DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY LUCKNOW

STUDY, EVALUATION SCHEME & SYLLABUS

For

B.TECH. 3RD YEAR

(BIOTECHNOLOGY)

Based on

AICTE MODEL CURRICULUM

(EFFECTIVE FROM THE SESSION: 2020-21)

DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY, LUCKNOW
B.TECH III YEAR V SEMESTER BIOTECHNOLOGY

			SEMESTER- V							**SESSION2020-21**			
Sl. No	**Subject Codes**	**Subject**	**Periods**			**Evaluation Scheme**				**End Semester**		**Total**	**Credit**
			L	**T**	**P**	**CT**	**TA**	**Total**	**PS**	**TE**	**PE**		
1	KBT 501	**Genetic Engineering**	3	1	0	30	20	50		100		150	4
2	KBT 502	**Fermentation Biotechnology**	3	1	0	30	20	50		100		150	4
3	KBT 503	**Bioinformatics I**	3	1	0	30	20	50		100		150	4
4	KBT 051-054	Departmental Elective-I	3	0	0	30	20	50		100		150	3
5	KBT 055-058	Departmental Elective-II	3	0	0	30	20	50		100		150	3
6	KBT 551	**Genetic Engineering lab**	0	0	2				25		25	50	1
7	KBT 552	Fermentation Technology Lab	0	0	2				25		25	50	1
8	KBT 553	**Bioinformatics- I virtual lab**	0	0	2				25		25	50	1
9		Mini Project or Internship Assessment*	0	0	2				50			50	1
10	KNC501/ KNC502	Constitution of India, Law and Engineering / Indian Tradition, Culture and Society	2	0	0	15	10	25		50			
11		MOOCs (Essential for Hons. Degree)											
		Total	**17**	**3**	**8**							**950**	**22**

*****The Mini Project or internship (4 weeks) conducted during summer break after IV semester and will be assessed during V semester.

DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY, LUCKNOW
B.TECH III YEAR VI SEMESTER BIOTECHNOLOGY

SEMESTER-VI												SESSION2020-21	
Sl. No	**Subject Codes**	**Subject**	**Periods**			**Evaluation Scheme**				**End Semester**		**Total**	**Credit**
			L	**T**	**P**	**CT**	**TA**	**Total**	**PS**	**TE**	**PE**		
1	KBT-601	**Bioprocess Engineering -II**	3	1	0	30	20	50		100		150	4
2	KBT-602	**Plant Biotechnology**	3	1	0	30	20	50		100		150	4
3	KBT-603	**Bioinformatics -II**	3	1	0	30	20	50		100		150	4
4	KBT-061 To 064	**Departmental Elective-III**	3	0	0	30	20	50		100		150	3
5		**Open Elective-I**	3	0	0	30	20	50		100		150	3
6	KBT-651	**Bioprocess Engineering –II Lab**	0	0	2				25		25	50	1
7	KBT-652	**Plant Biotechnology Lab**	0	0	2				25		25	50	1
8	KBT-653	**Bioinformatics-II Lab**	0	0	2				25		25	50	1
9	KNC601/ KNC602	**Constitution of India, Law and Engineering / Indian Tradition, Culture and Society**	2	0	0	15	10	25		50			
10		**MOOCs (Essential for Hons. Degree)**											
		Total	**0**	**3**	**6**							**900**	**21**

DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY, LUCKNOW
B.TECH III YEAR BIOTECHNOLOGY

(DEPARTMENT ELECTIVE SUBJECTS)

DEPARTDEPARTMENTAL ELECTIVES -I

KBT051: Pharmaceutical Biotechnology
KBT052: Nano Biotechnology
KBT053: Biomedical Instrumentation
KBT054: Metabolic Engineering

DEPARTMENTAL ELECTIVES - II

KBT-055: Biofuels and alcohol technology
KBT-056: Descriptive Statistics & Process Control
KBT-057: 3-D Printing
KBT-058: Molecular modelling and drug design

DEPARTMENTAL ELECTIVES – III

KBT-061: Animal Biotechnology
KBT-062: Biomarker & Diagnostics
KBT-063: Food Biotechnology
KBT-064: Entrepreneurship in Biotechnology

DR. A.P. J ABDUL KALAM TECHNICAL UNIVERSITY, LUCKNOW

B.TECH. III YEAR V SEMESTER BIOTECHNOLOGY

SUBJECT CODE: KBT 501	**COURSE TITLE: GENETIC ENGINEERING**
EXAM DURATION: 3 HOURS	**SEMESTER: V (ODD)**
L: T: P :: 3 : 1: 0 CREDITS: 4	**PREREQUISITE: Knowledge of Molecular Biology**

OBJECTIVE:

