4.5 | Critical region - large sample tests for proportion and mean - | 1 |
| 4.6 | Exact test based on normal, t, F and chi-square distribution | 1 |
| 4.7 | Test for goodness of fit. | 1 |
| 5 | **Design of Experiments (8 hours)** | |
| 5.1 | Basic principles of experimentation | 1 |
| 5.2 | Analysis of variance - one-way, | 2 |
| 5.3 | Analysis of variance - Two-way classifications | 2 |
| 5.4 | Randomized block design | 1 |
| 5.5 | Latin square design | 2 |

**Reference Book**

1. Gupta. S.C and Kapoor, V. K., “Fundamentals of Mathematical Statistics”, S. Chand & Sons.11th Edition, 2018.
2. Vittal, P.R. and V.Malini.,”Statistical and Numerical Methods”. Margam Publications, 1st Edition, 2012.

3. Rohatgi. V. K., “An Introduction to Probability and Statistics”. 3 rd Edition, John Wiley & Sons, 2015.
4. Johnson, R. A., “Miller & Freund’s Probability and Statistics for Engineers”. PHI, 8th Edition, 2011.
5. Arora, P. N. Smeet Arora, and Arora., S. “Comprehensive Statistical Methods”. S. Chand & Co, 2nd Edition, 2007.
6. Spiegel, Murray R., Schiller J and R. Alu Srinivasan.,”Schaum’s Outlines Probability and Statistics”, Tata McGraw- Hill, 4th Edition, 2012

| 241EBT006 | IMMUNOTECHNOLOGY AND MOLECULAR DIAGNOSTICS | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | Program Elective2 | 3 | 0 | 0 | 3 |

**Preamble:**

To study the different aspects of immunotechnology. To analyse various disease diagnostic techniques and its applications.

**Pre-requisites**: Nil

**Course Outcomes**: After the completion of the course, the student will be able to

| | |
|---|---|
| **CO 1** | To gain in depth knowledge in basics of immunology, immunotechnology and its applications. |
| **CO 2** | learn various immunotechniques |
| **CO 3** | Learn various Diagnostics and Traditional disease diagnosis methods |
| **CO 4** | Apply the knowledge of diagnostic molecular biology principles which are used in research and diagnostic laboratories, and perform quality assurance in the molecular diagnostic laboratory. |

**Mapping of course outcomes with program outcomes**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 |
|---|---|---|---|---|---|---|---|
| **CO 1** | 2 | 2 | 2 | - | - | - | - |
| **CO 2** | 2 | 2 | - | - | 2 | 2 | - |
| **CO 3** | 3 | 3 | 2 | - | 2 | 2 | 2 |
| **CO 4** | 3 | 3 | 2 | - | 2 | 2 | 2 |

**Assessment Pattern**

| Bloom's Category | End Semester Examination |
|---|---|
| Apply | 20% |
| Analyse | 30% |
| Evaluate | 50% |
| Create | |

**Mark distribution**

| Total Marks | CIE | ESE | ESE Duration |
|---|---|---|---|
| 100 | 40 | 60 | 2.5 hours |

**Continuous Internal Evaluation Pattern: 40 marks**

Micro/Course based project : 15 marks

Course based /Seminar/Quiz : 15 marks

Test paper, 1 no. : 10 marks

Test paper shall include minimum 80% of the syllabus.

**End Semester Examination Pattern: 60 marks**

The end semester examination will be conducted by the respective College. There will be two parts; Part A and Part B.

Part A will contain 5 numerical/short answer questions with one question from each module; having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions.

Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

**Model Question Paper**

**QP CODE:** **PAGES:**

**Reg No: _____** **Name: _____**

**SAHRDAYA COLLEGE OF ENGINEERING AND TECHNOLOGY**
**FIRST SEMESTER M. TECH DEGREE EXAMINATION, MONTH & YEAR**
**Course Code: 241EBT006**

Max. Marks: 60 Duration: 2.5 hrs.

**Immuno Technology and Molecular Diagnostics**

**PART – A**

Answer All the Questions.

One question from each module, having 5 marks for each question.

(5x 5 = 25)

1. Illustrate the structure and the function of Immunoglobulins.
2. Briefly explain about the design of antibody libraries for immunotherapy.
3. Explain the Diagnosis of infectious diseases caused by protozoa and Helminthes.
4. Write a note on Monoclonal antibodies as diagnostic reagents.
5. Illustrate two-dimensional gene scanning.

**PART – B**

Minimum one question from each module (Total seven questions)

Answer any five (5 x 7 = 35)

6. Explain the process of maturation, activation and differentiation of B cell and T cell.
7. Describe the principle of immunoassays.
8. Elaborate on the treatment and management of genetic disorders.
9. Explain the diagnosis of infectious diseases by using ELISA and Western blot.
10. Comment on Cancer biomarkers.
11. Elaborate on current issues and opportunities in the diagnostic sector.
12. Explain the application of PCR for diagnosis of infectious diseases.

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## SYLLABUS

**Module 1 (10 hours)**

**Introduction to Immunology**: Fundamental concepts and overview of the immune system Components of innate and acquired immunity; Innate immune cells and functions. Major Histocompatibility Complex Organs of immune system, primary and secondary lymphoid organs. Immunoglobulins, B-cell receptor, B cell and T cell maturation, activation and differentiation; cell-mediated immune responses, antigen processing and presentation, Adaptive immune system and response, antigen-antibody interactions.

**Module 2 (8 hours)**

**Immunotechnology**: Principles of immunization, Vaccine development, Immunotherapy, Development of monoclonal antibodies, Gene editing technology in designing antibody, Designing antibody library for immunotherapy. Immunoassays Types [RIA, ELISA, Chemiluminescent IA, FIA] and specific applications; Immunoelectrophoresis - Principles and techniques Immunohistochemistry – principle and techniques.

**Module 3 (6 hours)**

**Introduction to Diagnostics and Traditional disease diagnosis methods**: Introduction and History of diagnostics of diseases, mode of infection, types of infectious diseases, philosophy and general approach to clinical specimens. Diagnosis of infectious diseases caused by bacteria, fungi, viruses, protozoa and Helminthes. Disease identification and Genetic tests of disorders; Population screening for genetic disorders; Treatment and management of genetic disorders.

**Module 4 (7 hours)**

**Molecular Techniques for diagnosis**: DNA sequencing and diagnosis , Theoretical background of development of PCR and Real time PCR and its variations, application of PCR for diagnosis of infectious diseases . Present methods for diagnosis of Specific diseases like Tuberculosis, Malaria and AIDS. Monoclonal antibodies as diagnostic reagents. Diagnosis of infectious diseases by using ELISA and Western blot.

**Module 5 (9 hours)**

**Array based techniques in diagnosis (DNA & Protein array):** Single nucleotide polymorphism and disease association; Two-dimensional gene scanning. Cancer biomarkers. Diagnostic technology based on biosensors and nanotechnology. Ethics in Molecular Diagnosis. Current issues and opportunities in the diagnostic sector.

**Course Plan**

| No | Topic | No. of Lectures |
|---|---|---|
| 1 | **Introduction to Immunology (10 hours)** | |
| 1.1 | Fundamental concepts and overview of the immune system | 1 |
| 1.2 | Components of innate and acquired immunity; Innate immune cells and functions. | 1 |
| 1.3 | Major Histocompatibility Complex Organs of immune system, primary and secondary lymphoid organs. | 2 |
| 1.4 | Immunoglobulins | 1 |
| 1.5 | B-cell receptor, B cell and T cell maturation, activation and differentiation | 2 |
| 1.6 | Cell-mediated immune responses | 1 |
| 1.7 | Antigen processing and presentation | 1 |
| 1.8 | Adaptive immune system and response, antigen-antibody interactions. | 1 |
| 2 | **Immunotechnology (8 hours)** | |
| 2.1 | Principles of immunization | 1 |
| 2.2 | Vaccine development | 2 |
| 2.3 | Development of monoclonal antibodies | 1 |
| 2.4 | Gene editing technology in designing antibody, Designing antibody library for immunotherapy | 1 |
| 2.5 | Immunotherapy, Immunoelectrophoresis - Principles and techniques Immunohistochemistry – principle and techniques | 1 |
| 2.6 | Immunoassays Types [RIA, ELISA, Chemiluminescent IA, FIA] and specific applications; | 2 |
| 3 | **Introduction to Diagnostic sand Traditional disease diagnosis methods (6 hours)** | |
| 3.1 | Introduction and History of diagnostics of diseases, mode of infection, types of infectious diseases | 1 |
| 3.2 | philosophy and general approach to clinical specimens | 1 |
| 3.3 | Diagnosis of infectious diseases caused by bacteria, fungi, viruses, protozoa and Helminthes. | 1 |

| | | |
|---|---|---|
| 3.4 | Disease identification and Genetic tests of disorders | 2 |
| 3.5 | Population screening for genetic disorders; Treatment and management of genetic disorders | 1 |
| 4 | **Molecular Techniques for diagnosis (7 hours)** | |
| 4.1 | DNA sequencing and diagnosis, Theoretical background of development of PCR and Real time PCR and its variations | 2 |
| 4.2 | Application of PCR for diagnosis of infectious diseases | 1 |
| 4.3 | Present methods for diagnosis of Specific diseases like Tuberculosis, Malaria and AIDS. | 1 |
| 4.4 | Monoclonal antibodies as diagnostic reagents | 2 |
| 4.5 | Diagnosis of infectious diseases by using ELISA and Western blot | 1 |
| 5 | **Array based techniques in diagnosis (DNA & Protein array) (9 hours)** | |
| 5.1 | Single nucleotide polymorphism and disease association | 1 |
| 5.2 | Two-dimensional gene scanning. | 1 |
| 5.3 | Cancer biomarkers. | 2 |
| 5.4 | Diagnostic technology based on biosensors and nanotechnology. | 2 |
| 5.5 | Ethics in Molecular Diagnosis. | 2 |
| 5.6 | Current issues and opportunities in the diagnostic sector. | 1 |

**Reference Books**


1. 1. Immunology, Richard A. Goldsby, Thomas J. Kindt. Barbara, A. Osborne, Janis Kuby 5th Edition, 2003. W. H. Freeman & Company.
2. 2. Immunology, L.M. Roitt, J. Brestoff and D.K. Male, 1996.
3. 3. Elles R &Mountford R. 2004. Molecular Diagnosis of Geneti Disease. Humana Press.
4. 4. Rao JR, Fleming CC & Moore JE. 2006. Molecular Diagnostics Horizon Bioscience.
5. 5. Andrew Read and Dian Donnai, New clinical Genetics, Scion Publishing Ltd, Oxfordshire, UK, 2007. 6. James W Goding, Monoclonal antibodies: Principles and Practice, 3rd Edition, Academic Press, 1996.

| 241EBT007 | ADVANCED BIOANALYTICAL TECHNIQUES | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | Program Elective 2 | 3 | 0 | 0 | 3 |

**Preamble:**

To acquire knowledge on processing, analysis and interpretations of samples with the help of various analytical instruments.

**Pre-requisites**: Nil

**Course Outcomes**: After the completion of the course, the student will be able to

| | |
|---|---|
| **CO 1** | Familiar with working principle, instrumentation and operation of analytical techniques. |
| **CO 2** | Understand the requirements for successful operations of analytical techniques. |
| **CO 3** | Able to select suitable analytical technique for case studies. |
| **CO 4** | Apply principles of various analytical devices in research and enhance problem solving techniques. |

**Mapping of course outcomes with program outcomes**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 |
|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | 1 | 1 | 2 | 2 | - | - |
| **CO 2** | 3 | - | 1 | 2 | 2 | - | - |
| **CO 3** | 3 | 3 | - | 3 | - | - | - |
| **CO 4** | 3 | 2 | 2 | 3 | 3 | - | - |

**Assessment Pattern**

| Bloom's Category | End Semester Examination |
|---|---|
| Apply | 50% |
| Analyse | 35% |
| Evaluate | 15% |
| Create | |

**Mark distribution**

| Total Marks | CIE | ESE | ESE Duration |
|---|---|---|---|
| | | | |

| | | | |
|---|---|---|---|
| 100 | 40 | 60 | 2.5 hours |

**Continuous Internal Evaluation Pattern: 40 marks**

Micro/Course based project : 15 marks

Course based /Seminar/Quiz : 15 marks

Test paper, 1 no. : 10 marks

Test paper shall include minimum 80% of the syllabus.

**End Semester Examination Pattern: 60 marks**

The end semester examination will be conducted by the respective College. There will be two parts; Part A and Part B.

Part A will contain 5 numerical/short answer questions with one question from each module; having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions.

Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

**Model Question Paper**

**QP CODE:** **PAGES:**

**Reg No: _____** **Name: _____**

**SAHRDAYA COLLEGE OF ENGINEERING AND TECHNOLOGY**
**FIRST SEMESTER M. TECH DEGREE EXAMINATION, MONTH & YEAR**
**Course Code: 241EBT007**

Max. Marks: 60 Duration: 2.5 hrs.

**Advanced Bioanalytical Techniques**

**PART – A**

Answer All the Questions.

One question from each module, having 5 marks for each question.

(5x 5 = 25)

1. Discuss the relevance of bioassay techniques in today's scenario with any two examples
2. Explain the mechanism of high-resolution imaging in thick tissues by confocal microscopy
3. Explain the steps involved to compare two samples using IR spectrum with an example.
4. Distinguish between FISH and GISH for chromosomal studies.
5. Discuss the application of tandem LC-MS in biomedical applications.

**PART – B**

Minimum one question from each module (Total seven questions)

Answer any five (5 x 7 = 35)

6. Explain the basic steps involved in sample preparation for a bioanalytical technique.
7. Elaborate the working of TEM for the analysis of cellular organisation and structure.
8. Explain the application of UV-Visible spectroscopy for structural elucidation of organic molecules.
9. How do you separate protein based on their isoelectric point? Explain the technique behind.
10. Elaborate the instrumentation of flash column chromatography for the purification of chemical mixtures.
11. Differentiate horizontal and vertical gel electrophoresis. Discuss the application of both.
12. Biological specimens has to be processed heavily for SEM analysis. Explain.

*******

## SYLLABUS

**Module 1 (6 hours)**

**Introduction and separation techniques**: Introduction to bioanalytical techniques. Modern approaches in bioanalysis and bioassays. Preparation of samples for bioanalysis. Advanced separation techniques: Methods of separation of cells and their organelles, modern centrifugation methods.

**Module 2 (7 hours)**

**Microscopic techniques:** Light microscopy, Fluorescence microscopy, Confocal microscopy, atomic force microscopy (AFM), Electron microscopy-scanning electron microscopy (SEM) and transmission electron microscopy (TEM). Application of microscope in analysing biological samples.

**Module 3 (8 hours)**

**Spectroscopic techniques:** UV-Visible spectroscopy, Fluorescence spectroscopy, IR spectroscopy, CD spectroscopy, NMR- determination of macromolecular structure by NMR – magnetic resonance imaging, Mass spectroscopy.

**Module 4 (10 hours)**

**Electrophoretic Techniques:** Electrophoresis- horizontal and vertical gel electrophoresis, Electrophoresis of nucleic acids (Agarose gel, pulse-field), Electrophoresis of proteins (SDS-PAGE, native gels) isoelectric focusing and two-dimensional gels, Blotting Techniques-Southern, Northern, Western blotting. FISH and GISH, application of electrophoresis in analysing macromolecules.

**Module 5 (9 hours)**

**Chromatographic techniques:** Principle and types, HPLC, GLC, flash chromatography and HPTLC. Advances in tandem LC-MS and GC-MS techniques. Applications of chromatography in bioanalysis.

**Course Plan**

| No | Topic | No. of Lectures |
|---|---|---|
| 1 | **Introduction and separation techniques (6 hours)** | |
| 1.1 | Introduction to bioanalytical techniques | 1 |
| 1.2 | Modern approaches in bioanalysis and bioassays | 1 |
| 1.3 | Preparation of samples for bioanalysis | 1 |
| 1.4 | Advanced separation techniques | 1 |
| 1.5 | Methods of separation of cells and their organelles | 1 |
| 1.6 | Modern centrifugation methods | 1 |
| 2 | **Microscopic techniques (7 hours)** | |
| 2.1 | Light microscopy | 1 |
| 2.2 | Fluorescence microscopy | 1 |
| 2.3 | Confocal microscopy | 1 |
| 2.4 | Atomic force microscopy (AFM) | 1 |
| 2.5 | Electron microscopy-scanning electron microscopy (SEM) and transmission electron microscopy (TEM) | 2 |
| 2.6 | Application of microscope in analysing biological samples | 1 |
| 3 | **Spectroscopic techniques (8 hours)** | |
| 3.1 | UV-Visible spectroscopy | 1 |
| 3.2 | Fluorescence spectroscopy | 1 |
| 3.3 | IR spectroscopy | 1 |
| 3.4 | CD spectroscopy | 1 |
| 3.5 | NMR | 1 |
| 3.6 | Determination of macromolecular structure by NMR | 1 |
| 3.7 | Magnetic resonance imaging | 1 |
| 3.8 | Mass spectroscopy | 1 |
| 4 | **Electrophoretic Techniques (10 hours)** | |
| 4.1 | Electrophoresis- horizontal and vertical gel electrophoresis | 1 |
| 4.2 | Electrophoresis of nucleic acids (Agarose gel, pulse-field) | 1 |
| 4.3 | Electrophoresis of proteins (SDS-PAGE, native gels) | 1 |

| | | |
|---|---|---|
| 4.4 | isoelectric focusing and two-dimensional gels | 1 |
| 4.5 | Blotting Techniques | 1 |
| 4.6 | Southern Blotting | 1 |
| 4.7 | Northern Blotting | 1 |
| 4.8 | Western blotting | 1 |
| 4.9 | FISH and GISH | 1 |
| 4.10 | application of electrophoresis in analysing macromolecules | 1 |
| 5 | **Chromatographic techniques (9 hours)** | |
| 5.1 | Principle and types | 1 |
| 5.2 | HPLC | 1 |
| 5.3 | GLC | 1 |
| 5.4 | flash chromatography | 1 |
| 5.5 | HPTLC | 2 |
| 5.6 | Advances in tandem LC-MS and GC-MS techniques | 2 |
| 5.7 | Applications of chromatography in bioanalysis | 1 |

**Reference Books**


1. Keith Wilson and John Walker, *Principles and techniques of biochemistry and molecular biology*, 7th Edition, Cambridge University Press, Cambridge, UK 2, 2009.
2. R. Katoch, *Analytical techniques in biochemistry and molecular biology*, Springer, New York, 2011.
3. D. L.Spector and R. D. Goldman, *Basic Methods in Microscopy,Protocols and concepts from cells:A Laboratory Manual*, , Cold Spring Harbor Laboratory Press, 2006.
4. A. Manz, N.Pamme and D. Iossifidis, *Bioanalytical Chemistry*, World Scientific Publishing Company, 2004.
5. Rodney F Boyer, *Biochemistry laboratory: modern theory and techniques,* 2nd Edition, Pearson Prentice Hall, Boston,USA, 2012.

| 241EBT008 | MATHEMATICAL APPLICATIONS IN BIOTECHNOLOGY | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | Program Elective 2 | 3 | 0 | 0 | 3 |

**Preamble:**

Knowledge of bioprocess principles.

**Pre-requisites**: Nil

**Course Outcomes**: After the completion of the course, the student will be able to

| | |
|---|---|
| **CO 1** | Model simple systems related to biological field and solve using ordinary differentiation equation technique |
| **CO 2** | Develop the model in the biological field and solve using the partial differential method. |
| **CO 3** | Estimate variance and standard error and predict the experimental result is reproducible |
| **CO 4** | Analyze different probability distributions and check whether the experimental values are significant or not. |

**Mapping of course outcomes with program outcomes**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 |
|---|---|---|---|---|---|---|---|
| **CO 1** | 2 | 2 | 2 | 2 | 2 | 2 | - |
| **CO 2** | 2 | 2 | 2 | 2 | 2 | 2 | - |
| **CO 3** | 3 | 3 | 3 | 3 | 2 | 2 | - |
| **CO 4** | 3 | 3 | 3 | 3 | 2 | 2 | 2 |

**Assessment Pattern**

| Bloom's Category | End Semester Examination |
|---|---|
| Apply | 40% |
| Analyse | 25% |
| Evaluate | 25% |

| | |
|---|---|
| Create | 10% |

**Mark distribution**

| Total Marks | CIE | ESE | ESE Duration |
|---|---|---|---|
| 100 | 40 | 60 | 2.5 hours |

**Continuous Internal Evaluation Pattern: 40 marks**

Micro/Course based project : 15 marks

Course based /Seminar/Quiz : 15 marks

Test paper, 1 no. : 10 marks

Test paper shall include minimum 80% of the syllabus.

**End Semester Examination Pattern: 60 marks**

The end semester examination will be conducted by the respective College. There will be two parts; Part A and Part B.

Part A will contain 5 numerical/short answer questions with one question from each module; having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions.

Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

**Model Question Paper**

**QP CODE:** **PAGES:**

**Reg No: _____** **Name: _____**

**SAHRDAYA COLLEGE OF ENGINEERING AND TECHNOLOGY**
**FIRST SEMESTER M. TECH DEGREE EXAMINATION, MONTH & YEAR**
**Course Code: 241EBT008**

Max. Marks: 60 Duration: 2.5 hrs.

**Mathematical Applications in Biotechnology**

**PART – A**

Answer All the Questions.

One question from each module, having 5 marks for each question.

(5x 5 = 25)

1. Linear constant-coefficient differential equations are important in modelling dynamic systems. What role do differential equations play in the study of time-dependent biological processes? Explain the mechanism of high-resolution imaging in thick tissues by confocal microscopy
2. Find the partial differential equation of u = f(x2 - y2).
3. What does the standard deviation tell us about the data?
4. Human IgM class antibodies against human tubulin β class III in serum is detected by using enzyme-linked immunosorbent assay. The amount of bound antibodies is determined by a colour reaction by measuring the absorbance at 450 nm. The values of absorbance measured for 5 samples were: 1.012, 1.018, 1.123, 1.015, and 0.986. Determine the standard deviation correct to 3 significant figures.
5. How do you fit a polynomial by the least square method?

**PART – B**

Minimum one question from each module (Total seven questions)

Answer any five (5 x 7 = 35)

6. Theophylline is a drug used in the therapy for the treatment of respiratory diseases. A concentration of this drug in the blood below 5 mg/L has little effect, but undesirable side effects appear when the concentration exceeds 20 mg/L. Suppose a dose corresponding to 16 mg/L is administered initially. The rate of change of drug concentration can be modelled by the differential equation. The drug concentration (C) is measured in mg/L and time (t) in hours. Show that a second injection will need to be given after about 6 hours to prevent the drug from becoming ineffective.

7. Let N(t) be the population of a bacterial species at time t. Suppose that the rate of population growth depends only on the population size, so that. Find an expression for the bacterial population at time t.
8. How to solve one dimensional wave equation?
9. Show that if a is a constant, then u (x, t)=sin(at)cos(x) is a solution to $\frac{\partial^2 u}{\partial t^2} = \alpha^2 \frac{\partial^2 u}{\partial x^2}$.
10. Two common types of errors in the acquisition of data are the Random error and the Systematic error. Which of these errors can be traced to a defect in the measuring instrument? What is the consequence of this type of error?
11. Distinguish between Systematic and Random errors. Give an example of each type of error.
12. A study evaluates the effectiveness of Vitamin C for prevention of common cold as compared to other medication. The observed and predicted frequencies for the occurrence of cold is sown in the Table. Using the chi-square test, determine if the observed frequencies are consistent with the predicted results?

| | Observed frequencies | | Predicted frequencies | |
|---|---|---|---|---|
| | Cold | No cold | Cold | No cold |
| Vitamin C | 17 | 122 | 23.91 | 115.09 |
| Other medication | 31 | 109 | 24.09 | 115.91 |

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## SYLLABUS

**Module 1 (7 hours)**

**Differential equations:** homogeneous and inhomogeneous differential equations, development of differential equations using examples from biological systems and elementary reaction kinetics for first and second order reaction, series reaction, numerical simulation of differential equations.

**Module 2 (7 hours)**

**Partial differential equations:** models in physiology, Introduction to solution techniques such as variable separation, product method and Laplace Transform method.

**Module 3 (8 hours)**

**Probability in medicine, biology and genetics:** Bayes theorem, Normal distribution and application, states and parameter estimation, measures of central tendency, measures of dispersion probability distributions, average, variance, standard deviation and standard error.

**Module 4 (9 hours)**

**Elements of a statistical test:** F-test for equality of variances, significance tests, chi-squared test, statistical association between two variables, correlation coefficient, linear regression, one way analysis of variances (ANOVA).

**Module 5 (9 hours)**

**Simple linear regression:** least-square fit, testing for goodness of fit, linear approximation of a function of a single variable, parameter fitting, Karl Pearson coefficient of correlation.

**Course Plan**

| No | Topic | No. of Lectures |
|---|---|---|
| 1 | **Differential equations (7 hours)** | |
| 1.1 | Homogeneous and inhomogeneous differential equations | 2 |
| 1.2 | Development of differential equations using examples from biological systems and elementary reaction kinetics for first and second order reaction, series reaction | 2 |
| 1.3 | Numerical simulation of differential equations | 3 |
| 2 | **Partial differential equations (7 hours)** | |
| 2.1 | Partial differential equations, models in physiology | 2 |
| 2.2 | Introduction to solution technique such as variable separation | 2 |
| 2.3 | Product method and Laplace Transform method. | 3 |
| 3 | **Probability in medicine, biology and genetics(8 hours)** | |
| 3.1 | Probability in medicine, biology and genetics. | 2 |
| 3.2 | Bayes theorem, Normal distribution and application, states and parameter estimation | 3 |
| 3.3 | Measures of central tendency, measures of dispersion probability distributions, average, variance, standard deviation and standard error | 3 |
| 4 | **Elements of a statistical test (9hours)** | |
| 4.1 | Elements of a statistical test, F-test for equality of variances | 3 |
| 4.2 | Significance tests, chi-squared test, statistical association between two variables. | 3 |
| 4.3 | Correlation coefficient, linear regression, one way analysis of variances (ANOVA). | 3 |
| 5 | **Simple linear regression (9 hours)** | |
| 5.1 | Simple linear regression, least-square fit | 3 |
| 5.2 | Testing for goodness of fit, linear approximation of a function of a single variable | 3 |

| | | |
|---|---|---|
| 5.3 | Parameter fitting, Karl Pearson coefficient of correlation | 3 |

**Reference Books**

1. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, Wiley Eastern
2. Ronald W. Shonkwiler, Mathematical Biology- An Introduction with Maple and Matlab, Second Edition, Springer
3. Veerarajan, Probability, Statistics and Random Processes,Tata McGraw-Hill Education, 2008
4. Peter V. O'Neil, Advanced Engineering Mathematics, 7th Edition, Cengage Learning

| 241EBT009 | BIOPROCESS PLANT DESIGN | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | Program Elective 2 | 3 | 0 | 0 | 3 |

**Preamble:**

To impart basic concepts of process and mechanical design of process plants and also impart knowledge of scale up of bioprocesses.

**Pre-requisites**: Nil

**Course Outcomes**: After the completion of the course, the student will be able to

| | |
|---|---|
| **CO 1** | Understand the basic concepts of flow sheeting, material and energy balances and process development |
| **CO 2** | Understand safety and process simulation in a bioprocess plant. |
| **CO 3** | Understand the factors affecting the scale up of bioreactors. |
| **CO 4** | Design special vessels and various parts, design of equipment's based on economics and process considerations |
| **CO 5** | Design heat and mass transfer equipment. |

**Mapping of course outcomes with program outcomes**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 |
|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | 3 | 2 | 3 | 2 | - | - |
| **CO 2** | 3 | 2 | 2 | 3 | 2 | 2 | 2 |
| **CO 3** | 3 | 2 | 3 | - | 3 | - | - |
| **CO 4** | 3 | 3 | 3 | 2 | 2 | - | - |
| **CO 5** | 3 | 3 | 3 | 2 | 2 | - | - |

**Assessment Pattern**

| Bloom's Category | End Semester Examination |
|---|---|
| Apply | 35% |
| Analyse | 50% |
| Evaluate | 15% |
| Create | |

**Mark distribution**

| Total Marks | CIE | ESE | ESE Duration |
|---|---|---|---|
| 100 | 40 | 60 | 2.5 hours |

**Continuous Internal Evaluation Pattern: 40 marks**

Micro/Course based project : 15 marks

Course based /Seminar/Quiz : 15 marks

Test paper, 1 no. : 10 marks

Test paper shall include minimum 80% of the syllabus.

**End Semester Examination Pattern: 60 marks**

The end semester examination will be conducted by the respective College. There will be two parts; Part A and Part B.

Part A will contain 5 numerical/short answer questions with one question from each module; having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions.

Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

**Model Question Paper**

**QP CODE:** **PAGES:**

**Reg No: _____** **Name: _____**

**SAHRDAYA COLLEGE OF ENGINEERING AND TECHNOLOGY**
**FIRST SEMESTER M. TECH DEGREE EXAMINATION, MONTH & YEAR**
**Course Code: 241EBT009**

Max. Marks: 60 Duration: 2.5 hrs.

**Bioprocess Plant Design**

**PART – A**

Answer All the Questions.

One question from each module, having 5 marks for each question.

(5x 5 = 25)

1. Discuss the factors to be considered while planning a new plant layout?
2. Explain any 5 type material of construction and their mechanical properties
3. What are the factors which affect the scale up of a bioreactor
4. Explain the step involved in the design of a fermenter.
5. Explain about tray hydraulics of a distillation column.

**PART – B**

Minimum one question from each module (Total seven questions)

Answer any five (5 x 7 = 35)

6. Write the stepwise procedure for solving 'Material Balance Problems' encountered during the design and operation of a chemical plant
7. Explain the different process simulation softwares used in the chemical industry.
8. Explain the scale up of bioreactor based on impeller tip speed and mixing time.
9. A spherical pressure vessel having a volume $4m^3$ is to be designed for maximum operating pressure of $10kgf/cm^2$ and maximum temperature of $200^oC$. The vessel is made of IS:2041-1962,20Mn2 and fabricated as per Class II with no radiography IS specification. Assume that severe heating is provided during the process. Calculate the thickness of the spherical vessel
10. 500kg/hr of mixture of $SO_2$ and air is to be cleaned. The % of $SO_2$ in the inlet air is 12% and outlet air is 1% by wt. The absorbing fluid in water at $30^0c$. liquid rate 1560 kg/hr and gas rate 1520kg/hr pressure drop =1.5 inch water/ft. no of plate 8 and 75% column efficiency. Check pressure drop and entrainment for given process. Take equilibrium data from Hand book

11. Enumerate the steps involved in the process design of packed bed absorption column
12. A process vessel is to be designed for maximum operating pressure of 500kN/$m^2$. The vessel has a nominal diameter of 1.2m and tangent to tangent length of 2.4m. The vessel is made of IS 2002-1962, Grade 2B, quality steel having design stress value of 118 MN/$m^2$, at working temp. The corrosion clearance suggested to be 2mm for life span expected for vessel. The vessel is to be fabricated according to class 2 of Indian standard specification. What will be the standard plate thickness to fabricate the vessel?.

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## SYLLABUS

**Module 1 (6 hours)**

**Introduction**: General design information. Mass and Energy balances. Process flow sheeting, Piping and Instrumentation.

**Module 2 (7 hours)**

**Material of construction of bioprocess plant**: Common material of construction and their mechanical properties. Utility supply, facility design and equipment cleaning aspects. Safety in bioprocess plant, Process economics – case studies. Introduction to special software for steady and dynamic simulation of chemical engineering systems.

**Module 3 (8 hours)**

**Scale up of Bioreactors**: Factors affecting the scale up of bioreactors. Effect of scale on oxygenation, mixing, sterilization, pH, temperature, inoculum development, nutrient availability and supply. Bioreactor scale up based on constant power consumption per volume, mixing time, impeller tip speed (shear), mass transfer coefficients.

**Module 4 (10 hours)**

**Design of Bioreactors**: Design considerations for maintaining sterility of process streams and process equipment. Mechanical design aspect of pressure vessel (subjected to internal pressure only) using BIS IS 2825:1969 (R2002) Code for Unfired Pressure Vessels. Mechanical design of stirred batch fermenter.

**Module 5 (9 hours)**

**Process design of Heat and Mass Transfer equipment:** Process design of distillation columns, Process design of Packed absorption column, Process design of Tray dryers

**Course Plan**

| No | Topic | No. of Lectures |
|---|---|---|
| 1 | **Introduction (6 hours)** | |
| 1.1 | General design information. | 1 |
| 1.2 | Mass and Energy balances. | 2 |
| 1.3 | Process flow sheeting, Piping and Instrumentation. | 3 |
| 2 | **Material of construction for bioprocess plant (7 hours)** | |
| 2.1 | Common material of construction and their mechanical properties. | 1 |
| 2.2 | Utility supply, facility design and equipment cleaning aspects. | 2 |
| 2.3 | Safety in bioprocess plant, Process economics – case studies | 2 |
| 2.4 | Introduction to special software for steady and dynamic simulation of chemical engineering systems. | 2 |
| 3 | **Scale up of bioreactors (8 hours)** | |
| 3.1 | Factors affecting the scale up of bioreactors. | 1 |
| 3.2 | Effect of scale on oxygenation, mixing, sterilization, pH, temperature, inoculum development, nutrient availability and supply | 3 |
| 3.3 | Bioreactor scale up based on constant power consumption per volume, mixing time, impeller tip speed (shear), mass transfer coefficients. | 4 |
| 4 | **Design of Bioreactors (10 hours)** | |
| 4.1 | Design considerations for maintaining sterility of process streams and process equipment | 2 |
| 4.2 | Mechanical design aspect of pressure vessel (subjected to internal pressure only) using BIS IS 2825:1969 (R2002) Code for Unfired Pressure Vessels. | 4 |
| 4.3 | Mechanical design of stirred batch fermenter. | 4 |
| 5 | **Process design of Heat and Mass Transfer equipments (9 hours)** | |
| 5.1 | Process design of distillation columns | 3 |
| 5.2 | Process design of Packed absorption column | 3 |
| 5.3 | Process design of Tray dryers | 3 |

**Reference Books**

1. Perry's Chemical Engineer's Handbook; McGraw Hill
2. Chemical Engineering Design; R.K. Sinnot, Elsevier
3. Process Equipment Design; M.V. joshi and V.V. Mahajani, Mac Millan India Ltd
4. Process Engineering and Design; S.B. Thakor& B.I. Bhatt
5. Bioseparation Science and Engineering; Roger Harnsmetal, Oxford University Press
6. Plant Design & Economics for Chemical Engineers, 4th Edition; Max Peters & Klans D Timmerhauss, McGraw Hill Book Co 1991 5. Andrew Read and Dian Donnai, New clinical Genetics, Scion Publishing Ltd, Oxfordshire, UK, 2007. 6. James W Goding, Monoclonal antibodies: Principles and Practice, 3rd Edition, Academic Press, 1996.

| 241EBT010 | BIOPROCESS CONTROL AND INSTRUMENTATION | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | Program Elective 2 | 3 | 0 | 0 | 3 |

**Preamble:**

To impart fundamentals of Bioreactor control.

**Pre-requisites**: Nil

**Course Outcomes**: After the completion of the course, the student will be able to

| | |
|---|---|
| **CO 1** | Model simple systems and solve the mathematical equations using Laplace transforms |
| **CO 2** | Explain the various sensors in bioreactors |
| **CO 3** | Analyze the stability of open-loop and closed-loop systems and tune the controller |
| **CO 4** | Understand the basics of the advanced control system. |

**Mapping of course outcomes with program outcomes**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 |
|---|---|---|---|---|---|---|---|
| **CO 1** | 2 | 2 | 2 | 2 | 2 | 2 | - |
| **CO 2** | 2 | 2 | 2 | 3 | 2 | 2 | - |
| **CO 3** | 3 | 2 | 3 | 3 | 3 | 3 | - |
| **CO 4** | 3 | 2 | 2 | 2 | 2 | 2 | - |

**Assessment Pattern**

| Bloom's Category | End Semester Examination |
|---|---|
| Apply | 40% |
| Analyse | 25% |
| Evaluate | 25% |
| Create | 10% |

**Mark distribution**

| Total Marks | CIE | ESE | ESE Duration |
|---|---|---|---|
| 100 | 40 | 60 | 2.5 hours |

**Continuous Internal Evaluation Pattern: 40 marks**

| | |
|---|---|
| Micro/Course based project | : 15 marks |
| Course based /Seminar/Quiz | : 15 marks |
| Test paper, 1 no. | : 10 marks |

Test paper shall include minimum 80% of the syllabus.

**End Semester Examination Pattern: 60 marks**

The end semester examination will be conducted by the respective College. There will be two parts; Part A and Part B.

Part A will contain 5 numerical/short answer questions with one question from each module; having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions.

Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

**Model Question Paper**

**QP CODE:** **PAGES:**

**Reg No: _____** **Name: _____**

**SAHRDAYA COLLEGE OF ENGINEERING AND TECHNOLOGY**
**FIRST SEMESTER M. TECH DEGREE EXAMINATION, MONTH & YEAR**
**Course Code: 241EBT010**

Max. Marks: 60 Duration: 2.5 hrs.

**Bioprocess Control and Instrumentation**

**PART – A**

Answer All the Questions.

One question from each module, having 5 marks for each question.

(5x 5 = 25)

1. Differentiate state variables and state equations.
2. Explain the physical significance of the two parameters involved in a second order system.
3. Differentiate positive and negative feedback systems.
4. Derive amplitude ratio and phase angle for PI controller.
5. Discuss the safety factors involved in Bode stability criterion.

**PART – B**

Minimum one question from each module (Total seven questions)

Answer any five (5 x 7 = 35)

6. Solve the following differential equation using Laplace Transform.

$$\frac{d^2x}{dt^2} + 3\frac{dx}{dt} + x = 1$$

Where x (0) = 0 and x' (0) = 0**.**

7. Derive the dynamic response of the first-order system to a step input.
8. Derive the effect of the Proportional Integral controller on the response of the servo problem. Assume the dynamics of the final control element and that of the measuring device as unity.
9. Check the stability of the open loop transfer function using Routh Hurwiz Criterion.

$$G(s)H(s) = \frac{s+1}{s^3 + 4s^2 + 6s + 4}$$ Comment on Cancer biomarkers.

10. Draw the root locus diagram for an open loop transfer function of

$$G(s)H(s) = \frac{s+3}{s^2 - s - 2}$$ E

11. Discuss in detail about Cohen and Coon controller tuning technique.
12. By taking a suitable example, draw the bode diagram for a multi-capacity system.

