Basaveshwar Engineering College, Bagalkote
Department of Biotechnology
Schemes of Teaching and Examination
2025-26
B. E. VII SEMESTER

Sl. No	Category	Subject Code	Subject Title	Credits	Hours/ Week			SAAE/Sem		Examination Marks				Contact hour per sem
					L	T	P	Study Hours	Assignment/ Quiz/ MCQs	Duration in hours	CIE	SEE	TOTAL	
1.	AEC	22UHS711C	Research Methodology and IPR	03	3	0	0	42	6	3	50	50	100	90
2.	PCC	22UBT702C	Downstream Processing Technology	03	3	0	0	42	6	3	50	50	100	90
3.	HSMC	22UBT703H	Bioenterpreneurship Development	03	3	0	0	42	6	3	50	50	100	90
4.	PEC	22UBT7XXE	Elective -III	03	3	0	0	42	6	3	50	50	100	90
5.	PEC	22UBT7XXE	Electives - IV	03	3	0	0	42	6	3	50	50	100	90
6.	PCCL	22UBT704L	Upstream process & Bioseparation Techniques Lab	01	0	0	2	14	2	2	50	50	100	30
7.	PP	22UBT705P	Project	08	0	0	16	-	-	3	50	50	100	224
Total				**24**	**15**	**0**	**18**				**350**	**350**	**700**	

Elective-III

22UBT731E: Industrial BT
22UBT732E: Food Processing Technology
22UBT733E: Biosimulations
22UBT734E: Bioanalytical techniques

Elective-IV

22UBT741E: Nanobiotechnology & Biomaterials
22UBT742E: Food Product Development
22UBT743E: Clinical Research
22UBT744E: Pharmaceutical BT

Course Code:22UHS711C	RESEARCH METHODOLOGY & IPR	Credits: 03
Hours/ Week: (L:T:P:S): 3:0:0:0		CIE Marks: 50
Total Hours/week:03		SEE Marks: 50

UNIT-I	10 Hrs.

INTRODUCTION TO ENGINEERING RESEARCH

Fundamentals of Research: Meaning, objectives, and motivation in engineering research.

Types of Engineering Research: Basic, applied, and translational research; identifying and solving Worthwhile problems.

Research Ethics: Ethics in engineering research and practice, types of research misconduct, and ethical issues in authorship.

UNIT-II	10 Hrs.

LITERATURE REVIEW AND CITATIONS

Technical Reading & Analysis: Methods for reviewing literature, analyzing prior art, and synthesizing new and existing knowledge.

Bibliographic Databases: Web of Science, Google, Google Scholar, effective search strategies.

Conceptualizing Research: Critical and creative reading, taking notes, reading mathematical models, algorithms, and datasheets.

Citations & Acknowledgments: Attribution, citation styles, impact of keywords, citing datasets, and knowledge dissemination.

UNIT-III	10 Hrs.

INTELLECTUAL PROPERTY RIGHTS (IPR) & PATENTS:

Introduction to Intellectual Property: Concepts of property and rights, forms of IPR, role in research and economic development, IP governance, and global innovation indicators.

Patents: Definition, objectives, criteria for patentability, software/business method patents, infringement, compulsory licensing, and government use of inventions.

Patent Process: Prior art search strategies, patent databases (free and paid), drafting specifications and claims, filing requirements, jurisdiction, opposition procedures, and renewal.

Filing Requirement of patent: Patent Application Forms. Work flow chart in obtaining Patents, Jurisdiction of Filing Patent Application. Pre-grant & Post-grant Opposition. Forms to be submitted, filing mechanism through Individual patent office and PCT route. Need for a Patent Attorney/Agent Revocation. Term of Patent, Patent renewal and Fee Structure National Bodies Dealing with Patent Affairs. Utility Models

UNIT-IV	10 Hrs.

COPYRIGHTS AND RELATED RIGHTS

Classes of Copyrights. Criteria for Copyright. Owner ship of Copyright. Copyrights of the Author. Copyright Infringements. Copyright Infringement and remedies in case of infringement. Fair Use Doctrine. Copyrights and Internet. Non-Copyright Work. Copyright Registration. Judicial Powers of the Registrar of Copyrights. Fee Structure. Validity of Copyright. Copyright Profile of India. Copyright and the word 'Publish'. Transfer of Copyrights to aPublisher. Copyrights and the Word 'Adaptation'. Copyrights and the Word 'Indian Work'. Joint Authorship. Copyright Society. Copyright Board. Copyright Enforcement Advisory Council (CEAC). International Copyright Agreements, Conventions and Treaties. Interesting Copyrights Cases.

Trademarks: Eligibility Criteria. Who Can Apply for a Trademark. Acts and Laws. Classification of Trade marks. Registration of a Trademark. Process for Trademarks Registration. Prior Art Search. Validity of Trademark. Trade mark Registry. Famous Case Law: Coca-Cola Companyvs. Bisleri International Pvt. Ltd.

Industrial Designs: Eligibility Criteria. Acts and Laws to Govern Industrial Designs. Design Rights. Enforcement of Design Rights. Non-Protectable Industrial Designs India. Protection Term. Procedure for Registration of Industrial Designs. Prior Art Search. Application for Registration. Duration of the Registrationof a Design. Importance of Design Registration. Cancellation of the Registered Design. Application Forms.Classification of Industrial Designs. Designs Registration Trend in India. International Treaties. Famous CaseLaw:AppleInc.vs.Samsung ElectronicsCo.

Geographical Indications: Acts, Laws and Rules Pertaining to GI. Ownership of GI. Rights Granted to theHolders. Registered GI in India. Identification of Registered GI. Classes of GI. Non-Registerable GI. Protectionof GI. Collective or Certification Marks. Enforcement of GI Rights. Procedure for GI Registration Documents Required for

GI Registration.GIE co system in India.