- To Provide knowledge of manipulation of Genetic Material and Recombinant Technology
- To teach the construction of genomic c-DNA libraries, cloning and strain improvement
- To develop understanding of DNA sequencing, Molecular markers and related techniques.
- Application of Genetic Engineering and its application
- To impart knowledge of cell signaling and Ethical issues

COURSE OUTCOME:

On successful completion of the course, the student will be able to:

- To be able to appraise the appropriate use of host and vector for gene cloning
- Identification of appropriate method for DNA delivery into the host
- Use of gene library for screening of desired gene sequence/protein
- Cloning process of whole organism and its application
- Process of recombinant protein expression, cell signaling and ethical issues related to Gene transfer

REFERENCE BOOKS:

S. NO.	NAME OF AUTHORS/BOOKS/PUBLISHERS	YEAR OF PUBLICATION/ REPRINT
1.	T.A Brown (2006). Gene cloning and DNA analysis, WILEY-BLACKWELL	2006
2.	Molecular Biology of the Cell by Bruce Alberts.6th edition	2014
3.	Molecular Cloning, A laboratory Manual. Sambrook, J., Fritsch, E.F., Mariatis.3rd edition (Vol.1,2,3)	2001
4.	S.B Primrose (2001). Molecular biotechnology.Panima Publishing corporation, 2ndedition	2001
5.	Genetic Engineering by Dr Smita Rastogi & Dr Neelam Pathak, Oxford University Press	2009

COURSE DETAILS: GENETIC ENGINEERING

UNITS	CONTENTS	LECTURE HOURS
I	Manipulation of DNA – Restriction and Modification enzymes, Design of linkers and adaptors. Characteristics of cloning and expression vectors based on plasmid and bacteriophage, Vectors for yeast, insect and mammalian systems, Prokaryotic and eukaryotic expression host systems, Tissue specific promoter, wound inducible promoters, Strong and regulatable promoters, promoter analysis (EMSA and DNA footprinting); Introduction of recombinant DNA in to host cells and selection methods.	**8**
II	Construction of genomic and cDNA libraries, Artificial chromosomes – BACs and YACs, Chromosome walking, Screening of DNA libraries using nucleic acid probes and antisera.;cloning of insulin gene and other genes of commercial interest, strain improvement of industrially important organisms.	**8**
III	Maxam Gilbert's and Sanger Coulson's and automated methods of DNA sequencing, Inverse PCR, Nested PCR, AFLP-PCR, Allele specific PCR, Assembly PCR, Asymmetric PCR, Hot start PCR, Colony PCR, single cell PCR, Real-time PCR/qPCR – SYBR green assay, Taqman assay, Molecular beacons, Applications of PCR; Site directed mutagenesis.; molecular markers (RAPD, RFLP, AFLP, SNP)	**8**
IV	Applications of genetic engineering; Creation of recombinant microorganisms, transgenic plants and animals; cloning of sheep (Dolly) & other mammals; applications in conservation; therapeutic vs. reproductive cloning; ethical issues and the prospects for human cloning; Gene therapy; DNA drugs and vaccines.	**8**
V	Basic concepts of cell signaling, Extracellular signal molecule and their receptors, Operation ofSignaling molecules over various distances, Cellular response to specific combinations of extracellular signal molecules; Nuclear receptor; Ion channel linked, G-protein mediated receptors,Relay of signal by activated cell surface receptors via intracellular signaling proteins, IntracellularSignaling proteins as molecular switches.	**8**
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DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY, LUCKNOW
B.TECH III YEAR V SEMESTER BIOTECHNOLOGY

SUBJECT CODE: KBT 502	**COURSE TITLE: Fermentation Biotechnology**
EXAM DURATION: 3 HOURS	**SEMESTER : V (ODD)**
L: T: P :: 3 : 1:0 CREDITS: 4	**PRE REQUISITES: Knowledge of elementary microbiology and basic bioprocessing**

OBJECTIVE:

- To provide knowledge of fermentation technology and its industrial application.
- To teach the inoculums development, microbial kinetics and its measurement.
- To develop understanding of media component, sterilization and types of fermentation processes.
- To provide knowledge of regulation, control and overproduction of metabolites.
- To impart knowledge related to production and application metabolites.