********

**SYLLABUS**

**Module 1 (7 hours)**

**Introduction to process control with the help of examples of a tank heater system:** Overview of control system design - model based approach - theoretical, empirical and semi-empirical models.General modeling principles. Classification of variables in process control. Importance of state variables, state equations and degrees of freedom.

Tools for solving models: Laplace Transforms: Definition of the Laplace transforms. Laplace transforms of some basic forcing functions - step, exponential, ramp, sinusoidal, cosine, pulse, impulse and translated functions, Laplace transform of derivatives and integrals, initial value theorem and final value theorem. Numerical problems.

**Module 2 (9 hours)**

**Transfer functions and their general characteristics:** Transfer functions of general first-order and second-order systems. Dynamics of the first-order system for step and impulse input. First-order systems and its general characteristics. Development of transfer function models for first-order systems: a continuous single tank (mass storage) system and mercury in glass thermometer system. Development of transfer function models for second-order systems: multi capacity systems - two tanks connected in series, inherently second order systems - damped vibrator, Dynamics of second-order systems - General characteristics of under damped, over damped and critically damped systems. Numerical problem on overshoot, decay ratio, period of oscillation, ultimate value and maximum value. Numerical problems on transfer functions and dynamic response of first and second-order systems.

**Module 3 (8 hours)**

**Hardware elements of a control system:** Explanation with the help of an example temperature control set up for a bioreactor. Components of the bioreactor, Inline, Online and Offline measurements of a bioreactor. Sensors for bioreactors – temperature, pressure, flow, DO concentration, pH, cell concentration, foam sense, weight, agitation rate, biosensors in bioprocess monitoring, biosensors based on thermal effects and potentiometric biosensors. Dead time processes. Types of feedback controllers. Control laws and transfer functions of P, PI and PID controllers.

**Dynamic behavior of feedback-controlled processes:** Difference between open-loop and closed-loop control system. Closed-loop transfer function for feedback (positive and negative) processes. Servo and regulatory responses due to the presence of proportional control, integral control, derivative control action and composite control on the response of a feedback-controlled process.

**Module 4 (9 hours)**

**Frequency response characteristics:** of a general linear system, dead time process, pure capacitive process and their graphical representations. Frequency response characteristics of feedback controllers-P, PI and PID and composite controllers and their graphical representations.

Frequency response characteristics of second-order systems and graphical representation. Nyquist plots of first order, dead time and pure capacitive processes. Cross over frequency, Gain and Phase margin. Stability analysis of feedback systems: Notion of stability, Stable and unstable systems, BIBO stability, Prediction of stability of transfer function for open loop and closed-loop systems based on transfer function analysis. The characteristic equation, Routh Hurwitz criterion for stability. Numerical examples.

**Module 5 (7 hours)**

**Root locus analysis:** Rules for plotting Root locus Development of Root locus for multi capacity systems. Numerical Examples, Bode stability criterion, Nyquist stability criterion

**Design of feedback controllers:** Outline of the design problems, simple performance criteria, time-integral performance criteria, selection of the type of feedback controller. Controller tuning-semi empirical tuning techniques -CC and ZN

**Advanced Controls in Bioreactors:** Introduction to dead time compensation, pH measurement and control, Oxygen measurement and control, Adaptive control and online estimation, Cascade control for jacketed bioreactors, Feedforward controller, Designing of feed forward controller, Parts of digital computers, Computer-process interface for data acquisition and control, Sampling continuous signal, Conversion of continuous signal to discrete values, Z transforms.

**Course Plan**

| No | Topic | No. of Lectures |
|---|---|---|
| 1 | **Introduction to process control with the help of examples of a tank heater system (7 hours)** | |
| 1.1 | Overview of control system design - model based approach - theoretical, empirical and semi empirical models. | 2 |
| 1.2 | General modeling principles. Classification of variables in process control. Importance of state variables, state equations and degrees of freedom. | 2 |
| 1.3 | Tools for solving models: Laplace Transforms: Definition of the Laplace transforms. Laplace transforms of some basic forcing functions - step, exponential, ramp, sinusoidal, cosine, pulse, impulse and translated functions, Laplace transform of derivatives and integrals, initial value theorem and final value theorem. Numerical problems | 3 |
| 2 | **Transfer functions and their general characteristics (9 hours)** | |
| 2.1 | Transfer functions of a general first order and second order systems. Dynamics of a first order system for step and impulse input. | 2 |
| 2.2 | First order systems and its general characteristics, Development of transfer function models for first order systems: a continuous single tank (mass storage) system and a mercury in glass thermometer system. | 2 |
| 2.3 | Development of transfer function models for second order systems: multicapacity systems - two tanks connected in series, inherently second order systems - damped vibrator, General characteristics of under damped, over damped and critically damped systems | 2 |
| 2.4 | Numerical problem on overshoot, decay ratio, period of oscillation, ultimate value and maximum value, Numerical problems on transfer functions and dynamic response of first and second order systems | 3 |
| **3** | **Hardware elements of a control system and Dynamic behavior of feedback-controlled processes (8 hours)** | |
| 3.1 | Hardware elements of a control system. Explanation with the help of an example temperature control set up for a bioreactor | 1 |
| 3.2 | Components of bioreactor, Inline, Online and Offline measurements of a bioreactor. Sensors for bioreactors – temperature, pressure, flow, DO concentration, pH, cell concentration, foam sensing, weight, agitation rate, biosensors in bioprocess monitoring, biosensors based on thermal effects and potentiometric biosensors. | 2 |
| 3.3 | Dead time processes. Types of feedback controllers. Control laws and transfer functions of P, PI and PID controllers. | 2 |

| | | |
|---|---|---|
| 3.4 | Dynamic behaviour of feedback controlled processes. Difference between open loop and closed loop control system. Closed loop transfer function for feedback (positive and negative) processes. Servo and regulatory responses due to the presence of proportional control, integral control, derivative control action and composite control on the response of a feedback controlled process. | 3 |
| 4 | **Frequency response characteristics (9 hours)** | |
| 4.1 | Frequency response characteristics of a general linear system, dead time process, pure capacitive process and their graphical representations. Frequency response characteristics of feedback controllers-P,PI and PID and composite controllers and their graphical representations. | 3 |
| 4.2 | Frequency response characteristics of second order systems and graphical representation | 1 |
| 4.3 | Nyquist plots of first order, dead time and pure capacitive processes. Cross over frequency, Gain and Phase margin. | 2 |
| 4.4 | Stability analysis of feedback systems: Notion of stability, Stable and unstable systems, BIBO stability, Prediction of stability of transfer function for open loop and closed loop systems based on transfer function analysis. | 2 |
| 4.5 | The characteristic equation, Routh Hurwitz criterion for stability. Numerical examples | 1 |
| 5 | **Root locus analysis, Design of feedback controllers and Advanced Controls in Bioreactors(7 hours)** | |
| 5.1 | Root locus analysis. Rules for plotting Root locus Development of Root locus for multi capacity systems. Numerical Examples, Bode stability criterion, Nyquist stability criterion | 2 |
| 5.2 | Design of feedback controllers: Outline of the design problems, simple performance criteria, time-integral performance criteria, selection of the type of feedback controller. Controller tuning- semi empirical tuning techniques -CC and ZN | 2 |
| 5.3 | Advanced Controls in Bioreactors – Introduction to dead time compensation, pH measurement and control, Oxygen measurement and control, Adaptive control and online estimation, Cascade control for jacketed bioreactors. | 2 |
| 5.4 | Feedforward controller, Designing of feedforward controller,Parts of digital computers, Computer-process interface for data acquisition and control, Sampling continuous signal, Conversion of continuous signal to discrete values, Z transforms. | 1 |

**Reference Books**

1. Stephanopoulose G, Chemical Process Control: An Introduction to Theory and Practice, Prentice Hall of India, New Delhi, 1993.
2. Coughanowr R D, LeBlanc E S, Process Systems Analysis and Control, McGraw Hill International Edition.
3. Luyben W L, Process Modeling Simulation and Control for Chemical Engineers, 2/e, McGraw Hill, Singapore, 1990.
4. Seborg D E, Edgar TF, Mellichamp D A, Doyle FJ, Process Dynamics and Control, 3/e, John Wiley & Sons, 2010.
5. Peter Harriot, Process Control, Tata McGraw Hill, 1972.
6. S Tapobrata Panda, Bioreactor Analysis and Design, Tata McGraw Hill, 2011.
7. E M T El Mansi, C F A Bryce, B Dahhou S Sanchez, A L Demain, A R Allmen, Fermentationmicrobiology and biotechnology, CRC Press, 2012.
8. P F Stanbury, A Whitaker and S J Hall, Principles of Fermentation Technology, Elsevier,1995.

| 241EBT011 | GENOMICS AND PROTEOMICS | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | Program Elective 2 | 3 | 0 | 0 | 3 |

**Preamble:**

Enabling students to understand the various approaches in proteomics and genomics and to analyze and evaluate the theoretical and practical information available in the Proteomics and Genomics stream.

**Pre-requisites**: Nil

**Course Outcomes:**

After the completion of the course the student will be able to

| | |
|---|---|
| **CO 1** | Understand the basic principles governing the genome and protein structures |
| **CO 2** | Acquaint the students to identify key motifs on various strategies used in genomics and proteomics |
| **CO 3** | To evaluate the genomics and proteomics data |
| **CO 4** | Analyze the various approaches and applications of Genomics and Proteomics |

**Mapping of course outcomes with program outcomes**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 |
|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | - | - | - | - | 3 | - |
| **CO 2** | - | - | 3 | - | 2 | - | - |
| **CO 3** | - | - | - | - | 2 | 3 | - |
| **CO 4** | - | - | - | - | 2 | 3 | - |

**Assessment Pattern**

| Bloom's Category | End Semester Examination |
|---|---|
| Apply | 40% |
| Analyse | 25% |
| Evaluate | 25% |
| Create | 10% |

**Mark distribution**

| Total Marks | CIE | ESE | ESE Duration |
|---|---|---|---|
| 100 | 40 | 60 | 2.5 hours |

**Continuous Internal Evaluation Pattern: 40 marks**

Preparing a review article based on peer reviewed original publications (minimum 10 publications shall be referred) : 15 marks

Course based task/Seminar/Data collection and interpretation : 15 marks

Test paper, 1 no. : 10 marks

Test paper shall include minimum 80% of the syllabus.

**End Semester Examination Pattern: 60 marks**

The end semester examination will be conducted by the respective College. There will be two parts; Part A and Part B.

Part A will contain 5 numerical/short answer questions with one question from each module, having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions.

Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

**Model Question Paper**

**QP CODE:** **PAGES:**

**Reg No: _____** **Name: _____**

**SAHRDAYA COLLEGE OF ENGINEERING AND TECHNOLOGY**
**FIRST SEMESTER M. TECH DEGREE EXAMINATION, MONTH & YEAR**
**Course Code: 24EBT011**

Max. Marks: 60 Duration: 2.5 hrs.

**Genomics and Proteomics**

**PART – A**

Answer All the Questions.

One question from each module, having 5 marks for each question.

(5x 5 = 25)

1. Assess the role and capability of gene identification and prediction methods and softwares.
2. Critically evaluate on the requirement to study hidden Morkov models.
3. Define HGP. Give the significance of HGP relating it to human development.
4. Justify the need to analyze bioinformatics data analysis in proteomics and genomics.
5. Categorize the methods used for large scale synthesis of proteins.

**PART – B**

Minimum one question from each module (Total seven questions)

Answer any five (5 x 7 = 35)

6. Prioritize the molecular markers used in genomics and proteomics with reference to RFLP and AFLP
7. Define polymorphisms. Critically evaluate on the types of polymorphisms.
8. Organize the involvement and functions of gene variation studies in proteomics and genomics.
9. Define copy number. How is the copy number variation important for data integration in genomics?
10. Discuss in detail the microarray techniques commenting on the advantages and disadvantages of the technique.
11. Investigate on the experimental methods of micro sequencing.
12. With reference to the current scenario explain in detail the role of proteomics and genomics in diagnostics.

********

## SYLLABUS

**Module 1 (8hours)**

**Introduction to Genomics and Proteomics:** Organization and features of prokaryotic and eukaryotic genome, Gene identification and prediction methods and software's, Genome diversity and significance, Genome mapping and Polymorphisms, Molecular Markers-RFLP,AFLP,RAPD,SCAR,SNP,ISSR, Protein markers etc.

**Module 2 (8hours)**

**Applied Genomics and Genome projects:** Genetic and physical mapping, Data integration in Genomics – Gene expression, single nucleotide polymorphism, copy number variation, protein-protein/gene-gene interations, Framework for genome integration-Exon chaining, Genertaive models (Hidden Morkov), Generative and Discriminative learning principles, Structural genomics, Genotyping –DNA chips, The Human genome project, HapMap Project, The 1000 genome project, and The ENCODE Project.

**Module 3 (8hours)**

**Proteomics Analysis:** PAGE, Mass Spectrometry, De novo sequencing, 2DE Gel electrophoresis, LC/MS-MS, MALDITOF, SAGE and Micro array techniques, Bioinformatics analysis of proteomics data, Proteomics technologies and their Applications, Methods for large scale synthesis of proteins

**Module 4 (8hours)**

**Evaluation of proteomic and genomic data:** Proteogenomics- Concepts applications and computational strategies, Methods, tools and current perspectives in Proteogenomics, Fundamentals of data mining in Genomics and proteomics, Evaluation methods for functional genomic data.

**Module 5 (8hours)**

**Applications of Genomics and Proteomics:** Application of Genomics in Agriculture, Engineering novel proteins, Pharmaceutical Applications, Analysis of genomes, Proteomics in Drug discovery, Proteomics in plant genetics and plant breeding, Application of Genomics in diagnostics, forensics and gene therapy.

**Course plan**

| No | Topic | No. of Lectures |
|---|---|---|
| **1** | **Introduction to Genomics and Proteomics (8hours)** | |
| 1.1 | Organization and features of prokaryotic and eukaryotic genome | 1 |
| 1.2 | Gene identification and prediction methods and software's | 2 |
| 1.3 | Genome diversity and significance | 2 |
| 1.4 | Genome mapping and Polymorphisms | 1 |
| 1.5 | Molecular Markers-RFLP, AFLP, RAPD, SCAR, SNP, ISSR, Protein marksers etc | 2 |
| **2** | **Applied Genomics and Genome projects (8hours)** | |
| 2.1 | Genetic and physical mapping | 1 |
| 2.2 | Data integration in Genomics – Gene expression, single nucleotide polymorphism, copy number variation, protein-protein/gene-gene interations | 2 |
| 2.3 | Framework for genome integration-Exon chaining, Genertaive models (Hidden Morkov), Generative and Discriminative learning principles | 2 |
| 2.4 | Structural genomics, Genotyping –DNA chips | 1 |
| 2.5 | The Human genome project, HapMap Project, The 1000 genome project, and The ENCODE Project | 2 |
| **3** | **Proteomics Analysis (8hours)** | |
| 3.1 | PAGE, Mass Spectrometry, De novo sequencing, 2DE Gel electrophoresis, LC/MS-MS, MALDITOF, SAGE and Micro array techniques | 3 |
| 3.2 | Bioinformatics analysis of proteomics data | 1 |
| 3.3 | Proteomics technologies and their applications | 3 |
| 3.4 | Methods for large scale synthesis of proteins | 1 |
| **4** | **Evaluation of proteomic and genomic data** | |
| 4.1 | Proteogenomics- Concepts applications and computational strategies | 2 |
| 4.2 | Methods, tools and current perspectives in Proteogenomics | 2 |
| 4.3 | Fundamentals of data mining in Genomics and proteomics | 2 |
| 4.4 | Evaluation methods for functional genomic data | 2 |
| **5** | **Applications of Genomics and Proteomics (8hours)** | |
| 5.1 | Application of Genomics in Agriculture | 2 |
| 5.2 | Engineering novel proteins, Pharmaceutical Applications, Analysis of genomes | 3 |
| 5.3 | Proteomics in Drug discovery, Proteomics in plant genetics and plant breeding | 1 |
| 5.4 | Application of Genomics in diagnostics, forensics and gene therapy | 2 |

**Reference Books**

1. Andrezej K Konopka and James C. Crabbe, Compact Hand Book - Computational Biology, Marcel Dekker, USA, 2004.
2. Hartwell, L. H., L. Hood, M. L. Goldberg, A. E. Reynolds, L. M. Silver and R. G. Veres. 2004. Genetics from Genes to Genomes. McGraw Hill.
3. Pennington & Dunn - Proteomics from Protein Sequence to Function, 1 st edition, Academic Press, San Diego, 1996.
4. Lewin B. 2003. Genes VIII. Oxford University Press. Oxford.
5. The Human Genome 2001, Nature Vol. 409.
6. The Drosophila Genome. 2000, Science Vol. 267.
7. The Caenorhabditis elegans genome 1998. Science Vol. 282.
8. The Arabidopsis Genome 2000 Nature vol. 408.
9. Primrose, S. B., and R. M. Twyman . 2006. Principles of gene manipulation and Genomics, Blackwell Publi shing MA. USA.

| 241LBT003 | BIOPROCESS AND FERMENTATION | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | Laboratory | 0 | 0 | 2 | 1 |

**Preamble:** Bioprocess engineering and Fermentation technology are an integral part of Biotechnology which is essential for the production of Biomolecules in large quantities.

**Pre-requisites**: Nil

**Course Outcomes:**

After the completion of the course the student will be able to

| | |
|---|---|
| **CO 1** | Understand the kinetics of bacterial growth and death. |
| **CO 2** | Calculate the kinetic parameters for the degradation kinetics of substrates and the batch sterilization. |
| **CO 3** | Understand the instrumentation and control of a bioreactor |
| **CO 4** | Determine the volumetric mass transfer coefficient $K_La$ in bioreactor |
| **CO 5** | Perform the solid state fermentation and submerged fermentation. |
| **CO 6** | Process simulation by Plackett and Burman method |

**Mapping of course outcomes with program outcomes**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 |
|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | 2 | 2 | - | 2 | - | 2 |
| **CO 2** | 3 | 3 | 2 | - | 2 | - | - |
| **CO 3** | 3 | 3 | | 2 | - | - | - |
| **CO 4** | 3 | 2 | 2 | - | 2 | - | - |
| **CO 5** | 3 | 2 | | 2 | 3 | - | - |
| **CO 6** | 3 | 3 | 3 | 3 | - | - | 2 |

**Assessment Pattern**

| Bloom's Category | End Semester Examination |
|---|---|
| Apply | 30 % |
| Analyze | 70 % |

| | |
|---|---|
| Evaluate | |
| Create | |

**Internal Continuous Assessment: (MaximumMarks-100)**

Practical Records/Outputs : 40 marks

Regular class viva voce : 20 marks

End semester exam : 40 marks

**Number of Experiment to be performed**

At least 10 experiments must be performed from the experiments listed below.

**Experiments**

| No | Topic | No. of hours |
|---|---|---|
| 1 | Batch Growth Kinetics of Bacteria | 2 |
| 2 | Cell immobilization and degradation kinetics of substrate | 2 |
| 3 | Study of thermal death kinetics and del factor for bacterial culture | 2 |
| 4 | Batch Sterilization Kinetics | 2 |
| 5 | Bioreactor instrumentation and control | 2 |
| 6 | Determination of $K_La$ by Sulphite Oxidation Method | 2 |
| 7 | Determination of $K_La$ by Power Correlation | 2 |
| 8 | Anaerobic fermentation (wine). | 2 |
| 9 | Solid state fermentation for production of enzymes | 2 |
| 10 | Fermentation for the production of primary metabolites | 2 |
| 11 | Shake flask fermentation (study of effect of agitation) | 2 |
| 12 | Media optimization by Plackett and Burman method | 2 |

# SEMESTER II

| 242TBT004 | ADVANCED BIOPROCESS ENGINEERING | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | Discipline core 2 | 3 | 0 | 0 | 3 |

**Preamble:** Acquaint the students with the various methods of enhancing bioprocess in an industrial perspective.

**Pre-requisites**: Nil

**Course Outcomes:**

After the completion of the course the student will be able to

| | |
|---|---|
| **CO 1** | Know about Yield coefficients and black box stoichiometries involved in bioprocess |
| **CO 2** | Model various fermentation processes |
| **CO 3** | Analyse the parameters involved in designing the fermentation process |
| **CO 4** | Design and construct bioreactor based on process and production strategy |
| **CO 5** | Monitor the bioprocess for higher production efficiency |

**Mapping of course outcomes with program outcomes**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 |
|---|---|---|---|---|---|---|---|
| **CO 1** | - | 2 | - | 3 | 2 | - | - |
| **CO 2** | - | - | 2 | 3 | 2 | - | - |
| **CO 3** | 2 | - | - | 3 | 2 | - | - |
| **CO 4** | 2 | - | - | 3 | 2 | - | - |
| **CO 5** | - | - | - | 3 | 2 | - | - |

**Assessment Pattern**

| Bloom's Category | End Semester Examination |
|---|---|
| Apply | 35% |
| Analyse | 50% |
| Evaluate | 15% |
| Create | - |

**Mark distribution**

| Total Marks | CIE | ESE | ESE Duration |
|---|---|---|---|
| 100 | 40 | 60 | 2.5 hours |

**Continuous Internal Evaluation Pattern: 40 marks**

Micro/Course based project : 20 marks

Course based /Seminar/Quiz : 10 marks

Test paper, 1 no. : 10 marks

Test paper shall include minimum 80% of the syllabus.

**End Semester Examination Pattern: 60 marks**

The end semester examination will be conducted by the respective College. There will be two parts; Part A and Part B.

Part A will contain 5 numerical/short answer questions with one question from each module; having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions.

Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

**Model Question Paper**

**QP CODE:** **PAGES:**

**Reg No: _____** **Name: _____**

**SAHRDAYA COLLEGE OF ENGINEERING AND TECHNOLOGY**
**SECOND SEMESTER M. TECH DEGREE EXAMINATION, MONTH & YEAR**
**Course Code: 242TBT004**

Max. Marks: 60 Duration: 2.5 hrs.

**Advanced Bioprocess Engineering**

**PART – A**

Answer All the Questions.

One question from each module, having 5 marks for each question.

(5x 5 = 25)

1. Elaborate on yield coefficients on biomass. Give the relevant mathematical expressions
2. Explain the need of model development in biotechnological process
3. Explain the kinetics of substrate concentration in a CSTR
4. Explain the factors affecting the scaleup of a fermenter.
5. What is a Biosensor and different types of biosensors used for the monitoring of a reactor?

**PART – B**

Minimum one question from each module (Total seven questions)

Answer any five (5 x 7 = 35)

6. Discuss the oxygen consumption and heat evolution in aerobic cultures
7. Elaborate cybernetic models of a system based on enzyme concentration
8. Describe the operation of chemostat in series
9. What are the main parameters to be monitored and controlled in a bioreactor?
10. Explain biosensor based on thermal effects and its applications
11. Elaborate the steps involved in the mass transfer of oxygen in a bioreactor.
12. What are the parameter estimation techniques for biochemical process?

********

## SYLLABUS

**Module I (8 hours)**

**Stoichiometry of Cell Growth:** Yield coefficients of biomass and product formation, Elemental balances, heat balance, degrees of reduction of substrates and biomass, systematic analysis of black box stoichiometries, and identification of gross measurement errors. oxygen consumption and heat evolution in aerobic cultures. Thermodynamic efficiency of growth.

**Module II (8 hours)**

**Modelling Of Various Fermentation Processes:** Principles of model building for biotechnological processes, unstructured models on the population level, structured models on the cellular level, morphologically structured model, genetically structured models, cybernetic model, modelling of recombinant systems

**Module III (8 hours)**

**Design Of Fermentation Processes:** Kinetics of substrate utilization, biomass growth and product formation, inhibition of cell growth and product formation. Design and operation of continuous cultures, chemostat in series, batch and fed batch cultures, total cell retention cultivation

**Module IV (8 hours)**

**Bioreactor Design & Construction:** Basic design and construction of CSTR, bioreactor design of agitator / agitator motor, power consumption in aerated bioreactor, design of sparger, mixing time estimation, oxygen mass transfer capability in bioreactor, Removal of Heat in bioreactor, Main parameters to be monitored and controlled

**Module V (8 hours)**

**Monitoring Of Bioprocess:** On line data analysis for measurement and control of important physicochemical and biochemical parameters. Biosensors based on thermal effects, optical effects, potentiometric biosensors, Amperometric biosensors, enzyme electrodes, transducers. Parameter estimation techniques for biochemical processes, Computer based data acquisition.

**Course Plan**

| No | Topic | No. of Lectures |
|---|---|---|
| 1 | **Stoichiometry of Cell Growth (8 hours)** | |
| 1.1 | Yield coefficients of biomass and product formation | 2 |
| 1.2 | Elemental balances, heat balance | 1 |
| 1.3 | Degrees of reduction of substrates and biomass | 1 |
| 1.4 | Systematic analysis of black box stoichiometries | 1 |
| 1.5 | Identification of gross measurement errors | 1 |
| 1.6 | Oxygen consumption and heat evolution in aerobic cultures | 1 |
| 1.7 | Thermodynamic efficiency of growth | 1 |
| 2 | **Modelling Of Various Fermentation Processes (8 hours)** | |
| 2.1 | Principles of model building for biotechnological processes | 1 |
| 2.2 | Unstructured models on the population level | 2 |
| 2.3 | Structured models on the cellular level | 1 |
| 2.4 | Morphologically structured model | 1 |
| 2.5 | Genetically structured models | 1 |
| 2.6 | Cybernetic model | 1 |
| 2.7 | Modelling of recombinant systems | 1 |
| 3 | **Design Of Fermentation Processes (8 hours)** | |
| 3.1 | Kinetics of substrate utilization | 1 |
| 3.2 | Biomass growth and product formation | 1 |
| 3.3 | Inhibition of cell growth and product formation | 1 |
| 3.4 | Design and operation of continuous cultures, | 2 |
| 3.5 | Chemostat in series, batch and fed batch cultures, | 2 |
| 3.6 | Total cell retention cultivation | 1 |
| 4 | **Bioreactor Design & Construction (8 hours)** | |

| | | |
|---|---|---|
| 4.1 | Basic design and construction of CSTR | 1 |
| 4.2 | Bioreactor design of agitator / agitator motor | 1 |
| 4.3 | Power consumption in aerated bioreactor | 1 |
| 4.4 | Design of sparger | 1 |
| 4.5 | Mixing time estimation | 1 |
| 4.6 | Oxygen mass transfer capability in bioreactor | 1 |
| 4.7 | Removal of Heat in bioreactor | 1 |
| 4.8 | Main parameters to be monitored and controlled | 1 |
| 5 | **Monitoring Of Bioprocess (8 hours)** | |
| 5.1 | On line data analysis for measurement and control of important physicochemical and biochemical parameters. | 2 |
| 5.2 | Biosensors based on thermal effects, optical effects | 1 |
| 5.3 | Potentiometric biosensors, Amperometric biosensors | 1 |
| 5.4 | Enzyme electrodes, transducers | 1 |
| 5.5 | Parameter estimation techniques for biochemical processes | 1 |
| 5.6 | Computer based data acquisition | 2 |

**Reference Book**

1. Lydersen B.K., “Bioprocess Engineering Systems, Equipment and Facilities” , Wiley-Blackwell, 2nd edition, 2010.
2. Bailey, J.E. and Ollis, D.F. “Biochemical Engineering Fundamentals", 2nd Edition, McGraw Hill, 2017.
3. Stanbury, P.F., Stephen J.H., Whitaker A., “Principles of Fermentation Technology”, Science & Technology Books, 2nd edition, 2009.

| 242TBT005 | APPLIED GENETIC ENGINEERING | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | Program Core 3 | 3 | 0 | 0 | 3 |

**Preamble:** Genetic engineering is the targeted addition of a foreign gene or genes into the genome of an organism. These techniques and its variations have been used successfully to develop novel genes of economic importance that can be used to improve the genetics of crop plants, livestock and in vaccines or medical therapeutics. This subject looks at the advances, techniques and their economic and social applications.

**Pre-requisites**: Nil

**Course Outcomes:**

After the completion of the course the student will be able to

| | |
|---|---|
| **CO 1** | Articulate about rDNA technology and undertake research work in Modern Biotechnology. |
| **CO 2** | Distinguish different methods of transformation and their use in Genetic Engineering. |
| **CO 3** | Describe about different enzymes used in genetic engineering for DNA manipulations. |
| **CO 4** | Analyze the safety guidelines and public concerns for r-DNA technology. |

**Mapping of course outcomes with program outcomes**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 |
|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | | | 2 | | 2 | |
| **CO 2** | 2 | | | | | | |
| **CO 3** | | | | 2 | | | |
| **CO 4** | 2 | | | 2 | | 2 | |

**Assessment Pattern**

| Bloom's Category | End Semester Examination |
|---|---|
| Apply | 40% |
| Analyse | 25% |
| Evaluate | 25% |
| Create | 10% |

**Mark distribution**

| Total Marks | CIE | ESE | ESE Duration |
|---|---|---|---|
| 100 | 40 | 60 | 2.5 hours |

**Continuous Internal Evaluation Pattern: 40 marks**

Micro/Course based project : 20 marks

Course based /Seminar/Quiz : 10 marks

Test paper, 1 no. : 10 marks

Test paper shall include minimum 80% of the syllabus.

**End Semester Examination Pattern: 60 marks**

The end semester examination will be conducted by the respective College. There will be two parts; Part A and Part B.

Part A will contain 5 numerical/short answer questions with one question from each module; having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions.

Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

**Model Question Paper**

**QP CODE:** **PAGES:**

**Reg No: _____** **Name: _____**

**SAHRDAYA COLLEGE OF ENGINEERING AND TECHNOLOGY**
**SECOND SEMESTER M. TECH DEGREE EXAMINATION, MONTH & YEAR**
**Course Code: 242TBT005**

Max. Marks: 60 Duration: 2.5 hrs.

**Applied Genetic Engineering**

**PART – A**

Answer All the Questions.

One question from each module, having 5 marks for each question.

(5x 5 = 25)

1. Briefly describe the significance of biosafety guidelines.
2. Give the applications of gene therapy.
3. Discuss the significance of gene libraries.
4. Discuss the use of enzymes in Genetic Engineering.
5. Recall the different product obtained through biopharming.

**PART – B**

Minimum one question from each module (Total seven questions)

Answer any five (5 x 7 = 35)

6. Discuss in detail about the mechanism of control of oil spillage.
7. Briefly describe the significance of restriction endonucleases.
8. Enumerate the techniques implemented for livestock improvement.
9. Elaborate the products obtained through molecular pharming.
10. Elaborate on the technique of gene therapy.
11. Exemplify various forms of PCRs.
12. Give a brief account on cDNA library.

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## SYLLABUS

**Module 1 (7 hours)**

**rDNA Technology:** Method of creating recombinant DNA molecules, types, features of vectors in recombinant DNA technology: plasmids, phages, cosmids, fosmids, phagemids, and artificial chromosomes, safety guidelines for recombinant DNA research, control of spills and mechanism of implementation of biosafety guidelines.

**Module 2 (9 hours)**

**Role of enzymes in Genetic Engineering:** Restriction nucleases: exo & endo nucleases, Enzymes in modification- Polynucleotide phosphorylase, DNase and their mechanism of action,Enzymes in modification- Methylases and phosphatases and their mechanism of action. Polynucleotide kinase, Ligases, RNase and their mechanism of action.

Methods of nucleic acid detection, Polymerase chain reaction (PCR) and its applications, types of PCR and their applications, Methods of nucleic acid hybridization, probes, Nucleic acid mutagenesis *in vivo* and *in vitro*.

**Module 3 (7 hours)**

**DNA library:** Isolation and purification of nucleic acid (genomic/plasmid DNA and RNA), Quantification of nucleic acids, construction of cDNA library and genomic library, screening and preservation of DNA libraries, DNA Sequencing and cloning strategies.

**Module 4 (9 hours)**

**Gene transfer techniques:** Chemical and biological methods,Agrobacterium- mediated gene transfer in plants-applications in the field of agriculture , Chloroplast transformation. Transgenic science in plant and animal improvement, Biopharming- animals and plants as bioreactor for recombinant protein, Gene mapping in plants and animals, Marker-assisted selection for plant breeding and livestock improvement

**Module 5 (8 hours)**

**Genetic manipulation:** Engineering microbes for the production of antibiotics and enzymes, Engineering microbes for the production of insulin, growth hormones, monoclonal antibodies, Engineering microbes for clearing oil spills. Gene therapy: methods and applications, Gene targeting and silencing, Gene therapy in the treatment of diseases, Challenges and future of gene therapy

| Course Plan | | |
|---|---|---|
| **No** | **Topic** | **No. of Lectures** |
| 1 | **rDNA Technology (7 hours)** | |
| 1.1 | Method of creating recombinant DNA molecules, types, features of vectors in recombinant DNA technology | 2 |
| 1.2 | Plasmids, phages, cosmids, fosmids, phagemids, and artificial chromosomes | 2 |
| 1.3 | Safety guidelines for recombinant DNA research | 2 |
| 1.4 | Control of spills and mechanism of implementation of biosafety guidelines. | 1 |
| 2 | **Role of enzymes in Genetic Engineering (9 hours)** | |
| 2.1 | Restriction nucleases: exo & endo nucleases, Enzymes in modification- Polynucleotide phosphorylase, DNase and their mechanism of action | 2 |
| 2.2 | Enzymes in modification- Methylases and phosphatases and their mechanism of action. Polynucleotide kinase, Ligases, RNase and their mechanism of action. | 3 |
| 2.3 | Methods of nucleic acid detection, Polymerase chain reaction (PCR) and its applications, types of PCR and their applications | 2 |
| 2.4 | Methods of nucleic acid hybridization, probes, Nucleic acid mutagenesis in vivo and in vitro. | 2 |
| 3 | **DNA library (7 hours)** | |
| 3.1 | Isolation and purification of nucleic acid (genomic/plasmid DNA and RNA) | 1 |
| 3.2 | Quantification of nucleic acids | 1 |
| 3.3 | Construction of cDNA library and genomic library | 3 |
| 3.4 | Screening and preservation of DNA libraries, DNA Sequencing and cloning strategies. | 2 |
| 4 | **Gene transfer techniques (9 hours)** | |
| 4.1 | Chemical and biological methods, Agrobacterium- mediated gene transfer in plants-applications in the field of agriculture, | 3 |

| | | |
|---|---|---|
| 4.2 | Chloroplast transformation. Transgenic science in plant and animal improvement | 2 |
| 4.3 | Biopharming- animals and plants as bioreactor for recombinant protein, | 2 |
| 4.4 | Gene mapping in plants and animals, Marker-assisted selection for plant breeding and livestock improvement | 2 |
| 5 | **Genetic manipulation (8 hours)** | |
| 5.1 | Engineering microbes for the production of antibiotics and enzymes | 2 |
| 5.2 | Engineering microbes for the production of insulin, growth hormones, monoclonal antibodies, | 2 |
| 5.3 | Engineering microbes for clearing oil spills. Gene therapy: methods and applications | 2 |
| 5.4 | Gene targeting and silencing, Gene therapy in the treatment of diseases, Challenges and future of gene therapy | 2 |

**Reference Books**

1. Principles of Gene Cloning by Old and Primrose
2. Gene Cloning & DNA Analysis: An Introduction (4th edition) by T.A. Brown.
3. B.R.Glick & Jack J Pasternak ―Molecular Biotechnology.
4. From Genes to Genomes: Concepts & Applications of DNA Technology by J.W. Dale & M.V.

| 242EBT100 | BIOREACTOR DESIGN AND ANALYSIS | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | Program elective 3 | 3 | 0 | 0 | 3 |

**Preamble:**

To provide an understanding of the basic principles of the design of reactors for bioprocesses, develop mathematical descriptions of reaction kinetics and their relationships with reactor design and use them to analyze their behavior, and introduce scale-up and scale-down concepts.
After the completion of the course, the student will be able to

**Pre-requisites**: Nil

**Course Outcome**

| | |
|---|---|
| **CO 1** | To understand components and classification of Bioreactors. |
| **CO 2** | To study and analyze the biochemical aspects of Bioreactors. |
| **CO 3** | To understand, analyze and study the design aspects of the Bioreactors. |
| **CO 4** | To Understand, and analyze the performance, scale up and scale down of Bioreactors. |

**Mapping of course outcomes with program outcomes**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO7 |
|---|---|---|---|---|---|---|---|
| **CO 1** | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| **CO 2** | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| **CO 3** | 2 | 3 | 3 | 3 | 3 | 2 | 2 |
| **CO 4** | 2 | 3 | 3 | 3 | 3 | 2 | 2 |

**Assessment Pattern**

| Bloom's Category | End Semester Examination |
|---|---|
| Apply | 35 |
| Analyse | 35 |
| Evaluate | 15 |
| Create | 15 |

**Mark distribution**

| Total Marks | CIE | ESE | ESE Duration |
|---|---|---|---|
| 100 | 40 | 60 | 2.5 hours |

**Continuous Internal Evaluation Pattern: 40 marks**

| | |
|---|---|
| Micro/Course based project | : 15 marks |
| Course based /Seminar/Quiz | : 15 marks |
| Test paper, 1 no. | : 10 marks |

Test paper shall include minimum 80% of the syllabus.

**End Semester Examination Pattern: 60 marks**

The end semester examination will be conducted by the respective College. There will be two parts; Part A and Part B.

Part A will contain 5 numerical/short answer questions with one question from each module; having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions.

Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

**Model Question Paper**

**QP CODE:** **PAGES:**

**Reg No: _____** **Name: _____**

**SAHRDAYA COLLEGE OF ENGINEERING AND TECHNOLOGY**
**SECOND SEMESTER M. TECH DEGREE EXAMINATION, MONTH & YEAR**
**Course Code: 242EBT100**

Max. Marks: 60 Duration: 2.5 hrs.

**Bioreactor Design and Analysis**

**PART – A**

Answer All the Questions.

One question from each module, having 5 marks for each question.

(5x 5 = 25)

1. Mention 5 guidelines for bioreactor design.
2. Yeast growing in continuous culture produce 0.37g biomass per g glucose consumed; about 0.88g O2 is consumed per g cells formed. The nitrogen source is ammonia and the biomass composition is CH1.79O0.56N0.17. Are other products also synthesized?
3. Derive the dispersion model for non-ideal plug flow reactors.
4. Explain how dimensional analysis can be used in the scale-up of bioreactors.
5. Discuss the factors which are responsible for the lifetime of the membrane.