Case Studies on Patents. Case study of Curcuma (Turmeric) Patent, Case study of Neem Patent, Case study of Basmati patent. **IP Organizations In India. Schemes and Programmes**.

REFERENCE BOOKS

1. Dr. Nejakar Santosh M, Dr. Bendigeri Harish (2023-24) "Research Methodology and Intellectual Property Rights", ISBN978-93-5987-928-4,
2. Thiel DavidV. "Research Methods for Engineers" Cambridge University Press,
3. Acharya N. K Intellectual Property Rights. 6th Edition, Asia Law House.
4. P. Naryan, (2007). "Intellectual Property Law", 3rd Ed, Eastern Law House,
5. Dr. Myneni S.R., (2019) "Law of Intellectual Property", 9th edition, Asia law House,.
6. Dr. Reddy G.B, (2020) "Intellectual Property Rights and Law", Reprint edition, Gogia Law Agency. Hydrabad,.
7. N.R. Subbaram. S. Viswanathan, (2008). "Hand book Indian Patent Law and, Practice" Printers and publishers Pvt. Ltd,
8. Cornish, "Intellectual Property Rights", Universal publications.
9. Dr. B. L. Wadehra,"Law Relating to Intellectual Property" 5thedition,Universal Law publishing Co, Dehli.
10. **SWAYAM / NPTL/ MOOCS/ We blinks/ Internet sources/ YouTube videos** and other materials / notes

COURSE OUTCOMES:

At the completion of the course student will be able to:

CO1: Integrate research methodology in engineering sciences in relevant trades.

CO2: Exhibit reflective thinking in problem solving exercises.

CO3: Identify criteria to fit one's own intellectual work in particular form of IPRs and able to apply statutory provisions and procedure to protect different forms of IPRs at national and international level.

CO4: Develop skill of making search using modern tools and techniques and also student is able to become patent agent by cracking patent agent exam.

Course Outcomes	Programme Outcomes											Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	PSO1	PSO2	PSO3
CO 1	-	2	2	3	2	1	2	3	-	1	2			
CO 2	-	3	2	3	-	2	2	2	-	-	2			
CO 3	-	-	-	-	2	3	2	3	-	1	3			
CO 4	-	-	-	2	3	2	-	1	-	1	-			

Course Code:22UBT702C	DOWNSTREAM PROCESSING TECHNOLOGY	Credits (3:0:0)
Hours/ Week: L:T:P 3:0:0		CIE Marks: 50
Total Hours /Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.

INTRODUCTION:

Introduction to biomolecules and their properties: Range and Characteristics of Bioproducts, Downstream Processing Principles, economics, and issues, Importance of Downstream Processing in Industrial Processes – Examples.

Size reduction and Cell disruption methods: Recovery of intracellular products, cell disruption methods for intracellular products- physical, chemical, and mechanical methods.

Isolation of insolubles: Filtration, Sedimentation, Coagulation, Flocculation, and Centrifugation. Types of centrifuges and rotors, Differential, Density gradient (zonal and isopycnic).

UNIT–II	10 Hrs.

PRODUCT RECOVERY OR PARTIAL PURIFICATION:

Precipitation of Proteins, Nucleic acids, and Bioproducts by Ammonium Sulfate, Polyethylene Glycol, and Solvents;

Membrane separation processes: Dialysis, Reverse osmosis, Electrodialysis, Pervaporation, Ultrafiltration;

Extraction methods: Solid-liquid and liquid-liquid extraction methods, Advanced Extraction Methods like Ultrasound, Microwave-assisted, Supercritical fluid Extractions, Solid-phase Extraction (Adsorption).

UNIT–III	12 Hrs.

PRODUCT PURIFICATION OR PRODUCT ENRICHMENT:

Selective Separation Techniques: Aqueous Two-phase Extraction, Micellar and Reverse Micellar Extraction;

Chromatographic separation and Electrophoresis methods: Principles of Chromatographic separation methods, Different types of chromatographic methods, Ion–exchange chromatography, Gel chromatography, Affinity chromatography. Principles of Electrophoresis and Electrophoresis mobility, applications.

High-Performance Liquid Chromatography- Normal and Reverse Phase; Gas Chromatography.

UNIT–IV	10 Hrs.

PRODUCT FINISHING

Product polishing and finishing: Crystallization, Drying, Evaporation, Lyophilization, and Product stabilization.

REFERENCE BOOKS

1. Bioseparations: Principles and techniques, by B.Sivasankar, Kindle edition,PHI Publishers, 2010
2. Biophysical Chemistry Principles and Techniques by Upadhay and Nath, Himalaya Publishing House, 3rd edition, 2010
3. NPTEL Source material.
4. Bioseparations - Downstream processing for biotechnology by Belter P.A., Cussier E. and Wei Shan Hu., Wiley Interscience Pub, 1988
5. Separation Processes in Biotechnology by Asenjo J. and Dekker M, 1993.
6. Product Recovery in Bioprocess Technology – BIOTOL Series, VCH, 1990. Perry RH and Green DW (2008). Perry's Chemical Engineering Hand Book, 8th Edn. McGraw-Hill Publications.