**PART – B**

Minimum one question from each module (Total seven questions)

Answer any five (5 x 7 = 35)

6. Explain the operation of a membrane aerated and perfused animal cell bioreactor.
7. (i) Write a brief note on the reactor operation for immobilized system.
   (ii) It is desired to develop a bioreactor which can withstand sterilization temperature and pressure. Explain the step-wise design procedure you will adopt to develop the vessel wall of bioreactor.
8. (i) Consider a situation where the heat of bioreaction causes a variation in the temperature. Discuss the set of rules you would follow for writing the energy balance.
   (ii) Malonic acid and water are initially at 25oC. If 15g malonic acid is dissolved in 5kg water, how much heat must be added for the solution to remain at 25 oC? What is the solution enthalpy relative to the components; $\Delta hm$=4.493Kcalgmol-1
9. (i) Aerobic degradation of benzoic acid by a mixed culture of microorganism can be represented by the following reaction.

C6H5COOH + aO2 + bNH3 □ cC5H7NO2 + dH2O + eCO2

Determine a, b, c, d, and e if RQ = 0.9

Determine the yield coefficients, YX/S and YX/O2

(ii) From simple material balance considerations, derive an expression for the batch processing time to reduce the substrate concentration from S0 to Sf with substrate uptake rate in presence of product formation

10. (i)The production of an enzyme is desired in a chemostat operation. The system operates at steady state. A few related parameters are given below:

$D = 0.2\ h^{-1}$; $\mu_{\max} = 0.8\ h^{-1}$; $K_s = 0.05\ kg\ m^{-3}$; $Y_{X/S} = 0.4$; $S_i = 20\ kg\ m^{-3}$

Calculate the substrate and cell concentrations at steady state.

(ii) Aerobic degradation of benzoic acid by a mixed culture of microorganism can be represented by the following reaction.

C6H5COOH + aO2 + bNH3 □ cC5H7NO2 + dH2O + eCO2

Determine a, b, c, d, and e if RQ = 0.9

Determine the yield coefficients, YX/S and YX/O2

11. (i) A newly isolated microbial enzyme is produced in a small-scale agitated fermenter vessel. It is required to transform the small-scale vessel to a commercial-scale agitated fermenter. What criteria are translated between two scales of operation during scale-up? Explain

(ii) Describe the scale-down approach of bioreactor optimisation. Explain its principle and the common strategy used in this approach

12. Write notes on the following: Regime analysis, Hubbard method of scale-up

********

## SYLLABUS

**Module I (8 hours)**

**Overview of bioreactors** - Classification of bioreactors, major components of a typical stirred tank bioreactor with functions, basic features of special purpose bioreactors such as membrane bioreactors, perfusion bioreactors, pulsating column bioreactor, photobioreactors, bioreactors for animal and plant cell cultivation, microbioreactors, centrifugal field reactors, rotating drum bioreactor, bioreactors for environmental applications.

**Module II (8 hours)**

**Biochemical aspects of bioreactor design** - Stoichiometry of bioreactions, mass balances for bioreactors, yield factors, application of yield factors to arrive at single-carbon and energy yielding substrate, determination of yield factors, distinction between observed yields and true yields, factors influencing yield, degree of reductance of substrate and its influence on yield coefficient, general energy balance in bioreactors, numerical problems.

**Module III (7 hours)**

**Design aspects of bioreactors**- bioreactor geometry, bioreactor vessels, agitator assembly, mass transfer aspects, rheology and mixing, design, operation and types of agitators, power requirements for agitation, effects of agitation on mass transfer, oxygen delivery system - spargers, foam control system, oxygen uptake in fermenters.

**Module IV(9 hours)**

**Analysis of bioreactor performance** - Development of performance equations for ideal batch, CSTR and plug flow reactors, non-ideal behaviour in bioreactors, models for non-ideal reactors, transient behaviour in bioreactors, stability of bioreactors, phase-plane analysis, bifurcation analysis, numerical problems.

**Module V (8 hours)**

**Scale-up and Scale-down of bioreactors** - strategies and methods for scale-up, similarity criteria, Hubbard method, method of Wang et al., Ettler's method, dimensionless numbers and scale up, scale up based on aeration and power requirement, regime analysis and the scale-down bioreactor.

**Course Plan**

| No | Topic | No. of Lectures |
|---|---|---|
| 1 | **Overview of bioreactors (8 hours)** | 1 |
| 1.1 | Classification of bioreactors | 1 |
| 1.2 | Major components of a typical stirred tank bioreactor with functions | 1 |
| 1.3 | Basic features of special purpose bioreactors such as membrane bioreactors | 1 |
| 1.4 | Perfusion bioreactors, pulsating column bioreactor | |
| 1.5 | Photobioreactors, bioreactors for animal and plant cell cultivation, | 1 |
| 1.6 | Microbioreactors | 1 |
| 1.7 | Bioreactors for immobilised enzymes and cells | 1 |
| 1.8 | Bioreactors for environmental applications | 1 |
| 2 | **Mechanical aspects of bioreactor design (8 hours)** | |
| 2.1 | Biochemical aspects of bioreactor design | 1 |
| 2.2 | Stoichiometry of bioreactions, | 1 |
| 2.3 | Mass balances for bioreactors, yield factors | 1 |
| 2.4 | Application of yield factors to arrive at single-carbon and energy yielding substrate, biomass and product formation | |
| 2.5 | Nitrogen and oxygen requirements, | 1 |
| 2.6 | Experimental determination of yield factors | 1 |
| 2.7 | Distinction between observed yields and true yields, factors influencing yield | 1 |
| 2.8 | Degree of reductance of substrate and its influence on yield coefficient | |
| 2.9 | General energy balance in bioreactors | 1 |
| 3 | **Design aspects of bioreactors (7 hours)** | 1 |
| 3.1 | Bioreactor geometry, bioreactor vessels, agitator assembly | 1 |
| 3.2 | Mass transfer aspects, rheology and mixing, design, operation and types of agitators | 1 |
| 3.3 | Power requirements for agitation, effects of agitation on mass transfer | 2 |
| 3.4 | Oxygen delivery system - spargers, foam control system, oxygen uptake in fermenters | 2 |
| 4 | **Analysis of bioreactor performance (9 hours)** | 1 |
| 4.1 | Development of performance equations for ideal batch, CSTR and plug flow reactors, | 1 |
| 4.2 | Non-ideal behaviour in bioreactors | 1 |
| 4.3 | Models for non-ideal reactors | 1 |
| 4.4 | Prediction of conversion in non-ideal chemostat, | 1 |
| 4.5 | Transient behaviour in bioreactors, | 1 |

| | | |
|---|---|---|
| | Stability of bioreactors, | 1 |
| 27 | Phase-plane analysis, bifurcation analysis, | 1 |
| 30 | Numerical problems | 1 |
| 31 | **Scale-up and Scale-down of bioreactors (8 hours)** | 1 |
| 32 | Strategies and methods for scale-up, similarity criteria | 1 |
| 33 | Hubbard method, method of Wang et al., Ettler's method | 1 |
| 34 | Dimensionless numbers and scale up | 1 |
| 35 | Scale up based on aeration and power requirement | 1 |
| 36 | Regime analysis | 1 |
| 37 | Scale-down bioreactor. | 1 |

**Reference Books**


1. Tapobrata Panda., "Bioreactors - Analysis and Design", Tata McGraw-Hill Education.
2. Michael L. Shuler, Fikret Kargi., "Bioprocess Engineering: Basic Concepts", (2nd Edition), Prentice Hall.
3. James Edwin Bailey., "Biochemical Engineering Fundamentals", McGraw-Hill.
4. Alan H. Scragg, Bioreactors in biotechnology: a practical approach" Ellis Horwood Limited.

| 242EBT001 | APPLIED NANOBIOTECHNOLOGY | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | Program Elective 3 | 3 | 0 | 0 | 3 |

**Preamble:**

To understand the synthesis, characterization, applications and safety aspects of nanomaterials.

**Pre-requisites**: Nil

**Course Outcomes**: After the completion of the course, the student will be able to

| | |
|---|---|
| **CO 1** | Analyse the properties, methods of synthesis and characterization of nanostructures in Biotechnology |
| **CO 2** | Evaluate the cellular nanostructures and understand their functions |
| **CO 3** | Apply the knowledge of nanostructures and evaluate their applications in industry and health care |
| **CO 4** | Describe the ethical and socio-economic challenges |

**Mapping of course outcomes with program outcomes**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 |
|---|---|---|---|---|---|---|---|
| **CO 1** | 2 | - | 2 | 3 | 2 | 2 | - |
| **CO 2** | 2 | - | 2 | 3 | - | 2 | - |
| **CO 3** | 2 | - | 2 | 3 | 2 | 2 | - |
| **CO 4** | - | - | 2 | 3 | - | - | - |

**Assessment Pattern**

| Bloom's Category | End Semester Examination |
|---|---|
| Apply | 40% |
| Analyse | 25% |
| Evaluate | 25% |
| Create | 10% |

**Mark distribution**

| Total Marks | CIE | ESE | ESE Duration |
|---|---|---|---|
| 100 | 40 | 60 | 2.5 hours |

**Continuous Internal Evaluation Pattern: 40 marks**

| | |
|---|---|
| Micro/Course based project | : 15 marks |
| Course based /Seminar/Quiz | : 15 marks |
| Test paper, 1 no. | : 10 marks |

Test paper shall include minimum 80% of the syllabus.

**End Semester Examination Pattern: 60 marks**

The end semester examination will be conducted by the respective College. There will be two parts; Part A and Part B.

Part A will contain 5 numerical/short answer questions with one question from each module; having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions.

Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

**Model Question Paper**

**QP CODE:** **PAGES:**

**Reg No: _____** **Name: _____**

**SAHRDAYA COLLEGE OF ENGINEERING AND TECHNOLOGY**
**SECOND SEMESTER M. TECH DEGREE EXAMINATION, MONTH & YEAR**
**Course Code: 242EBT001**

Max. Marks: 60 Duration: 2.5 hrs.

**Applied Nanobiotechnology**

**PART – A**

Answer All the Questions.

One question from each module, having 5 marks for each question.

(5x 5 = 25)

1. Elucidate the types of nanostructures on the basis for size.
2. Demonstrate the salient features of a resonance-based method for the characterization of nanostructures.
3. Comment on the self-assembly of protein-based nanostructure.
4. Justify the role of lipid-based nanostructures in drug delivery.
5. Explain any two methods for the modification of nanomaterials to make them eco-friendly.

**PART – B**

Minimum one question from each module (Total seven questions)

Answer any five (5 x 7 = 35)

6. Demonstrate the applications of nano materials in analytical applications.
7. Elucidate the spectroscopic methods used for characterization of nanostructures.
8. Explain the importance of studying the thermal properties.
9. Elaborate on the self-assembled DNA nanotubes.
10. Exemplify the significance of biofunctionalization of nanostructures.
11. Illustrate the importance of nanomaterials in pharmaceutical applications.
12. Elaborate on the ethical and socio-economic challenges of nanomaterials.

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## SYLLABUS

**Module 1 (8 hours)**

Nanobiotechnology- Introduction and types. Progress, prospects and challenges. Applications – medical, environment, food and analytical applications. Methods of synthesis – Chemical, Physical and Biological.

**Module 2 (8 hours)**

**Characterisation**: Structural: X-ray diffraction, Scanning Electron Microscopy (SEM), Scanning Probe Microscopy (SPM), TEM and EDAX analysis, Scanning Tunneling Microscopy (STM), Atomic force Microscopy (AFM). Spectroscopic: Basic concepts of spectroscopy: UV-VIS-IR Spectrophotometers, Raman spectroscopy. Resonance Methods: Electron Spin Resonance (ESR), Ferromagnetic Resonance (FMR), Nuclear Magnetic Resonance (NMR). Thermal: DTA, TGA, DSC (Principle and Applications).

**Module 3 (8 hours)**

Protein and Peptide based Nanostructures- S-layers-Chemistry and structure and Assembly. Magnetosomes- Bacteriorhodopsins - Nanoproteomics. DNA based Nanostructures- DNA-protein nanostructures - Methods- Self assembled DNA nanotubes—Nucleic acid Nanoparticles, DNA as a Biomolecular template - Properties.

**Module 4 (8 hours)**

Pharmaceutically important nanomaterials - Drug Nanoparticles- Structure and Preparation, Liposomes, Cubosomes and Hexosomes, Lipid based Nanoparticles-Liquid nanodispersions-Solid Lipid Nanoparticles (SLP). Biofunctionalization and Characterization- Nanoparticles for crossing biological membranes. Fundamentals- Physicochemical Principles of Nanosized Drug Delivery Systems. Biosensors – Point-of-care devices, Personalized medicine, Lab on a chip).

**Module 5 (8 hours)**

Risk assessment of nano materials – toxicity of nanomaterials – biological toxicity and environmental toxicity, legal issues, life-cycle assessment and risk assessment, reasons for toxicity, toxicity assessment, modification of nanomaterials to make them eco-friendly.

**Course Plan**

| No | Topic | No. of Lectures |
|---|---|---|
| 1 | **Nanobiotechnology- Introduction (8hours)** | |
| 1.1 | Introduction | 2 |
| 1.2 | Types | 1 |
| 1.3 | Progress and prospects | 1 |
| 1.4 | Challenges | 1 |
| 1.5 | Applications- Medical | 1 |
| 1.6 | Applications- Environment, food and analytical | 2 |
| 2 | **Characterization (8 hours)** | |
| 2.1 | Structural: X-ray diffraction, Scanning Electron Microscopy (SEM) | 1 |
| 2.2 | Scanning Probe Microscopy (SPM), TEM and EDAX analysis | 2 |
| 2.3 | Scanning Tunneling Microscopy (STM), Atomic force Microscopy (AFM) | 1 |
| 2.4 | Spectroscopic: Basic concepts of spectroscopy: UV-VIS-IR Spectrophotometers, Raman spectroscopy | 1 |
| 2.5 | Resonance Methods: Electron Spin Resonance (ESR), Ferromagnetic Resonance (FMR), Nuclear Magnetic Resonance (NMR). | 2 |
| 2.6 | Thermal: DTA, TGA, DSC (Principle and Applications) | 1 |
| 3 | **Protein and DNA based structures (8 hours)** | |
| 3.1 | Protein and Peptide based Nanostructures- S-layers-Chemistry and structure and Assembly | 2 |
| 3.2 | Magnetosomes- Bacteriorhodopsins- Nanoproteomics | 2 |
| 3.3 | DNA based Nanostructures | 1 |
| 3.4 | DNA-protein nanostructures | 1 |
| 3.5 | Self-assembled DNA nanotubes—Nucleic acid Nanoparticles | 1 |
| 3.6 | Nucleic acid Nanoparticles, DNA as a Biomolecular template - Properties | 1 |
| 4 | **Pharmaceutically important nanomaterials & Biomedical applications (8 hours)** | |
| 4.1 | Drug Nanoparticles- Structure and Preparation, Liposomes, Cubosomes and Hexosomes | 2 |
| 4.2 | Lipid based Nanoparticles-Liquid nanodispersions- Solid Lipid Nanoparticles (SLP) | 1 |
| 4.3 | Biofunctionalization and Characterization- Nanoparticles for crossing biological membranes. | 1 |

| | | |
|---|---|---|
| 4.4 | Fundamentals- Physicochemical Principles of Nanosized Drug Delivery Systems | 2 |
| 4.5 | Biosensors – Point-of-care devices, Personalized medicine, Lab on a chip). | 2 |
| 5 | **Risk assessment of nano materials (8 hours)** | |
| 5.1 | Toxicity of nanomaterials – biological toxicity and environmental toxicity, legal issues | 2 |
| 5.2 | life-cycle assessment and risk assessment, reasons for toxicity, toxicity assessment | 3 |
| 5.3 | Modification of nanomaterials to make them ecofriendly | 3 |

**Reference Books**


1. Christof M Niemeyer, Chad A Mirkin (Eds.), *Nano biotechnology: Concepts, Applications and Perspectives*, Wiley VCH, 2004.
2. Tuan Vo-Dinh (Ed.), *Nanotechnology in Biology and Medicine: Methods, Devices, and Applications*, CRC Press, 2007.
3. Chandran Karunakaran, Kalpana Bhargava, Robson Benjamin (Eds.), *Biosensors and Bioelectronics*, Elsevier, 2015.
4. David S Goodsell, *Bionanotechnology*, John Wiley & Sons, 2004.
1. Mark Wiesner, Jean-Yves Bottero, *Environmental Nanotechnology: Applications and Impacts of nanomaterials*, McGraw Hill, 2007.

| 242EBT002 | BIO-SENSORS AND INSTRUMENTATION | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | Program Elective 3 | 3 | 0 | 0 | 3 |

**Preamble:** Acquaint the students with knowledge regarding the basic physiology and different types of biosensors used in medical applications.

**Pre-requisites**: Nil

**Course Outcomes:** After the completion of the course the student will be able to

| | |
|---|---|
| **CO 1** | Know about the significance of biosensors and their applications |
| **CO 2** | Understand various types of signals and design signal processing systems |
| **CO 3** | Apply the signalling aspects in basic cell physiology |
| **CO 4** | Design the systems for measuring the blood flow and pressure |
| **CO 5** | Analyse and design the respiratory monitors |

**Mapping of course outcomes with program outcomes**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 |
|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | 2 | - | - | 2 | - | - |
| **CO 2** | 3 | 2 | - | - | 2 | - | - |
| **CO 3** | 3 | 2 | 2 | 2 | 2 | - | - |
| **CO 4** | 3 | 2 | 2 | 2 | 2 | - | - |
| **CO 5** | 3 | 2 | 2 | 2 | 2 | - | - |

**Assessment Pattern:**

| Bloom's Category | End Semester Examination |
|---|---|
| Apply | 35% |
| Analyse | 50% |
| Evaluate | 15% |
| Create | |

**Mark distribution:**

| Total Marks | CIE | ESE | ESE Duration |
|---|---|---|---|
| 100 | 40 | 60 | 2.5 hours |

**Continuous Internal Evaluation Pattern: 40 marks**

Micro/Course based project : 15 marks

Course based /Seminar/Quiz : 15 marks

Test paper, 1 no. : 10 marks

Test paper shall include minimum 80% of the syllabus.

**End Semester Examination Pattern: 60 marks**

The end semester examination will be conducted by the respective College. There will be two parts; Part A and Part B.

Part A will contain 5 numerical/short answer questions with one question from each module; having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions.

Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

**Model Question Paper**

**QP CODE:** **PAGES:**

**Reg No: _____** **Name: _____**

**SAHRDAYA COLLEGE OF ENGINEERING AND TECHNOLOGY**
**SECOND SEMESTER M. TECH DEGREE EXAMINATION, MONTH & YEAR**
**Course Code: 242EBT002**

Max. Marks: 60 Duration: 2.5 hrs.

**Bio-Sensors and Instrumentation**

**PART – A**

Answer All the Questions.

One question from each module, having 5 marks for each question.

(5x 5 = 25)

1. Explain the classification of medical electronic devices.
2. Explain the concept of signal transduction
3. Give a description about ionic currents in a single cell.
4. Explain the physiology of circulatory system in detail
5. Give a brief description about oxymetry and spectrometry

**PART – B**

Minimum one question from each module (Total seven questions)

Answer any five (5 x 7 = 35)

6. Explain the working principle for pacemakers
7. Discuss the methods used for signal processing
8. Explain the working of electrocardiography based on the physiology
9. Discuss non-invasive pressure monitoring methods
10. Explain the working of respiratory monitors
11. Explain the principle of Doppler Ultrasound.
12. Explain the working of closed loop systems.

**SYLLABUS**

**Module 1 (8 hours)**

**Introduction**: Overview of Course, Types of medical electronic devices- Pacemakers, Defibrillators, Drug-releasing pumps, Heart Rate Monitors, Blood Pressure Monitors, Hearing aids X-Rays, MRI Scans, CT scans, General characteristics of biomedical signals.

**Module 2 (5 hours)**

**Basic concepts: Mathematical descriptions of random signals,** Measurement systems fundamentals- Transduction, Signal processing methods, Close loop systems, Equipment specifications

**Module 3 (12 hours)**

**Bio-potentials:** Origin- Ionic currents in a single cell, Action potentials (nerve and muscle), Multiple cells: Generation of body-surface potentials, Electrocardiography (EEG)- Physiology of the heart, Dipole concept, Lead systems, Electrodes, amplifiers, ECG instrument design, Electroencephalography (EEG), Electromyography (EMG)

**Module 4 (7 hours)**

**Blood Pressure and Flow Measurement**, Physiology of the circulatory system, Pressure transducers (invasive) - Strain-gauge (1, 2, 4-arm bridges), Inductive, Capacitive, Piezoelectric, Optical. Non-invasive pressure monitoring- Manual cuff, Oscillometric (Second lab assignment). Flow measurement- Indicator-dilution method (dye, thermal), Electromagnetic, Doppler ultrasound

**Module 5 (8 hours)**

**Respiratory Monitors**- Physiology of blood/gas exchange, Capnography, Oximetry, Clinical Chemistry, Spectrometry- Bee-Lambert law, Light sources, Wavelength selection: interference gratings, Photodetection. Electrochemical sensors- Potentimetric (pH, Pco2 electrodes), Amperometric (Po2 electrode). Hematology counting- Cell counting (Coulter principle) Cytometry

**Course Plan**

| No | Topic | No. of Lectures |
|---|---|---|
| 1 | **Introduction to biosensors and instrumentation (8 hours)** | 1 |
| 1.1 | Types of medical electronic devices | 1 |
| 1.2 | Pacemakers, Defibrillators, Drug-releasing pumps | 2 |
| 1.3 | Heart Rate Monitors, Blood Pressure Monitors, Hearing aids X-Rays | 2 |
| 1.4 | MRI Scans, CT scans | 1 |
| 1.5 | General characteristics of biomedical signals | 1 |
| 2 | **Mathematical descriptions of random signals (5 hours)** | 1 |
| 2.1 | Measurement systems fundamentals- Transduction, Signal processing methods | 1 |
| 2.2 | Close loop systems | 2 |
| 2.3 | Equipment specifications | 1 |
| 3 | **Bio-potentials (12 hours)** | 1 |
| 3.1 | Origin- Ionic currents in a single cell | 2 |
| 3.2 | Action potentials (nerve and muscle) | 1 |
| 3.3 | Multiple cells: Generation of body-surface potentials | 1 |
| 3.4 | Electrocardiography (EEG)- Physiology of the heart | 1 |
| 3.5 | Dipole concept, Lead systems, Electrodes, amplifiers | 2 |
| 3.6 | ECG instrument design, Electroencephalography (EEG) | 2 |
| 3.7 | Electromyography (EMG) | 2 |
| 4 | **Blood Pressure and Flow Measurement (7 hours)** | 1 |
| 4.1 | Physiology of the circulatory system | 1 |
| 4.2 | Pressure transducers (invasive) - Strain-gauge (1, 2, 4-arm bridges), Inductive, Capacitive, Piezoelectric, Optical | 1 |
| 4.3 | Non-invasive pressure monitoring- Manual cuff, Oscillometric (Second lab assignment). | 2 |

| | | |
|---|---|---|
| 4.4 | Flow measurement- Indicator-dilution method (dye, thermal), | 1 |
| 4.5 | Electromagnetic, Doppler ultrasound | 1 |
| 5 | **Respiratory Monitors (8 hours)** | 1 |
| 5.1 | Physiology of blood/gas exchange, Capnography | 1 |
| 5.2 | Oximetry, Clinical Chemistry | 1 |
| 5.3 | Spectrometry- Bee-Lambert law, Light sources | 2 |
| 5.4 | Wavelength selection: interference gratings, Photodetection | 2 |
| 5.5 | Electrochemical sensors- Potentimetric (pH, Pco2 electrodes) | 1 |

**Reference Books**

1. Donald L Wise, Bioinstrumentation and biosensors, Taylor and Francis, 1991
2. Jagriti Narang & C S Pundir, Biosensors, An introductory text book, Taylor and Francis, 2017
3. Chandran Karunakaran, Kalpana Bhargava, Robson Benjamin, Biosensors and bioelectronics,Elsevier, 2015
4. F Scheller, F Schubert, Biosensors, Elsevier, 1991

| 242EBT003 | APPLIED BIOINFORMATICS | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | Program Elective 3 | 3 | 0 | 0 | 3 |

**Preamble:**

Basic knowledge in Bioinformatics.

**Pre-requisites**: Nil

**Course Outcomes:** After the completion of the course the student will be able to

| | |
|---|---|
| **CO 1** | Articulate the use of various biological databases and resources to explore more about the biological world. |
| **CO 2** | Develop protein models based on the principles of Structural Bioinformatics |
| **CO 3** | Design drug molecules applying the techniques in Cheminformatics. |

**Mapping of course outcomes with program outcomes**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 |
|---|---|---|---|---|---|---|---|
| **CO 1** | | | | | 3 | | |
| **CO 2** | | | | 3 | 3 | | |
| **CO 3** | | | 3 | 3 | 3 | | |

**Assessment Pattern**

| Bloom's Category | End Semester Examination |
|---|---|
| Apply | 40% |
| Analyse | 30% |
| Evaluate | 15% |
| Create | 15% |

**Mark distribution**

| Total Marks | CIE | ESE | ESE Duration |
|---|---|---|---|
| 100 | 40 | 60 | 2.5 hours |

**Continuous Internal Evaluation Pattern: 40 marks**

Micro/Course based project : 15 marks

Course based /Seminar/Quiz : 15 marks

Test paper, 1 no. : 10 marks

Test paper shall include minimum 80% of the syllabus.

**End Semester Examination Pattern: 60 marks**

The end semester examination will be conducted by the respective College. There will be two parts; Part A and Part B.

Part A will contain 5 numerical/short answer questions with one question from each module; having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions.

Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

**Model Question Paper**

**QP CODE:** **PAGES:**

**Reg No: _____** **Name: _____**

**SAHRDAYA COLLEGE OF ENGINEERING AND TECHNOLOGY**
**SECOND SEMESTER M. TECH DEGREE EXAMINATION, MONTH & YEAR**
**Course Code: 242EBT003**

Max. Marks: 60 Duration: 2.5 hrs.

**Applied Bioinformatics**

**PART – A**

Answer All the Questions.

One question from each module, having 5 marks for each question.

(5x 5 = 25)

1. Recommend the different biological databank repositories for accessing biological data
2. Briefly explain about secondary structure prediction methods.
3. Write a short note on STRING database.
4. Explain about Protein Data Bank.
5. Discuss the significance of Virtual screening.

**PART – B**

Minimum one question from each module (Total seven questions)

Answer any five (5 x 7 = 35)

6. Briefly explain the role of Uniprot database.
7. Write about the significance of PSI-BLAST
8. Mention the major resources for Gene prediction.
9. Point out the methods employed in protein modeling.
10. Represent the notations used in a biological network.
11. Elaborate the role of molecular dynamics simulation of proteins.
12. Explain the significance of QSAR.

********

## SYLLABUS

**Module 1 (8 hours)**

**Databases and tools**, Major Biological Databases and Information Retrieval, Bioinformatics tools and automation in Genome Sequencing, Basic Local Alignment Search Tool (BLAST), Other Blast options, PSI-BLAST. Applications of BLAST tool.

**Module 2 (8 hours)**

Computational Genomics & structure prediction, Computational Gene Prediction and Genome annotation, Protein Secondary structure prediction methods, Tertiary structure Prediction methods (Homology modeling, Fold recognition and ab-initio method)

**Module 3 (7 hours)**

Biological Networks, Representation, Protein-protein Interaction Networks., Protein- Protein Interaction Databases

**Module 4 (8 hours)**

Structural Bioinformatics, Molecular dynamics and simulation study of protein, Force field concepts., Protein Databank, Protein Structural Alignment and Superposition

**Module 5 (9 hours)**

Computer aided drug design, Quantity Structure Activity Relationships (QSAR) – basic concept. Application to drug designing, Introduction and scope of Chemo-informatics, Drug target identification and Drug design.

**Course Plan**

| No | Topic | No. of Lectures |
|---|---|---|
| 1 | **Databases and tools (8 hours)** | |
| 1.1 | Major Biological Databases and Information Retrieval. | 3 |
| 1.2 | Bioinformatics tools and automation in Genome Sequencing | 2 |
| 1.3 | Basic Local Alignment Search Tool (BLAST), Other Blast options, PSI-BLAST. Applications of BLAST tool | 3 |
| 2 | **Computational Genomics & structure prediction (8 hours)** | |
| 2.1 | Computational Gene Prediction and Genome annotation | 2 |
| 2.2 | Protein Secondary structure prediction methods. | 3 |
| 2.3 | Tertiary structure Prediction methods (Homology modeling, Fold recognition and ab-initio method). | 3 |
| 3 | **Biological Networks (7 hours)** | |
| 3.1 | Representation | 2 |
| 3.2 | Protein-protein Interaction Networks. | 3 |
| 3.3 | Protein- Protein Interaction Databases | 2 |
| 4 | **Structural Bioinformatics (8 hours)** | |
| 4.1 | Molecular dynamics and simulation study of protein, Force field concepts. | 3 |
| 4.2 | Protein Databank | 2 |
| 4.3 | Protein Structural Alignment and Superposition | 3 |
| 5 | **Computer aided drug design (9 hours)** | |
| 5.1 | Quantity Structure Activity Relationships (QSAR) – basic concept. Application to drug designing. | 3 |
| 5.2 | Introduction and scope of Chemo-informatics | 3 |
| 5.3 | Drug target identification and Drug design. | 3 |

**Reference Books**

1. Lesk, A.M. 2005, 2nd edition, Introduction to Bioinformatics. Oxford University Press.
2. Mount, D.W., Bioinformatics 2004. Sequence and Genome Analysis. CSHL Press
3. Attwood and Parry-Smith 2002. Introduction to Bioinformatics. Pearson
4. Baxevanis, A.D. and Francis Ouellette, B.F. 2004 Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. Second Edition, Wiley.
5. Gasteiger, 2003 Chemo-informatics A Text Book
6. Palsson B., 2006 Systems Biology - Properties of Reconstructed Networks, Cambridge University Press.
7. Leech Andrew, 2001 Molecular Modelling: Principles and applications (2nd Edition) Prentice Hall

| 242EBT004 | ADVANCED CELL CULTURE TECHNIQUES | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | Program Elective 3 | 3 | 0 | 0 | 3 |

**Preamble:**

To familiarize with the different approaches to generate transgenic animals for various applications and to attain the concept of animal cloning along with gene therapy and its significance.

**Pre-requisites:** Nil

**Course Outcomes:**

After the completion of the course the student will be able to

| | |
|---|---|
| **CO 1** | Describe basic principles and techniques in animal cell culture. |
| **CO 2** | Illustrate basic principles and techniques in genetic manipulation and genetic engineering. |
| **CO 3** | Understand the principles of gene therapy and know different types of disease treatable by gene therapy |
| **CO 4** | Apply their knowledge in cell culture technology in pharmaceutical industry, cloning and its importance |

**Mapping of course outcomes with program outcomes**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 |
|---|---|---|---|---|---|---|---|
| **CO 1** | 2 | - | 2 | - | - | - | - |
| **CO 2** | 2 | 2 | 2 | - | 2 | 2 | - |
| **CO 3** | 2 | 3 | - | - | - | 2 | - |
| **CO 4** | 2 | 2 | 3 | - | 2 | 2 | 2 |

**Assessment Pattern**

| Bloom's Category | End Semester Examination |
|---|---|
| Apply | 35% |
| Analyse | 35% |
| Evaluate | 15% |
| Create | 15% |

**Mark distribution**

| Total Marks | CIE | ESE | ESE Duration |
|---|---|---|---|
| 100 | 40 | 60 | 2.5 hours |

**Continuous Internal Evaluation Pattern: 40 marks**

Micro/Course based project : 15 marks

Course based /Seminar/Quiz : 15 marks

Test paper, 1 no. : 10 marks

Test paper shall include minimum 80% of the syllabus.

**End Semester Examination Pattern: 60 marks**

The end semester examination will be conducted by the respective College. There will be two parts; Part A and Part B.

Part A will contain 5 numerical/short answer questions with one question from each module; having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions.

Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

**Model Question Paper**

**QP CODE:** **PAGES:**

**Reg No: _____** **Name: _____**

**SAHRDAYA COLLEGE OF ENGINEERING AND TECHNOLOGY**

**SECOND SEMESTER M. TECH DEGREE EXAMINATION, MONTH & YEAR**

**Course Code: 242EBT004**

Max. Marks: 60 Duration: 2.5 hrs.

**ADVANCED CELL CULTURE TECHNIQUES**

**PART – A**

Answer All the Questions.

One question from each module, having 5 marks for each question.

(5x 5 = 25)

1. Define cell line and cell strain. Differentiate between finite and continuous cell line.
2. Comment on the role of cryopreservation in animal cell culture.
3. Write on Safety regulations in the production of transgenic animals.
4. Illustrate any 2 methods of gene editing.
5. How tissue engineering can be used to revolutionize tissue transplantation?

**PART – B**

Minimum one question from each module (Total seven questions)

Answer any five (5 x 7 = 35)

6. Discuss the principle and applications of Hollow fibre reactor in scaling up of animal cell culture.
7. What are the basic components of a culture media? What are the criteria's that has to be looked upon when selecting a media?
8. Comment on the role of Vaccinia virus in Animal cell technology.
9. What is a transgenic mouse? Discuss in brief the procedure of its transgenesis and its applications.
10. Discuss different strategies used for the production of knockout mouse.
11. Explain how double stranded RNA can cause gene silencing.
12. Differentiate monoclonal antibodies and polyclonal antibodies. Write the applications of monoclonal antibodies.

**********

## SYLLABUS

**Module 1 (7 hours)**

**Animal Cell Culture:** Historical Background, Importance and progress in Animal Cell Culture, Cell culture media and reagents; Animal cell, tissue and organ cultures; Primary culture, secondary culture; Continuous cell lines; Suspension cultures; Importance of Serum and Serum Free Media, Culturing and Sub-Culturing of Animal Cells, Various bio-reactors used for animal cell culture-Roller bottle culture; stirred animal cell culture, Air-lift fermentor, Chemostat/Turbidostat.

**Module 2 (7 hours)**

***In Vitro* Transformation of Animal Cells**: Biology of animal viral vectors- SV40, adeno virus, retrovirus, vaccinia virus, herpes virus and baculo virus. Cloning of Animal Cells, Cell Line Preservation, Cell Line Characterization, Chromosome Spreading and Karyotype Analysis, cytotoxicity and cell viability assays

**Module 3 (8 hours)**

**Transgenic animals:** Construction of transgenic animals, Biopharming - Transgenic animals (Mice, Cows, Pigs, Sheep, Goat, Birds and Insects); Artificial insemination and embryo transfer, gene knockouts, ethical and biosafety considerations.

**Module 4 (9 hours)**

**Gene therapy:** Genetic disorders, vector engineering, types of gene therapy, strategies of gene delivery, targeted gene replacement/augmentation, gene editing, gene correction, gene silencing.

**Module 5 (9 hours)**

**Application of cell culture technology**- production of human and animal vaccines and pharmaceutical proteins. Hybridoma and monoclonal antibodies, Applications of monoclonal antibodies, Animal cloning, Therapeutic cloning, Tissue engineering, Knock out animals.

**Course Plan**

| No | Topic | No. of Lectures |
|---|---|---|
| 1 | **Animal Cell Culture (7 hours)** | |
| 1.1 | Historical Background, Importance and progress in Animal Cell Culture | 1 |
| 1.2 | Cell culture media and reagents; Animal cell, tissue and organ cultures | 1 |
| 1.3 | Primary culture, secondary culture; Continuous cell lines; Suspension cultures; Importance of Serum and Serum Free Media | 2 |
| 1.4 | Culturing and Sub-Culturing of Animal Cells | 1 |
| 1.5 | Bio-reactors used for animal cell culture | 2 |
| 2 | ***In vitro* Transformation of Animal Cells (7 hours)** | |
| 2.1 | Biology of animal viral vectors | 1 |
| 2.2 | Cloning of Animal Cells, Cell Line Preservation | 2 |
| 2.3 | Cell Line Characterization | 1 |
| 2.4 | Chromosome Spreading and Karyotype Analysis | 1 |
| 2.5 | Cytotoxicity and cell viability assays | 2 |
| 3 | **Transgenic animals (8 hours)** | |
| 3.1 | Construction of transgenic animals | 3 |
| 3.2 | Artificial insemination and embryo transfer | 2 |
| 3.3 | Gene knockouts | 2 |
| 3.4 | Ethical and biosafety considerations | 1 |
| 4 | **Gene therapy (9 hours)** | |
| 4.1 | Genetic disorders, vector engineering | 2 |
| 4.2 | Types of gene therapy | 2 |
| 4.3 | Strategies of gene delivery, targeted gene replacement/augmentation | 2 |
| 4.4 | Gene editing, gene correction | 2 |
| 4.5 | Gene silencing | 1 |
| 5 | **Application of cell culture technology (9 hours)** | |
| 5.1 | Production of human and animal vaccines and pharmaceutical proteins. | 3 |
| 5.2 | Hybridoma and monoclonal antibodies | 1 |
| 5.3 | Animal cloning, Therapeutic cloning | 2 |
| 5.4 | Tissue engineering | 2 |
| 5.5 | Knock out animals | 1 |

**Reference Books**

1. Freshney, R. I. (2010). Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications. Wiley-Blackwell, 2010. 6th Edition.
2. Davis, J. M. (2008). Basic Cell Culture. Oxford University Press. New Delhi.
3. Butler, M. (2004). Animal Cell Culture and Technology. Taylor and Francis. New York, USA.
4. Verma, A. S. and Singh, A. (2014). Animal Biotechnology. Academic Press, Elsevier, USA. Cartwright, E. J. (2009). Transgenesis Techniques. Humana Press. London, UK.
5. McArthur, R. A. and Borsini, F. (2008). Animal and Translational Models for CNS Drug Discovery. Elsevier. London, UK.

| 242EBT005 | TRANSPORT PHENOMENA IN BIOLOGICAL SYSTEMS | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | Program Elective 3 | 3 | 0 | 0 | 3 |

**Preamble:**

To study and understand the applications of momentum, energy and mass balance in bioprocess systems.

**Pre-requisites:** Nil

**Course Outcomes**: After the completion of the course, the student will be able to

| | |
|---|---|
| **CO 1** | Analyse transport properties of gases and liquids |
| **CO 2** | Decipher the numerical problems in momentum, energy and mass transfer using shell balances |
| **CO 3** | Interpret industrial problems with appropriate approximations and boundary conditions |
| **CO 4** | Evaluate the applications of transport phenomena in bioprocess systems |

**Mapping of course outcomes with program outcomes**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 |
|---|---|---|---|---|---|---|---|
| **CO 1** | 2 | - | - | - | - | - | - |
| **CO 2** | 2 | 3 | - | - | - | - | - |
| **CO 3** | - | 3 | 3 | 3 | 3 | 2 | 2 |
| **CO 4** | - | - | 3 | 3 | - | 2 | 2 |

**Assessment Pattern**

| Bloom's Category | End Semester Examination |
|---|---|
| Apply | 40% |
| Analyse | 25% |
| Evaluate | 25% |
| Create | 10% |

**Mark Distribution**

| Total Marks | CIE | ESE | ESE Duration |
|---|---|---|---|
| 100 | 40 | 60 | 2.5 hours |

**Continuous Internal Evaluation Pattern: 40 marks**

| | |
|---|---|
| Micro/Course based project | : 15 marks |
| Course based /Seminar/Quiz | : 15 marks |
| Test paper, 1 no. | : 10 marks |

Test paper shall include minimum 80% of the syllabus.

**End Semester Examination Pattern: 60 marks**

The end semester examination will be conducted by the respective College. There will be two parts; Part A and Part B.

Part A will contain 5 numerical/short answer questions with one question from each module; having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions.

Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

**Model Question Paper**

**QP CODE:** **PAGES:**

**Reg No: _____** **Name: _____**

**SAHRDAYA COLLEGE OF ENGINEERING AND TECHNOLOGY**
**SECOND SEMESTER M. TECH DEGREE EXAMINATION, MONTH & YEAR**
**Course Code: 242EBT005**

Max. Marks: 60 Duration: 2.5 hrs.

**Transport Phenomena in Biological System**

**PART – A**

Answer All the Questions.

One question from each module, having 5 marks for each question.

(5x 5 = 25)

1. Elucidate the application of mass transfer in bioprocessing.
2. Demonstrate the mixing in a bioreactor with a neat diagram.
3. Differentiate natural and forced convection.
4. Explain the Fick's law of diffusion.
5. Explain the importance of aeration in oxygen transfer.

**PART – B**

Minimum one question from each module (Total seven questions)

Answer any five (5 x 7 = 35)

6. Demonstrate the equations of change in isothermal systems with the help of basic concepts of conservation of mass and energy.
7. Elucidate the fermentation broth rheology.
8. Explain the relation between the heat transfer, cell concentration and stirring conditions in bioreactors.
9. Elaborate on liquid-liquid mass transfer with its applications.
10. Exemplify the significance of role of diffusion in bioprocessing with examples.
11. Differentiate between aeration and agitation methods of oxygen transfer in microbial cultures.
12. Derive the expression for determination of mass transfer coefficient by oxygen balance method.

**********

## SYLLABUS

**Module 1 (8 hours)**

**Introduction to Transport Phenomena** – momentum, heat and mass transfer in bioprocessing Review of basic concepts – Conservation of Mass, Conservation of Energy, Momentum Balance – Momentum Balance in a Circular Pipe, Flow Velocity Profile. Shell momentum balances and boundary conditions for momentum, heat and mass transport.

**Module 2 (8 hours)**

**Applications of momentum transfer in bioprocess** - Fermentation Broth Rheology – Viscosity, Rheological Properties of Fermentation Broths, Factors affecting broth viscosity, mixing in a Bioreactor – Flow regimes with and without baffles, various types of impellers and mixing equipment

**Module 3 (8 hours)**

**Various Modes of heat transfer**, viz., conduction convection and radiation. Calculation of Heat-Transfer Coefficients. Application of heat transfer in bioprocessing, Heat Management in Bioreactors, Relationship between heat transfer, cell concentration and stirring conditions

**Module 4 (8 hours)**

**Review of basic concepts** – Diffusivity, theory of diffusion, analogy between mass, heat and momentum transfer, role of diffusion in bioprocessing. Definition of binary mass transfer coefficients. Convective mass transfer – Liquid-solid mass transfer, liquid-liquid mass transfer, gas liquid mass transfer.

**Module 5 (8 hours)**

**Applications of mass transfer in bioprocess** - Oxygen transport to microbial cultures – Gas liquid mass transfer fundamentals. Oxygen requirement of microbial cultures. Oxygen transfer by aeration and agitation. Determination of oxygen mass transfer coefficient by various methods including dynamic gassing out and oxygen balance methods.

**Course Plan**

| No | Topic | No. of Lectures |
|---|---|---|
| 1 | **Introduction to Transport Phenomena (8 hours)** | |
| 1.1 | Introduction to Transport Phenomena – momentum, heat and mass transfer in bioprocessing | 2 |
| 1.2 | Review of basic concepts – Conservation of Mass, Conservation of Energy, | 2 |
| 1.3 | Momentum Balance – Momentum Balance in a Circular Pipe, Flow Velocity Profile. | 2 |
| 1.4 | Shell momentum balances and boundary conditions for momentum, heat and mass transport. | 2 |
| 2 | **Applications of momentum transfer in bioprocess (8 hours)** | |
| 2.1 | Fermentation Broth Rheology | 2 |
| 2.2 | Viscosity, Rheological Properties of Fermentation Broths Factors affecting broth viscosity | 2 |
| 2.3 | Mixing in a Bioreactor – Flow regimes with and without baffles, | 2 |
| 2.4 | Various types of impellers and mixing equipment. | 2 |
| 3 | **Heat Transfer (8 hours)** | |
| 3.1 | Various Modes of heat transfer, viz., conduction convection and radiation. | 2 |
| 3.2 | Calculation of Heat-Transfer Coefficients. Application of heat transfer in bioprocessing, | 2 |
| 3.3 | Heat Management in Bioreactors, | 2 |
| 3.4 | Relationship between heat transfer, cell concentration and stirring conditions | 2 |
| 4 | **Mass Transfer (8 hours)** | |
| 4.1 | Review of basic concepts – Diffusivity, theory of diffusion | 1 |
| 4.2 | Analogy between mass, heat and momentum transfer | 2 |
| 4.3 | Role of diffusion in bioprocessing. | 2 |
| 4.4 | Definition of binary mass transfer coefficients. Convective mass transfer – Liquid-solid mass transfer | 2 |
| 4.5 | Liquid-liquid mass transfer, gas liquid mass transfer | 1 |
| 5 | **Applications of mass transfer in bioprocess (8 hours)** | |
| 5.1 | Oxygen transport to microbial cultures – Gas liquid mass transfer fundamentals. | 2 |
| 5.2 | Oxygen requirement of microbial cultures. | 2 |
| 5.3 | Oxygen transfer by aeration and agitation. | 2 |

| | | |
|---|---|---|
| 5.4 | Determination of oxygen mass transfer coefficient by various methods including dynamic gassing out and oxygen balance methods. | 2 |

**Reference Books**


1. Pauline M. Doran, Bioprocess Engineering Principles, Academic Press, 1995.
2. Blanch H.W and Douglas S. C, Biochemical Engineering, CRC Press, 1997.
3. Michael L Shuler and Fikret Kargi, Bioprocess Engineering: Basic Concepts, Prentice-Hall of India Pvt Ltd, 2008.
4. Arthur T. Johnson, Biological Process Engineering: An Analogical Approach to Fluid Flow, Heat Transfer, and Mass Transfer Applied to Biological Systems, John Wiley and Sons, 1998.
5. Bird R B, Stewart W E and Lightfoot R N, Transport Phenomena, John Wiley and Sons.
6. John C Slattery, Momentum, Energy and Mass transfer in continua, McGraw Hill, Co.
7. Bennet C U and Myers J E, Momentum, Heat and Mass Transfer, Tata McGraw Hill Publishing Co.
8. Atkinson B and Mavituna F, Biochemical Engineering and Biotechnology, Handbook, Macmillan.

| 242EBT006 | PATENTING FOR BIOTECHNOLOGISTS | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | Program Elective 4 | 3 | 0 | 0 | 3 |

**Preamble:**

To study the importance of Intellectual Property Rights and its relevance to biological patenting with reference to the implications, case studies and the debates associated with the Indian Biotechnological Scenario. To introduce students to the basics of patent drafting, searching and the procedures involved in patent filing in India.

**Pre-requisites:** Nil

**Course Outcomes:**

After the completion of the course the student will be able to

| | |
|---|---|
| **CO 1** | Relate to the need for an Intellectual Property Rights System, its historical evolution and its importance to International trade and commerce today |
| **CO 2** | Discern the debate over biological patenting and the commercial potential of biotechnology inventions and understand the International treaties regulating the patenting of life. |
| **CO 3** | Understand the patent types, specifications , laws and the procedures involved for patent drafting and filing in India |
| **CO 4** | To evaluate the risk of bio piracy and the development of Indian safeguards like the TKDL and the PPFVR Act to control and protect the interests of Indian farmers |

**Mapping of course outcomes with program outcomes**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 |
|---|---|---|---|---|---|---|---|
| **CO 1** | | 2 | 2 | | | 2 | 2 |
| **CO 2** | | 3 | 2 | | | 2 | 2 |
| **CO 3** | | 3 | 2 | 3 | 2 | | 3 |
| **CO 4** | | 3 | 2 | 2 | | 3 | 2 |

**Assessment Pattern**

| Bloom's Category | End Semester Examination |
|---|---|
| Apply | 30% |
| Analyse | 40% |
| Evaluate | 25% |
| Create | 05% |

**Mark distribution**

| Total Marks | CIE | ESE | ESE Duration |
|---|---|---|---|
| 100 | 40 | 60 | 2.5 hours |

**Continuous Internal Evaluation Pattern: 40 marks**

Preparing a review article based on peer reviewed article

based on a pertinent Biological Patenting topic/issue : 15 marks

Course based task/Seminar/Data collection and interpretation : 15 marks

Test paper, 1 no. : 10 marks

Test paper shall include minimum 80% of the syllabus.

**End Semester Examination Pattern: 60 marks**

The end semester examination will be conducted by the respective College. There will be two parts; Part A and Part B.

Part A will contain 5 numerical/short answer questions with one question from each module, having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions.

Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

**Model Question Paper**

**QP CODE:** **PAGES:**

**Reg No: _____** **Name: _____**

**SAHRDAYA COLLEGE OF ENGINEERING AND TECHNOLOGY**
**SECOND SEMESTER M. TECH DEGREE EXAMINATION, MONTH & YEAR**
**Course Code: 242EBT006**

Max. Marks: 60 Duration: 2.5 hrs.

**Patenting for Biotechnologists**

**PART – A**

Answer All the Questions.

One question from each module, having 5 marks for each question.

(5x 5 = 25)

1. What are the seven types of Intellectual Property Rights that are to be legislated by every signatory of the WTO?
2. Explain the relevance of the Diamond VS Chakrabarty case to biological patenting.
3. What are the three important criteria for filing a patent? Explain each with an example.
4. What is the difference between complete and provisional patents in India and discuss the benefits and drawbacks of each..
5. What are GURT technologies and how do they affect farmers in India?

**PART – B**

Minimum one question from each module (Total seven questions)

Answer any five (5 x 7 = 35)

6. With a help of a timeline show the historical development of IPR agreements from the Paris Agreement to the present day TRIPS.
7. What is an IDA and discuss its relevance under the Budapest treaty.
8. What is the difference between “pre-grant” and “post-grant” opposition and discuss the benefits of India following this patent process over the USA?
9. Summarise any 5 important portions to be considered while drafting a patent application.
10. What is a patent search and discuss any three databases used for conducting a patent search.
11. Explain the reasons why the WTO had to be formed and the inclusion of the TRIPS agreement under it in spite of the WIPO being already there.?.
12. What do you understand by biopiracy and highlight it with the NEEM case study and the development of the TKDL.

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## SYLLABUS

**Module 1 (8 hours)**

**IPR Introduction and History:** Invention and Creativity – Intellectual Property (IPR) –The Genesis and historical development of IPR, .Paris Agreement, Madrid Agreement , Hague Agreement, Role of WIPO and its evolution. Need for and formation of the WTO and its global role. The GATT, GATS and TRIPS Agreements. – Objectives, Rationale, international treaties, Indian perspectives: Seven types of IPR recognized as per the TRIPS Agreement.

**Module 2 (7 hours)**

**Patenting of biological products:** Factors justifying patentability of biotechnological inventions, Diamond VS Chakrabarty case. Budapest Treaty and IDAs. Biotechnology and IPR, commercial potential of biotechnology inventions, , Patenting of life forms (GEMs) Problems in biotechnology patenting,

**Module 3 (9 hours)**

**Patenting Fundamentals**. Types of Patents. Requirements of a patent- Patentability of Inventions Statutory Exceptions to Patentability; Novelty and Anticipation; Inventive Step; Capable of Industrial Application; Person Skilled in the Art. Patent search. National and international patent databases. United States Patent and Trademark Office (USPTO), European Patent Office (EPO), PatentScope (WIPO), Patent cooperation treaty. Patenting procedures, time frame and cost,. Indian Patent Act 1970 & recent amendments

**Module 4 (8 hours)**

**Patent Drafting**: Specification Provisional and Complete Specifications; Structure of a Patent Specification—Title, Abstract, Description, Claims, etc.; Reading a Patent Specification—Fair basis, Enabling Disclosure, Definiteness, Priority; Introduction to Patent Drafting. Patent Application—Who Can Apply, True and First Inventor, ,What to include in a Patent Application, Types of Patent Applications, Patents of Addition, Dating of Application;

**Module 5 (8 hours)**

**Patenting of Traditional knowledge**:. Biopiracy- Rosy Periwinkle case. Turmeric and Neem patent Case Studies. Formation of the TKDL. Arogya Pasha as a case study of the Benefit Sharing model with TBGRI. Patenting of Plant varieties. UPOV treaties and relevance of the Protection of Plant varieties and Farmers Right Act in India. Genetic Use Restriction Technology Terminator Technology and its implications to Indian Farmers.

**Course plan**

| No | Topic | No. of Lectures |
|---|---|---|
| **1** | **IPR Introduction and History (8 hours)** | |
| 1.1 | Invention and Creativity – Intellectual Property (IPR) –The Genesis and historical development of IPR, Paris Agreement, Madrid Agreement , Hague Agreement, | 2 |
| 1.2 | Role of WIPO and its evolution. Need for and formation of the WTO and its global role. | 2 |
| 1.3 | The GATT, GATS and TRIPS Agreements. – Objectives, Rationale, international treaties, Indian perspectives | 2 |
| 1.4 | Seven types of IPR recognized as per the TRIPS Agreement. | 2 |
| **2** | **Patenting of biological products (7 hours)** | |
| 2.1 | Factors justifying patentability of biotechnological inventions, | 2 |
| 2.2 | Diamond VS Chakrabarty case, Budapest Treaty and IDAs | 3 |
| 2.3 | Biotechnology and IPR, commercial potential of biotechnology inventions, , Patenting of life forms (GEMs) Problems in biotechnology patenting, | 2 |
| **3** | **Patenting Fundamentals (9 hours)** | |
| 3.1 | Types of Patents. Requirements of a patent- Patentability of Inventions Statutory Exceptions to Patentability; | 2 |
| 3.2 | Novelty and Anticipation; Inventive Step; Capable of Industrial Application; Person Skilled in the Art | 2 |
| 3.3 | Patent search. National and international patent databases. United States Patent and Trademark Office (USPTO), European Patent Office (EPO), PatentScope (WIPO), | 2 |
| 3.4 | Patent cooperation treaty. Patenting procedures, time frame and cost, Indian Patent Act 1970 & recent amendments | 3 |
| **4** | **Patent Drafting (8 hours)** | |
| 4.1 | Specification Provisional and Complete Specifications; Structure of a Patent Specification—Title, Abstract, Description, Claims, | 2 |
| 4.2 | Reading a Patent Specification—Fair basis, Enabling Disclosure, Definiteness, Priority | 2 |
| 4.3 | Introduction to Patent Drafting. Patent Application—Who Can Apply, True and First Inventor,, What to include in a Patent Application | 2 |
| 4.4 | Types of Patent Applications, Patents of Addition, Dating of Application | 2 |
| **5** | **Patenting of Traditional knowledge (8hours)** | |
| 5.1 | Biopiracy- Rosy Periwinkle case. Turmeric and Neem patent Case Studies. | 2 |
| 5.2 | Formation of the TKDL. Arogya Pasha as a case study of the Benefit Sharing model with TBGRI. | 2 |

| | | |
|---|---|---|
| 5.3 | Patenting of Plant varieties. UPOV treaties and relevance of the Protection of Pant varieties and Farmers Right Act in India. | 2 |
| 5.4 | Genetic Use Restriction Technology Terminator Technology and its implications to Indian Farmers. | 2 |

**Reference Books**


1. Subbaram N.R. ―Handbook of Indian Patent Law and Practice ―, S. Viswanathan Printers and Publishers Pvt. Ltd., 1998.
2. Jeffrey G. Sheldon, How to Write a Patent Application, Third Edition, Practising Law Institute, 2016
3. Feroz Ali, The Law of Patents,- with a special focus on Pharmaceuticals in India LexisNexis, 2009
4. Prabuddha Ganguli Intellectual Property Rights-Unleashing the Knowledge Economy. Tata McGraw Hill Publishing Company Limited, New Delhi., 2017
5. Beier, F.K, Crespi, R.S and Straus, T. Biotechnology and Patent protection – Oxford and IBH Publishing Co. New Delhi.

| 242EBT007 | BIOSAFETY AND QUALITY ASSURANCE | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | Program Elective 4 | 3 | 0 | 0 | 3 |

**Preamble:**

To familiarize the student with basic concepts of different levels of Biosafety and quality management system, QC/QA, preparation and documentation of quality control charts.

**Pre-requisites**: Nil

**Course Outcomes**: After the completion of the course, the student will be able to

| | |
|---|---|
| **CO 1** | Impart knowledge of different levels of biosafety system |
| **CO 2** | Identify and implementing safety procedures |
| **CO 3** | Provide awareness of QA/QC documentation |
| **CO 4** | Fundamentals of safety testing process and introduction lab safety and safe lab practices. |
| **CO 5** | Principles of product validation system, process monitoring |

**Mapping of course outcomes with program outcomes**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 |
|---|---|---|---|---|---|---|---|
| **CO 1** | - | 2 | 2 | - | - | 2 | 2 |
| **CO 2** | - | - | 2 | - | 2 | 2 | 2 |
| **CO 3** | - | 2 | - | - | - | 2 | 2 |
| **CO 4** | 2 | - | - | - | 2 | 2 | 2 |
| **CO 5** | 2 | - | 3 | - | 2 | 2 | 3 |

**Assessment Pattern**

| Bloom's Category | End Semester Examination |
|---|---|
| Apply | 15% |
| Analyse | 35% |
| Evaluate | 50% |
| Create | |

**Mark distribution**

| Total Marks | CIE | ESE | ESE Duration |
|---|---|---|---|
| 100 | 40 | 60 | 2.5 hours |

**Continuous Internal Evaluation Pattern: 40 marks**

| | |
|---|---|
| Micro/Course based project | : 15 marks |
| Course based /Seminar/Quiz | : 15 marks |
| Test paper, 1 no. | : 10 marks |

Test paper shall include minimum 80% of the syllabus.

**End Semester Examination Pattern: 60 marks**

The end semester examination will be conducted by the respective College. There will be two parts; Part A and Part B.

Part A will contain 5 numerical/short answer questions with one question from each module; having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions.

Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

**Model Question Paper**

**QP CODE:** **PAGES:**

**Reg No: _____** **Name: _____**

**SAHRDAYA COLLEGE OF ENGINEERING AND TECHNOLOGY**

**SECOND SEMESTER M. TECH DEGREE EXAMINATION, MONTH & YEAR**

**Course Code: 242EBT007**

Max. Marks: 60 Duration: 2.5 hrs.

**Biosafety and Quality Assurance**

**PART – A**

Answer All the Questions.

One question from each module, having 5 marks for each question.

(5x 5 = 25)

1. What are the different biosafety safety programmes.
2. Discuss accidents identification and prevention
3. Explain document preparation of QC/QA.
4. Quality control of antibiotics.
5. Explain the Principles of quality assurance and validation.

**PART – B**

Minimum one question from each module (Total seven questions)

Answer any five (5 x 7 = 35)

6. Explain potential hazards operating conditions.
7. What are hazards identification checklists
8. Explain Quality control in microbiology
9. Differentiate GMP and cGMP practices.
10. What are the requirements of documentation of FDA?
11. Explain Quality control and its validation.
12. What are the different norms of handling pathological samples**?**

************

## SYLLABUS

**Module 1 (9 hours)**

**Biosafety in Industrial Biotechnology:** Safety Programmes, components and realization, Potential hazards – extreme operating conditions, toxic chemicals, safe handling. Aseptic Operation and Containment. Biosafety levels of specific Microorganisms (food and water borne pathogens), Infectious Agents (Chemicals and carcinogens). MSDS-Material Safety Data Sheet. Understanding. Health hazards in biotechnology, Freeze-drying of bio-hazardous products. Industrial Safety and Hazard Management in Bio-Technology & related industry - live viruses, bacteria.

**Module 2 (7 hours)**

**Implementation of safety procedures:** periodic inspection and replacement. Accidents - identification and prevention; promotion of industrial safety. **Safety Audits** Hazard identification, checklist, vulnerability models event tree analysis fault tree analysis, Hazan past accident analysis Flixborough – Mexico – Bhopal – Madras – Vizag accident analysis. Hazard Analysis Critical Control Points (HACCP) in foods, cosmetics and pharmaceuticals.

**Module 3 (6 hours)**

**Document preparation for QC/QA norms of different sectors:** Quality assurance and Quality control in industry basic principles. Quality control in Microbiology. Laboratory, assessment of aseptic condition, evaluation of possible channels of contamination, QC /QA norms for handling pathological samples.

**Module 4 (9 hours)**

**International Biological standards**: safety testing of pharmaceuticals, Quality control of antibiotics. Sterile Pharmaceutical Products. GMP and cGMP aspects related to sterile products, General guidelines, personnel, building and premises, equipment, sanitation, processing, sterilization. Quality control and validation, documentation. Introduction to Laboratory Safety and Safe laboratory practices, regulatory agencies, handling & storage of chemicals, reagents, microbial specimens and its preservation.

**Module 5 (9 hours)**

**Microbial analysis of consumable products:** Microbial quality assurance, monitoring of factory hygiene and sanitation, microbiological quality of ingredients, processing and finished products with regard to specified standards. Quality assurance and validation principles and their applications in industries related to food and beverage. FDA rationale, documentation requirements. Hazardous Operations, Hazop-guide words, parameters, derivation-causes-consequences-recommendation-coarse. Hazop study-case studies-pumping system-reactor-mass transfer system.

**Course Plan**

| No | Topic | No. of Lectures |
|---|---|---|
| 1 | **Biosafety in Industrial Biotechnology (9 hours)** | |
| 1.1 | Biosafety in Industrial Biotechnology. | 1 |
| 1.2 | Safety Programmes, components and realization, | 1 |
| 1.3 | Potential hazards – extreme operating conditions, toxic chemicals, safe handling. | 1 |
| 1.4 | Aseptic Operation and Containment, Containment Levels (Primary and secondary containments) | 2 |
| 1.5 | Biosafety levels of specific Microorganisms (food and water borne pathogens) | 1 |
| 1.6 | Infectious Agents (Chemicals and carcinogens) | 1 |
| 1.7 | MSDS-Material Safety Data Sheet. Understanding. | 1 |
| 1.8 | Industrial Safety and Hazard Management in Bio-Technology & related industry - live viruses, bacteria. | 1 |
| 2 | **Implementation of Safety procedures (7 hours)** | |
| 2.1 | Implementation of safety procedures, periodic inspection and replacement | 1 |
| 2.2 | Accidents -identification and prevention promotion of industrial safety | 1 |
| 2.3 | Safety Audits Hazard identification, checklist | 1 |
| 2.4 | Vulnerability models event tree analysis fault tree analysis | 1 |
| 2.5 | Hazan past accident analysis Flixborough – Mexico – Bhopal – Madras – Vizag accident analysis | 2 |
| 2.6 | Hazard Analysis Critical Control Points (HACCP) in foods, cosmetics and pharmaceuticals. | 1 |
| 3 | **Document preparation for QC/QA (6 hours)** | |
| 3.1 | Document preparation for QC/QA norms of different sectors | 2 |
| 3.2 | Quality control in Microbiology | 1 |
| 3.3 | Laboratory, assessment of aseptic condition, | 1 |
| 3.4 | Evaluation of possible channels of contamination | 1 |
| 3.5 | QC /QA norms for handling pathological samples | 1 |
| 4 | **International Biology policies (9 hours)** | |
| 4.1 | International Biological standards | 1 |
| 4.2 | Safety testing of pharmaceuticals | 1 |
| 4.3 | Quality control of antibiotics | 1 |

| | | |
|---|---|---|
| 4.4 | Sterile Pharmaceutical Products | 1 |
| 4.5 | GMP aspects related to sterile products. | 1 |
| 4.6 | General guidelines personnel, building and premises, equipment, sanitation, processing sterilization. | 1 |
| 4.7 | Quality control and validation, documentation. | 1 |
| 4.8 | Introduction to Laboratory Safety and Safe laboratory practices, regulatory agencies, | 1 |
| 4.9 | Handling & storage of chemicals, reagents, microbial specimens and its preservation | 1 |
| 5 | **Food microbiology and QA (9 hours)** | |
| 5.1 | Microbial analysis of consumable products | 1 |
| 5.2 | Microbial quality assurance, monitoring of factory hygiene and sanitation, | 1 |
| 5.3 | Microbiological quality of ingredients, processing and finished products with regard to specified standards | 1 |
| 5.4 | Quality assurance and validation principles and their applications in industries related to food and beverage | 1 |
| 5.5 | FDA rationale, GMP and cGMP, documentation requirements | 1 |
| 5.6 | **Hazardous Operations,** Hazop-guide words, parameters | 1 |
| 5.7 | Derivation-causes-consequences-recommendation-coarse | 1 |
| 5.8 | Hazop study - case studies-pumping system | 1 |
| 5.9 | Reactor-mass transfer system. | 1 |

**Reference Books**


1. Juran's Quality Control Handbook J.M. Jupron.4th Ed. Good design practices for GMP Pharmaceutical facilities. Andrew A Signature, Marcel Dekker.
2. cGMP for Pharmaceuticals. Pharma. Med. Press, Ist edition by Manohar H. Potdar
3. Methods in Food Analysis by Rui M. S. Cruz, Igor Khmelinskii, Margarida Vieira.
4. Fundamental Food Microbiology, Fifth Edition by Bibek Ray, Arun Bhunia.
5. Managing Food Safety Risks in the Agri-Food Industries by Jan Mei Soon, Richard Baine

| 242EBT008 | BIOLOGICAL WASTE MANAGEMENT | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | Program Elective 4 | 3 | 0 | 0 | 3 |

**Preamble:**

The purpose of this course is to provide specialized knowledge in the area of wastewater treatment processes. The course will provide fundamental principles of aerobic and anaerobic biological waste treatment processes, application of microbial systems to the operations and design of waste (domestic, industrial) treatment processes.

**Pre-requisites**: Nil

**Course Outcomes**: After the completion of the course, the student will be able to

| | |
|---|---|
| **CO 1** | At the end of the course, students will develop knowledge and skills to know the nature of raw waste water. |
| **CO 2** | Acquire knowledge on treatment objectives, number and sequence of unit processes, |
| **CO 3** | Able to perform the fundamental and scientific basis governing the design |
| **CO 4** | Develop skills on performance of the treatment technologies |
| **CO 5** | Create awareness on waste Analysis and Waste Audit |

**Mapping of course outcomes with program outcomes**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 |
|---|---|---|---|---|---|---|---|
| **CO 1** | 2 | 2 | 2 | 2 | 2 | 2 | - |
| **CO 2** | 2 | 2 | 2 | 2 | 2 | 2 | 3 |
| **CO 3** | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| **CO 4** | 3 | 3 | 3 | 3 | 2 | 3 | 3 |
| **CO 5** | 2 | 2 | 3 | 3 | 3 | 2 | 3 |

**Assessment Pattern**

| Bloom's Category | End Semester Examination |
|---|---|
| Apply | 35% |
| Analyse | 35% |
| Evaluate | 15% |
| Create | 15% |

**Mark distribution**

| Total Marks | CIE | ESE | ESE Duration |
|---|---|---|---|
| 100 | 40 | 60 | 2.5 hours |

**Continuous Internal Evaluation Pattern: 40 marks**

Micro/Course based project : 15 marks

Course based /Seminar/Quiz : 15 marks

Test paper, 1 no. : 10 marks

Test paper shall include minimum 80% of the syllabus.

**End Semester Examination Pattern: 60 marks**

The end semester examination will be conducted by the respective College. There will be two parts; Part A and Part B.

Part A will contain 5 numerical/short answer questions with one question from each module; having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions.

Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

**Model Question Paper**

**QP CODE:** **PAGES:**

**Reg No: _____** **Name: _____**

**SAHRDAYA COLLEGE OF ENGINEERING AND TECHNOLOGY**
**SECOND SEMESTER M. TECH DEGREE EXAMINATION, MONTH & YEAR**
**Course Code: 242EBT008**

Max. Marks: 60 Duration: 2.5 hrs.

**Biological Waste Management**

**PART – A**

Answer All the Questions.

One question from each module, having 5 marks for each question.

(5x 5 = 25)

1. Give the standards for drinking water.
2. If COD of water collected from a river is found to be 1500 mg/ l. Which method can be adopted for treating this water?
3. What are the mechanisms involved in the removal of suspended particles in granular media filters?
4. Why does biogas not contain any sulphur content?
5. Demonstrate People's responsibility of waste management.

**PART – B**

Minimum one question from each module (Total seven questions)

Answer any five (5 x 7 = 35)

6. List the common impurities found in natural water. Mention the diseases which occur due to excess/absence of (i) Flouride (ii) nitrate (iii) iodine and (iv) iron in drinking water.
7. a) Test bottle containing seeded dilution water has dissolved O2 dropped by 1 mg/l in a 5 day test. A 300 ml bottle filled with 15 ml of waste water and rest is the seeded dilution water (sometimes expressed as dilution of 1:20) experiences a drop of 7.2 mg/l in the same time period. What will be the BOD5 of waste sample?(4)

   b) How can we evaluate mass and volume of solid wasted wasted each day in activated sludge process?(3)
8. (a)What is the design parameters should be considered in rotating biological contactors?(4)

   (b) Enumerate the process chemistry and microbiology involved in methanogenesis (3)How are bioplastics manufactured? Discuss the mode of bioplastic degradation as compared to that of regular plastics.

9. a) Elucidate the difference between suspended growth and attached growth process. (4)
   (b) An aeration tank has MLSS Concentration of 30010 mg/l after 30 min in a one litre graduated cylinder, sludge volume is measured to be 158 ml. Compute sludge volume index(3)
10. The hardness of water was found to be 10 gpg. Which method can be chosen for removing the hardness of water and what is the principle behind that? For removing chromium from the waste stream, which method can be selected?
11. Demonstrate the relevance of occupational Safety and Health Act (OSHA).
12. Explain how to implement waste audit, checklist for performance audit in waste collection, segregation, transport, treatment.

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## SYLLABUS

**Module 1 (8 hours)**

**Activated Sludge Process:** Process Analysis and Selection, Characteristics of Activated Sludge (aerobic and anaerobic), analysis of data – mass balance analysis. Reactors used in waste water treatment- up flow anaerobic sludge blanket (UASB), two-stage aerobic uni tank system (TSU-system), route zone treatment, submerged aerobic fixed film (SAFF) reactor, and fluidized aerobic bioreactor (FAB).

**Module 2 (8 hours)**

**Aerobic Fixed-Film and Anaerobic Treatment Processes:** Bio film process considerations, trickling filters and biological towers, rotating biological contactors, granular – media filters; fluidized– bed and circulating bed- bio film reactors. Hybrid bio film/suspended growth processes. Anaerobic processes: methanogenesis, process chemistry and microbiology; process kinetics and factors for the design of anaerobic digesters.

**Module 3 (6 hours)**

**Advanced Waste Water Treatment:** Technologies used in advanced treatment – Classification of technologies; Removal of Colloids and suspended particles – Depth Filtration – Surface Filtration – Membrane Filtration Absorption – Ion Exchange – Advanced oxidation process - Activated Carbon, Air Stripping, Heavy Metals Removal, Steam Stripping, Chemical Precipitation, and Electrolysis.

**Module 4 (7 hours)**

**Environmental Concerns and Recycling of Wastes:** Environmental regulations and technology- Regulatory Concerns, Technology; Laws, regulations and permits- Air, Water, Solid Waste, Environmental Auditing, National Environmental Policy act, Occupational Safety and Health Act (OSHA), Storm Water Regulations; Technology (waste water); Recycling of Industrial wastes: paper, plastics, leather and chemicals.

**Module 5 (11 hours)**

**Waste Analysis and Waste Audit:** Introduction to terminology of waste, waste analysis, introduction to waste audit, checklist for performance audit in waste collection, segregation, transport, treatment. People's responsibility of waste management responsibility of waste management, polluter pays principle (ppp), assimilative capacity and the precautionary principle, world scenario in scrap trade extended producer responsibility (epr), carrying capacity, precautionary principle 5 waste reduction towards zero waste sustainable living, waste reduction at business (producer) level, waste reduction at individual level: zero waste living, waste reduction at community level.

**Course Plan**

| No | Topic | No. of Lectures |
|---|---|---|
| 1 | **Activated Sludge Process (8 hours)** | |
| 1.1 | Process Analysis and Selection Characteristics of Activated Sludge (aerobic and anaerobic), analysis of data – mass balance analysis | 3 |
| 1.2 | Reactors used in waste water treatment- up flow anaerobic sludge blanket (UASB | 3 |
| 1.3 | Two-stage aerobic uni tank system (tsu-system), route zone treatment, submerged aerobic fixed film (SAFF) reactor, and fluidized aerobic bioreactor (fab). | 2 |
| 2 | **Aerobic Fixed-Film and Anaerobic Treatment Processes (8 hours)** | |
| 2.1 | Bio film process considerations, | 3 |
| 2.2 | Trickling filters and biological towers, rotating biological contactors, | 3 |
| 2.3 | Granular – media filters; fluidized– bed and circulating bed | 2 |
| 3 | **Advanced Waste Water Treatment (6 hours)** | |
| 3.1 | Technologies used in advanced treatment – Removal of Colloids and suspended particles – Depth Filtration – Surface Filtration – Membrane Filtration | 2 |
| 3.2 | Absorption – Ion Exchange – Advanced oxidation process - Activated Carbon, Air Stripping, Heavy Metals Removal, Classification of technologies Steam Stripping, Chemical | 2 |
| 3.3 | Precipitation, and Electrolysis | 2 |
| 4 | **Environmental Concerns and Recycling of Wastes (7 hours)** | |
| 4.1 | Environmental regulations and technology- Regulatory Concerns, Technology; Laws, regulations and permits-Air, Water, Solid Waste | 2 |
| 4.2 | Environmental Auditing, National Environmental Policy act, Occupational Safety and Health Act (OSHA), | 2 |
| 4.3 | Storm Water Regulations; Technology (waste water); Recycling of Industrial wastes: paper, plastics, leather and chemicals. | 3 |
| 5 | **Waste Analysis and Waste Audit (11 hours)** | |
| 5.1 | Introduction to terminology of waste, waste analysis, introduction to waste audit, checklist for performance audit in waste collection, segregation, transport, treatment. | 3 |

| | | |
|---|---|---|
| 5.2 | People's responsibility of waste management responsibility of waste management, polluter pays principle (ppp), assimilative capacity and the precautionary principle | 3 |
| 5.3 | World scenario in scrap trade extended producer responsibility (epr), carrying capacity, precautionary principle 5 waste reduction towards zero waste sustainable living, waste reduction at business (producer) level | 2 |
| 5.4 | Waste reduction at individual level: zero waste living, waste reduction at community level | 3 |

**Reference Books**


1. Wastewater Engineering: Treatment Disposal Reuse by Metcalf & Eddy
2. Environmental Biotechnology : Principles and Applications by Bruce E. Rittmann
3. Waste water Engineering Treatment and Reuse: McGraw Hill, G. Tchobanoglous, FI Biston, 2002.
4. Industrial Waste Water Managemnet Treatment and Disposal by Waste Water McGraw Hill, 3rd Edition 2008.
5. Environmental Biotechnology: Principles and Applications by Bruce E. Rittmann.
6. Biological Wastewater Treatment, Second Edition, Marcel Dekker, Inc., New York.

| 242EBT009 | Management Entrepreneurship and Bio business | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | Program Elective 4 | 3 | 0 | 0 | 3 |

**Preamble:**

Research and business belong together and both are needed for the strong economic growth of our country. In a rapidly developing biotechnology industry, there is an urgent need for people who combine business knowledge with the understanding of science & technology. Bio business, is an interdisciplinary course, which revolves around the central theme of how to manage and develop life science companies and projects.

**Pre-requisites**: Nil

**Course Outcomes:**

After the completion of the course the student will be able to

| | |
|---|---|
| **CO 1** | Comprehend the fundamental aspects of Entrepreneurship and introduce him/her to available funding methods for enabling startups. |
| **CO 2** | Identify the scope for entrepreneurship in biosciences and utilize the schemes promoted through knowledge centres and various agencies |
| **CO 3** | Understand the various management and legal documentation needed in biotechnological venture creation, such as project reports, company incorporation and contract drafting |
| **CO 4** | Analyse and shortlist projects in various biotechnology sectors with the help of case studies of such start ups. |

**Mapping of course outcomes with program outcomes**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 |
|---|---|---|---|---|---|---|---|
| **CO 1** | | | | | 3 | | 3 |
| **CO 2** | 2 | | 2 | | | 2 | 3 |
| **CO 3** | 2 | 3 | 2 | 2 | | 2 | 3 |
| **CO 4** | 2 | 3 | 2 | 3 | | 3 | 3 |

**Assessment Pattern**

| Bloom's Category | End Semester Examination |
|---|---|
| Apply | 25% |
| Analyse | 40% |
| Evaluate | 20% |
| Create | 5% |

**Mark distribution**

| Total Marks | CIE | ESE | ESE Duration |
|---|---|---|---|
| 100 | 40 | 60 | 2.5 hours |

**Continuous Internal Evaluation Pattern: 40 marks**

Preparing a review article based on peer reviewed Original publications (minimum 10 publications shall be referred) : 15 marks

Course based task/Seminar/Data collection and interpretation : 15 marks

Test paper, 1 no. : 10 marks

Test paper shall include minimum 80% of the syllabus.

**End Semester Examination Pattern: 60 marks**

The end semester examination will be conducted by the respective College. There will be two parts; Part A and Part B.

Part A will contain 5 numerical/short answer questions with one question from each module, having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions.

Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

**Model Question Paper**

**QP CODE:** **PAGES:**

**Reg No: _____** **Name: _____**

**SAHRDAYA COLLEGE OF ENGINEERING AND TECHNOLOGY**
**SECOND SEMESTER M. TECH DEGREE EXAMINATION, MONTH & YEAR**
**Course Code: 242EBT009**

Max. Marks: 60 Duration: 2.5 hrs.

**Management, Entrepreneurship and Bio business**

**PART – A**

Answer All the Questions.

One question from each module, having 5 marks for each question.

(5x 5 = 25)

1. What is the difference between an intrapreneur and entrepreneur?
2. What are some of the Threats facing the Biotech sector in India..
3. Enumerate any three difficulties faced in marketing biopharmaceuticals..
4. Write the model equation of heating in open vessel.
5. What are the benefits of drafting Project report for the introduction of a new biotechnology product into the market.?

**PART – B**

Minimum one question from each module (Total seven questions)

Answer any five (5 x 7 = 35)

6. What are the various opportunities afforded by BIRAC for biotechnology entrepreneurs in India? Elaborate,
7. Discuss the growth of the Biotech Industry in India over the last three years and analyze the various high growth areas .
8. Discuss the economic state of the Indian Biotechnology Industry in 2021-22 and what was the role and contribution of biopharmaceuticals towards this growth...
9. Discuss the salient points to be followed in drawing up a joint venture agreement with a research agency for product manufacture and marketing.

10. What are the benefits of drafting Project report for the introduction of a new biotechnology product into the market.?
11. With a suitable case study and example highlight the opportunities available in India for vaccine production in India with reference to the COVID-19 global pandemic. Your answer should mention the major players, the market size and a SWOT analysis of the same.
12. What are the benefits and drawbacks of Technology leasing, licensing and transfer instead of having one's own Research and Development centre..

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## SYLLABUS

**Module 1 (8 hours)**

**Module 1:**

**Entrepreneurship:** Definition, functions and kinds of entrepreneurs, intrapreneur-entrepreneurship and economic development, entrepreneurial competencies-, developing competencies, project identification, selection and financing. Entrepreneurship development programs of public and private agencies (MSME, DBT, BIRAC, Make In India),

**Module 2 (8 hours)**

**Bio-entrepreneurship** :Introduction and scope in Bio-entrepreneurship, Types of bio-industries and competitive dynamics between the sub-industries of the bio-sector (e.g. pharmaceuticals vs. Industrial biotech) in India, Strategy and operations of bio-sector firms: Factors shaping opportunities for innovation and entrepreneurship in bio-sectors, and the business implications of those opportunities, Alternatives faced by emerging bio-firms and the relevant tools for strategic decision. Strategic dimensions of patenting & commercialization strategies.

**Module 3 (8 hours)**

**Negotiating the road from lab to the market**: Strategies and processes of negotiation with financers, government and regulatory authorities), Pricing strategy, Challenges in marketing in bio business (market conditions & segments; developing distribution channels, the nature, analysis and management of customer needs), Basic contract principles, different types of agreement and contract terms typically found in joint venture and development agreements, Dispute resolution skills.

**Module 4 (8 hours)**

**Bio Business opportunity**, Essential requirement, marketing strategies, schemes, challenges and scope-with case study- Pollution monitoring and Bioremediation for Industrial pollutants, Pesticides, Herbicides etc. I Fermented products-probiotic and prebiotics. Stem cell production, stem cell bank, contract research. Production of monoclonal/polyclonal antibodies, Single cell protein and secondary metabolite production. Contact research in microbial genomics. Building Biotech business challenges in Indian context-biotech partners (BICEPS,BIRAC,DBT, Incubation centers. Etc.,), operational biotech parks in India.

**Module 5 (8 hours)**

**Bio business-schemes and subsidies.** Meaning of Project; Project Identification; Project Selection; Project Report; Need and Significance of Report; Contents; Formulation; Guidelines by Planning Commission for Project report; Network Analysis; Errors of Project Report; Project Appraisal. Identification of business opportunities: Market Feasibility Study; Technical Feasibility Study; Financial Feasibility Study & Social Feasibility Study. Patent expiry and Entrepreneurship opportunity, Principles of Technology leasing, licensing and transfer, Startup schemes in Indian government, Business incubation support schemes,

**Course plan**

| No | Topic | No. of Lectures |
|---|---|---|
| **1** | **Entrepreneurship (8 hours)** | |
| 1.1 | Definition, functions and kinds of entrepreneurs economic development,. - | 2 |
| 1.2 | Entrepreneurial competencies-traits, developing competencies, project identification, selection and financing | 2 |
| 1.3 | Entrepreneurship development programs of public and private agencies (MSME, DBT, BIRAC, Make In India), Strategic dimensions of patenting & commercialization strategies. | 2 |
| 1.4 | Strategic dimensions of patenting & commercialization strategies. | 2 |
| **2** | **Bio-entrepreneurship (8hours)** | |
| 2.1 | Types of bio-industries and competitive dynamics between the sub-industries of the bio-sector (e.g. pharmaceuticals vs. Industrial biotech) in India, Strategy and operations of bio-sector firms | 2 |
| 2.2 | Factors shaping opportunities for innovation and entrepreneurship in bio-sectors, and the business implications of those opportunities, | 2 |
| 2.3 | Alternatives faced by emerging bio-firms and the relevant tools for strategic decision, | 2 |
| 2.4 | Strategic dimensions of patenting & commercialization strategies. | 2 |
| **3** | **Negotiating the road from lab to the market (8 hours)** | |

| | | |
|---|---|---|
| 3.1 | Strategies and processes of negotiation with financers, government and regulatory authorities), | 2 |
| 3.2 | Pricing strategy, Challenges in marketing in bio business (market conditions & segments; developing distribution channels, the nature, analysis and management of customer needs), | 2 |
| 3.3 | Basic contract principles, different types of agreement and contract terms typically found in joint venture and development agreements | 3 |
| 3.4 | Dispute resolution skills | 1 |
| **4** | **Biobusiness Opportunity (8hours)** | |
| 4.1 | Essential requirement, marketing strategies, schemes, | 1 |
| 4.2 | Challenges and scope-with case study- Pollution monitoring and Bioremediation for Industrial pollutants,Pesticides, Herbicides etc | 2 |
| 4.3 | Fermented products-probiotic and prebiotics. Stem cell production, stem cell bank, contract research. | 1 |
| 4.4 | Production of monoclonal/polyclona antibodies, Single cell protein and secondary metabolite production. Contact research in microbial genomics. | 2 |
| 4.5 | Building Biotech business challenges in Indian context-biotech partners (BICEPS,BIRAC,DBT, Incubation centers. Etc.,), operational biotech parks in India. | 2 |
| **5** | **Bio business-schemes and subsidies (8hours)** | |
| 5.1 | Meaning of Project; Project Identification; Project Selection; | 1 |
| 5.2 | Project Report; Need and Significance of Report; Contents; Formulation; Guidelines by Planning Commission for Project report; Network Analysis; Errors of Project Report; Project Appraisal. | 3 |
| 5.3 | Identification of business opportunities: Market Feasibility Study; Technical Feasibility Study; Financial Feasibility Study & Social Feasibility Study | 2 |
| 5.4 | Patent expiry and Entrepreneurship opportunity, Principles of Technology leasing, licensing and transfer, Startup schemes in Indian government, Business incubation support schemes, | 2 |
| | | |

**Reference Books**

1. Adams, D. J., & Sparrow, J. C. (2008). Enterprise for Life Scientists: Developing Innovation and Entrepreneurship in the Biosciences. Bloxham: Scion.
2. Shimasaki, C. D. (2014). Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies. Amsterdam: Elsevier. Academic Press is an imprint
3. Jordan, J. F. (2014). Innovation, Commercialization, and Start-Ups in Life Sciences. London: CRC Press.
4. Desai, V. (2009). The Dynamics of Entrepreneurial Development and Management. New Delhi: Himalaya Pub. House.
5. Robert D Hisrich, Michael P Peters, & Dean A Shepherd, “Entrepreneurship”, Tata McGraw Hill, 2007
6. C.B Gupta & S. Srinivasan, “Entrepreneurial Development”, S. Chand & Co., Limited New Delhi. 2005

| 242EBT010 | ADVANCES IN BIOPOLYMER TECHNOLOGY | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | Program Elective 4 | 3 | 0 | 0 | 3 |

**Preamble:**

Acquaint the students with knowledge regarding the basic biopolymers and different types of polymers used in industries.

**Pre-requisites**: Nil

**Course Outcomes**: After the completion of the course, the student will be able to

| | |
|---|---|
| **CO 1** | Appreciate the importance of sustainable materials |
| **CO 2** | Understand the properties and applications of PLA, PHA and Starch derivatives |
| **CO 3** | Know the properties and applications of Cellulose, proteins and hemi - cellulose |
| **CO 4** | Recognize the importance of biopolymers in the field of Food packaging. |
| **CO 5** | Identify the importance of biopolymers in the field of Agriculture. |

**Mapping of course outcomes with program outcomes**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 |
|---|---|---|---|---|---|---|---|
| **CO 1** | - | - | - | - | 2 | 3 | - |
| **CO 2** | - | - | - | 2 | 3 | - | - |
| **CO 3** | - | - | - | - | 3 | - | - |
| **CO 4** | - | - | - | 3 | 3 | 2 | - |
| **CO 5** | - | - | - | - | 2 | 2 | - |

**Assessment Pattern**

| Bloom's Category | End Semester Examination |
|---|---|
| Apply | 35% |
| Analyse | 50% |
| Evaluate | 15% |
| Create | |

**Mark distribution**

| Total Marks | CIE | ESE | ESE Duration |
|---|---|---|---|
| 100 | 40 | 60 | 2.5 hours |

**Continuous Internal Evaluation Pattern: 40 marks**

| | |
|---|---|
| Micro/Course based project | : 15 marks |
| Course based /Seminar/Quiz | : 15 marks |
| Test paper, 1 no. | : 10 marks |

Test paper shall include minimum 80% of the syllabus.

**End Semester Examination Pattern: 60 marks**

The end semester examination will be conducted by the respective College. There will be two parts; Part A and Part B.

Part A will contain 5 numerical/short answer questions with one question from each module; having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions.

Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

**Model Question Paper**

**QP CODE:** **PAGES:**

**Reg No: _____** **Name: _____**

**SAHRDAYA COLLEGE OF ENGINEERING AND TECHNOLOGY**

**SECOND SEMESTER M. TECH DEGREE EXAMINATION, MONTH & YEAR**

**Course Code: 242EBT010**

Max. Marks: 60 Duration: 2.5 hrs.

**Advances in Biopolymer Technology**

**PART – A**

Answer All the Questions.

One question from each module, having 5 marks for each question.

(5x 5 = 25)

1. How can we evaluate the biodegradation of biopolymers?
2. Explain the different resources for polymers.
3. Discuss how Plant and animal-based Proteins can be used as polymers.
4. How biopolymers can be used in the food industry?
5. Briefly explain the process of Biodegradable mulching.

**PART – B**

Minimum one question from each module (Total seven questions)

Answer any five (5 x 7 = 35)

6. Discuss the role of life cycle assessment in biopolymers.
7. Derivatives as biopolymers can be used to replace polymers. Justify
8. Explain the role of Cellulose based Composites
9. Bio-nanocomposite films can be used to replace polymers in Industry. Justify
10. Explain how Functionalized Biopolymer Coatings can be used in food Industry.
11. List out the Mechano structural function of biopolymers.
12. Discuss the safety and Environmental aspects of biopolymers.

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## SYLLABUS

**Module 1 (8 hours)**

**Chemistry of Biopolymers:** Raw materials for polymers – Sustainability of Petroleum resources - Need for Alternate Sources for Polymers –Polymer Recycling and Environmental Issues – Bio derived Polymers - Biodegradation and its Evaluation techniques – Standards for biodegradation – Need for biodegradation of packaging materials – Introduction to Life Cycle Assessment – Monomers from BioSource.

**Module 2 (8 hours)**

**Resources for Biopolymers:** Polysaccharide based polymers – Gelatinization – Starch based blends - Biodegradation of Starch based Polymers - Production of Lactic acid and Polylactide - Properties and applications of Polylactides – Introduction to Polyhydroxyalkanoates and their derivatives – Applications – Chitin & Chitosan and its derivatives as biopolymers.

**Module 3 (8 hours)**

**Types of Polymers:** Plant and animal-based Proteins – Solution casting of proteins – Processing of proteins as plastics – preparation and properties of hemicellulose – Cellulose based Composites – Surface and Chemical modifications of Cellulose fibres. Structure and enzymatic activity. Mechano structural function of biopolymers.

**Module 4 (8 hours)**

**Applications of Biopolymers**: Food Packaging – Functional Properties – safety and Environmental aspects – Shelf life – Films and coatings in Food Applications – Materials for edible films and coatings – Biopolymer coatings for paper and paperboard – Bio-nanocomposite films and coatings.

**Module 5 (8 hours)**

**Biopolymer in Agriculture:** Biopolymer Films – Biodegradable mulching – Advantages and Disadvantages - Chemical sensors – Biosensors - Functionalized Biopolymer Coatings and Films – Hydrogel in farming. Applications of biopolymers in horticulture.

**Course Plan**

| No | Topic | No. of Lectures |
|---|---|---|
| 1 | **Chemistry of Biopolymers (8 hours)** | |
| 1.1 | Raw materials for polymers | 1 |
| 1.2 | Sustainability of Petroleum resources - Need for Alternate Sources for Polymers | 1 |
| 1.3 | Polymer Recycling and Environmental Issues | 1 |
| 1.4 | Bio derived Polymers - Biodegradation and its Evaluation techniques | 1 |
| 1.5 | Standards for biodegradation | 1 |
| 1.6 | Need for biodegradation of packaging materials | 1 |
| 1.7 | Introduction to Life Cycle Assessment | 1 |
| 1.8 | Monomers from BioSource | 1 |
| 2 | **Resources For Biopolymers (8 hours)** | |
| 2.1 | Polysaccharide based polymers | 1 |
| 2.2 | Gelatinization – Starch based blends | 1 |
| 2.3 | Biodegradation of Starch based Polymers | 1 |
| 2.4 | Production of Lactic acid and Polylactide | 1 |
| 2.5 | Properties and applications of Polylactides | 1 |
| 2.6 | Introduction to Polyhydroxy alkenoates and their derivatives | 2 |
| 2.7 | Applications – Chitin & Chitosan and its derivatives as biopolymers | 1 |
| 3 | **Types of Polymers (8 hours)** | |
| 3.1 | Plant and animal-based Proteins | 1 |
| 3.2 | Solution casting of proteins | 1 |
| 3.3 | Processing of proteins as plastics | 1 |
| 3.4 | preparation and properties of hemicellulose | 1 |
| 3.5 | Cellulose based Composites | 1 |
| 3.6 | Surface and Chemical modifications of Cellulose fibres | 1 |
| 3.7 | Structure and enzymatic activity | 1 |
| 3.8 | Mechano structural function of biopolymers | 1 |
| 4 | **Applications of Biopolymers (8 hours)** | |

| | | |
|---|---|---|
| 4.1 | Food Packaging | 1 |
| 4.2 | Functional Properties | 1 |
| 4.3 | Safety and Environmental aspects | 1 |
| 4.4 | Shelf life | 1 |
| 4.5 | Films and coatings in Food Applications | 1 |
| 4.6 | Materials for edible films and coatings | 1 |
| 4.7 | Biopolymer coatings for paper and paperboard | 1 |
| 4.8 | Bio-nanocomposite films and coatings | 1 |
| 5 | **Biopolymer in Agriculture (8 hours)** | |
| 5.1 | Biopolymer Films | 1 |
| 5.2 | Biodegradable mulching | 1 |
| 5.3 | Advantages and Disadvantages | 1 |
| 5.4 | Chemical sensors – Biosensors | 2 |
| 5.5 | Functionalized Biopolymer Coatings and Films | 1 |
| 5.6 | Hydrogel in farming | 1 |
| 5.7 | Applications of biopolymers in horticulture | 1 |

**Text Book:**

1. Charles Gebelein, Biotechnological Polymers: Medical, pharmaceutical and industrial applications, CRC press,1993.
2. W.Schnabel, Polymer Degradation – Principles and Practical Applications, Hanser International, 1982.
3. Hand Book of Plastic Test Methods, R.P.Brown (Ed.), George Godwin, London 1981

**Reference Book:**

1. David Plackett, “Biopolymers – New Materials for Sustainable films and Coatings”, John Wiley & Sons Ltd, 2011 101
2. David Kaplan, “Biopolymers from Renewable resources”, Springer, 1998
3. Carmen Scholz, Richard A Gross, “Polymers from Renewable Resources: Biopolymers and Biocatalysis”, American Chemical Society, 2001.

| 242EBT011 | CANCER BIOLOGY AND CELL SIGNALLING | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | Program Elective 4 | 3 | 0 | 0 | 3 |

**Preamble:**

Students are allowed to tailor the knowledge of Cancer Biology and cell signalling to suit their knowledge, interests and skills for the future medical research insight.

**Pre-requisites**: Nil

**Course Outcomes**: After the completion of the course, the student will be able to

| | |
|---|---|
| **CO 1** | Fundamentals biomolecules and principles of cancer biology |
| **CO 2** | Idea of causes and histopathology of Cancer |
| **CO 3** | Metastasis and extracellular matrix and tumour micro environment |
| **CO 4** | Importance of cell signalling |
| **CO 5** | Enhanced immunology-based detection methods and imaging technique, various types of cancer therapy |

**Mapping of course outcomes with program outcomes**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 |
|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | - | 2 | 2 | - | - | - |
| **CO 2** | 3 | - | 2 | - | - | - | - |
| **CO 3** | 3 | - | 2 | - | 2 | 2 | - |
| **CO 4** | 2 | 2 | 2 | - | - | 2 | - |
| **CO 5** | 3 | 2 | 2 | - | 2 | 2 | - |

**Assessment Pattern**

| Bloom's Category | End Semester Examination |
|---|---|
| Apply | 50% |
| Analyse | 15% |
| Evaluate | 35% |
| Create | |

**Mark distribution**

| Total Marks | CIE | ESE | ESE Duration |
|---|---|---|---|
| 100 | 40 | 60 | 2.5 hours |

**Continuous Internal Evaluation Pattern: 40 marks**

| | |
|---|---|
| Micro/Course based project | : 15 marks |
| Course based /Seminar/Quiz | : 15 marks |
| Test paper, 1 no. | : 10 marks |

Test paper shall include minimum 80% of the syllabus.

**End Semester Examination Pattern: 60 marks**

The end semester examination will be conducted by the respective College. There will be two parts; Part A and Part B.

Part A will contain 5 numerical/short answer questions with one question from each module; having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions.

Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

**Model Question Paper**

**QP CODE:** **PAGES:**

**Reg No: _____** **Name: _____**

**SAHRDAYA COLLEGE OF ENGINEERING AND TECHNOLOGY**
**SECOND SEMESTER M. TECH DEGREE EXAMINATION, MONTH & YEAR**
**Course Code: 242EBT011**

Max. Marks: 60 Duration: 2.5 hrs.

**Cancer Biology and Cell Signalling**

**PART – A**

Answer All the Questions.

One question from each module, having 5 marks for each question.

(5x 5 = 25)

1. Briefly explain the role of different biomolecules in cancer.
2. Explain different classes of cancer.
3. What is cell cycle and different phases of cell cycle?
4. Explain fundamentals of cell signalling.
5. Different methods used in the diagnosis of cancer detection.

**PART – B**

Minimum one question from each module (Total seven questions)

Answer any five (5 x 7 = 35)

6. Explain the importance of glucose in cancer cell metabolism.
7. Illustrate various types of chemical carcinogens.
8. What are the important causes of cancer?
9. Discuss various methods of cancer spreading.
10. Highlight the role of cytoskeletal regulatory proteins.
11. List out the major methods of the prevention of cancer.
12. Discuss the use of signal targets therapy in cancer

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## SYLLABUS

**Module 1 (8 hours)**

**Fundamentals of cancer biology:** Role of biomolecules in cancer – Carbohydrates, Proteins and Lipids in cancer, Membrane components. Role of Biomolecules Membrane trafficking, The Proteasome and cancer. **Principles of Carcinogens** - Theory of carcinogenesis, Chemical carcinogenesis, metabolism of carcinogenesis, principles of physical carcinogenesis, x-ray radiation-mechanisms of radiation carcinogenesis.

**Module 2 (6 hours)**

**Introduction to Cancer biology:** Definition of cancer, different forms of cancers, different causes of cancer - mutations and cancer – Life style and environment (diet and other life style factors) – age –histopathology of cancer –hall marks of cancer. Cancer cell growth and spreading of cancer.

**Module 3 (8 hours)**

**Metastasis and the Cytoskeleton:** Overview of the Cell Cycle, Regulation of cell cycle, Modulation of cell cycle in cancer. DNA damage and checkpoint, Cytoskeletal regulatory proteins. Extracellular Matrix (ECM) and the Tumor microenvironment - Overview of the ECM, Metabolic alternations in the tumour microenvironment - Regulators of the tumor microenvironment, Extracellular matrix alterations in the tumor microenvironment and extracellular matrix fragments as tumor biomarkers. Cellular motility and metastasis. p53 and Apoptosis.

**Module 4 (8 hours)**

**Cell Signalling:** Effects of receptors in cell signalling, signal switches G-protein coupled receptors, G protein, Ras and rho family signalling –Types of Cell signalling, Hedgehog signalling – *Nuclear signalling* -Heat shock and ER stress response - Cytoplasmic Signalling - sustained growth signals, Receptor tyrosine kinases Oncogenes -Tumour suppressor genes.

**Module 5 (10hours)**

**Therapy:** Importance of early detection of cancer. Molecular tools used for the diagnosis of cancer. Methods of prevention of cancer. Treatment of cancer - Different forms of therapy, chemotherapy, radiation therapy, prediction of aggressiveness of cancer, Use of signal targets towards therapy of cancer. Gene Therapy, Role of virus in cancer therapy, Importance of advanced technology in cancer therapy.

**Course Plan**

| No | Topic | No. of Lectures |
|---|---|---|
| 1 | **Fundamentals of Cancer Biology (8 hours)** | |
| 1.1 | Role of biomolecules in cancer | 1 |
| 1.2 | Carbohydrates, Proteins and Lipids in cancer | 1 |
| 1.3 | Membrane components | 1 |
| 1.4 | Role of Biomolecules Membrane trafficking | 1 |
| 1.5 | The Proteasome and cancer. | 1 |
| 1.6 | **Principles of Carcinogens** - Theory of carcinogenesis, | 1 |
| 1.7 | Chemical carcinogenesis, metabolism of carcinogenesis, | 1 |
| 1.8 | Principles of physical carcinogenesis, x-ray radiation-mechanisms of radiation carcinogenesis. | 1 |
| 2 | **Introduction to Cancer biology (6 hours)** | |
| 2.1 | **Introduction to Cancer biology** – Definition of cancer | 1 |
| 2.2 | Different forms of cancers, different causes of cancer | 1 |
| 2.3 | Mutations and cancer | 1 |
| 2.4 | Life style and environment (diet and other life style factors) – age | 1 |
| 2.5 | Histopathology of cancer –hall marks of cancer | 1 |
| 2.6 | Cancer cell growth and spreading of cancer. | 1 |
| 3 | **Microbial Metabolism and Biochemistry (8 hours)** | |
| 3.1 | **Metastasis and the Cytoskeleton -** Overview of the Cell Cycle | 1 |
| 3.2 | Regulation of cell cycle, Modulation of cell cycle in cancer. DNA damage and checkpoint | 1 |
| 3.3 | Cytoskeletal regulatory proteins | 1 |
| 3.4 | Extracellular Matrix (ECM) and the Tumour microenvironment - Overview of the ECM | 1 |
| 3.5 | Metabolic alternations in the tumour microenvironment - Regulators of the tumour microenvironment, | 1 |
| 3.6 | Extracellular matrix alterations in the tumour microenvironment and extracellular matrix fragments as tumour biomarkers | 1 |
| 3.7 | Cellular motility and metastasis. | 1 |
| 3.8 | p53 mediated Apoptosis and necrosis | 1 |
| 4 | **Cellular Process Technology (8 hours)** | |

| | | |
|---|---|---|
| 4.1 | **Cell Signalling** - Effects of receptors in cell signalling, | 1 |
| 4.2 | Signal switches, G-protein coupled receptors | 1 |
| 4.3 | Ras and rho family signalling | 1 |
| 4.4 | Types of Cell signalling, Hedgehog signalling | 1 |
| 4.5 | Nuclear signalling -Heat shock and ER stress response | 1 |
| 4.6 | Cytoplasmic Signalling - sustained growth signals | 1 |
| 4.7 | Receptor tyrosine kinases, Oncogenes | 1 |
| 4.8 | Tumour suppressor genes, | 1 |
| 5 | **Bioprocess monitoring (10hours)** | |
| 5.1 | **Therapy -** Importance of early detection of cancer | 1 |
| 5.2 | Molecular tools used for the diagnosis of cancer. | 1 |
| 5.3 | Methods of prevention of cancer | 1 |
| 5.4 | Treatment of cancer | 1 |
| 5.5 | Different forms of therapy | 1 |
| 5.6 | Chemotherapy, radiation therapy, | 1 |
| 5.7 | Use of signal targets towards therapy of cancer | 1 |
| 5.8 | Gene Therapy | 1 |
| 5.9 | Role of virus in cancer therapy | 1 |
| 5.10 | Importance of advanced technology in cancer therapy | 1 |

**Text Book**


1. Lehninger Principles of Biochemistry 8th edition 2021 David L Nelson Michael M Cox
2. Palmer, Trevor. “Enzymes: Biochemistry, Biotechnology, Clinical Chemistry.” 2nd Edition, East West Press, 2008.
3. Weinberg, R.A. “The Biology of Cancer” Garland Science, 2007
4. McDonald, F et al., “Molecular Biology of Cancer” IInd Edition. Taylor & Francis, 2004.


**Reference Books**


1. Principles of Biochemistry 4th Edition ISE 2013 By Voet Publisher Wiley
2. Yeh W.K., Yang H.C., James R.M., “Enzyme Technologies: Metagenomics, Biocatalysis and Biosynsthesis”, WileyBlackwell, 1st Edition, 2010.
3. King, Roger J.B. “Cancer Biology” Addison Wesley Longman, 1996.
4. Ruddon, Raymond W. “Cancer Biology” III rd Edition. Oxford University Press, 1995.
5. Lewis J Kelinsmith, Pearson Principles of Cancer biology 2016 1st Edition

| 242EBT041 | INTRODUCTION TO BIOINFORMATICS | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | Interdisciplinary | 3 | 0 | 0 | 3 |

**Preamble:** Introduction to biological databases, sequence analysis and drug designing.

**Pre-requisites**: Nil

**Course Outcomes:** The COs shown are only indicative. For each course, there can be 4 to 6 COs.

After the completion of the course the student will be able to

| | |
|---|---|
| **CO 1** | Differentiate various biological databases and its tools |
| **CO 2** | Basic algorithms used in pairwise and multiple sequence alignment |
| **CO 3** | Introduction to computational gene and protein prediction methods |
| **CO 4** | Construct evolutionary tree based on phylogentic algorithms |
| **CO 5** | Develop and modify insilico models that enable efficient drug design |

**Mapping of course outcomes with program outcomes**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 |
|---|---|---|---|---|---|---|---|
| **CO 1** | - | - | - | - | 2 | 2 | - |
| **CO 2** | - | - | - | 2 | 2 | 2 | - |
| **CO 3** | 2 | - | 2 | 3 | 2 | 3 | - |
| **CO 4** | - | - | - | 2 | 2 | 2 | - |
| **CO 5** | 2 | - | 2 | 3 | 3 | 3 | - |

**Assessment Pattern**

| Bloom's Category | End Semester Examination |
|---|---|
| Apply | 35% |
| Analyse | 50% |
| Evaluate | 15% |
| Create | |

**Mark distribution**

| Total Marks | CIE | ESE | ESE Duration |
|---|---|---|---|
| 100 | 40 | 60 | 2.5 hours |

**Continuous Internal Evaluation Pattern: 40 marks**

Micro/Course based project : 15 marks

Course based /Seminar/Quiz : 15 marks

Test paper, 1 no. : 10 marks

Test paper shall include minimum 80% of the syllabus.

**End Semester Examination Pattern: 60 marks**

The end semester examination will be conducted by the respective College. There will be two parts; Part A and Part B.

Part A will contain 5 numerical/short answer questions with one question from each module; having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions.

Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

**Model Question Paper**

**QP CODE:** **PAGES:**

**Reg No: _____** **Name: _____**

**SAHRDAYA COLLEGE OF ENGINEERING AND TECHNOLOGY**
**SECOND SEMESTER M. TECH DEGREE EXAMINATION, MONTH & YEAR**
**Course Code: 242EBT041**

Max. Marks: 60 Duration: 2.5 hrs.

**Introduction to Bioinformatics**

**PART – A**

Answer All the Questions.

One question from each module, having 5 marks for each question.

(5x 5 = 25)

1. List out the steps in microarray experiment
2. Differentiate between Local and Global alignment methods with example
3. Explain various virtual screening methods
4. Name any 5 structure prediction software. Explain its features.
5. List out the steps in phylogenetic tree construction in detail. Summarize the steps involved in CADD. Give example of software used in the field

**PART – B**

Minimum one question from each module (Total seven questions)

Answer any five (5 x 7 = 35)

6. Explain the working of Heuristic databse searching methods? List out the variants of BLAST.
7. Compute the Smith-Waterman dynamic programming table, alignments andassociated sequence identities for the following sequences

   Sequence 1 = GCGCATGGATTG

   Sequence 2 = TGCGCCATTGA

   Scores: Match = +1, Mismatch = 0, Gap = -1
8. Define the different computational methods of 3D Protein structure modeling and explain computational strategy for homology based 3D protein structure modeling.
9. Illustrate with an example explain about the construction of a phylogenetic tree using distance-based method.
10. Explain QSAR. List out its applications
11. Describe the various applications medical applications in the field of bioinformatics
12. Differentiate between the *ab initio* based and homology-based gene prediction methods

## SYLLABUS

**Module I (9 hours)**

**Bioinformatics & Biological Databases**: Introduction to Bioinformatics, Applications in biological science and medicine and Limitations, Sequence Databases, Structure Databases, Special Databases and applications: Genome, Microarray, Metabolic pathway, motif, domain databases. Mapping databases – genome wide maps. Chromosome specific human maps. Applications of these databases. Database Similarity Searching: Unique Requirements of Database Searching. Heuristic Database searching - BLAST, FASTA, C Database Searching with the Smith–Waterman Method.

**Module II (8 hours)**

**Sequence Alignment**: Evolutionary basis, Homology vs Similarity, Similarity vs Identity. Types of Sequence alignment - Pairwise and Multiple sequence alignment, Alignment algorithms, Scoring matrices, Statistical significance of sequence alignment. Multiple Sequence Alignment: Scoring function, Exhaustive algorithms, Heuristic algorithms, Practical issues. Profiles and Hidden Markov Models: Position-Specific scoring matrices, Profiles, Markov Model and Hidden Markov Model.

**Module III (8 hours)**

**Predictive Methods**: Predictive methods using Nucleic acid sequence – DNA framework, Masking of repetitive DNA, predicting RNA secondary structure, Finding RNA genes, Detection Of functional sites and Codon bias in the DNA. Predictive methods using protein sequence – Protein identity and Physical properties. Structure prediction - Prediction of secondary structure of protein, Antigenic sites, Active sites, Folding classes, specialized structures and Tertiary structures. Discussions with case studies. Concepts involved in insilico Primer Designing and developing Restriction Maps.

**Module IV (7 hours)**

**Molecular Phylogenetics** – Phylogenetics Basics: Molecular Evolution and Molecular Phylogenetics, Terminology, Gene Phylogeny versus Species Phylogeny, Forms of Tree Representation; Phylogenetic Tree Construction Methods and Programs**:** Distance-Based Methods, Character-Based Methods, Phylogenetic Tree Evaluation, Phylogenetic Programs.

**Module V (8 hours)**

**Drug discovery process**: Target identification and validation, lead optimization and validation, Analog-Based drug design: Pharmacophores (3D database searching, conformation searches, deriving and using 3D Pharmacophore, constrained systematic search, Genetic Algorithm, clique detection techniques, maximum likelihood method), QSAR, Structure-based drug design: Docking, De Novo Drug Design (Fragment Placements, Connection Methods, Sequential Grow), Virtual screening.

| Course Plan | | |
|---|---|---|
| No | Topic | No. of Lectures |
| 1 | **Bioinformatics & Biological Databases (9 hours)** | |
| | Introduction to Bioinformatics, Applications in biological science and medicine and Limitations | 1 |
| 1.1 | Sequence Databases, Structure Databases, Special Databases and applications | 2 |
| 1.2 | Genome Microarray, Metabolic pathway, motif, domain databases | 1 |
| 1.3 | Mapping databases – genome wide maps, Chromosome specific human maps, Applications of these databases | 2 |
| 1.4 | Database Similarity Searching: Unique Requirements of Database Searching | 1 |
| 1.5 | Heuristic Database searching - BLAST, FASTA, C Database Searching with the Smith–Waterman Method. | 2 |
| 2 | **Sequence Alignment (8 hours)** | |
| 2.1 | Evolutionary basis, Homology vs Similarity, Similarity vs Identity. | 1 |
| 2.2 | Types of Sequence alignment - Pairwise and Multiple sequence alignment | 1 |
| 2.3 | Alignment algorithms, Scoring matrices, Statistical significance of sequence alignment | 2 |
| 2.4 | Multiple Sequence Alignment: Scoring function, Exhaustive algorithms, Heuristic algorithms, Practical issues | 2 |
| 2.5 | Profiles and Hidden Markov Models: Position-Specific scoring matrices, Profiles, Markov Model and Hidden Markov Model. | 2 |
| 3 | **Predictive Methods (8 hours)** | |
| 3.1 | Predictive methods using Nucleic acid sequence – DNA framework, Masking of repetitive DNA | 1 |
| 3.2 | predicting RNA secondary structure, Finding RNA genes, Detection Of functional sites and Codon bias in the DNA | 1 |
| 3.3 | Predictive methods using protein sequence –Protein identity and Physical properties | 1 |
| 3.4 | Structure prediction - Prediction of secondary structure of protein, Antigenic sites, Active sites, Folding classes, specialized structures and Tertiary structures | 2 |

| | | |
|---|---|---|
| 3.5 | Discussions with case studies | 1 |
| 3.6 | Concepts involved in insilico Primer Designing and developing Restriction Maps | 2 |
| 4 | **Molecular Phylogenetics (7 hours)** | |
| 4.1 | Phylogenetics Basics: Molecular Evolution and Molecular Phylogenetics | 1 |
| 4.2 | Terminology, Gene Phylogeny versus Species Phylogeny, Forms of Tree Representation | 1 |
| 4.3 | Phylogenetic Tree Construction Methods and Programs**:** Distance-Based Methods, Character-Based Methods | 3 |
| | Phylogenetic Tree Evaluation, Phylogenetic Programs. | 2 |
| 5 | **Computer Aided Drug Design (8 hours)** | |
| 5.1 | Drug discovery process: Target identification and validation, lead optimization and validation | 1 |
| 5.2 | Analog-Based drug design: Pharmacophores (3D database searching, conformation searches, deriving and using 3D Pharmacophore, constrained systematic search, Genetic Algorithm, clique detection techniques, maximum likelihood method) | 3 |
| 5.3 | QSAR | 1 |
| | Structure-based drug design: Docking, De Novo Drug Design (Fragment Placements, Connection Methods, Sequential Grow) | 2 |
| 5.4 | Virtual screening | 1 |

**Reference Books**


1. D.W. Mount Bioinformatics: Genome and Sequence Analysis: (2001) Cold Spring Harbor LaboratoryPress, Cold Spring Harbor, New York.
2. A.D. Baxevanis& B.F.F. OuletteBioinformatics – A practical guide to the Analysis of Genes and Proteins,2002, Willey International publishers
3. Attwood TK and Parry-Smith DJ (2014) Introduction to bioinformatics, Pearson Education
4. Michael S Waterman Introduction to Computational Biology: Maps, Sequences, and Genomes by - Science - 1995

| 242EBT042 | BASICS OF BIOSENSOR TECHNOLOGY | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | Interdisciplinary | 3 | 0 | 0 | 3 |

**Preamble:**

This course gives an idea about basics of biosensors, its construction and its application in various disciplines**.**

**Pre-requisites**: Nil

**Course Outcomes:**

After the completion of the course the student will be able to

| | |
|---|---|
| **CO 1** | Identify the different components of biosensors and understand its different types. |
| **CO 2** | Understand the different transducers used in the manufacture of biosensors and their specific uses. |
| **CO 3** | Understand the different detection methods commonly adopted. |
| **CO 4** | Analyse the applications of biosensors in different areas and also to design specific enzyme biosensors for different applications. |
| **CO 5** | Understand the use of nanomaterials and its applications in the manufacture of biosensors. |

**Mapping of course outcomes with program outcomes**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 |
|---|---|---|---|---|---|---|---|
| **CO 1** | 2 | - | 2 | - | - | 2 | - |
| **CO 2** | 2 | 2 | 3 | - | 2 | - | - |
| **CO 3** | 2 | 3 | 2 | - | 2 | - | - |
| **CO 4** | 3 | 2 | 3 | 3 | 3 | 3 | 3 |
| **CO 5** | - | - | 2 | 3 | 3 | 3 | - |

**Assessment Pattern**

| Bloom's Category | End Semester Examination |
|---|---|
| Remember | 40% |
| Understand | 20% |
| Apply | 30% |
| Create | 10% |

**Mark distribution**

| Total Marks | CIE | ESE | ESE Duration |
|---|---|---|---|
| 100 | 40 | 60 | 2.5 hours |

**Model Question Paper**

**QP CODE:** **PAGES:**

**Reg No: _____** **Name: _____**

**SAHRDAYA COLLEGE OF ENGINEERING AND TECHNOLOGY**

**SECOND SEMESTER M. TECH DEGREE EXAMINATION, MONTH & YEAR**

**Course Code: 242EBT042**

Max. Marks: 60 Duration: 2.5 hrs.

**Basics of Biosensor Technology**

**Part – A**

Answer All the Questions.

One question from each module, having 5 marks for each question.

(5x 5 = 25)

1. Give example of wearable biosensors.
2. List the application of impedimetric biosensors.
3. Give notes on microorganisms based biosensors.
4. Discuss the relevance of nanobiosensors in this current scenario.
5. Differentiate between bioreceptors and biodetectors.