COURSE OUTCOMES

After completion of the course, students will be able to

1. Evaluate different techniques used for cell disruption and the extraction of intracellular components
2. Develop proficiency in various downstream processing techniques such as chromatography and Advanced Extraction Methods.
3. Analyze the importance of downstream processing in the purification of biopharmaceuticals
4. Design downstream processing strategies for specific biopharmaceutical products, considering factors such as yield, purity, and cost-effectiveness

Course Outcomes	Programme Outcomes											Programme Specific Outcomes		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**PSO1**	**PSO2**	**PSO3**
CO 1	2	-	3			3	2	2				2	1	1
CO 2	3	-	3			3	2	3				2	1	1
CO 3	3	3	-			3	2	2				2	1	1
CO 4	3	2	-			3	2	2				2	1	1

Course Code: 22UBT703H	BIOENTREPRENEURSHIP DEVELOPMENT	Credits: 03
Hours/ Week: L:T:P–3-0-0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.

ENTREPRENEUR & ENTREPRENEURSHIP: Definition, History, Concept, Characteristics, Need& Importance, types of entrepreneurship, Entrepreneurial process.

Soft Skills for entrepreneurs: Soft skills - Communicative skills, Creativity & Problem solving skills, & other managerial & leadership skills.

Business opportunity identification: Market survey tools, preparation of schedule and techniques of data collection. Production programme, plant capacity, manpower requirements and layout. Business plan format for micro and small enterprises. The financials of a project report.

UNIT–II	10 Hrs.

ENTREPRENEURSHIP MANAGEMENT AND ITS FUNCTIONS:

Principle functions of management: planning, organizing, staffing, coordinating & controlling. Concept of Authority & Responsibility. Social responsibilities of the management: to the owners, employees, customers, community & government.

Administration: Definition, Nature, Principles & Elements of management. Management VS administration.

UNIT–III	12 Hrs.

PRODUCTION MANAGEMENT:

Concept of productivity, measuring productivity, Productivity improvement techniques.

Concept of budget, classifications of the budget, components of budget, effective budgetary control.

Break even analysis.

Manufacturing /material planning, factory planning. Systems of wage payments, bonus, automation

Organization of production planning.

PERSONNEL MANAGEMENT:

Elements of personnel management, role of personnel manager, functions of personnel management –man power planning, recruitment, employee selection & training of personnel.

Employer - Employee relationship. Settlement of disputes.

UNIT–IV	10 Hrs.

MATERIAL AND MARKETING MANAGEMENT :

Material Functions of purchasing & materials management, quality, quality standard & inspection, sources of supply, pricing, principles & practices, Inventory management (ABC analysis), product promotional strategy

Entrepreneurship in Biobusiness: BioMedical field, Clinical research, Agriculture. Government schemes for commercialization of technology. Legal requirements

Entrepreneurship in India: Scope & opportunities in Biotechnology. Government schemes.

A case study on developing the financial scheme of a project report or business plan. Costing and pricing of products with one case study

REFERENCE BOOKS

1. O.P. Khanna - "Industrial Engineering & Management", DhanpatRai& Sons publications, 2006.
2. T. R. Banga& S. C. Sharma - "Industrial Engineering & Management Science", 6th. Edn, Khanna Publications, 2003
3. Poornima Charanthimath – Entrepreneurship Development –small business entreprises,
4. Pearson Education-2006
5. NSTEDB material for entrepreneurship development programme, EDI, Ahmadabad

COURSE OUTCOMES

After completion of the course student will be able to

1. Understand entrepreneur skill and to do market survey.
2. Understand entrepreneurship management functions.

3. Understand product and personal management in the entrepreneurial journey.
4. Understand the material management and to prepare project feasibility report.

Course Outcomes	Program Outcomes											Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	11	**PSO1**	**PSO2**	**PSO3**
CO1	1	1			1			2		3	3			3
CO2	1				2			1		3	3			3
CO3	1				2			2		3	3			3
CO4	1	1			2			1		3	3			3

Course Code: 22UBT732E	FOOD PROCESSING TECHNOLOGY	Credits:03
Hours/ Week: L:T:P–3-0-0		CIE Marks:50
Total Hrs/Week:03		SEE Marks: 50

UNIT-I	10 Hrs

INTRODUCTION

Constituents of food, soluble fibres, protein rich foods, popular fats and oils in foods, Food flavors, Browning reactions and its effects. Intrinsic and extrinsic parameters of foods, effect of inhibitors, pH and temperature. Minerals in foods. Aroma compounds in foods. Food additives, Vitamins, aminoacids, Sweeteners, Food colours. Toxic-trace elements in food.

UNIT–II	12 Hrs

DETECTION OF MICROORGANISMS

Culture, Microscopic and Sampling Methods, Conventional; SPC, Membrane Filters, Microscope colony Counts, Agar Droplets, Dry Films, Most probable Numbers (MPN), Dye reduction, Roll Tubes, Direct, Microscopic Count (DMC), Microbiological Examination of surfaces, Air Sampling, Metabolically Injured Organisms, Enumeration and Detection of Food-borne Organisms. Dairy products: Composition of milk, Sterilization of milk (Pasteurization and UHT), Cheese production, Acidophilus milk Yoghurt, Kumiss and Kefir. Marketing scope of dairy & food products Fruit and vegetable processing: Jam, jelly, Juice,squash, wine, pickles and sauerkraut.

UNIT–III	10 Hrs

FOOD SPOILAGE &PRESERVATION

The Role and Significance of Microorganisms, Primary Sources of Microorganisms found in Foods Synopsis of common borne bacteria, Molds& Yeasts. Microbial Spoilage of Vegetables, Fruits, Fresh and Processed Meats, Poultry, and Seafood. Spoilage of Miscellaneous Foods, Food Preservation: Principles Underlying in spoilage and preservation, Application, Effect and Legal Status of Food Irradiation, Food Preservation with Low Temperatures, High Temperatures and Drying. Food Industry: Characteristics of Food Industry. Factors influencing food product development, marketing and promotional strategies, Risks and benefits of food industry.

UNIT–IV	10 Hrs

FOOD ENGINEERING

Properties of fluid foods, Measurement of rheological parameters .Thermal properties of frozen foods. Food freezing equipment, storage of frozen foods. Food dehydration: Freeze Dehydration Calculation of drying times. Nutritional food supplements. Food packaging, New trends in packing, edible films.Food waste management.

REFERENCE BOOKS

1. Food Science & Nutrition, by Sunetra Roady, Oxford University Press, 2007.
2. FoodmicrobiologybyWilliamFrazierandWesthoffD.C,4thEdn,TATAMcGrawHill Pub(2005)
3. Modern Food Micro-Biology by James M.Jay, CBS Publishers. 2005.
4. Food Microbiology by K. Vijay Ramesh M J P Publishers, 2007.
5. Plant biotechnology In Agriculture by K. Lindsey and M. G. K. Jones, Prentice Hall, USA. 1990.
6. Food Science By Potter N.N. and Joseph Hotchkiss, 5th Edn, CBS Pub, 1996

COURSE OUTCOMES

After completion of the course student will be able to

1. Analyze the basic constituents and importance various nutrients in food.
2. Examine the techniques involved in detection of microbes in food industry and analyze the steps in food production.
3. Differentiate the microbes causing food spoilage and exhibit the preservation techniques and to know the Characteristics of food industry and scope.
4. Apply the concepts of food Engineering and food waste management.

Course Outcomes	Programme Outcomes											Programme Specific Outcomes		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**PSO1**	**PSO2**	**PSO3**
CO 1	2		2			3	1				3	2	2	3
CO 2	2		2		3	3	1				2	2	3	3
CO 3	2	1	1		3	3	2				1	2	2	3
CO 4	2	3	2		2	3	2				2	2	1	3

Course Code: 22UBT733E	BIOSIMULATIONS	Credits: 03
Hours/ Week: L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hours

Modelling Principles: Basic modeling principles, uses of mathematical modeling classification of modeling techniques Fundamental laws, energy equations, continuity equation, equations of motion, transport equations, equations of state, equilibrium states and chemical kinetics-examples.

UNIT–II	10 Hrs.

Mathematical Models for Biochemical Engineering Systems: Mathematical models for Biochemical engineering systems, Mathematical models in batch and continuous process, continuous flow tanks, reversible reaction.

UNIT–III	12 Hrs.

Simulation Softwares in Bioprocess: Introduction to SuperPro Designer for Material balance, Software for mass and energy balance; Energy Balance with and without reaction. **Metabolic Flux** Balance Analysis: Introduction, Principle of steady state metabolic flux balance analysis, COPASI, COBRA.

UNIT–IV	10Hrs.

Matlab and Simulink: MATLAB for data analysis Basics, Data analysis, curve fittings, Numerical integration, Euler and fourth order RungeKutta method, Simulation of gravity flow tank, SIMULINK for dynamic systems.

REFERENCE BOOKS

1. Luben W.L. “Process Modelling Simulation and Control for Chemical Engineers”, McGrawHill, International New York, 1990.
2. Franks RGE. “Mathematical Modeling in Chemical Engineering”, John Wiley and Sons, Inc., New York, 2004.
3. Biquette W.B. “Process Dynamics- Modeling analysis with simulation”, Prentice Hall; 1 edition January 15, 1998.
4. William J. Palm. “Introduction to Matlab 7 for Engineers”, III, McGraw Hill 2005.
5. Kenneth J. Beers. “Numerical Methods for Chemical Engineering Applications in MATLAB”, Massachusetts Institute of Technology, Cambridge University press 2007 edition.
6. http://www.mathworks.com

COURSE OUTCOMES

After completion of the course student will be able to

1. Analyse the biological and bioprocess data and make suitable interpretation of them.
2. Handle mathematical models.
3. Understand simulation software’s for bioprocess development.
4. Analyze using Matlab and Simulink.

Course Outcomes	Programme Outcomes											Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	PSO1	PSO2	PSO3
CO 1	2	2	2		3						3	2	3	
CO 2	2	2	2		3						3	2	3	
CO 3	2	1	1		3						3	2	3	
CO 4	2	3	2		3						3	2	3	

Course Code: 22UBT734E	BIOANALYTICAL TECHNIQUES	Credits 03
Hours/ Week : 03		CIE Marks : 50
Total Hours/Week : 3		SEE Marks : 50

UNIT – I	10 Hrs.

CENTRIFUGATION

Introduction: Basic, Types of centrifuges: Desktop, High Speed and Ultracentrifuge (Preparatory and Analytical), Design and their working principle, Types of Rotors, Wall-effect

SPECTROSCOPY :

(i) Absorption Spectroscopy

Simple theory of absorption of light by molecules, Chromophore and terminologies associated with absorption of molecules

The Beer-Lambert Law and its deviations

Single and double beam spectrophotometers for measuring Visible and Ultraviolet light: Instrumentation and Parameters measured in absorption Spectroscopy **(UV-Vis spectrophotometer)**

Empirical rule for the absorption spectra of biological macromolecules

Chemical Analysis by absorption spectroscopy using Visible and Ultraviolet light

(ii) Fluorescence Spectroscopy

Simple theory of Fluorescence

Instrumentation and Technology of Fluorescence Spectroscopy **(Fluorescence spectrometer)**

Intrinsic Fluorescence measurements for information about the conformation and binding sites of proteins

Extrinsic fluorescence measurements for information about the conformation and binding sites of proteins

UNIT – II	10 Hrs.