**PART – B**

Minimum one question from each module (Total seven questions)

Answer any five (5 x 7 = 35)

6. With a neat diagram describe the basic components of a biosensor
7. What are bioaffinity based biosensors? Explain.
8. Explain the Conductometric based Biosensors with a neat diagram.
9. Explain Emission Surface Plasmon Resonance.
10. Explain the uses of biosensors in animal health.
11. Design a biosensor that can be used for food adulteration detection giving specific emphasis to milk industry
12. With suitable example describe the application of nanotechnology-based biosensors.

**********

## SYLLABUS

**Module 1 (8 hours)**

**Biosensors-Introduction** -Biosensors- Advantages and limitations, various components of biosensors .Biocatalysis based biosensors, Bioaffinity based biosensors & Microorganisms based biosensors, biologically active material and analyte. Types of membranes used in biosensor constructions.

**Module 2 (10 hours)**

**Transducers in Biosensors** -Various types of transducers; principles and applications Calorimetric, Optical, Potentiometric / Amperometric, Piezoelectric, Semiconductor based biosensors, Impedimetric, Chemiluminiscene biosensors, Conductometric / Resistometric based Biosensors.

**Module 3 (6 hours)**

**Basics of Detection Methods**- Fluorescence Spectroscopy, UV-Vis Absorption and Emission Surface Plasmon Resonance, Magnetic labeling, Electrochemical Detection.

**Module 4 (9 hours)**

**Application and Uses of Biosensors** - Biosensors in clinical chemistry, medicine and health care, Biosensors for veterinary, agriculture and food. Biosensor for industrial processes for online monitoring; biosensors for environmental monitoring.

**Module 5 (7 hours)**

**Nanotechnology and Biosensors**-Nano Materials in biosensors; Carbon based Nano Material, Metal oxide and nano particle, Quantum dots, Role of nano material in Signal Amplifications, Detection and Transducer Fabrication.

**Course Plan**

| No | Topic | No. of Lectures |
|---|---|---|
| 1 | **Biosensors-Introduction (8 hours)** | |
| 1.1 | Biosensors- Advantages and limitations various components of biosensors | 2 |
| 1.2 | Biocatalysis based biosensors | 1 |
| 1.3 | Bioaffinity based biosensors & Microorganisms based biosensors, | 2 |
| 1.4 | Biologically active material and analyte. | 1 |
| 1.5 | Types of membranes used in biosensor constructions | 2 |
| 2 | **Transducers in Biosensors (10 hours)** | |
| 2.1 | Various types of transducers; principles and applications | 2 |
| 2.2 | Calorimetric, Optical, Potentiometric / Amperometric, | 2 |
| 2.3 | Piezoelectric, Semiconductor based biosensors | 2 |
| 2.4 | Impedimetric, Chemiluminiscene biosensors | 2 |
| 2.5 | Conductometric / Resistometric, - - based Biosensors. | 2 |
| 3 | **Basics of Detection Methods (6 hours)** | |
| 3.1 | Fluorescence Spectroscopy, UV-Vis Absorption and Emission | 2 |
| 3.2 | Surface Plasmon Resonance | 2 |
| 3.3 | Magnetic labeling, Electrochemical Detection | 2 |
| 4 | **Application and uses of Biosensors (9 hours)** | |
| 4.1 | Biosensors in clinical chemistry, medicine and health care, | 3 |
| 4.2 | Biosensors for veterinary, agriculture and food Low cost | 2 |
| 4.3 | Biosensor for industrial processes for online monitoring; | 2 |
| 4.4 | biosensors for environmental monitoring | 2 |
| 5 | **Nanotechnology and Biosensors (7 hours)** | |
| 5.1 | Nano Materials in biosensors; Carbon based Nano Material, | 2 |
| | Metal oxide and nano particle, Quantum dots, | 2 |
| 5.2 | Role of nano material in Signal Amplifications, Detection and Transducer Fabrication | 3 |

**Reference Books**


1. Biosensors: An Introductory Textbook, Jagriti Narang and Chandra Shekhar Pundir 2017.
2. Introduction to Biosensors by Jeong Yeol Yoon 2016.
3. Biosensors, Fundamentals and Applications, Chandra Mouli Pandey and BansiDhar Malhotra 2019.
4. Biosensors and Nanotechnology: Applications in Health Care Diagnostics, Zeynep Altintas , 2017.

| 242EBT043 | PATENT DRAFTING FOR ENGINEERING | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | Interdisciplinary | 3 | 0 | 0 | 3 |

**Preamble:**

To comprehend the types of IPR with special emphasis on patents and to gain an overview on the system of patent application. To introduce the importance of patent protection to an intellectual property.

**Pre-requisites**: Nil

**Course Outcomes:** After the completion of the course the student will be able to

| | |
|---|---|
| **CO 1** | Explain the types of Intellectual Property Rights |
| **CO 2** | Enumerate the patentability criteria required and the types of patents |
| **CO 3** | Explain the Indian patent system and rules for patent filing |
| **CO 4** | Examine the structure of a patent specification and draft |
| **CO 5** | Understand the aspects of patent enforcement and its implementation |

**Mapping of course outcomes with program outcomes**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO7 |
|---|---|---|---|---|---|---|---|
| **CO 1** | | | | | 2 | 2 | 2 |
| **CO 2** | | 2 | 2 | | | 2 | |
| **CO 3** | 2 | 2 | | | 2 | | 2 |
| **CO 4** | | 2 | | 2 | | 2 | 2 |
| **CO 5** | 2 | | | | | 2 | |

**Assessment Pattern**

| Bloom's Category | End Semester Examination |
|---|---|
| Apply | 40% |

| | |
|---|---|
| Analyse | 25% |
| Evaluate | 25% |
| Create | 10% |

**Mark distribution**

| **Total Marks** | **CIE** | **ESE** | **ESE Duration** |
|---|---|---|---|
| 100 | 40 | 60 | 2.5 hours |

**Continuous Internal Evaluation Pattern: 40 marks**

Micro/Course based project : 15 marks

Course based /Seminar/Quiz : 15 marks

Test paper, 1 no. : 10 marks

Test paper shall include minimum 80% of the syllabus.

**End Semester Examination Pattern: 60 marks**

The end semester examination will be conducted by the respective College. There will be two parts; Part A and Part B.

Part A will contain 5 numerical/short answer questions with one question from each module; having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions.

Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

**Model Question Paper**

**QP CODE:** **PAGES:**

**Reg No: _____** **Name: _____**

**SAHRDAYA COLLEGE OF ENGINEERING AND TECHNOLOGY**

**SECOND SEMESTER M. TECH DEGREE EXAMINATION, MONTH & YEAR**

**Course Code: 242EBT043**

Max. Marks: 60 Duration: 2.5 hrs.

**Patent Drafting for Engineering**

**PART – A**

Answer All the Questions.

One question from each module, having 5 marks for each question.

(5x 5 = 25)

1. Give a brief account on types of Intellectual Properties
2. State any 03 Indian laws that provide protection from infringement of patents
3. Comment on the statutory exceptions in patentability
4. Enumerate the essential components of a patent draft
5. Signify the importance of Intellectual Property Appellate Board

**PART – B**

Minimum one question from each module (Total seven questions)

Answer any five (5 x 7 = 35)

6. Elaborate the types of IPR and significance of an IPR protection
7. With a case study discuss about patent infringement, consequences and scope for protection
8. Describe the essential features of the Indian Patents Act and its amendment
9. What are the essential parts of a patent draft? Explain the contents covered in each section.
10. Write notes on the Patents Act, 1970 and the Patents Rules, 2003.
11. Provide a brief write-up on the process of granting a patent with reference to the fee and timeline involved.
12. What is the infringement and declaratory suits available for a patent protection- Explain

## SYLLABUS

**MODULE 1 (8 hours)**

**Introduction to IPR**: Discovery, Invention, Creativity, Innovation, History & Significance of IPR, Overview of IPR -Patent, Copyright, Trade Mark, Trade Secret , GI, Industrial Design & Integrated Circuit, Non-patentable criteria

**MODULE 2 (8 hours)**

**Patents: Patents- Patentability Criteria**, Types of Patents-Process, Product & Utility Models, Software Patenting and protection, Patent infringement- Case studies- Apple Vs Samsung, Enfish LLC Vs Microsoft, Overview of Patent search-Types of Searching, Public & Private Searching Databases, Basics of Patent Filing & Drafting, Indian Patents Law

**MODULE 3 (8 hours)**

**Introduction to the Indian Patent System**- Patent Laws as Concepts; Understanding the Patents Act, 1970; Understanding the Patents Rules, 2003; Preliminary Sections; Preliminary Rules; What's New in the Patents (Amendment) Rules, 2016; Easy way to read the Patents Act and Rules; Patentability of Inventions Statutory Exceptions to Patentability; Novelty and Anticipation; Inventive Step; Capable of Industrial Application; Person Skilled in the Art

**MODULE 4 (8 hours)**

**Patent Specification**- Provisional and Complete Specifications; Structure of a Patent Specification—Title, Abstract, Description, Claims, etc.; Reading a Patent Specification—Fair basis, Enabling Disclosure, Definiteness, Priority; Introduction to Patent Drafting.

**MODULE 5 (8 hours)**

Patent Enforcement, International Arrangements and Other Miscellaneous Provisions, Intellectual Property Appellate Board; Declaratory Suits, Infringement Suits; International Application—Convention Application, PCT Application, Application Designating India, Multiple Priorities; PCT Timeline; Fees—Application, In Relation to Grant of Patents; Timelines, Application, Examination, Publication

**Course Plan**

| No | Topic | No. of Lectures |
|---|---|---|
| 1 | **IPR- An Introduction (8 hours)** | |
| 1.1 | Introduction to IPR: Discovery, Invention, Creativity, Innovation | 3 |
| 1.2 | Overview of IPR -Patent, Copyright, Trade Mark, Trade Secret, GI, Industrial Design | 3 |
| 1.3 | Significance of IPR, Non-patentable criteria | 2 |
| 2 | **Patentability Criteria & Search (8 hours)** | |
| 2.1 | Explain the patentability Criteria and types of Patents | 3 |
| 2.2 | Case studies on patent infringement and consequences and scope for protection | 3 |
| 2.3 | Overview of Patent search, drafting and Indian rules | 2 |
| 3 | **Introduction to the Indian Patent System (8 hours)** | |
| 3.1 | Understanding a Patent Draft | 2 |
| 3.2 | Indian patent acts and rules with amendments | 2 |
| 3.3 | Reading and understanding a patent | 2 |
| 3.4 | Patentability of Inventions Statutory Exceptions | 2 |
| 4 | **Patent Specification (8 hours)** | |
| 4.1 | Structure of a Patent | 2 |
| 4.2 | Patent Specification- Provisional and Complete Specifications; | 0 |
| 4.3 | Structure of a Patent Specification—Title, Abstract, Description, Claims, etc.; | 2 |
| 4.4 | Reading a Patent Specification and drafting a patent | 2 |
| 5 | **Infringement Suits- Basics (8 hours)** | |
| 5.1 | Patent Enforcement, International Arrangements | 3 |
| 5.2 | Intellectual Property Appellate Board and Infringement Suits | 3 |
| 5.3 | Patent application fees and timeline | 2 |

**Reference Books**

1. Feroz Ali, The Law of Patents, LexisNexis
2. Ronald D. Slusky, Invention Analysis and Claiming – A Patent Lawyer's Guide, Second Edition, American Bar Association, 2012.
3. Feroz Ali, The Touchstone Effect – The Impact of Pre-grant Opposition on Patents, LexisNexis, 2009

| 242LBT003 | MOLECULAR BIOLOGY AND GENETIC ENGINEERING | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | Laboratory | 0 | 0 | 2 | 1 |

**Preamble:**

1. Provide hands-on experience in performing molecular biology and genetic engineering techniques.
2. This will facilitate the students to take up specialized project and research work in Molecular Biology

**Course Outcomes:**

After the completion of the course the student will be able to

| | |
|---|---|
| CO 1 | Apply the knowledge in understanding the applications of the techniques in molecular biology and genetic engineering techniques |
| CO 2 | Design experiments understanding the molecular approach used in research relevant to human and environmental welfare |
| CO 3 | Analyze and interpret the results of the laboratory experiments performed and be able to write scientific reports and discuss scientific literature |
| CO 4 | Exhibit the awareness of the hazardous chemicals and safety precautions in case of emergency. |

**Mapping of course outcomes with program outcomes**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 |
|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | - | 3 | - | 3 | 3 | - |
| **CO 2** | 3 | - | 3 | - | 3 | 3 | - |
| **CO 3** | - | 3 | - | 3 | 2 | 3 | - |
| **CO 4** | - | 3 | - | 3 | - | 3 | - |

**Assessment Pattern**

| Bloom's Category | End Semester Examination |
|---|---|
| Apply | 30 % |
| Analyze | 70 % |

| | |
|---|---|
| Evaluate | |
| Create | |

**Internal Continuous Assessment: (MaximumMarks-100)**

Practical Records/Outputs : 40 marks

Regular class viva voce : 20 marks

End semester exam : 40 marks

**Number of Experiment to be performed**

At least 10 experiments must be performed from the experiments listed below.

**Experiments**

| No | Topic | No. of hours |
|---|---|---|
| 1 | Gel Electrophoresis of DNA | 2 |
| 2 | Isolation of Prokaryotic DNA | 3 |
| 3 | Isolation of plasmid DNA | 3 |
| 4 | Isolation of eukaryotic genomic DNA | 3 |
| 5 | Qualitative and Quantitative analysis of DNA (UV/ Vis) | 3 |
| 6 | Analysis of restriction enzyme digestion & Ligation | 6 |
| 7 | Preparation of competent cells | 6 |
| 8 | Transformation & Selection of recombinants | 6 |
| 9 | Polymerase Chain Reaction (PCR) | 3 |
| 10 | Extraction of RNA | 3 |
| 11 | Lamda phage lysis in liquid cultures | 3 |
| 12 | Polyacrylamide Gel electrophoresis | 3 |
| 13 | Blotting techniques | 3 |

| COURSE CODE | COURSE NAME | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| 222PBT100 | MINI PROJECT | PROJECT | 0 | 0 | 4 | 2 |

Mini project can help to strengthen the understanding of student's fundamentals through application of theoretical concepts and to boost their skills and widen the horizon of their thinking. The ultimate aim of an engineering student is to resolve a problem by applying theoretical knowledge. Doing more projects increases problem solving skills.

The introduction of mini projects ensures preparedness of students to undertake dissertation. Students should identify a topic of interest in consultation with PG Programme Coordinator that should lead to their dissertation/research project. Demonstrate the novelty of the project through the results and outputs.The progress of the mini project is evaluated based on three reviews, two interim reviews and a final review. A report is required at the end of the semester.

Evaluation Committee - Programme Coordinator, One Senior Professor and Guide.

| Sl. No | Type of evaluations | Mark | Evaluation criteria |
|---|---|---|---|
| 1 | Interim evaluation 1 | 20 | |
| 2 | Interim evaluation 2 | 20 | |
| 3 | Final evaluation by a Committee | 35 | Will be evaluating the level of completion and demonstration of functionality/ specifications, clarity of presentation, oral examination, work knowledge and involvement |
| 4 | Report | 15 | the committee will be evaluating for the technical content, adequacy of references,templates followed and permitted plagiarism level(not more than 25% ) |
| 5 | Supervisor/Guide | 10 | |
| | Total Marks | 100 | |

# SEMESTER III

| CODE | | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| 243AGE100 | **ACADEMIC WRITING** | AUDIT COURSE | 3 | 0 | 0 | NIL |

**Preamble:** Learning academic writing sharpens minds, teaches students how to communicate, and develops their thinking capacities and ability to understand others. Writing is thinking, and every student deserves to be a strong thinker. It can also make them think more carefully about what they write. Showing work to others can help to foster a better culture of learning and sharing among students. It also gives students a sense of how they are contributing to the body of work that makes up an academic subject.

**Course Outcomes:** The COs shown are only indicative. For each course, there can be 4 to 6 COs. After the completion of the course the student will be able to

| | |
|---|---|
| **CO 1** | Understand the principles of scientific/ academic writing |
| **CO 2** | Analyse the technique of scientific writing from the reader's perspective |
| **CO 3** | Apply the concepts of setting expectations and laying the progression tracks |
| **CO 4** | Evaluate the merits of a title, abstract , introduction, conclusion and structuring of a research paper |
| **CO 5** | Justify the need using a project proposal or a technical report |
| **CO 6** | Prepare a review paper, an extended abstract and a project proposal |

**Mapping of course outcomes with program outcomes**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 |
|---|---|---|---|---|---|---|---|
| CO 1 | | 3 | 1 | | | | |
| CO 2 | | 3 | 1 | | | | |
| CO 3 | | 3 | 1 | | | 2 | |
| CO 4 | | 3 | 1 | | | | |
| CO 5 | | 3 | 2 | 2 | | 2 | |
| CO 6 | 1 | 3 | 3 | 2 | | 2 | |

**Assessment Pattern**

| Bloom's Category | End Semester Examination |
|---|---|
| Apply | 40% |
| Analyse | 30% |

| | |
|---|---|
| Evaluate | 30% |

**Mark distribution**

| Total Marks | CIE | ESE | ESE Duration |
|---|---|---|---|
| 100 | 40 | 60 | 2.5 hours |

**Continuous Internal Evaluation Pattern: 40 marks**

Course based task : 15 marks
Seminar/Quiz : 15 marks Test
paper, 1 no. : 10 marks
Test paper shall include minimum 80% of the syllabus.

**End Semester Examination Pattern:** 60 marks

The examination will be conducted by the respective College. The examination willbe for 150 minutes and will contain 7 questions, with minimum one question from each module of which student should answer any Vive. Each question can carry 12 marks.

**Model Question paper**

| | | | |
|---|---|---|---|
| | | **SET1** | **Total Pages:** |
| Reg No.:_____ | | Name:_____ | |
| **SAHRDAYA COLLEGE OF ENGINEERING AND TECHNOLOGY**<br>THIRD SEMESTER M.TECH DEGREE EXAMINATION, MONTH, YEAR | | | |
| **Course Code: 243AGE100** | | | |
| **Course Name: Academic Writing** | | | |
| Max. Marks: 60 | | | Duration: 2.5 Hours |
| ***Answer any five full questions, each carries 12 marks.*** | | | |
| 1 a) | Make clear-cut distinctions between 6 factors that take their toll on readers' memory. | | 6 |
| 1 b) | How can you sustain the attention of the reader to ensure continuous reading? | | 6 |
| 2 a) | What are the different methods by which you can create expectations in the reader? | | 6 |
| 2 b) | Give an account of the topic and non-topic based progression schemes. | | 6 |
| 3 a) | Bring out the differences between an abstract and the introduction of a research paper. | | 8 |
| 3 b) | How are the title of the research paper and its structure related? | | 4 |

| | | |
|---|---|---|
| 4 | What are 7 principles for including visuals in your research paper. What are the recommended constituents of a conclusion segment of a research paper? | 12 |

| | | |
|---|---|---|
| 5 | Give a detailed description of the process and contents of a project proposal for funding. | 12 |
| 6 a) | What are the contexts recommended for choosing between active and passive voices in technical writing? | 8 |
| 6 b) | What are the different visual forms that are relevant in a research paper and how do you choose them? | 4 |
| 7 | Give the design of a research paper with the purposes each part serves. | 12 |
| **** | | |

**Syllabus and Course Plan** (For 3 credit courses, the content can be for 40 hrs and for 2 credit courses, the content can be for 26 hrs. The audit course in third semester can have content for 30 hours).

**Syllabus:**

| **CODE** 243AG E100 | **ACADEMIC WRITING** | **Audit** |
|---|---|---|
| Module No. | Topics in a module | Hours |
| 1 | Fundamentals of Academic writing from a reader's perspective: acronyms, synonyms, pronouns, disconnected phrases, background ghettos, abusive detailing, cryptic captions, long sentences : all that take their toll on readers' memory. | 6 |
| 2 | Fluid reading & reading energy consumption: setting expectations and laying Progression tracks; Reading energy consumption | 6 |
| 3 | How to write the Title, abstract, introduction ; Structure the writing with headings & subheadings | 6 |
| 4 | Visuals: Resources, Skills, and Methods; Conclusion; References; Bibliography; Grammar in technical writing | 6 |
| 5 | Techniques of writing: An extended abstract, a project proposal, a research paper, a technical report. | 6 |

**Course Plan:**

| No | Topic | No. of Lectures |
|---|---|---|
| 1 | Fundamentals of Academic writing from a reader's perspective: acronyms, synonyms, pronouns, disconnected phrases, background ghettos, abusive detailing, cryptic captions, long sentences all take their toll on readers' memory. | |
| 1.1 | The Reading tool-kit to reduce memory required; reduce reading time | 1 |

| | | |
|---|---|---|
| 1.2 | Acronyms, Pronouns, Synonyms; Background, broken couple, words overflow | 1 |
| 1.3 | Sustain attention: Keep the story moving forward; Twists, shouts, Pause to clarify, recreate suspense | 2 |
| 1.4 | Keep the reader motivated: Fuel and meet Expectations; Bridge knowledge gap: ground level; Title words; Just In Time to local background | 2 |
| 2 | Fluid reading & reading energy consumption: setting expectations and laying Progression tracks; Reading energy consumption | |
| 2.1 | Setting expectations of the reader from Grammar, from theme | 1 |
| 2.2 | Progression tracks for fluid reading: Topic & stress; topic and non topic based progression tracks; pause in progression | 2 |
| 2.3 | Detection of sentence fluidity problems: No expectations/ Betrayed expectations | 2 |
| 2.4 | Controlling reading energy consumption: the energy bill; Energy fuelling stations: Pause | 1 |
| 3 | How to write the Title, abstract, introduction ; Structure the writing with headings & subheadings | |
| 3.1 | Title: Face of the paper: Techniques, Qualities & Purpose of title; Metrics | 1 |
| 3.2 | Abstract: Heart of the paper: 4 parts; coherence; tense of verbs, precision; purpose & qualities of the abstract; Metrics | 2 |
| 3.3 | Structure: Headings & sub-headings: Skeleton of the paper: principles for a good structure; Syntactic rules; Quality & Purpose of structures; Metrics | 1 |
| 3.4 | Introduction: Hands of the paper: Start, finish; scope, definitions; answers key reader questions; As a personal active story; Traps, qualities; Metrics | 2 |
| 4 | Visuals: Resources, Skills, and Methods; Conclusion; References; Bibliography; Grammar in technical writing | |
| 4.1 | Visuals as the voice of your paper: principles; purpose & qualities of visuals; metrics | 2 |
| 4.2 | Conclusion: contents; purpose, quality; metrics; Abstracts Vs. Conclusion; examples, counter-examples | 1 |
| 4.3 | References, Bibliography: Styles, punctuation marks, quotes, citations | 1 |
| 4.4 | Grammar in Technical writing: Articles, Syntax, Main and subordinate clauses; Active & passive voices; some commonly made mistakes in technical writing. | 2 |
| 5 | Techniques of writing: An extended abstract, a project proposal, a research paper, a technical report. | |
| 5.1 | Extended abstract: abstract and keywords, introduction and objective, method, findings and argument, conclusion and suggestions and references. | 1 |

| | | |
|---|---|---|
| 5.2 | Project Proposal:Types, executive summary, background including status, objectives, solution, milestones, deliverables, timelines, resources, budgeting, conclusion | 2 |
| 5.3 | Research paper: writing an overview article: provide a comprehensive foundation on a topic; explain the current state of knowledge; identify gaps in existing studies for potential future research; highlight the main methodologies and research techniques | 2 |
| 5.4 | Writing Technical Reports: Title page; Summary; Table of contents; Introduction; Body; Figures, tables, equations and formulae; Conclusion; Recommendations. | 1 |
| | | 30 |

**Reference Books**

1. SCIENTIFIC WRITING 2.0 A Reader and Writer's Guide: Jean-Luc Lebrun, World ScientiVic Publishing Co. Pte. Ltd., 2011

2. How to Writeand Publish a ScientiVic Paper: Barbara Gastel and Robert A. Day, Greenwood publishers, 2016

3. Grammar, Punctuation, and Capitalisation; a handbook for technical writers and editors. www.sti.nasa.gov/publish/sp7084.pdf www.sti.nasa.gov/sp7084/contents.html

4. Everything You Wanted to Know About Making Tables and Figures. http://abacus.bates.edu/%7Eganderso/biology/resources/writing/ HTWtableVigs.html

| 223AGE001 | ADVANCED ENGINEERING MATERIALS | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | AUDIT COURSE | 3 | 0 | 0 | - |

**Preamble:** This course is designed in a way to provide a general view on typically used advanced classes of engineering materials including metals, polymers, ceramics, and composites.

**Course Outcomes:** After the completion of the course the student will be able to

| | |
|---|---|
| **CO 1** | Analyse the requirement and find appropriate solution for use of materials. |
| **CO 2** | Differentiate the properties of polymers, ceramics and composite materials. |
| **CO 3** | Recognize basic concepts and properties of functional materials. |
| **CO 4** | Comprehend smart and shape memory materials for various applications. |
| **CO 5** | Appraise materials used for high temperature, energy production and storage applications. |

**Mapping of course outcomes with program outcomes**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 |
|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | | | | 2 | 3 | |
| **CO 2** | 3 | | | | 3 | 3 | |
| **CO 3** | 3 | | | | 3 | 3 | |
| **CO 4** | 3 | | | | 3 | 3 | |
| **CO 5** | 3 | | | | 2 | 3 | |

**Assessment Pattern**

| Bloom's Category | End Semester Examination |
|---|---|
| Understand | 60% |
| Apply | 20% |
| Analyse | 20% |

**Mark distribution**

| Total Marks | CIE | ESE | ESE Duration |
|---|---|---|---|
| 100 | 40 | 60 | 2.5 hours |

**Continuous Internal Evaluation Pattern: 40 marks**

Course based task : 15 marks
Seminar/Quiz : 15 marks Test
paper, 1 no. : 10 marks
Test paper shall include minimum 80% of the syllabus.

**End Semester Examination Pattern:** 60 marks

The examination will be conducted by the respective College. The examination willbe for 150 minutes and will contain 7 questions, with minimum one question from each module of which student should answer any Vive. Each question can carry 12 marks.

**Model Question paper**

AUDIT COURSE

**243AGE001 - ADVANCED ENGINEERING MATERIALS**

**(Answer any five questions. Each question carries 12 Marks)**

| | | |
|---|---|---|
| **1.** | a) State the relationship between material selection and processing. | **5** |
| | b) Write about the criteria for selection of materials with respect to the cost and service requirements for engineering applications. | **7** |
| **2.** | a) Differentiate thermosetting and thermoplastics with suitable examples. | **5** |
| | b) Briefly discuss about the properties and applications of polymer nano composite materials. | **7** |
| **3.** | a) Write about the potential application areas of functionally graded materials. | **5** |
| | b) With a neat sketch describe any one processing technique of functionally graded materials. | **7** |
| **4.** | a) “Smart materials are functional”? Justify the statement. | **5** |
| | b) Explain the terms electrostriction and magnetostriction with its application. | **7** |

| | | |
|---|---|---|
| **5.** | a) What are the factors influencing functional life of components at elevated temperature? | **5** |
| | b) What are super alloys and what are their advantages? | **7** |
| **6** | a) What is a shape memory alloy? What metals exhibit shape memory characteristics? | **4** |
| | b) Explain about the detection capabilities and uses of pyroelectric sensors. | **8** |
| **7** | a) Differentiate between conventional batteries and fuel cells. | **4** |
| | b) Explain the construction and working of a Li-ion battery. | **8** |

## Syllabus

| Module | Content | Hours | Semester Exam Marks (%) |
|---|---|---|---|
| **I** | Requirements / needs of advanced materials. Classification of materials, Importance of materials selection, Criteria for selection of materials; motivation for selection, cost basis and service requirements. Relationship between materials selection and processing. | **5** | **20** |
| **II** | Classification of non-metallic materials. Polymer, Ceramics: Properties, processing and applications.<br>Nano Composites - Polymer nanocomposites (PNCs), Processing and characterisation techniques – properties and potential applications. | **7** | **20** |
| **III** | Functionally graded materials (FGMs), Potential Applications of FGMs, classification of FGMs, processing techniques. limitations of FGMs. | **6** | **20** |
| **IV** | Smart Materials: Introduction, smart material types - pyroelectric sensors, piezoelectric materials, electrostrictors and magnetostrictors, shape memory alloys – associated energy stimulus and response forms, applications. | **5** | **20** |
| **V** | High Temperature Materials: super alloys – main classes, high temperature properties of superalloys, applications.<br>Energy Materials: materials for batteries. | **7** | **20** |

## Course Plan

| No | Topic | No. of Lectures |
|---|---|---|
| 1 | **Selection of materials for engineering applications** | |
| 1.1 | Benefits of advanced materials, classification of materials, importance of materials selection | 2 |
| 1.2 | Selection of materials for different properties, strength, toughness, fatigue and creep | 1 |
| 1.3 | Selection for surface durability, corrosion and wear resistance | 1 |
| 1.4 | Relationship between materials selection and processing | 1 |
| **2** | **Classification of non-metallic materials & nano composites** | |
| 2.1 | Rubber: properties, processing and applications. | 1 |
| 2.2 | Plastics: thermosetting and thermoplastics, applications and properties. | 2 |
| 2.3 | Ceramics: properties and applications. | 1 |
| 2.4 | Introduction to nano composites, classification | 1 |
| 2.5 | Processing and characterisation techniques applicable to polymer nanocomposites. | 2 |
| **3** | **Functionally graded materials** | |
| 3.1 | General concept, Potential Applications of FGMs | 2 |
| 3.2 | Classification of FGMs | 1 |
| 3.3 | FGMs processing techniques: powder metallurgy route, melt-processing route | 2 |
| 3.4 | Limitations of FGMs | 1 |
| **4** | **Smart materials** | |
| 4.1 | Introduction to smart materials, types | 1 |
| 4.2 | Pyroelectric sensors-material class, stimulus, detection capabilities and uses | 1 |
| 4.3 | Piezoelectric materials- material class, stimulus, sensing and actuating applications | 1 |
| 4.4 | Electrostrictors and magnetostrictors - material class, stimulus, micro positioning capabilities and applications | 1 |
| 4.5 | Shape memory alloys (SMAs) - material class, stimulus, temperature sensing and high strain responses, applications. | 1 |
| **5** | **High Temperature Materials and Energy Materials** | |
| 5.1 | Characteristics of high-temperature materials, superalloys as high-temperature materials | 1 |
| | superalloys - properties and applications | 2 |
| 5.2 | Introduction to lithium-ion battery (LIBs), operating mechanisms and applications | 2 |
| 5.3 | Introduction to Zn-based battery system, types and existing challenges | 2 |

**Reference Books**


1. DeGarmo et al, “Materials and Processes in Manufacturing”, 10th Edition, Wiley, 2008.
2. R.E. Smallman and A.H.W. Ngan, Physical Metallurgy and Advanced Materials, Seventh Edition, Butterworth-Heinemann, 2007
3. Vijayamohanan K. Pillai and Meera Parthasarathy, “Functional Materials: A chemist’s perspective”, Universities Press Hyderabad (2012).
4. M.V. Gandhi, B.S. Thompson: Smart Materials and Structures, Chapman & Hall, 1992.
5. G. W. Meetham and M. H. Van de Voorde, Materials for High Temperature Engineering Applications (Engineering Materials) Springer; 1 edition (May 19, 2000)
6. Inderjit Chopra, Jayant Sirohi, “Smart Structures Theory”, Cambridge University Press, 2013

| 243AGE003 | DATA SCIENCE FOR ENGINEERS | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | AUDIT COURSE | 3 | 0 | 0 | 0 |

**Preamble:** This course covers essentials of statistics and Linear Algebra and how to prepare the data before processing in real time applications. The students will be able to handle missing data and detection of any outliers available in the dataset. This course explores data science, Python libraries and it also covers the introduction to machine learning for engineers.

**Course Outcomes:** After the completion of the course the student will be able to

| | |
|---|---|
| **CO 1** | Study Data Science Concepts and statistics |
| **CO 2** | Demonstrate Understanding of Mathematical Foundations needed for Data Science |
| **CO 3** | Understand Exploratory analysis and Data Visualization and Preprocessing on given dataset |
| **CO 4** | Implement Models such as Naive Bayes, K-Nearest Neighbors, Linear and Logistic Regression |
| **CO 5** | Build real time data science applications and test use cases |

**Mapping of course outcomes with program outcomes**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO7 |
|---|---|---|---|---|---|---|---|
| **CO 1** | 2 | | 2 | | | 2 | |
| **CO 2** | 2 | | 2 | 1 | | 2 | |
| **CO 3** | 2 | | 2 | 2 | 2 | 2 | |
| **CO 4** | 2 | | 2 | 2 | 3 | 2 | |
| **CO 5** | 2 | | 2 | 3 | 3 | 3 | 2 |

**Assessment Pattern**

| Bloom's Category | End Semester Examination |
|---|---|
| Understand | 50% |
| Apply | 30% |
| Analyse | 20% |

**Mark distribution**

| Total Marks | CIE | ESE | ESE Duration |
|---|---|---|---|
| 100 | 40 | 60 | 2.5 hours |

**Continuous Internal Evaluation Pattern: 40 marks**

Course based task (Project/Assignments/Simulations/Case studies): 15 marks

Seminar/Quiz : 15 marks

Test paper, 1 no. : 10 marks

Test paper shall include minimum 80% of the syllabus.

**End Semester Examination Pattern:60 marks**

The examination will be conducted by the respective College. The examination will be for 150 minutes and will contain 7 questions, with minimum one question from each module of which student should answer any five. Each question can carry 12 mark.

**Syllabus**

| Module | Content | Hours | Semester Exam Marks (%) |
|---|---|---|---|
| I | **Statistics for Data science**<br>Probability: Basic concepts of probability, conditional probability, total probability, independent events, Bayes' theorem, random variable, Population, Sample, Population Mean, Sample Mean, Population Distribution, Sample Distribution and sampling Distribution, Mean, Mode, Median, Range, Measure of Dispersion, Variance, Standard Deviation, Gaussian/Normal Distribution, covariance, correlation. | **6** | **20** |
| II | **Linear Algebra**<br>Vectors and their properties, Sum and difference of Vectors, distance between Vectors, Matrices,Inverse of Matrix, Determinant of Matrix, Trace of a Matrix, Dot Product, Eigen Values, Eigen Vectors, Single Value Decomposition | **6** | **20** |
| III | **Hypothesis Testing**<br>Understanding Hypothesis Testing, Null and Alternate Hypothesis, Non-directional Hypothesis, Directional Hypothesis Critical Value Method, P-Value Method, Types of Errors-Type1 Error,Type2 Error, Types of Hypothesis Test Z Test, Chi-Square | **6** | **20** |

| | | | |
|---|---|---|---|
| **IV** | **Exploratory Data Analysis**<br>Data Collection –Public and Private Data, Data Cleaning-Fixing Rows and Columns, Missing Values, Standardizing values, invalid values, filtering data, Data-Integration,Data-Reduction,Data Transformation | **6** | **20** |
| **V** | **Machine Learning and Python for Data Science**<br>Python Data structures-List, Tuple, Set, Dictionary, Pandas, Numpy, Scipy, Matplotlib, Machine Learning-Supervised Machine Learning, Unsupervised Machine Learning,Regression, Classification, Naïve-Bayes | **6** | **20** |

## Course Plan

| No | Topic | No. of Lectures |
|---|---|---|
| 1 | **Statistics for Data science** | |
| 1.1 | Probability: Basic concepts of probability, conditional probability, total probability | 1 |
| 1.2 | independent events, Bayes' theorem, random variable, Population | 1 |
| 1.3 | Sample, Population Mean, Sample Mean, Population Distribution | 1 |
| 1.4 | Sample Distribution and sampling Distribution, Mean, Mode, Median, Range, Propositional logic and predicate logic | 1 |
| 1.5 | Measure of Dispersion, Variance, Standard Deviation | 1 |
| 1.6 | Gaussian/Normal Distribution, covariance, correlation. | 1 |
| **2** | **Linear Algebra** | |
| 2.1 | Vectors and their properties, | 1 |
| 2.2 | Sum and difference of Vectors, distance between Vectors | 1 |
| 2.3 | Matrices,Inverse of Matrix, | 2 |
| 2.4 | Determinant of Matrix, Trace of a Matrix, Dot Product, Eigen Values, Eigen Vectors, Single Value Decomposition | 2 |
| **3** | **Hypothesis Testing** | |
| 3.1 | Understanding Hypothesis Testing, Null and Alternate Hypothesis | 1 |
| 3.2 | Non-directional Hypothesis, Directional Hypothesis Critical Value Method, P-Value Method, | 2 |
| 3.3 | Types of Errors-Type1 Error,Type2 Error, | 1 |
| 3.4 | Types of Hypothesis Test Z Test, Chi-Square, | 2 |
| **4** | **Exploratory Data Analysis** | |
| 4.1 | Data Collection –Public and Private Data | 1 |
| 4.2 | Data Cleaning-Fixing Rows and Columns | 1 |
| 4.3 | Missing Values | 1 |
| 4.4 | Standardizing values | 1 |
| 4.5 | Invalid values, filtering data | 1 |

| | | |
|---|---|---|
| 4.6 | Data Integration, Data Reduction, Data Transformation | 1 |
| 5 | **Machine Learning and Python for Data Science** | |
| 5.1 | Python Data structures-List, Tuple, Set, | 1 |
| 5.2 | Dictionary, Pandas, Numpy, Matplotlib | 2 |
| 5.3 | Machine Learning-Supervised Machine Learning, Unsupervised Machine Learning | 1 |
| 5.4 | Regression, Classification | 1 |
| 5.5 | Naïve-Bayes | 1 |

**Reference Books**


1. Python Data Science Handbook. Essential Tools for Working with Data, Author(s): Jake VanderPlas, Publisher: O'Reilly Media, Year: 2016
2. Practical Statistics for Data Scientists: 50 Essential Concepts, Author(s): Peter Bruce, Andrew Bruce, Publisher: O'Reilly Media, Year: 2017
3. Practical Linear Algebra for Data Science, by Mike X Cohen, Released September 2022, Publisher(s): O'Reilly Media, Inc.
4. Data Science from Scratch 'by Joel Grus, Released, April 2015, Publisher(s): O'Reilly Media, Inc.
5. Hands-On Exploratory Data Analysis with Python, by Suresh Kumar Mukhiya, Usman Ahmed, Released March 2020,Publisher(s): Packt Publishing

**odel question Paper** **PAGES:**

**Reg No: _____ Name: _____**

**SAHRDAYA COLLEGE OF ENGINEERING AND TECHNOLOGY**
**SECOND SEMESTER M. TECH DEGREE EXAMINATION, MONTH & YEAR**

Course Code: **243AGE003**

Max. Marks: 60 Duration: 2.5 hrs.