(iii) Infrared Spectroscopy

Infrared Spectroscopy: Basic Principle Instrumentation and Technology of Infrared Spectroscopy (Fourier-transform infrared spectroscopy (FTIR))

Information in Infrared Spectra and Applications of Infrared spectroscopy

(iv) Optical Rotatory Dispersion (ORD) & Circular Dichroism (CD)

Theory of Optical Rotatory Dispersion (ORD) & Circular Dichroism (CD)

Relative values of ORD and CD measurements, Advantages of CD over ORD

Instrumentation for measuring ORD and CD, Applications of ORD and CD

(v) Nuclear Magnetic Resonance (NMR) Spectroscopy

Nuclear Magnetic Resonance (NMR) Spectroscopy : Principle Basic Instrumentation of NMR Spectrometer

Applications of NMR Spectroscopy

(vi) Mass spectrometry

Mass spectrometry: Basic Principle Instrumentation and main components of mass spectrometers Ionization source, Mass analyzers, and Detectors **(LC-MS and GC-MS)**

Applications of Mass Spectrometry

UNIT – III	12Hrs.

CHROMATOGRAPHY

Adsorption Chromatography: Simple Theory & Types
Operations of columns : Terminologies and concept
Elution : Types of elution methods
Supports : Concept of mesh size and mesh screen
Gas Chromatography: Principle, Basic set up of Gas chromatography system, Detectors and Uses of Gas chromatography
Gel Chromatography (molecular-sieve chromatography): Simple Theory, Materials (dextran, agarose and polyacrylamide gels), Advantages of gel chromatography, Estimation of molecular weight and applications of gel chromatography
Ion-Exchange Chromatography: Principle, Properties of Ion Exchangers, Choice of Ion Exchangers, Technique and application of Ion Exchange chromatography.

High-Performance of Liquid Chromatography (HPLC): Principle, Application of pressure in HPLC, Advantages and uses of HPLC.
Affinity Chromatography: Principle, Methods of Ligand immobilization (Cyanogen-bromide-activated agarose, Aminoethyl- and hydrazide-activated polyacrylamide), uses of affinity chromatography

UNIT – IV **10 Hrs.**

ELECTROPHORESIS

Iso-electric focusing (IEF): Principle, Technique and application, 2-D PAGE: Steps involved in 2-D PAGE, application in proteomics
Pulse-field gel electrophoresis: Principle, Technique and Application
Capillary electrophoresis: Principle, Technique and Application

X-ray crystallography

Interaction of X-ray with matter: Absorption, Scattering and diffraction (Bragg' s Law)
Preparation of crystals : Hanging and sitting drop vapor diffusion methods
X-ray diffraction methods
Application of X-ray Diffraction in Crystal structure

REFERENCES BOOKS

1. Fundamentals of Bioanalytical Techniques And Instrumentation, Ghosal, Sabari, Avasthi, Anupama Sharma, Second Edition, Phi Learning Pvt. Ltd., 2018.
2. Bioanalytical Techniques, Abhilasha Shourie, Shilpa S. Chapadgaonkar, The Energy and Resources Institute, 2015
3. Biomolecular and Bioanalytical Techniques: Theory, Methodology and Applications, Vasudevan Ramesh, John Wiley & Sons Ltd, 2019
4. Handbook of Analytical Techniques, Helmut Günzler, Alex Williams, WILEY, 2001
5. Analytical Techniques in Biotechnology, Suzy Hill, Syrawood Publishing House, 2016
6. Analytical Techniques In Biotechnology, Goutam Bhowmik, Tata McGraw Hill Education Private Limited, 2010
7. Instrumental Methods of Chemical Analysis, G. R. Chatwal and A. K. Sham, 5th edition Himalaya Publishing House, 2005.
8. Instrumental Analysis, D. A. Skoog, F. J. Holler, S. R. Crouch, 11th edition, Brooks/Cole, a part of Cengage Learning, 2012.

COURSE OUTCOMES

After completion of the course student will be able to

1. Understand the basic concepts and principles of the major analytical techniques including instrumentation, sample preparation and standardization.
2. Evaluate the proper application of various analytical techniques for problem solving in biological sciences.
3. Demonstrate the ability to plan and execute experiments, and analyze and interpret the outcomes.
4. Design an analytical regimen to obtain data relevant to their research problem

Course Outcomes	Programme Outcomes											Programme Specific Outcomes		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**PSO1**	**PSO2**	**PSO3**
CO 1	3	3	3								2	2	1	
CO 2	2	3	3								2	2	1	
CO 3	3	3	3								1	2	1	
CO 4	3	3	3								1	2	1	

Course Code: 22UBT741E	NANOBIOTECHNOLOGY AND BIOMATERIALS	Credits: 03
Hours/ Week :L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	12 Hrs.

INTRODUCTION TO NANOTECHNOLOGY:

A Brief History of the Nano particles : Bottom-Up versus Top-Down; What Is Nanobiotechnology. Discussions on nanofabrication, nanolithography, nanotubes, buckyballs, structure-property relationships in materials, materials characterization techniques, scanning electron, scanning tunneling and atomic force microscopy(SEM,STM & AFM), biomolecule-surface interactions, quantum dots,

Applications of nanotechnology in the life sciences:

Buckyballs and Buckytubes, Diagnostics and Sensors, Drug Delivery Revenues Health Risks and Challenge.

UNIT–II	10 Hrs.

BIOPOLYMERS:

Polymers as biomaterials, microstructure, mechanical properties – effects of environment on elastic moduli,sterilization and disinfections of polymeric materials. Biocompatibility of polymers, chemically modified glycosaminoglycans, heparin like substances from nonglycosaminoglycan polysaccharides and microbial glycosaminoglycan, surface immobilized heparins.

UNIT–III	10 Hrs.