**Course Name: DATA SCIENCE FOR ENGINEERS**

**M**

Max. Marks: 60 Duration: 2.5 Hours

***Answer any five full questions, each carries 12 marks.***

| | | |
|---|---|---|
| 1 | a ) It is observed that 50% of mails are spam. There is software that filters spam mail before reaching the inbox. It accuracy for detecting a spam mail is 99% and chances of tagging a non-spam mail as spam mail is 5%. If a certain mail is tagged as spam finds the probability that it is not a spam mail. | 5 |
| | b ) Depict the relevance of measures of central tendency in data wrangling with a suitable example | 7 |
| 2. | a) Calculate the inverse of the Matrix<br>2 4 -6<br>7 3 5<br>1 -2 4 | 4 |
| | b)Find all Eigenvalues and Corresponding Eigenvectors for the matrix if<br>2 -3 0<br>2 -5 0<br>0 0 3 | 8 |
| 3. | a) A statistician wants to test the hypothesis H0: $\mu = 120$ using the alternative hypothesis H$\alpha$: $\mu > 120$ and assuming that $\alpha = 0.05$. For that, he took the sample values as n =40, $\sigma = 32.17$ and $\bar{x} = 105.37$. Determine the conclusion for this hypothesis? | 5 |
| | b) Hypothesis testing is an integral part of statistical inference, list out the various types of hypothesis testing and also mentions their significances in data science. | 7 |
| 4. | a) Brief in detail directional and non-directional hypothesis | 6 |
| | b) Differentiate null and alternate hypothesis and also elaborateon type 1 and type 2 errors | 6 |
| 5. | a) Explain the concepts of Tuple, List and Directory in python with example | 6 |

b) Elucidate reinforcement learning and application in real world. 6

6. a) What is Feature Engineering , demonstrate with an example 6

b) Describe in detail different steps involved in data preprocessing. 6

7. a) Illustrate supervised learning model with linear regression model 5

b) Predict the probability for the given feature vector if an accident will happen or not? 7

Weather condition: rain, Road condition: good, Traffic condition: normal, Engine problem: no, the task is to predict using Naïve Bayes classification.

| SNo. | Weather condition | Road condition | Traffic condition | Engine problem | Accident |
|---|---|---|---|---|---|
| 1 | Rain | bad | high | no | yes |
| 2 | snow | average | normal | yes | yes |
| 3 | clear | bad | light | no | no |
| 4 | clear | good | light | yes | yes |
| 5 | snow | good | normal | no | no |
| 6 | rain | average | light | no | no |
| 7 | rain | good | normal | no | no |
| 8 | snow | bad | high | no | yes |
| 9 | clear | good | high | yes | no |
| 10 | clear | bad | high | yes | yes |

| 243AGE004 | DESIGN THINKING | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | AUDIT COURSE | 3 | 0 | 0 | - |

**Preamble:**

This course offers an introductory exploration of fundamental engineering concepts and techniques, the design process, analytical thinking and creativity, as well as the fundamentals and development of engineering drawings, along with their application in engineering problems.

**Course Outcomes:**

After the completion of the course the student will be able to

| | |
|---|---|
| CO 1 | Identify and frame design challenges effectively. |
| CO 2 | Generate creative ideas through brainstorming and ideation |
| CO 3 | Iterate on designs based on user insights |
| CO 4 | Apply Design Thinking to real-world problems and projects. |

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 |
|---|---|---|---|---|---|---|---|
| CO 1 | | | | 2 | | 2 | 2 |
| CO 2 | 2 | | 2 | 2 | | | 2 |
| CO 3 | | 2 | | 2 | | 2 | 2 |
| CO 4 | 2 | | 2 | 3 | 2 | | 2 |

**Assessment Pattern**

| Bloom's Category | End Semester Examination |
|---|---|
| Apply | 40 |
| Analyse | 30 |
| Evaluate | 30 |
| Create | |

**Mark distribution**

| Total Marks | CIE | ESE | ESE Duration |
|---|---|---|---|
| 100 | 40 | 60 | 2.5 hours |

**Continuous Internal Evaluation Pattern**

## Audit Courses:

**Continuous Internal Evaluation Pattern: 40 marks**

Course based task : 15 marks
Seminar/Quiz : 15 marks Test
paper, 1 no. : 10 marks
Test paper shall include minimum 80% of the syllabus.

**End Semester Examination Pattern:** 60 marks

The examination will be conducted by the respective College. The examination willbe for 150 minutes and will contain 7 questions, with minimum one question from each module of which student should answer any five. Each question can carry 12 marks.

**Model Question paper**

| | | | |
|---|---|---|---|
| | | **SET1** | **Total Pages:** |
| Reg No.:_____ | | Name:_____ | |
| **SAHRDAYA COLLEGE OF ENGINEERING AND TECHNOLOGY**<br>THIRD SEMESTER M.TECH DEGREE EXAMINATION, MONTH, YEAR | | | |
| **Course Code: 243AGE004** | | | |
| **Course Name: DESIGN THINKING** | | | |
| Max. Marks: 60 | | | Duration: 2.5 Hours |
| ***Answer any five full questions, each carries 12 marks.*** | | | |
| 1 a) | How can a multidisciplinary team collaborate effectively to implement design principles? | | 7 |
| 1 b) | What are the key differences between human-centred design and other design methodologies? | | 5 |
| 2 a) | How do you measure the success of a design project in terms of user satisfaction and impact? | | 7 |
| 2 b) | How does the iterative nature of the design process contribute to better outcomes | | 5 |

| | | |
|---|---|---|
| 3 a) | What are the fundamental principles of effective brainstorming, and how do they differ from traditional problem-solving approaches? | 7 |
| 3 b) | What are some key principles of ergonomic design, and how do they contribute to the usability and comfort of products? | 5 |
| 4 a) | Enumerate some examples of successful and unsuccessful market testing scenarios, and what lessons can be learned from these experiences to improve future product or service launches? | 7 |
| 4b) | What is the primary purpose of creating prototypes in the design and development process? | 5 |
| 5 | What strategies and methodologies can designers use to embrace agility and respond quickly to changing user needs and market dynamics? | 12 |
| 6 | Illustrate any four examples of successful bio-mimicry applications in various industries. | 12 |
| 7 | What ethical considerations should designers keep in mind when designing for diverse user groups? | 12 |
| **** | | |

## Syllabus

**Module 1**

Design process: Traditional design, Design Thinking Approach, Introduction to Design Thinking, History and evolution of Design Thinking, Role of design thinking in the human-centred design process. Design space, Design Thinking in a Team Environment, Team formation.

**Module 2**

Design Thinking Stages: Empathize, Define, Ideate, Prototype and Test. The importance of empathy, Building a user-centred mindset. Problem statement formulation, User needs and pain points, establishing target specifications, Setting the final specifications.

**Module 3**

Generating Ideas, Brainstorming techniques, Application of Aesthetics and Ergonomics in Design. Bio-mimicry, Conceptualization, Visual thinking, Drawing/Sketching, Presenting ideas.

**Module 4**

Use of prototyping, Types of prototypes, Rapid prototyping techniques, User testing and feedback collection, Iterative prototyping, testing to gauge risk and market interest

**Module 5**

Entrepreneurship/business ideas, Patents and Intellectual Property, Agility in design, Ethical considerations in design. Overcoming common implementation challenges

**Corse Plan Syllabus and Corse Plan** (For 3credit courses, the content can be for 40 hrs. and for2credit courses, the content can be for 26 hrs. The audit course in third semester can have content for 30hours).

| No | Topic | No. of lectures |
|---|---|---|
| **1** | **Design process:** | |
| 1.1 | Design process: Traditional design, Design Thinking Approach, Introduction to Design Thinking, History and evolution of Design Thinking. | 3 |
| 1.2 | Role of design thinking in the human-centred design process. Design space, | 2 |
| 1.3 | Design Thinking in a Team Environment, Team formation. | 2 |

| | | |
|---|---|---|
| **2** | **Design Thinking Stages:** | |
| 2.1 | Design Thinking Stages: Empathize, Define, Ideate, Prototype and Test. | 2 |
| 2.2 | The importance of empathy, Building a user-centred mindset. | 2 |
| 2.3 | Problem statement formulation, User needs and pain points, establishing target specifications, Setting the final specifications. | 3 |
| **3** | **Ideation** | |
| 3.1 | Generating Ideas, Brainstorming techniques. | 2 |
| 3.2 | Application of Aesthetics and Ergonomics in Design. Bio-mimicry. | 3 |
| 3.3 | Conceptualization, Visual thinking, Drawing/Sketching, Presenting ideas. | 2 |
| **4** | **Prototyping and testing** | |
| 4.1 | Use of prototyping, Types of prototypes, Rapid prototyping techniques. | 3 |
| 4.2 | User testing and feedback collection, Iterative prototyping, testing to gauge risk and market interest | 2 |
| **5** | **IPR in design** | |
| 5.1 | Entrepreneurship/business ideas, Patents and Intellectual Property. | 2 |
| 5.2 | Agility in design, Ethical considerations in design. Overcoming common implementation challenges | 2 |

**Reference Books**


1. Christoph Meinel, Larry Leifer and Hasso Plattner- "Design Thinking: Understand – Improve – Apply", Springer Berlin, Heidelberg, 2011.
2. Thomas Lockwood and Edgar Papke – "Design Thinking: Integrating Innovation, Customer Experience, and Brand Value", Allworth Press, 2009.
3. Pavan Soni – "Design Your Thinking", Penguin Random House India Private Limited, 2020.
4. Andrew Pressman- "Design Thinking : A Guide to Creative Problem Solving for Everyone", Taylor & Francis, 2018.
5. N Siva Prasad, "Design Thinking Techniques an Approaches" Ane Books Pvt. Ltd.,2023

| CODE | COURSE NAME | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| 243AGE005 | FUNCTIONAL PROGRAMMING IN HASKELL | AUDIT COURSE | 3 | 0 | 0 | - |

Preamble: This course introduces a functional programming approach in problem solving. Salient features of functional programming like recursion, pattern matching, higher order functions etc. and the implementation in Haskell are discussed.

**Course Outcomes:**

After the completion of the course the student will be able to

| | |
|---|---|
| **CO 1** | Understand the functional programming paradigm which is based on the mathematics of lambda calculus. |
| **CO 2** | Develop Haskell programs using functions, guards and recursive functions |
| **CO 3** | Apply the concept of tuples, lists and strings in Haskell programming |
| **CO 4** | Apply the concept of algebraic data types, abstract data types, modules, recursive data types and user defined data types in Haskell programming |
| **CO 5** | Develop Haskell programs with files for reading input and storing output |

**Mapping of course outcomes with program outcomes**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 |
|---|---|---|---|---|---|---|---|
| **CO 1** | | | | | 3 | | |
| **CO 2** | 2 | | | 2 | 3 | | |
| **CO 3** | 2 | | | 2 | 3 | | |
| **CO 4** | 2 | | | 2 | 3 | | |
| **CO 5** | 2 | | | 2 | 3 | | |

**Assessment Pattern**

| Bloom's Category | End Semester Examination |
|---|---|
| Apply | 40% |
| Analyse | 40% |
| Evaluate | 20% |
| Create | |

**Mark distribution**

| Total Marks | CIE | ESE | ESE Duration |
|---|---|---|---|
| 100 | 40 | 60 | 2.5 hours |

**Continuous Internal Evaluation: 40 marks**

Course based task : 15 marks

Seminar/Quiz : 15 marks

Test paper, 1 no. : 10 marks

Test paper shall include minimum 80% of the

syllabus**. End Semester Examination: 60 marks**

The examination will be conducted by the respective College. The examination will be for 150 minutes and will contain 7 questions, with minimum one question from each module of which student should answer any five. Each question can carry 12 marks.

**Model Question paper**

| | | | |
|---|---|---|---|
| | | | **Total Pages:** |
| Reg No.:_____ | | Name:_____ | |
| **SAHRDAYA COLLEGE OF ENGINEERING AND TECHNOLOGY**<br>THIRD SEMESTER M.TECH DEGREE EXAMINATION, MONTH, YEAR | | | |
| **Course Code: 243AGE005** | | | |
| **Course Name: Functional Programming in Haskell** | | | |
| Max. Marks: 60 | | Duration: 2.5 Hours | |
| ***Answer any five full questions, each carries 12 marks.*** | | | |
| 1 a. | Explain the basic differences between imperative style programming and functional style programming. | | 3 |
| 1 b. | Analyse each of the following lambda expressions to clarify its structure. If the expression is a function, identify the bound variable and the body expression, and then analyse the body expression. If the expression is an application, identify the function and argument expressions, and then analyse the function and argument expressions:<br>i) λa.(a λb.(b a))<br>ii) λx.λy.λz.((z x) (z y))<br>iii) (λf.λg.(λh.(g h) f) λp.λq.p) | | 9 |
| 2 a. | Design a recursive function to find $2^n$ where n is a natural number. | | 4 |

| | | |
|---|---|---|
| 2 b. | Explain various forms of function definitions in Haskell with the help of examples. | 8 |
| 3 a. | Explain any three list operations along with function definitions and examples. | 6 |
| 3 b. | Write a program to duplicate only even numbers among the elements of a list using a Haskell function by (i) Recursion (ii) List Comprehension and explain. Example : λ> dupli [1, 2, 3] ANS: [2,2] | 6 |
| 4 | Write Recursive definitions along with an explanation for the below arithmetic operations. Illustrate the recursive flow with the help of a diagram.<br>i. add x y<br>ii. mult x y<br>iii. div x y | 12 |
| 5 | Write the Haskell code to split a list into two lists such that the elements with odd index are in one list while the elements with even index are in the other list. | 12 |
| 6 a | Give the type definition of a binary tree along with explanation of two functions on binary trees. | 6 |
| 6 b | Define a queue data type in Haskell along with any two operations on it with examples. | 6 |
| 7 a. | Explain the basic steps of reading from files and writing to files in Haskell. | 4 |
| 7 b. | Write a Haskell program to read from the file "input.txt", display the contents on the screen and write the contents to another file "output.txt". | 8 |
| **** | | |

**Syllabus and Corse Plan** (For 3 credit courses, the content can be for 40 hrs and for 2 credit courses, the content can be for 26 hrs. The audit course in third semester can have content for 30 hours).

**Module 1 (5 Hrs)**

**Introduction to Functional Programming**: Programming language paradigms, imperative style programming, comparison of programming paradigms.
Functional programming, Functions - Mathematical concepts and terminology, Lambda calculus, Function definitions, programs as functions, Functional programming Languages. Haskell basics, GHCi interpreter.

**Module 2 (6 Hrs)**

**Programming in Haskell:** Expressions and evaluation, Lazy evaluation, let expressions, scopes.

Basic data types in Haskell, operators, infix operators, associativity and precedence, Arithmetic functions.

types, definitions, currying and uncurrying, type abstraction.

Function definitions, pattern matching, guards, anonymous functions, higher order

functions. Recursion, Programming exercises.

**Module 3 (7 Hrs)**

**Data types: tuples and lists**: Tuples , Lists: building lists, decomposing lists, functions on lists, built- in functions on lists, primitive and general recursion over lists, infinite lists.

Strings: functions on strings.

Polymorphism and overloading, conditional polymorphism

**Module 4 (6 Hrs)**

Type classes, Algebraic data types, Modules, Recursive data types.

User defined data types, Records, Stacks, Queues, Binary trees, Constructors, Destructors.

**Module 5 (6 Hrs)**

Functor, Applicative functor, Monad

**Programming with actions:** Functions vs actions, Basics of input / output, the do notation, interacting with the command line and lazy I/O, File I/O.

| No | Topic | No. of Lectures |
|---|---|---|
| 1 | **Introduction to Functional Programming** | |
| 1.1 | Programming language paradigms, imperative style programming, comparison of programming paradigms | 1 |
| 1.2 | Functional programming, Functions - Mathematical concepts and terminology | 1 |
| 1.3 | Lambda calculus | 1 |
| 1.4 | Function definitions, programs as functions, Functional programming Languages | 1 |
| 1.5 | Haskell basics, GHCi interpreter | 1 |
| 2 | **Haskell basics** | |
| 2.1 | Expressions and evaluation, Lazy evaluation | 1 |
| 2.2 | let expressions, scopes, Basic data types in Haskell | 1 |
| 2.3 | operators, infix operators, associativity and precedence, Arithmetic | 1 |

| | | |
|---|---|---|
| | functions | |
| 2.4 | types, definitions, currying and uncurrying, type abstraction. | 1 |
| 2.5 | Function definitions, pattern matching, Guards | 1 |
| 2.6 | anonymous functions, higher order functions, Recursion | 1 |
| 3 | **Data types: tuples and lists** | |
| 3.1 | Tuples , Lists: building lists, decomposing lists | 1 |
| 3.2 | functions on lists, built-in functions on lists | 1 |
| 3.3 | primitive and general recursion over lists | 1 |
| 3.4 | infinite lists | 1 |
| 3.5 | Strings: functions on strings | 1 |
| 3.6 | Polymorphism and overloading | 1 |
| 3.7 | conditional polymorphism | 1 |
| 4 | **User defined data types** | |
| 4.1 | Type classes, Algebraic data types, Modules | 1 |
| 4.2 | Recursive data types | 1 |
| 4.3 | User defined data types, Records | 1 |
| 4.4 | Stacks, Queues | 1 |
| 4.5 | Binary trees | 1 |
| 4.6 | Constructors, Destructors | 1 |
| 5 | **Programming with actions** | |
| 5.1 | Functor, Applicative functor, | 1 |
| 5.2 | Monad | 1 |
| 5.3 | Programming with actions: Functions vs actions, Basics of input / output, the do notation | 1 |
| 5.4 | interacting with the command line and lazy I/O | 1 |
| 5.5 | File I/O | 2 |

**Reference Books**

[1] Richard Bird, "Introduction to functional programming using Haskell', second edition, Prentice hall series in computer science

[2] Bryan O'Sullivan, Don Stewart, and John Goerzen, "Real World Haskell"

[3] Richard Bird, "Thinking Functionally with Haskell", Cambridge University Press, 2014

[4] Simon Thompson, "Haskell: The Craft of Functional Programming", Addison-Wesley, 3rd Edition, 2011

[5] H. Conrad Cunningham, "Notes on Functional Programming with Haskell", 2014

[6] Graham Hutton, "Programming in Haskell", Cambridge University Press, 2nd Edition, 2016

[7] Alejandro Serrano Mena, "Practical Haskell: A Real-World Guide to Functional Programming", 3rd Edition, Apress, 2022

[8] Miran Lipovaca, "Learn You a Haskell for Great Good!: A Beginner's Guide", No Starch Press, 2011

| 243AGE010 | REUSE AND RECYCLE TECHNOLOGY | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | AUDIT COURSE | 3 | 0 | 0 | - |

**Preamble:** "Reuse and Recycle Technology" typically focuses on sustainable practices and technologies aimed at reducing waste, conserving resources, and promoting environmental responsibility.

**Course Outcomes:** After the completion of the course the student will be able to

| | |
|---|---|
| **CO 1** | Explain the principles and technologies behind waste reduction, resource conservation, and sustainable practices |
| **CO 2** | Describe and Analyze waste generation and management. |
| **CO 3** | Apply the knowledge of various reuse strategies and their application in different industries and Analyze various recycling technologies |
| **CO 4** | Appraise the methods of E-waste management and Eco friendly packaging |
| **CO 5** | Comprehend Environmental Regulations and Policies**,** Understand the importance of environmental regulations and policies in addressing environmental challenges |

**Mapping of course outcomes with program outcomes**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 |
|---|---|---|---|---|---|---|
| **CO 1** | | | 3 | | | |
| **CO 2** | | | | 3 | | |
| **CO 3** | | | | 3 | | |
| **CO 4** | | | | | 3 | |
| **CO 5** | | | 3 | | | |

**Assessment Pattern**

| Bloom's Category | End Semester Examination |
|---|---|
| Understand | 60% |
| Apply | 20% |
| Analyse | 20% |

**Mark distribution**

| Total Marks | CIE | ESE | ESE Duration |
|---|---|---|---|
| 100 | 40 | 60 | 2.5 hours |

**Continuous Internal Evaluation Pattern: 40 marks**

Course based task : 15 marks
Seminar/Quiz : 15 marks
Test paper, 1 no. : 10 marks
Test paper shall include minimum 80% of the syllabus.

**End Semester Examination Pattern:** 60 marks

The examination will be conducted by the respective College. The examination willbe for 150 minutes and will contain 7 questions, with minimum one question from each module of which student should answer any five. Each question can carry 12 marks.

**Model Question paper**

AUDIT COURSE

**243AGE010 - REUSE AND RECYCLE TECHNOLOGY**

***Answer any five full questions, each carries 12 marks.***

| | | |
|---|---|---|
| **1.** | (a) What are the 3 pillars of sustainability?<br>*(b)* What is sustainable waste management? What makes sustainable waste management so important? | 5<br>7 |
| **2.** | (a)How do the three categories of municipal solid waste differ?<br>*(b)* Discuss the municipal waste collection and management? | 5<br>7 |
| **3.** | (a)Explain the major differences between Reuse and Recycle?<br>*(b)* Give an overview of recycling technologies used for any two materials. Discuss the Process involved. | 5<br>7 |
| **4.** | (a)What are the common source of E-waste<br>*(b)* What are the challenges and opportunities in E-waste management | 5<br>7 |
| **5.** | (a)What is the case law for waste recycling in India<br>*(b)* Discuss sustainable packaging and its environmental impacts | 5<br>7 |
| **6.** | Explain the various environmental regulations in India for addressing Environmental challenges | 12 |
| **7.** | a) Give examples of water reuse technologies in circular economy<br>b) How can we reduce e-waste with sustainable solutions | 5<br>7 |

## Syllabus

| Module | Content | Hours | Semester Exam Marks (%) |
|---|---|---|---|
| I | **Introduction to Sustainability**, Understanding sustainability and its importance, The three pillars of sustainability: Environmental, Social, and Economic. Biodiversity conservation, Climate change and mitigation Sustainable resource management. | 6 | 20 |
| II | **Waste Management,** Definition and classification of waste, Waste Generation and Composition**,** Waste Collection and Transportation, Waste Segregation and Sorting. Waste Disposal Methods Historical perspectives on waste management, The three Rs: Reduce, Reuse, and Recycle. | 6 | 20 |
| III | **Recycling and Reuse:** Importance of reuse, Application of reuse in various industries, Challenges and opportunities in reuse, Overview of recycling technologies, Circular economy, Sorting and processing of recyclable materials, Advanced recycling methods. Emerging technologies in recycling. | 6 | 20 |
| IV | **E-waste Recycling,** Challenges and environmental impact of electronic waste, E-waste recycling methods and regulations, Sustainable electronics design, **Sustainable Packaging,** Packaging materials and their environmental impact, Eco-friendly packaging alternatives, Packaging design for sustainability | 6 | 20 |
| V | **Environmental Regulations and Policies,** Understand the importance of environmental regulations and policies in addressing environmental challenges, National and international waste and recycling regulations, Compliance and enforcement, Industry standards and certifications | 6 | 20 |

| | Course Plan | |
|---|---|---|
| **No** | **Topic** | **No. of Lectures** |
| 1 | **Introduction to Sustainability (6)** | |
| 1.1 | Understanding sustainability and its importance | 1 |
| 1.2 | The three pillars of sustainability: Environmental, Social, and Economic. | 3 |
| 1.3 | Biodiversity conservation, Climate change and mitigation | 1 |
| 1.4 | Sustainable resource management | 1 |
| **2** | **Waste Management (6)** | |
| 2.1 | Definition and classification of waste | 1 |
| 2.2 | Waste Generation and Composition | 1 |
| 2.3 | Waste Collection and Transportation. | 1 |
| 2.4 | Waste Segregation and Sorting. | 1 |
| 2.5 | Waste Disposal Methods | 1 |
| 2.6 | Historical perspectives on waste management, The three Rs: Reduce, Reuse, and Recycle. | 1 |
| **3** | **Recycling and Reuse (6)** | |
| 3.1 | Importance of reuse, Examples of reuse in various industries. | 1 |
| 3.2 | Challenges and opportunities in reuse | 1 |
| 3.3 | Overview of recycling technologies, Sorting and processing of recyclable materials | 2 |
| 3.4 | Advanced recycling methods | 1 |
| 3.5 | Emerging technologies in recycling. | 1 |
| **4** | **E-waste Recycling (6)** | |
| 4.1 | Challenges and environmental impact of electronic waste | 1 |
| 4.2 | E-waste recycling methods and regulations | 1 |
| 4.3 | Sustainable electronics design | 1 |
| 4.4 | Packaging materials and their environmental impact | 1 |
| 4.5 | Eco-friendly packaging alternatives | 1 |
| 4.6 | Packaging design for sustainability | 1 |
| **5** | **Environmental Regulations and Policies (6)** | |
| 5.1 | Importance of environmental regulations and policies in addressing environmental challenges | 2 |
| 5.2 | National and international waste and recycling regulations | 2 |
| 5.3 | Industry standards and certifications, Compliance and enforcement | 2 |

**Reference Books**


1. Sustainable Engineering: Concepts, Design and Case Studies, David T. Allen, Pearson Publication.
2. A Comprehensive Book on Solid Waste Management with Application, Dr. H.S. Bhatia , Misha Books, 2019
3. "Cradle to Cradle: Remaking the Way We Make Things" by William McDonough and Michael Braungart.
4. "Recycling of Plastic Materials" edited by Vijay Kumar Thakur
5. E-waste: Implications, Regulations and Management in India and Current Global Best Practices, Rakesh Johri, TERI
6. "Sustainable Packaging", Subramanian Senthilkannan Muthu , Springer Nature.
7. **I**ndian Environmental Law: Key Concepts and Principles " Orient Black swan Private Limited, New Delhi.

| 243AGE012 | EXPERT SYSTEMS | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | AUDIT COURSE | 3 | 0 | 0 | - |

**Preamble:** The course aims to provide an understanding of the basic concepts of Artificial Intelligence (AI) and Expert Systems. The course also covers the knowledge representation in expert systems, classes of expert systems, applications of expert systems.

**Course Outcomes:** After the completion of the course the student will be able to:

| | |
|---|---|
| **CO 1** | Explain the concepts of Artificial Intelligence and different ways of knowledge representations. |
| **CO 2** | Explain the components of expert systems, development stages of expert systems and tools available for expert system design. |
| **CO 3** | Apply the concept of knowledge representation in expert systems |
| **CO 4** | Differentiate the classes of expert systems and examine properties of existing systems |

**Mapping of course outcomes with program outcomes**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO7 |
|---|---|---|---|---|---|---|---|
| **CO 1** | 1 | | 2 | 1 | 2 | 2 | |
| **CO 2** | 1 | | 1 | 3 | 2 | 2 | |
| **CO 3** | 1 | | 1 | 2 | 2 | 2 | |
| **CO 4** | 2 | | 2 | 2 | 3 | 2 | |

**Assessment Pattern**

| Bloom's Category | End Semester Examination |
|---|---|
| Understand | 60% |
| Apply | 20% |
| Analyse | 20% |

**Mark distribution**

| Total Marks | CIE | ESE | ESE Duration |
|---|---|---|---|
| 100 | 40 | 60 | 2.5 hours |

**Continuous Internal Evaluation Pattern: 40 marks**

Course based task (Project/Assignments/Simulations/Case studies): 15 marks

Seminar/Quiz : 15 marks

Test paper, 1 no. : 10 marks

Test paper shall include minimum 80% of the syllabus.

**End Semester Examination Pattern**:**60 marks**

The examination will be conducted by the respective College. The examination will be for 150 minutes and will contain 7 questions, with minimum one question from each module of which student should answer any five. Each question can carry 12 mark.

| | | |
|---|---|---|
| **SAHRDAYA COLLEGE OF ENGINEERING AND TECHNOLOGY**<br>THIRD SEMESTER M.TECH DEGREE EXAMINATION, MONTH, YEAR | | |
| **Course Code: 243AGE012** | | |
| **Course Name: EXPERT SYSTEMS** | | |
| Max. Marks: 60 | | Duration: 2.5 Hours |
| ***Answer any five full questions, each carries 12 marks.*** | | |
| 1 | a) What are the types of AI? Explain with examples . | 6 |
| | b) What do you mean by knowledge in AI and explain the different ways of knowledge representation used in AI? | 6 |
| 2. | a) Write note on semantic network. | 6 |
| | b) What are Predicates? Explain its syntax and semantics. | 6 |
| 3. | a) Write notes on different tools available for expert system design. | 6 |
| | b). What are the different stages in the development of an expert system? | 6 |
| 4. | a) Illustrate Conceptual Dependencies with an example. | 6 |
| | b) Illustrate with an example the Structured Knowledge representation of an Expert System. | 6 |
| 5. | a) What do you mean by Frame based Expert System? Explain | 6 |
| | b)Explain the architecture of MYCIN | 6 |
| 6. | a)Explain Fuzzy based expert systems | 6 |
| | b) Explain the neural network based expert systems | 6 |
| 7. | a) Explain any two applications of expert systems? | 6 |
| | b)What are the limitations of expert system ? Explain | 6 |

## Syllabus

| Module | Content | Hours | Semester Exam Marks (%) |
|---|---|---|---|
| I | Overview of Artificial Intelligence (AI): Definition & Importance of AI.<br><br>Knowledge general concepts: Definition and Importance of knowledge, Knowledge-Based Systems, Knowledge organization, Knowledge Manipulation and acquisition.<br><br>Knowledge Representation: Introduction, Syntax and Semantics- Propositional logic and predicate logic. | 6 | 20 |
| II | Basic concepts of expert systems-Introduction to expert systems, Components of expert systems. Features of Expert System, Stages in the development of expert system, Types of tools available for expert system design | 6 | 20 |
| III | Knowledge representation in expert systems: Structured Knowledge representation: Graphs, Frames and related structures, Associative networks, Conceptual dependencies, Examples of structured knowledge representation. | 6 | 20 |
| IV | Classes of expert systems: Rule-based expert systems, Example- MYCIN, Frame-based expert system, terminologies, IF-THEN structure. Fuzzy and Neural network based expert systems(basic concepts) | 7 | 20 |
| V | Currents trends in expert systems, Advantages and limitations of expert systems, Applications of expert systems. | 5 | 20 |

## Course Plan

| No | Topics | No. of Lectures |
|---|---|---|
| 1 | **Overview of Artificial Intelligence& Knowledge general concepts** | |
| 1.1 | Definition & Importance of AI | 1 |
| 1.2 | Definition and Importance of Knowledge, | 1 |
| 1.3 | Knowledge-Based Systems, Knowledge Organization | 1 |
| 1.4 | Knowledge Manipulation and acquisition | 1 |
| 1.5 | Knowledge Representation: Introduction, Syntax and Semantics | 1 |
| 1.6 | Propositional logic and predicate logic | 1 |
| **2** | **Basic concepts of expert systems** | |
| 2.1 | Introduction to Expert System, Components of expert systems | 2 |
| 2.2 | Features of Expert System, Stages in the development of expert system | 2 |
| 2.3 | Types of tools available for expert system design | 2 |
| **3** | **Knowledge representation in expert systems** | |
| 3.1 | Structured Knowledge representation | 1 |
| 3.2 | Graphs, Frames and Related Structures | 2 |
| 3.3 | Associative Networks, Conceptual Dependencies | 2 |
| 3.4 | Examples of structured knowledge representation | 1 |
| **4** | **Classes of expert systems** | |
| 4.1 | A rule-based expert system -Introduction | 1 |
| 4.2 | MYCIN | 1 |
| 4.3 | IF-THEN structure | 1 |
| 4.4 | Frame-based expert system | 2 |
| 4.5 | Fuzzy based expert systems | 1 |
| 4.6 | Neural network based expert systems | 1 |
| **5** | **Currents trends and applications of expert systems** | |
| 5.1 | Currents trends of expert systems | 2 |
| 5.2 | Advantages and limitations of expert systems | 1 |
| 5.3 | Applications of expert systems | 2 |

### Reference Books


1. E. Rich & K. Knight - Artificial Intelligence, 2/e, TMH, New Delhi, 2005.
2. P.H. Winston - Artificial Intelligence, 3/e, Pearson Edition, New Delhi, 2006.
3. D.W. Rolston - Principles of AI & Expert System Development, TMH, New Delhi
4. Kevin Night and Elaine Rich, Nair B., "Artificial Intelligence (SIE) ", McGraw Hill – 2010
5. Dan W Patterson, 'Introduction to Artificial intelligence and Expert systems', Prentice Hall of India Pvt. Ltd,2007
6. Russel (Stuart), 'Artificial Intelligence- Modern approach, Pearson Education series in AI', 3rd Edition, 2009.
7. I. Gupta, G. Nagpal · Artificial Intelligence and Expert Systems, Mercury Learning and Information -2020

| 243AGE011 | SYSTEM MODELLING | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | AUDIT COURSE | 3 | 0 | 0 | - |

**Preamble:** Study of this course provides the learners a clear understanding of fundamental concepts in simulation and modelling. This course covers the different statistical models, importance of data collection and various types of simulations. The course helps the learners to find varied applications in engineering, medicine and bio-technology.

**Course Outcomes:** After the completion of the course the student will be able to

| | |
|---|---|
| **CO 1** | Analyse the requirement and find appropriate tool for simulation. |
| **CO 2** | Differentiate the different statistical models. |
| **CO 3** | Discuss the different techniques for generating random numbers. |
| **CO 4** | Analyse the different methods for selecting the different input models.. |
| **CO 5** | Discuss the different measures of performance and their estimation |

**Mapping of course outcomes with program outcomes**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 |
|---|---|---|---|---|---|---|
| **CO 1** | 2 | | 1 | 1 | 2 | |
| **CO 2** | 2 | | 1 | 1 | 1 | |
| **CO 3** | 1 | | | | | |
| **CO 4** | 1 | | 1 | 1 | | |
| **CO 5** | 2 | | 1 | 1 | 1 | |

**Assessment Pattern**

| Bloom's Category | End Semester Examination |
|---|---|
| Understand | 60% |
| Apply | 20% |
| Analyse | 20% |

**Mark distribution**

| Total Marks | CIE | ESE | ESE Duration |
|---|---|---|---|
| 100 | 40 | 60 | 2.5 hours |

**Continuous Internal Evaluation Pattern:**

Course based task (Project/Assignments/Simulations/Case studies): 15 marks
Seminar/Quiz: 15 marks
Test paper, 1 no.: 10 marks
Test paper shall include minimum 80% of the syllabus.

**End Semester Examination Pattern:**

The examination will be conducted by the respective College. The examination will be for 150 minutes and will contain 7 questions, with minimum one question from each module of which student should answer any five. Each question can carry 12 marks.

**Model Question paper**

AUDIT COURSE

**243AGE001 – SYSTEM MODELLING**

***Answer any five questions Each carries 12 marks***

**PART A**

1. a. Discuss the advantages and disadvantages of simulation. (5marks)

   b. What are the areas of applications of simulation (7 marks)

2. a.A bus arrives every 20 minutes at a specified stop beginning at 6:40 A.M. and continuing until 8:40 A.M. A certain passenger does not know the schedule, but arrives randomly (uniformly distributed) between 7:00A.M. and 7:30 A.M. every morning. What is the probability that the passenger waits more than 5 minutes for a bus? (5 marks)

   b. A production process manufactures computer chips on the average at 2% nonconforming. Every day, a random sample of size 50 is taken from the process. If the sample contains more than two nonconforming chips, the process will be stopped. Compute the probability that the process is stopped by the sampling scheme. (7 marks)

3. a.Discuss the different types of tests for random numbers. (5 marks)

   b. Generate random numbers using multiplicative congruential method with X0 = 5, a 11, and m = 64. (7 marks)

4. a. What are the different methods of data collection. (4marks)

   b. Records pertaining to the monthly number of job-related injuries at an underground coalrnine were being studied by a federal agency. The values for the past 100 months were as follows:

| Injuries per Month | Frequency of Occurrence |
|---|---|
| 0 | 35 |
| 1 | 40 |
| 2 | 13 |
| 3 | 6 |
| 4 | 4 |
| 5 | 1 |
| 6 | 1 |

(a) Apply the chi-square test to these data to test the hypothesis that the underlying distribution is Poisson. Use the level of significance $\alpha == 0.05$.

(b) Apply the chi-square test to these data to test the hypothesis that the distribution is Poisson with mean 1.0. Again let $\alpha = 0.05$. ·

c) What are the differences between parts (a) and (b), and when might each case arise? (8 marks)

5. a.What is the difference between validation and verification.(5 marks)
   b. Discuss the different measures of performance and their estimation(7 marks)
6. a. Discuss the different methods of parameter estimation(5 marks)
   b. With an example, describe the Poisson process.(7 marks)
7. a. Distinguish between discrete and continuous systems(5 marks)
   b.What are the different components of a simulation system(7 marks)

## Syllabus

| Module | Content | Hours | Semester Exam Marks (%) |
|---|---|---|---|
| **I** | When simulation is the appropriate tool. Advantages and disadvantages of Simulation; Areas of application, Systems and system environment; Components of a system; Discrete and continuous systems, Model of a system; Types of Models, Discrete-Event System Simulation, Steps of a simulation study. | **6** | **20** |
| **II** | Review of terminology and concepts, Useful statistical models, Discrete distributions. Continuous distributions, Poisson process, Empirical distributions. (basic idea only) | **6** | **20** |
| **III** | Properties of random numbers; Generation of pseudo-random numbers, Techniques for generating random numbers, Tests for Random Numbers | **6** | **20** |
| **IV** | Data Collection; Identifying the distribution with data, Parameter estimation, Goodness of Fit Tests, Fitting a non-stationary Poisson process, Selecting input models without data, Multivariate and Time-Series input models. | **6** | **20** |
| **V** | Measures of performance and their estimation, Output analysis for terminating simulations, Output analysis for steady-state simulations, Verification, calibration and validation | **6** | **20** |

## Course Plan

| No | Topic | No. of Lectures |
|---|---|---|
| 1 | **Introduction** | |
| 1.1 | When simulation is the appropriate tool | 1 |
| 1.2 | Advantages and disadvantages of Simulation; | 1 |
| 1.3 | Areas of application, Systems and system environment; | 1 |
| 1.4 | Components of a system; Discrete and continuous systems, | 1 |
| 1.5 | Model of a system; Types of Models, | 1 |
| 1.6 | Discrete-Event System Simulation ,Steps of a simulation study | 1 |
| **2** | **Statistical Models in Simulation** | |
| 2.1 | Review of terminology and concepts, Empirical distributions. (basic idea only) | 1 |
| 2.2 | Useful statistical models, | 1 |
| 2.3 | Discrete distributions. | 1 |
| 2.4 | Continuous distributions,. | 1 |
| 2.5 | Poisson process | 1 |
| 2.6 | Empirical distributions | 1 |
| **3** | **Random Number Generation** | |
| 3.1 | Properties of random numbers; | 1 |
| 3.2 | Generation of pseudo-random numbers, | |
| 3.3 | Techniques for generating random numbers | 1 |
| 3.4 | Techniques for generating random numbers(cont) | 1 |
| 3.5 | Tests for Random Numbers | 1 |
| 3.6 | Tests for Random Numbers(cont) | 1 |
| **4** | **Input Modelling** | |
| 4.1 | Data Collection; | 1 |
| 4.2 | Identifying the distribution with data. | 1 |
| 4.3 | Parameter estimation, Goodness of Fit Tests | 1 |
| 4.4 | Fitting a non-stationary Poisson process | 1 |
| 4.5 | Selecting input models without data, | 1 |
| 4.6 | Multivariate and Time-Series input models | 1 |
| **5** | **Measures of Performance and their Estimation** | |
| 5.1 | Measures of performance and their estimation | 1 |
| 5.2 | Measures of performance and their estimation(cont) | 1 |
| 5.3 | Output analysis for terminating simulations | 1 |
| 5.4 | Output analysis for steady-state simulations | 1 |
| 5.5 | Verification, calibration and validation | 1 |
| 5.6 | Verification, calibration and validation(cont) | 1 |

**Textbooks:**

1. Jerry Banks, John S. Carson II, Barry L. Nelson, David M. Nicol: Discrete-Event System Simulation, 5th Edition, Pearson Education, 2010.

**Reference Books:**

1. Lawrence M. Leemis, Stephen K. Park: Discrete – Event Simulation: A First Course, Pearson Education, 2006.

2. Averill M. Law: Simulation Modeling and Analysis, 4 th Edition, Tata McGraw-Hill, 2007

3. System Modelling and Response by Ernest O. Doebelin

4. Averill M Law, "Simulation Modeling and Analysis",McGraw-Hill Inc,2007 Geoffrey Gorden, "System Simulation",Prentice Hall of India,1992.

| 243AGE009 | Principles of Automation | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | AUDIT COURSE | 3 | 0 | 0 | 0 |

**Preamble:**

This course deals in detail with the various aspects of automation such as sensors, actuators, controllers, mechanical and electrical elements and their integration for automating new and existing manufacturing and process industries and applications. This course will be beneficial to students in designing automation schemes for industries and to design automated systems

**Course Outcomes:** After the completion of the course the student will be able to

| | |
|---|---|
| **CO 1** | Explain the fundamentals of sensor systems and to choose a suitable sensor system for the given application based on the evaluation of the constraints. |
| **CO 2** | Explain the fundamentals of signal conditions and to design a suitable signal conditioning scheme for given application. |
| **CO 3** | Describe the characteristics of various actuator systems and to decide the right type of actuator for the given application. |
| **CO 4** | Describe the importance of an industrial robot and fundamentals of numerical control in automation. |
| **CO 5** | Explain the fundamentals of controllers used in industrial automation and to construct simple automation schemes by ladder logic programs. |

**Mapping of course outcomes with program outcomes**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 |
|---|---|---|---|---|---|---|---|
| **CO 1** | 2 | | 2 | 2 | 2 | | |
| **CO 2** | 2 | | 2 | 2 | 2 | | |
| **CO 3** | 2 | | 2 | 2 | 2 | | |
| **CO 4** | 2 | | 2 | 2 | 2 | | |
| **CO 5** | 2 | | 2 | | | | |

**Assessment Pattern**

| Bloom's Category | End Semester Examination |
|---|---|
| Understand | 70 % |
| Apply | 30 % |

**Mark distribution**

| Total Marks | CIE | ESE | ESE Duration |
|---|---|---|---|
| 100 | 40 | 60 | 2.5 hours |

**Continuous Internal Evaluation Pattern: 40 marks**

Course based task (Project/Assignments/Simulations/Case studies): 15 marks

Seminar/Quiz: 15 marks

Test paper, 1 no.: 10 marks

Test paper shall include minimum 80% of the syllabus.

**End Semester Examination Pattern**:**60 marks**

The examination will be conducted by the respective College. The examination will be for 150 minutes and will contain 7 questions, with minimum one question from each module of which student should answer any five. Each question can carry 12 marks.

Model Question Paper

**243AGE009 Principles of Automation**

Time 2.5 Hrs Marks 60

***Answer any five questions Each carries 12 marks***

1. (a) Differentiate the static and dynamic characteristics of a temperature sensor and explain how it affects the selection of a suitable temperature sensor. (6 marks)
   (b) Explain the working of a strain-gauge. (6marks)

2. (a) Explain why anti-aliasing filters are used in analog to digital converters. (3 marks)
   (b) Design a first order low pass filter with a cutoff frequency of 2 kHz. (9 marks)

3. (a) What are the factors to consider while deciding choosing between hydraulic, pneumatic or electrical actuation systems for an automation scheme? (4 marks)
   (b) Explain the working of a three-way pressure reducing valve. (4 marks)
   (c) Explain the working of solenoids. In what applications would you use a Solenoid valve. (4 marks)

4. (a) Explain the principle of the Touch sensor and also mention how they are used in robots. (5 marks)
   (b) Explain the basic terminologies in robotic system and also explain the components of robotic system. (7 marks)

5. (a)With neat schematic explain the architecture of the PLC. (6 marks)
   (b) Explain the use of an up-down counter in PLC with a suitable example. (6 marks)

6. (a) Write short note on SCADA. What is difference PLC and SCADA? (3 marks)

   (b)Construct a ladder logic for controlling a process tank as per the logic given below;

i. The tank should be filled by a valve V1 when low level float switch L1 is ON and an external input S1 is received.

ii. V1 should be closed when the liquid level reaches a high-level float switch L2.
iii. An agitator motor should be turned on after a delay of 5sec after L2 is triggered.
iv. After agitating for 30mins, contents of the tank should be emptied by opening another valve V2.
v. The temperature should be maintained at 70℃ using a thermostat T1 and Heater H (9 marks)

7. (a) Explain the levels of Automation. (6 marks)
(b) Explain the working of Flow sensor (6 marks)

**Syllabus and Course Plan**

| No | Topics | No. of Lectures |
|---|---|---|
| 1 | **Introduction to Industrial Automation** | |
| 1.1 | Basic Elements of an Automated System, Levels of Automation | 2 |
| 1.2 | Hardware components for Automation: Sensors, classification, Static and dynamic behaviour of sensors. | 2 |
| 1.3 | Basic working principle of different sensors: Proximity sensors, Temperature sensors, flow sensors, Pressure sensors, Force sensors. Position sensors | 4 |
| 2 | **Signal conditioning** | |
| 2.1 | Need for signal conditioning, Types of signal conditioning. | 2 |
| 2.2 | Signal conditioning using operational amplifier-Amplifier (Inverting and Non-inverting) and Filter circuits (Basic concepts). Design of first order low pass filter. | 2 |
| 2.3 | Signal conditioning for data acquisition systems, anti-aliasing filters, Analog–Digital Conversions, Analog-to-Digital Converters (ADC)- Steps in analog-to-digital conversion, Successive Approximation Method, Digital-to-Analog Converters (DAC)- Steps in digital to analog conversion, Zero-order and first order data hold circuits | 4 |
| 3 | **Actuators** | |
| 3.1 | Types of actuators- mechanical, electrical, pneumatic and hydraulic actuators. (Basic working principle) | 2 |
| 3.2 | Mechanical systems for motion conversion, transmission systems | 3 |
| 3.3 | Solenoids, Electric and stepper motors control. | 3 |
| 4 | **Robotics and Automated Manufacturing Systems** | |
| 4.1 | Robot Anatomy and Related Attributes: Joints and Links, Common Robot Configurations, Joint Drive Systems, Sensors in Robotics (Basic concepts) | 3 |
| 4.2 | Robot Control Systems, Applications of Industrial Robots- Material handling | 4 |
| 4.3 | Fundamentals of Numerical control (NC) Technology | 1 |
| 5 | **Discrete Control and Programmable Logic Controllers** | |

| | | |
|---|---|---|
| 5.1 | Discrete Process Control: Logic and Sequence control | 2 |
| 5.2 | Ladder Logic Diagrams, Programmable Logic Controllers: Components of the PLC, PLC Operating Cycle, Programming the PLC (Basic concepts only) | 4 |
| 5.3 | Introduction to Distributed control system (DCS) and Supervisory Control and Data Acquisition Systems (SCADA) | 2 |

**Reference Books**


1. Mikell Groover, Automation, Production Systems, and Computer-Integrated Manufacturing, 5th Edition, Pearson, 2019.
2. Yoram Koren, "Computer Control of Manufacturing Systems",TataMcGraw Hill Edition2005.
3. S. R. Deb; Sankha Deb. Robotics Technology and Flexible Automation, Second Edition McGraw-Hill Education: New York, 2010.
4. W. Bolton, "Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering" - PrenticeHall- 2013 - 5th Edition.
5. Doebelin, E.O. and Manic, D.N., "Measurement Systems: Applications and Design", 7th Edition, McGraw Hill, 2019.
6. Krishna Kant, Computer Based Industrial Control-, EEE-PHI,2nd edition,2010.
7. Nathan Ida, Sensors, Actuators, and Their Interfaces- A multidisciplinary introduction, 2nd Edition, IET Digital Library, 2020.
8. Salivahanan, S., and VS Kanchana Bhaaskaran. Linear integrated circuits. McGraw-Hill Education, 2nd edition, 2014.
9. Petruzella, Frank D. Programmable logic controllers. Tata McGraw-Hill Education, 2005
10. Chapman and Hall, "Standard Handbook of Industrial Automation", Onsidine DM C & Onsidine GDC", NJ, 1986

| 243AGE002 | FORENSIC ENGINEERING | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | Audit Course | 3 | 0 | 0 | - |

**Preamble:** This course explores various aspects of Forensic Engineering and different methods ,tools and procedures used by Engineers to investigate and analyze . The students will learn to develop their awareness in Forensic Engineering .

**Pre-requisite:** Nil

**Course Outcomes:**

After the completion of the course the student will be able to

| | |
|---|---|
| **CO 1** | Identify the fundamental aspects of forensic Engineering |
| **CO 2** | Apply forensic Engineering in Practical work flow and Investigation |
| **CO 3** | Apply methods and analysis in Forensic Investigation |
| **CO 4** | Develop practical strategies and standards of Investigation |
| **CO 5** | Create an awareness in criminal cases and create Engineering expertise in court room on forensic Engineering |

**Mapping of course outcomes with program outcomes**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO7 |
|---|---|---|---|---|---|---|---|
| **CO 1** | 2 | 2 | 3 | 3 | 3 | 3 | |
| **CO 2** | 2 | 2 | 3 | 3 | 3 | 3 | 1 |
| **CO 3** | 3 | 3 | 3 | 3 | 3 | 3 | 1 |
| **CO 4** | 3 | 3 | 3 | 3 | 3 | 3 | 1 |
| **CO 5** | 3 | 3 | 3 | 3 | 3 | 3 | |

**Assessment Pattern**

| Bloom's Category | Continuous Internal Evaluation | End Semester Examination |
|---|---|---|
| Apply | 40 % | 60 % |
| Analyse | 40 % | 40 % |
| Evaluate | 20 % | |

**Mark distribution**

| Total Marks | CIE | ESE | ESE Duration |
|---|---|---|---|
| 100 | 40 | 60 | 2.5 hours |

**Continuous Internal Evaluation: 40 marks**

Course based task :15marks

Seminar/Quizz :15marks

Test paper :10 marks

Test paper shall include minimum 80% of the syllabus.

**End Semester Examination: 60 marks**

The examination will be conducted by the respective College. The examination will be for 150 minutes and will contain 7 questions, with minimum one question from each module of which student should answer any five. Each question can carry 12 marks.

**Model Question paper**

**SAHRDAYA COLLEGE OF ENGINEERING AND TECHNOLOGY**

**THIRD SEMESTER M. TECH DEGREE EXAMINATION**

**Course Code: 243AG002**

**Course Name: FORENSIC ENGINEERING**

**Max. Marks: 60** **Duration: 2.5 Hours**

**PART A**

| | | ***Answer any 5 questions, each question carries 12 marks.*** | **Marks** |
|---|---|---|---|
| 1. | (a) | What are the uses of forensic engineering in legal laws ? | (7) |
| | (b) | Discuss the professional responsibility of a forensic Engineer . | (5) |
| 2. | (a) | What are the steps in preliminary on site Investigation ? | (7) |
| | (b) | With suitable examples, explain photo cataloguing? | (5) |
| 3. | (a) | Discuss STEP method . | (7) |
| | (b) | Explain root cause Analysis | (5) |
| 4. | (a) | Detail about EDAX Method. | (7) |
| | (b) | Enlist the uses of NDT in forensic Analysis with example | (5) |
| 5. | (a) | Differentiate NFPA & FMV Standards | (7) |
| | (b) | Briefly discuss the term Email Phishing ? | (5) |
| 6. | | Define the responsibility and duty of a forensic expert in the court. | (12) |
| 7. | | Explain Forensic Engineering workflow with examples | (12) |

## Syllabus and Course Plan

| Module No | Topic | No. of Lectures (Hours) |
|---|---|---|
| **1** | **Module 01: Introduction to Forensic Engineering (6 Hours)** | |
| 1.1 | Forensic Engineering-Definition, Investigation Pyramid, Eyewitness Information, Role in Legal System | 2 |
| 1.2 | Scientific Method-Applying scientific methods in Forensic Engineering-Engineer as expert Witness-Scientific methods and legal system | 2 |
| 1.3 | Qualification of Forensic Engineer-Technical- Knowledge- Oral-written-Communication- other skills-Personality Characteristics | 1 |
| 1.4 | Ethics and professional responsibilities. | 1 |
| **2** | **Module 02: Forensic Engineering Workflow and Investigation Methods (6 Hours)** | |
| 2.1 | Forensic Engineering Workflow-Team &planning-preliminary onsite investigation. Sampling-selection of sample-collection- packing-sealing of samples. | 2 |
| 2.2 | Source and type of evidence - Paper documentation- digital documentation-electronic data. Physical Evidence-Collection of photograph-cataloguing -Recognizing the Evidence-organizing-Evidence Analysis -Reporting | 2 |
| 2.3 | Investigation Methods- Cause and Causal mechanism analysis-Time and event sequence-STEP method. Human Factors, Human errors - Analysis of Operative Instruction and working Procedures | 2 |
| **3** | **Module 03: Physical Product Failure & Analytical Methods (6 Hours)** | |
| 3.1 | Introduction to typical Forensic Engineering Tool box-NDT, Crack detection and human eye -Hardness testing- and Destructive testing Methods with case studies | 2 |
| 3.2 | Indirect stress strain Analysis-Brittle lacquer technique, Contact Radiography-Metallography-EDAX method | 1 |
| 3.3 | Forensic Optical Microscopy-Examination- Magnification-USB Microscopy -Wifi Enabled microscopy -Reflected microscopy | 2 |
| 3.4 | Novel Tools and System -Contour Method-Flash Thermography-Thermographic signal reconstruction (TSR)-Electromagnetically induced acoustic Emission (EMAE)-Pulsed Eddy Current (PEA)-Theory only | 1 |
| **4** | **Module 04: Cyber Forensic , Civil ,Electrical Accidents & Standards (6 Hours)** | |
| 4.1 | Basics of Digital & Cyber forensics: Technical concepts; labs and tools; collecting evidence Operating System Forensic basics with - Windows, Linux -Mobile Forensic-Anti forensics-Malware- Web attack forensics with Email Crimes-Cyber Laws | 3 |
| 4.2 | Different types of Forensic accident investigations- Civil Engineering-Structural- Road accidents -Fire accidents - Water related accidents-Electrical accidents and Investigation methods | 2 |
| 4.3 | Protocol for forensic Investigations-Standard guides-scope significance -use -procedures- reports. Standards – ASTM standards -FMV Standards -SAE Standards -Relevant Standards -NFPA Standards -International Standards | 1 |

| 5 | **Module 05: Engineer in the Court room& Criminal Cases (6 Hours)** | |
|---|---|---|
| 5.1 | Role of an Engineering Expert-Report-pre trial meetings-Alternative dispute resolution-Single joint expert. Engineer in the court room | 2 |
| 5.2 | Criminal Cases-Introduction-Counterfeit coins-fraudulent road accidents-Fraudulent Insurance claims. | 2 |
| 5.3 | Cyber Crimes and Cases- SIM Swapping -ATM Cloning-Microsoft Internal Spam- Intellectual property cases. | 2 |

**Reference Books**


1. Colin R Gagg, *Forensic EngineeringThe Art &Craft of a failure detective* , Taylor & Francis Publishing, 2020
2. Luca Fiorentini ,Luca Marmo *Principles of Forensic Engineering Applied to Industrial Accidents* , Wiley, 2019
3. Harold Franck, Darren Franck , *Forensic Engineering Fundamentals* ,Taylor & Francis publishing 2013
4. Randall K Noon , *Forensic Engineering Investigation*, CRC press limited , 2001
5. Stephen E Petty , *Forensic Engineering: Damage assessment for residential and commercial structures* CRC press 2nd edition , 2017
6. Joshua B Kardon , *Guideliness for forensic Engineering practice* , ASCE, 2012
7. Richard W. Mclay and Robert N. Anderson, *Engineering standards for forensic Applications* , Academic Press; 1st edition 2018
8. Max M Houck ,*Forensic Engineering (Advanced forensic Science ),* Academic press 1st edition 2017
9. Niranjan Reddy - Practical Cyber Forensics. *An Incident-based Approach to Forensic Investigations-Apress (2019)*
10. Peter Rhys Lewis, Ken Reynolds, Colin Gagg - *Forensic Materials Engineering Case Studies-CRC Press (2003) (1)*

**INTERNSHIP**

A student shall opt for carrying out the Internship at an Industry/Research Organization or at another institute of higher learning and repute (Academia). The organization for Internship shall be selected/decided by the students on their own with prior approval from the faculty advisor/respective PG Programme Coordinator/Guide/Supervisor. Every student shall be assigned an internship Supervisor/Guide at the beginning of the Internship. The training shall be related to their specialisation after the second semester for a minimum duration of six to eight weeks. On completion of the course, the student is expected to be able to develop skills in facing and solving the problems experiencing in the related field.

**Objectives**

- Exposure to the industrial environment, which cannot be simulated in the classroom and hence creating competent professionals for the industry.
- Provide possible opportunities to learn understand and sharpen the real time technical / managerial skills required at the job.
- Exposure to the current technological developments relevant to the subject area of training.
- Create conducive conditions with quest for knowledge and its applicability on the job.
- Understand the social, environmental, economic and administrative considerations that influence the working environment.
- Expose students to the engineer's responsibilities and ethics.

**Benefits of Internship**

**Benefits to Students**

- An opportunity to get hired by the Industry/ organization.
- Practical experience in an organizational setting & Industry environment.
- Excellent opportunity to see how the theoretical aspects learned in classes are integrated into the practical world. On-floor experience provides much more professional experience which is often worth more than classroom

teaching.

- Helps them decide if the industry and the profession is the best career option

  to pursue.
- Opportunity to learn new skills and supplement knowledge.
- Opportunity to practice communication and teamwork skills.
- Opportunity to learn strategies like time management, multi-tasking etc in an industrial setup.
- Makes a valuable addition to their resume.
- Enhances their candidacy for higher education/placement.
- Creating network and social circle and developing relationships with industry people.
- Provides opportunity to evaluate the organization before committing to a full time position.

**Benefits to the Institute**

- Build industry academia relations.
- Makes the placement process easier.
- Improve institutional credibility & branding.
- Helps in retention of the students.
- Curriculum revision can be made based on feedback from Industry/

  students.
- Improvement in teaching learning process.

**Benefits to the Industry**

- Availability of ready to contribute candidates for employment.
- Year round source of highly motivated pre-professionals.
- Students bring new perspectives to problem solving.
- Visibility of the organization is increased on campus.

- Quality candidate's availability for temporary or seasonal positions and projects.
- Freedom for industrial staff to pursue more creative projects.
- Availability of flexible, cost-effective workforce not requiring a long-term employer commitment.
- Proven, cost-effective way to recruit and evaluate potential employees.
- Enhancement of employer's image in the community by contributing to the educational enterprise.

**Types of Internships**

- Industry Internship with/without Stipend
- Govt / PSU Internship (BARC/Railway/ISRO etc)
- Internship with prominent education/research Institutes
- Internship with Incubation centres /Start-ups

**Guidelines**

- All the students need to go for internship for minimum duration of 6 to 8 weeks.
- Students can take mini projects, assignments, case studies by discussing it with concerned authority from industry and can work on it during internship.
- All students should compulsorily follow the rules and regulations as laid by industry.
- Every student should take prior permissions from concerned industrial authority if they want to use any drawings, photographs or any other document from industry.
- Student should follow all ethical practices and SOP of industry.
- Students have to take necessary health and safety precautions as laid by the industry.
- Student should contact his /her Guide/Supervisor from college on weekly basis to communicate the progress.
- Each student has to maintain a diary/log book
- After completion of internship, students are required to submit
    - Report of work done
    - Internship certificate copy
    - Feedback from employer / internship mentor
    - Stipend proof (in case of paid internship).

**Total Marks 100:** The marks awarded for the Internship will be on the basis of (i) Evaluation done by the Industry (ii) Students diary (iii) Internship Report and (iv) Comprehensive Viva Voce.

**Continuous Internal Evaluation: 50 marks**

| | | | |
|---|---|---|---|
| Student's diary | - | 25 | Marks |
| Evaluation done by the industry | - | 25 | Marks |

**Student's Diary/ Daily Log**: The main purpose of writing daily diary is to cultivatethe habit of documenting and to encourage the students to search for details. It develops the students' thought process and reasoning abilities. The students should record in the daily training diary the day to day account of the observations,

impressions, information gathered and suggestions given, if any. It should contain the sketches & drawings related to the observations made by the students. The daily training diary should be signed after every day by the supervisor/ in charge of the section where the student has been working. The diary should also be shown to the Faculty Mentor visiting the industry from time to time and got ratified on the day of his visit. Student's diary will be evaluated on the basis of the following criteria:

- Regularity in maintenance of the diary
- Adequacy & quality of information recorded
- Drawings, design, sketches and data recorded
- Thought process and recording techniques used
- Organization of the information.

**The format of student's diary**

Name of the Organization/Section:

Name and Address of the Section Head:

Name and Address of the Supervisor:

Name and address of the student:

Internship Duration: From ..... To .....

Brief description about the nature of internship:

| Day | Brief write up about the Activities carried out: Such as design, sketches, result observed, issues identified, data recorded, etc. |
|---|---|
| 1 | |
| 2 | |
| 3 | |

*Signature of Industry Supervisor* *Signature of Section Head/HR Manager*

*Office Seal*

**Attendance Sheet**

Name of the Organization/Section:

Name and Address of the Section Head:

Name and Address of the Supervisor:

Name and address of the student:

Internship Duration: From ..... To .....

| Month & Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | ... |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | | | | | |
| Month & Year | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| Month & Year | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |

*Signature of Industry Supervisor* *Signature of Section Head/HR Manager*

*Office Seal*

**Note:**

- Student's Diary shall be submitted by the students along with attendance record and an evaluation sheet duly signed and stamped by the industry to the Institute immediately after the completion of the training.
- Attendance Sheet should remain affixed in daily training diary. Do not remove or tear it off.
- Student shall sign in the attendance column. Do not mark 'P'.
- Holidays should be marked in red ink in the attendance column. Absent should be marked as 'A' in red ink.

**Evaluation done by the Industry (Marks 25)**

**Format for Supervisor Evaluation of Intern**

Student Name : _____ Date: _____

Supervisor Name : _____ Designation: _____

Company/Organization : _____

Internship Address: _____

Dates of Internship: From _____ To _____

***Please evaluate intern by indicating the frequency with which you observed the following parameters:***

| **Parameters** **Marks** | Needs improvement (0 – 0.25 mark) | Satisfactory (0.25 – 0.50 mark) | Good (0.75 mark) | Excellent (1 mark) |
|---|---|---|---|---|
| Behavior | | | | |
| Performs in a dependable Manner | | | | |
| Cooperates with coworkers and supervisor | | | | |
| Shows interest in work | | | | |
| Learns quickly | | | | |
| Shows initiative | | | | |
| Produces high quality work | | | | |
| Accepts responsibility | | | | |
| Accepts criticism | | | | |
| Demonstrates organizational skills | | | | |
| Uses technical knowledge and expertise | | | | |
| Shows good judgment | | | | |
| Demonstrates creativity/originality | | | | |
| Analyzes problems effectively | | | | |
| Is self-reliant | | | | |
| Communicates well | | | | |
| Writes effectively | | | | |
| Has a professional attitude | | | | |
| Gives a professional appearance | | | | |
| Is punctual | | | | |
| Uses time effectively | | | | |

Overall performance of student

Intern (Tick one) : Needs improvement (0 - 0.50 mark) / Satisfactory (0.50 – 1.0 mark) / Good (1.5 mark) / Excellent (2.0 mark)

Additional comments, if any (2 marks) :

*Signature of Industry Supervisor* *Signature of Section Head/HR Manager*

*Office Seal*

**End Semester Evaluation (External Evaluation): 50 Marks**

| | | |
|---|---|---|
| Internship Report | - | 25 Marks |
| Viva Voce | - | 25 Marks |

**Internship Report**: After completion of the internship, the student should prepare a comprehensive report to indicate what he has observed and learnt in the training period and should be submitted to the faculty Supervisor. The student may contact Industrial Supervisor/ Faculty Mentor for assigning special topics and problems and should prepare the final report on the assigned topics. Daily diary will also help to a great extent in writing the industrial report since much of the information has already been incorporated by the student into the daily diary. The training report should be signed by the Internship Supervisor, Programme Coordinator and Faculty Mentor.

The Internship report (25 Marks) will be evaluated on the basis of following criteria:

- Originality
- Adequacy and purposeful write-up
- Organization, format, drawings, sketches, style, language etc.
- Variety and relevance of learning experience
- Practical applications, relationships with basic theory and concepts taught in the course

Viva Voce (25 Marks) will be done by a committee comprising Faculty Supervisor, PG Programme Coordinator and an external expert (from Industry or research/academic Institute). This committee will be evaluating the internship report also.

## RESEARCH PROJECT/DISSERTATION

**Research Project:** Students choosing track 2 shall carry out the research project in their parent Institution only under the guidance of a supervisor assigned by the DLAC.

**Dissertation:** All categories of students in track 1 are to carry out the dissertation in the Institute they are studying or can work either in any CSIR/Industrial R&D organization/any other reputed Institute which have facilities for dissertation work in the area proposed.

**Mark Distribution:**

**Phase 1: Total marks: 100, only CIA**

| CODE | COURSE NAME | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| 243PBT100 | DISSERTATION PHASE I | Project Work | 0 | 0 | 17 | 11 |

**COURSE OBJECTIVES:**

Dissertation is aimed to bridge the gap between theoretical knowledge and practical application, fostering a well-rounded skill set that prepares students for success in their future engineering careers. Engineering projects often simulate real-world engineering scenarios. This exposure allows students to become familiar with industry practices, standards, and expectations and preparing them for the challenges they might face in their future careers. Depending on the nature of the project, students may acquire practical skills related to specific tools, software, or equipment. This hands-on experience can be highly beneficial when transitioning to a professional engineering role.

Dissertation Phase I can help to identify the problem based on the area of interest through proper literature survey and to foster innovation in design of products, processes or systems based on the identified problem. perform feasibility study by creative thinking and requirement analysis in finding viable solutions to engineering problems

All categories of students in track 1 are to carry out the dissertation in the Institute they are studying or in any CSIR/Industrial/ R&D organization/any other reputed institute which have facilities for dissertation work in the area proposed.

**Course Outcomes:**

After the completion of the course the student will be able to

| | |
|---|---|
| **CO 1** | Identify and define a relevant and significant problem or challenge in the relevant field |
| **CO2** | Formulate research methodologies for the innovative and creative solutions |
| **CO 3** | Plan and execute tasks utilizing available resources within timelines, following ethical professional and financial norms |
| **CO 4** | Organize and communicate technical and scientific findings effectively in written reports, oral presentation, and visual aids |

**Mapping of course outcomes with program outcomes**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO7 |
|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | | 3 | 2 | 2 | 3 | 2 |
| **CO 2** | 3 | | 3 | 3 | 3 | 2 | |
| **CO 3** | 3 | | 2 | | 3 | 3 | 2 |
| **CO 4** | | 3 | 3 | 2 | | | 2 |

**Continuous Internal Assessment (CIA) Total Marks: 100**

The evaluation committee comprises

1- Project Coordinator(s)
2- A Senior faculty member
3- Supervisor of the student

**Pattern:**

| | |
|---|---|
| Zeroth evaluation by the Evaluation Committee | - |
| Interim evaluation by the Evaluation Committee | 20 marks |
| Final evaluation by the Evaluation Committee | 40 marks |
| Project Phase - I Report (By Evaluation Committee) | 20 marks |
| Project progress evaluation by supervisor | 20 marks |

The Plagiarism level in the project report shall be less than 25%.

**Interim Review**

Literature Survey (CO1- 5 marks)
Comprehension and Problem Identification (CO2-5 marks)
Objective Identification (CO2-5 marks)
Document Preparation and Presentation (CO4-5 marks)

**Final Review**

Literature Survey (CO1-10 marks)
Project Design (CO2-10 marks)
Execution of tasks by utilizing available resources within timelines (CO3 – 10 marks)
Presentation and document preparation (CO4-10 marks)

**Evaluation by the supervisor**

The guide/supervisor shall monitor the progress being carried out by the student on a regular basis. In case it is found that progress is unsatisfactory it shall be reported to the Department Evaluation Committee for necessary action.

**Student's Diary/ Log book**: The main purpose of writing diary/log book is to cultivate the habit of documenting and to encourage the students to search for details. The activity diary shall be signed after every week by the supervisor.

The minimum attendance for completing the course is 75%. The pass minimum for the course is 50% for CIA.

**SYLLABUS:**

| DETAILS | HOURS |
|---|---|
| `<br>1. Literature study/survey of published literature on the assigned topic<br>2. Formulation of objectives<br>3. Formulation of hypothesis/ design/ methodology<br>4. Formulation of work plan and task allocation.<br>5. Design documentation<br>6. Preliminary analysis/Modelling/Simulation/Experiment/Design/Feasibility study<br>7. Preparation of Phase 1 report | 150 |

**Dissertation outside the Institute:** For doing dissertation outside the Institution, the following conditions are to be met:

i. They have completed successfully the course work prescribed in the approved curriculum up to the second semester.
ii. The student has to get prior approval from the DLAC and CLAC.
iii. Facilities required for doing the dissertation shall be available in the Organization/Industry (A certificate stating the facilities available in the proposed organization and the time period for which the facilities shall be made available to the student, issued by a competent authority from the Organization/Industry shall be submitted by the student along with the application).
iv. They should have an external as well as an internal supervisor. The internal supervisor should belong to the parent institution and the external supervisor should be Scientists or Engineers from the Institution/Industry/ R&D organization with which the student is associated for doing the dissertation work. The external supervisor shall be with a minimum post graduate degree in the related area.
v. The student has to furnish his /her monthly progress as well as attendance report signed by the external supervisor and submit the same to the concerned Internal supervisor.
vi. The external supervisor is to be preferably present during all the stages of evaluation of the dissertation.

**Internship leading to Dissertation:** The M. Tech students who after completion of 6 to 8 weeks internship at some reputed organizations are allowed to continue their work as dissertation for the third and fourth semester after getting approval from the CLAC. Such students shall make a brief presentation regarding the work they propose to carry out before the DLAC for a detailed scrutiny and to resolve its suitability for accepting it as an M.Tech dissertation. These students will be continuing as regular students of the Institute in third semester for carrying out all academic requirements as per the curriculum/regulation. However, they will be permitted to complete their dissertation in the Industry/Organization (where they have successfully completed their internship) during fourth semester. They should have an external as well as an internal supervisor. The internal supervisor should belong to the parent institution and the external supervisor should be Scientists or Engineers from the external organization with which the student is associated for doing the dissertation work. The external supervisor shall be with a minimum post graduate degree in the related area. The student has to furnish his /her monthly progress as well as attendance report signed by the external guide and submit the same to the concerned internal guide. The external guide is to be preferably present during all the stages of evaluation of the dissertation.

**Dissertation as part of Employment**: Students may be permitted to discontinue the programme and take up a job provided they have completed all the courses till second semester (FE status students are not permitted) prescribed in the approved curriculum. The dissertation work can be done during a later period either in the organization where they work if it has R&D facility, or in the Institute. Such students should submit application with details (copy of

employment offer, plan of completion of their project etc.) to the Dean (PG) through HoD. The application shall be vetted by CLAC before granting the approval. When the students are planning to do the dissertation work in the organization with R&D facility where they are employed, they shall submit a separate application having following details:

i. Name of R&D Organization/Industry
ii. Name and designation of an external supervisor from the proposed Organization/Industry (Scientists or Engineers with a minimum post graduate degree in the related area) and his/her profile with consent
iii. Name and designation of a faculty member of the Institute as internal supervisor with his/her consent
iv. Letter from the competent authority from the Organization/Industry granting permission to do the dissertation
v. Details of the proposed work
vi. Work plan of completion of project

DLAC will scrutinize the proposal and forward to CLAC for approval. When students are doing dissertation work along with the job in the organization (with R & D facility) where they are employed, the dissertation work shall be completed in four semesters normally (two semesters of dissertation work along with the job may be considered as equivalent to one semester of dissertation work at the Institute). Extensions may be granted based on requests from the student and recommendation of the supervisors such that he/she will complete the M. Tech programme within four years from the date of admission as per the regulation. Method of assessment and grading of the dissertation will be the same as in the case of regular students. The course work in the 3rd semester for such students are to be completed as per the curriculum requirements (i) MOOC can be completed as per the norms mentioned earlier (ii) Audit course are to be carried out either in their parent Institution or by self-learning. However, for self-learning students, all assessments shall be carried out in their parent institution as in the case of regular students.

# SEMESTER IV

| CODE | COURSE NAME | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| **244PBT100** | **DISSERTATION PHASE II** | **Project Work** | **0** | **0** | **24** | **16** |

All categories of students in track 1 are to carry out the DISSERTATION PHASE II in the institute they are studying or in any Industrial/ R&D organization/any other reputed institute which have facilities for dissertation work in the area proposed. DISSERTATION PHASE II shall not compulsorily continuation of DISSERTATION PHASE I. The student has to publish a research article in a conference or a reputed journal before appearing for the end-semester examination. The eligibility criteria for registering to the end semester examination are attendance in the course and no pending disciplinary action. The minimum attendance for appearing for the end semester examination is 75%. Students who do not meet these eligibility criteria are ineligible (identified by FE grade) to appear for the ESE. Students, who have completed a course but could not appear for the end semester examination, shall be awarded 'AB' Grade, provided they meet other eligibility criteria The pass minimum for the course is 45% for ESE and 50% for (CIA and ESE) put together.

**Continuous Internal Assessment (CIA) Total Marks: 100**

The evaluation committee comprises

1- Project Coordinator(s)
2- A Senior faculty member
3- Supervisor of the student

**Pattern (CIA)**

| | |
|---|---|
| Zeroth evaluation by the Evaluation Committee | - |
| Interim evaluation by the Evaluation Committee | 30 marks |
| Final evaluation by the Evaluation Committee | 50 marks |
| Project progress evaluation by supervisor | 20 marks |

**Evaluation by the supervisor**

The guide/supervisor shall monitor the progress being carried out by the student on a regular basis. In case it is found that progress is unsatisfactory it shall be reported to the Department Evaluation Committee for necessary action.

**Student's Diary/ Log book**: The main purpose of writing diary/log book is to cultivate the habit of documenting and to encourage the students to search for details. The activity diary shall be signed after every week by the supervisor.

**End Semester Evaluation (ESE) Total Marks: 100**

The evaluation committee comprises

1- Project Coordinator(s)
2- An external expert (from Industry or research/academic institute)
3- Supervisor of the student

**Pattern (ESE)**

1. **Innovation and Originality (10 marks):**

Assessment of the uniqueness and innovation demonstrated in the project work.
Original contributions, if any, to the field or problem area.

2. **Implementation and Execution (20 marks):**

Evaluation of the actual implementation or execution of the project, including:

- Quality of work done
- Demonstrated skills and techniques applied
- Adherence to project timelines and milestones

3. **Project Documentation (25 marks):**

Comprehensive project report evaluation including:

- Introduction and problem statement
- Literature review
- Methodology and approach
- Results and analysis
- Conclusion and recommendations
- References and citations
- Details of the publications
- Plagiarism certificate

The Plagiarism level in the project report shall be less than 25%.

4. **Presentation and Defence (40 marks):**

Oral presentation of the project to a panel of examiners, including:

- Clarity and effectiveness of the presentation
- Ability to explain the project objectives, methodologies, and findings
- Handling questions and providing satisfactory answers during the defence

5. **Publication of the work either in a conference or in a journal (5 marks)**

**SYLLABUS:**

| DETAILS | HOURS |
|---|---|
| `<br>1. Literature study/survey of published literature on the assigned topic<br>2. Topic Selection and Proposal<br>3. Formulation of objectives<br>4. Research and Planning<br>5. Formulation of work plan and task allocation.<br>6. Execution<br>7. Documentation and Reporting<br>8. Project Showcase reflecting on the project experience and lessons learned | 200 |

**Dissertation outside the Institute:** For doing dissertation outside the Institution, the following conditions are to be met:

i. They have completed successfully the course work prescribed in the approved curriculum up to the second semester.
ii. The student has to get prior approval from the DLAC and CLAC.
iii. Facilities required for doing the dissertation shall be available in the Organization/Industry (A certificate stating the facilities available in the proposed organization and the time period for which the facilities shall be made available to the student, issued by a competent authority from the Organization/Industry shall be submitted by the student along with the application).
iv. They should have an external as well as an internal supervisor. The internal supervisor should belong to the parent institution and the external supervisor should be Scientists or Engineers from the Institution/Industry/ R&D organization with which the student is associated for doing the dissertation work. The external supervisor shall be with a minimum post graduate degree in the related area.
v. The student has to furnish his /her monthly progress as well as attendance report signed by the external supervisor and submit the same to the concerned internal supervisor.
vi. The external supervisor is to be preferably present during all the stages of evaluation of the dissertation