SYNTHETIC POLYMERS:

Polymers in biomedical use, polyethylene and polypropylene, perfluorinated polymers, acrylic polymers, hydrogels, polyurethanes, polyamides, biodegradable synthetic polymers, silicone rubber, plasma polymerization, micro-organisms in polymeric implants, polymer sterilization.

UNIT–IV	10 Hrs.

BIOCOMPATIBILITY:

Definition, Wound healing process-bone healing, tendon healing. Material response: Function and Degradation of materials in vivo. Host response: Tissue response to biomaterials . Testing of implants: Methods of test for biological performance-In vitro implant tests, In vivo implant test methods.

Medical devices:

Polyurethane elastomers, applications of polymers in medicine and surgery. Skin graft polymers, Properties of implant materials, metals and alloys.

REFERENCE BOOKS

1. B.Vishwanath (2011). " Nano Materials" Published by Narosa Publishing House Pvt. Ltd., New Delh.
2. Mark Ratner and Daniel Ratner (2003). "Nanotechnology:A Gentle Introduction to Next Gig Idea" Pearson Ecducation Ltd.
3. K Eric Drexler (1993). "Unbounding the future" Quill.
4. Stephen Lee and Lynn M Savage (2010). "Biological molecules in Nanotechnology".

COURSE OUTCOMES**

After completion of the course student will be able to

1. Identify the characterization techniques of nanotechnology.
2. Analyze the importance of nano-particles in drug delivery system.
3. Analyze the importance of biopolymers.
4. Differentiate biopolymer and synthetic polymer.
5. Know the importance of biocompatibility.
6. Apply the methods to test the implants and use in medical devices.

Course Outcomes	Programme Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**PSO1**	**PSO2**	**PSO3**
CO1	2	3	3	-	-	1	2	-	-	-	-	2	2	1
CO2	1	2	3	-	-	1	-	-	-	-	-	3	-	-
CO3	2	2	3	-	-	2	-	-	-	-	-	2	2	1
CO4	3	3	3	-	-	2	-	-	-	-	-	2	1	1
CO5	3	3	3	-	-	1	-	-	-	-	1	2	-	-
CO6	2	3	3	-		3	3	-	-	-		3	1	-

Course Code: 22UBT742E	FOOD PRODUCT DEVELOPMENT	Credits: 3
Hours/ Week :L: T: P – 3-0-0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	12 Hrs.

ESSENTIALS OF PRODUCT DEVELOPMENT

The product development process, privacy policies and *K*nowledge of basic laboratory procedures, Standard Operating Procedure (SOPs), process flows in manufacturing, product life cycle and competitor studies. Stability studies – Stability Testing of new Drug Substances and Products –types and stages of testing, Stress Testing, storage conditions. Manufacturing Process for Recombinant pharma Products. Production of pharmaceuticals by genetically engineered cells- hormones and vaccines. Approved Biotech Drugs.

UNIT–II	10 Hrs.

INTERPERSONAL SKILLS

Understand work output requirements, company policies, delivery of quality work on time and report any anticipated reasons for the delay, effective interpersonal communication, conflict-resolution techniques, importance of collaborative working, multi-tasking, training the team members, knowledge of project management.

UNIT–III	10 Hrs.

REPORTING AND FORMULATIONS

Reporting – power point presentations, technical writing, Principal investigator, communication with upstream and downstream teams.Problem Solving and Decision Making. Types of adverse drug reactions (ADR) and their treatment. Activity screening, formulations of energy drinks, bars, sports drinks, fortified products, geriatric products, veterinary products, immune boosters

UNIT–IV	10 Hrs.

SAFETY AND SECURITY AT WORKPLACE

Different types of occupational health hazards, knowledge of chemical substances -characteristics & safety measures. Use of safety gears, masks, gloves and accessories, evacuation procedures for workers and visitors. Health, safety and security issues – types (illness, fire accidents). Classification of dangerous materials with pictorial symbols, Safety in transportation of dangerous materials by road, rail, ships and pipelines. Safety in bulk storage of hazardous substances.

REFERENCE BOOKS

1. Endrenyi, L., Declerck, D. and Chow, S. (2017). Biosimilar Drug Product Development. Boca Raton: CRC Press.
2. Jain, N. (2011). Pharmaceutical product development. New Delhi: CBS Publishers

COURSE OUTCOMES

After completion of the course student will be able to

1. Analyze and apply the techniques and essentials of product development.
2. Identify the various techniques in Pharma industries.
3. Demonstrate the different interpersonal skills.
4. Demonstrate the methodologies and applications of Project development and management.
5. Comprehend various techniques involved in Reporting.
6. Describe the different formulations of various energy drinks
7. Analyse and list the various health hazards in industry.
8. Know importance of safety and implement in various Industries.

Course Outcomes	Programme Outcomes											Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	**PSO1**	**PSO2**	**PSO3**
CO 1		2	2	3	1			3	1		2	2	1	1
CO 2		2	2	3	3		2				3	2	1	
CO 3					2	3		2	3	3	3	2	1	1
CO 4		3	3	3	3	3	2	3	3	3	3	2	1	2
CO 5			3	3	3		2			2	3	2	1	
CO 6					2						3	2	1	
CO 7				2	3	3		3				2	1	
CO 8					2	3	3	3			2			

Course Code: 22UBT743E	CLINICAL RESEARCH	Credits: 03
Hours/ Week :L:T:P – 3:0:0		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hours

INTRODUCTION

The philosophy behind organization of research. Disease target identification and selection. Patenting new active substances. Receptor-based approaches, agonists, antagonists, enzyme inhibitors. Lead optimization and candidate selection of molecules for exploratory human investigation. In vitro and In vivo testing of new compounds Relationship between animal and human pharmacology.

CLINICAL PHARMACOLOGY

Pre-clinical development to support testing in humans. Safety testing, Pharmaceutical development -formulations, manufacture and supply of materials, labeling and presentation, stability and storage, purity, compatibility, disposal; Concepts of Pharmacovigilance.

UNIT–II	12 Hrs.

THERAPEUTICS

Clinical importance of Therapeutic Proteins, Antibodies, Enzymes; Hormones and Growth Factors, Interferon's, Interleukins and Additional Regulatory Factors.

MANAGEMENT OF DRUGS

Management of common acute and chronic diseases. Major drug classes including biologicals. Measurement of drug effects Adverse drug reactions (short term & long term). Benefit and risk, Drug interactions; Prescribing for particular populations . Controlled drugs and drug dependence, Over dosage and treatment of poisoning. Patient compliance and information, Therapeutic Drug Monitoring.

UNIT–III	10 Hrs.

HEALTHCARE MARKETPLACE

National and local formularies. Product information (Generic v/s Rx), advertising and claims Product support and promotion Product life-cycle management Product liability Codes of practice including the MHRA Blue Principles of health economics Pharmacoepidemiology Competition, in-licensing, co-marketing.

SOCIAL, ETHICAL ISSUES

patents and copyrights. Social-genetic discrimination: insurance and employment, human cloning, foeticide, sex determination. Ethical: somatic and germ line gene therapy, clinical trials, the right to information, ethics committee function. Preservation and clinical use of blood and blood components.

UNIT–IV	10 Hrs.

CLINICAL RESEARCH

Types of Epidemiology study designs, ecological (correlation) studies, Case reports and case series, prevalence surveys or cross-sectional studies, case control studies, Clinical Trials, Small Clinical Trials, Placebo Responses in Clinical Trials, Large Clinical Trials and Registries – Clinical Research Institutes, Data **Management in Clinical Research:** General Principles and Guide to Sources, Clinical Research from Pharmaceutical Industry Perspective.

REFERENCE BOOKS

1. Gary Walsh., Biochemistry and Biotechnology, 2002, John Wiley & Sons Ltd.
2. Gallin and . J. I. Ognibene F. P, 2007 Principles and Practice of Clinical Research by, 2nd Edition, Elsevier Publication. ,
3. William J. Williams, Ernest Beutler, Allan JU. Erslev, Marshall A. Lichtman,2005, Hematology,
4. John Wiley & Sons Ltd by Arunabha Ray & Kavitha Gulati, 2007,Current Trends in Pharmacology IK Intl.

COURSE OUTCOMES

After completion of the course student will be able to

1. Exploit the knowledge to know the clinical importance of different therapeutic products
2. Identify the formulations, manufacturing and supply of materials

3. Study the philosophy behind organization of research Ability to understand control measures uised in drug and its control
4. Elucidate the marketing strategies of pharma products
5. Compare the social and ethical issues
6. Inculcate the epidemiology study designs, case reports and case series

Course Outcomes	Programme Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**PSO1**	**PSO2**	**PSO3**
CO1	1	3	3	-	2	-	2	1	-	-	2	2	2	1
CO2	1	2	3	-	1	-	2	1	-	-	3	3	1	1
CO3	1	2	3	-	2	-	2		-	-	3	2	2	1
CO4	1	3	3	-	1	-	1	1	-	-	2	2	1	1
CO5	1	3	3	-	-	-	-	-	-	-	1	2	3	
CO6	1	3	3	-	1	-	2	-	-	-	3	3	3	3

Course Code: 22UBT744E	PHARMACEUTICAL BT	Credits: 03
Hours/ Week :3:0:0 - N_L : N_T: N_P		CIE Marks: 50
Total Hours/Week: 03		SEE Marks: 50

UNIT-I	10 Hrs.

INTRODUCTION:

Introduction to Pharmaceutical Biotechnology, History of Pharmaceutical Industry. Drug discovery and development process, Fundamental principles and processes involved in preclinical and clinical development of a chemical or biological entity. Orphan drugs, Provisions for and use of unlicensed medicines, Drug abuse and dependence, Prescriptional and Non-prescriptional drugs.

DRUG METABOLISM:

Evolution of Drug Metabolism as a Science, Phase I Metabolism (microsomal oxidation, Reduction, Hydrolysis), Phase II Metabolism (Drug conjugation reactions). Pharmacodynamics and Pharmacokinetics of drugs.

UNIT–II	12 Hrs.

TOXICOLOGY:

Branches of Toxicology-In vivo toxicity tests- Acute, Sub acute and chronic toxicity tests.

MANUFACTURING PRINCIPLES AND FORMULATIONS:

Tablets-Types of tablets, Role and composition of tablets, Preformulation of tablets-organoleptic, solubility, flowability, bulk and tap density, evaluation of tablets-weight variation test, hardness, disintegration, and friability. Preparation of tablets- Wet and Dry Granulation method and compression method, Tablet coating and its applications, Parental preparations, herbal extracts, Oral liquids, Ointments, Quality control, storage and stability of biotech products. Short study of current biotech products. Adverse drug reactions.

UNIT–III	10 Hrs.

BIOSIMILARS:

Biosimilars- Key Characteristics of Biosimilars, Therapeutics Based on Biotechnology- Hematopoietic growth factor and Tissue plasminogen activators, Interferons and Hepatitis B vaccine.

STEM CELLS AND TISSUE ENGINEERING:

stem cells-types of stem cells, embryonic stem cells, adult stem cells ,Tissue engineering, Cells as Therapeutic Agents for tissue defects, artificial liver and pancreas.

DRUG DELIVERY SYSTEM:

Delivery of biopharmaceuticals-Use of Artificial Intelligence in drug delivery, Advanced drug Delivery Systems-Liposomes,Nanoparticles based Drug Delivery System, Hydrogel based Drug Delivery System.

UNIT–IV	10 Hrs.

ANALYSIS OF BIOLOGICALS & PHARMACEUTICALS:

Vitamins, Cold remedies, Laxatives, Analgesics, NSAID, Antiseptics, Antacids, Antibiotics and Biologicals. Packaging techniques – Glass containers, plastic containers, film wrappers and bottle seals.

ADVANCED PHARMACOLOGY:

Introduction to pharmaceutical chemistry, classification of drugs based on therapeutic actions using suitable examples. Antineoplastic agents, Immunomodulators, Heavy metals and heavy metal antagonists, Therapeutic gases. Free radical biology and antioxidants.

REFERENCE BOOKS

1. Gary Walsh, (2013),Biopharmaceuticals Biochemistry and Biotechnology (2nd Edition), Wiley Publishers.
2. Bartram Katzung, (2009),Basic & Clinical Pharmacology(9th Edition), McGrawHill.
3. Leon Lachman, Herbert. Lieberman & Joseph Kanig, Vergese, (1987) The Theory & Practice of Industrial Pharmacy, (3rd Edition) Publishing House Bombay.

COURSE OUTCOMES

After completion of the course student will be able to

1. Apply the basics of biology in drug discovery, drug formulation and analyze the Pharmacokinetics and Pharmacodynamics parameters of drugs along with drug metabolism in drug development.
2. Select and apply the knowledge of the techniques used in the manufacture of pharmaceutical products in the field of Biopharmaceuticals.
3. Select and apply appropriate techniques and advanced techniques in drug delivery system and understand the role of biotherapeutics and stem cells in Biopharmaceuticals.
4. Demonstrate an ability to apply principles of Pharmaceutical Biotechnology to protect the global community from various dreadful diseases.

Course Outcomes	**Programme Outcomes (POs)**											**Program Specific Outcomes (PSOs)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
CO1	2	3	2	2	2	3	1	-	-	1	3	3	3	2
CO2	2	2	2	2	3	3	2	-	-	2	2	3	3	2
CO3	2	3	3	2	3	3	2	-	-	2	3	3	3	3
CO4	2	3	3	1	2	3	3	-	-	2	2	3	3	3

22UBT704L	UPSTREAM PROCESS & BIOSEPARATION TECHNIQUES LAB	Credits 01
L:T:P **(0:0:2)**		CIE Marks: 50
Total Hours/Week: 02		SEE Marks: 50

LIST OF EXPERIMENTS

1. Microbial Growth kinetics and Estimation of Monod parameters in Batch Bioreactor/Batch culture.
2. Production and estimation of citric acid from *Aspergillus niger*.
3. Preparation and production of ethanol in fermenter: Study of growth, product formation, and substrate utilization.
4. Bioprocess Modeling using SuperPro Designer: Flow sheeting of the Bioprocess using SuperPro Designer, Design of various Bioreactors using SuperPro Designer.
5. Solid-liquid separation method: Removal of Intracellular Proteins by cell disruption methods.
6. Solid-liquid separation method: Separation of biomass and extracellular components by Filtration (Cross flow) and Centrifugation.
7. Product enrichment operations: Precipitation of a bioproducts from crude solution or the extract.
8. Product enrichment operations: Liquid-liquid and Aqueous two – phase extraction of bio products from biological sources.
9. Extraction and estimation of bioactive compounds from natural sources.
10. Lyophilization of any bioproduct
11. Analysis of biomolecules/bioactive compounds by HPLC / GC

REFERENCE BOOKS

1. Protein Purification by Scopes R.K., IRL Press, 1993.
2. Rate controlled separations by Wankat P.C., Elsevier, 1990
3. Bioseparations by Belter P.A. and Cussier E., Wiley, 1985.
4. Bio-separations Science & Engineering By Roger G Harrison, Paul Todd, Scott R Rudge, Demetri.
5. Product Recovery in Bioprocess Technology - BIOTOL Series, VCH, 1990
6. Separation processes in Biotechnology by Asenjo J. and Dekker M. 1993

COURSE OUTCOMES

After completion of the course, students will be able to

1. Design and optimize bio-manufacturing processes based on measured bioprocess parameters
2. Utilize basic principles of bioprocess operations for process development.
3. Analyze the product both quantitative/qualitatively and observe/record the experimental data and interpret them in the graphical/tabular form.
4. Competent to handle fermenter and maintain the fermentation process for specific application.

Course Outcomes	Programme Outcomes											Programme Specific Outcomes		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**PSO1**	**PSO2**	**PSO3**
CO 1	1	3	3	2	2	1	-	-	-	-	1	2	3	1
CO 2	1	3	3	2	2	1	-	-	-	-	1	2	3	1
CO 3	2	3	3	2	2	1	-	-	-	-	1	2	3	1
CO 4	2	3	3	2	2	1	-	-	-	-	1	2	3	1

B. E. VIII SEMESTER
2025-26

Sl. No.	Category	Subject Code	Subject Title	Credits	Hours/ Week			SAAE/Sem		Examination Marks				Contact hour per sem
					L	T	P	Study Hours	Assignment/ Quiz/ MCQs	Duration in hours	CIE	SEE	TOTAL	
1.	AEC	22UBT0XXO	MOOCs*	03	3	0	0	42	6	3	50	50	100	90
2.	OEC	22UBT0XXO	MOOCs*	03	3	0	0	42	6	3	50	50	100	90
3.	INT	22UBT801I	Industrial Internship	10	0	0	20	-	-	3	50	50	100	280
Total				**16**	**6**	**0**	**20**				**150**	**150**	**300**	