COURSE OUTCOME:

After successful completion of the course the students will be able to:

- Understanding of the concepts and process technologies of fermentation.
- Application and use of different raw materials and its use in industrial scale production.
- Regulatory system in the microorganism.
- Strain improvement technologies and its role in Fermentation.
- Concepts of the scale up and scale down criteria of fermentation process and production of metabolites

REFERENCE BOOKS

S.NO	NAME OF AUTHORS/BOOKS /PUBLISHERS	YEAR OF PUBLICATION/ REPRINT
1	Murray Moo -Young , Comprehensive Biotechnology, Vol. 1 & III-latest ed.	2011
2	Principles of Fermentation Technology-Whitaker & Stanbury	1984
3	Industrial Fermentations-Leland, N. Y. Chemical Publishers.	1954
4	Prescott and Dunn's-Industrial Microbiology, 4 th, ed.	1959
5	Biotechnology Series, Rehm, Reed &Weinheim, Verlag-Chemie.	2001

COURSE DETAILS Fermentation Biotechnology		
UNITS	**CONTENTS**	**LECTURE HOURS**
I	Introduction to fermentation technology: Interaction between Bio-chemical engineering, Microbiology and Biochemistry. History and development of fermentation industry: Microbial culture selection for fermentation processes, Strain development; Preservation and improvement of industrially important microorganisms.	**8**
II	Inoculum development for industrial fermentation & Microbial Kinetics: Introduction, Criteria for transfer of inoculum, development of inocula for bacterial processes, yeast processes and mycelial processes. Inoculum development for plant fermenter, aseptic method of inoculation, achievement and maintenance of aseptic conditions. Fermentation Material and Energy balance, Microbial growth kinetics: Microbial growth cycle, measurement of growth, Batch culture, continuous culture, fed-batch culture, applications and examples.	**9**
III	Media ingredients, medium formulation, oxygen requirements, antifoams, medium optimization, Media sterilization, Batch Process (thermal death kinetics), continuous sterilization process; sterilization of fermenter and other ancillaries, filter sterilization of air and media.	**9**
IV	Different regulatory mechanisms involved in controlling the catabolic and anabolic processes of microbes. Induction, nutritional repression, carbon catabolite repression, crabtree effect, feedback inhibition and feedback repression;Concept for overproduction ofprimary and secondary metabolites.	**8**
V	Details of the process, parameters and materials -for the industrial manufacture of Antibiotics (β-lactum), Solvents (acetone) Amino acid (Lysine), Organic acids (Citric acid), Alcohols (Ethanol), Ind. Enzymes (Protease/Amylase) and Biopharmaceuticals (Insulin/Interferon etc.)-Microbial Transformations, Microbial leaching.	**8**
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DR. A.P. J ABDUL KALAM TECHNICAL UNIVERSITY, LUCKNOW

B.TECH. III YEAR V SEMESTER BIOTECHNOLOGY

SUBJECT CODE: KBT 503	**COURSE TITLE: Bioinformatics-I**
EXAM DURATION: 3 HOURS	**SEMESTER: V (ODD)**
L: T: P :: 3 : 1: 0 CREDITS:4	**PRE-REQUISITE: Elementary knowledge of Molecular Biology, Mathematics and Computer**

OBJECTIVE:

- To teach the basic concept of Bioinformatics, databases and sequence analysis
- To develop understanding of sequence analysis
- To provide knowledge of scoring matrix and detection of functional sites etc.
- To impart knowledge related to phylogenetic analysis protein structure predicvtion

COURSE OUTCOME:

On completion of this course, the students will be able to:

- Understand concepts and application of Bioinformatics, types of databases, sequence similarity, sequence patterns and profiles
- Use sequence alignment techniques, database searching, pairwise and multiple sequence alignment using various tools.
- Understand scoring matrices and its types including PAM , BLOSUM series and matrices for nucleic acid and protein sequences.
- Apply phylogeny and its concepts in molecular evolution and different methods of Phylogenetic tree construction
- Understand and apply the protein structure prediction and application of bioinformatics in drug designing

REFERENCE BOOKS:

S. NO	NAME OF AUTHORS / BOOKS / PUBLISHERS	YEAR OF PUBLICATION/ REPRINT
1.	D.W.Mount; Bioinformatics-Sequence and genome analysis; Cold Spring HarbourLab press.	2001
2.	B.N.Mishra; Bioinformatics: Concept and application, Pearson Education (in press)	2020
3.	O' Reilly; Developing Bioinformatics computer skills-1stIndian edition, SPD publication.	2001
4.	Anthony J.F. Griffiths et al; An introduction to genetic analysis, 1stEd	1976
5.	Michael Starkey and Ramnath Elaswarapu; Genomics protocols, Humana press	2001

COURSE DETAILS Bioinformatics-I**:**

UNITS	CONTENTS	LECTURE HOURS
I	Introduction to Bioinformatics; Biological databases: Nucleotide databases, Protein databases, Specialized databases; Laboratory data submission and data retrieval; Various file formats for biomolecular sequences: Genbank, EMBL, FASTA, GCG, msf, nbrf-pir etc.; Basic concepts of sequence similarity: identity and homology, definitions of homologues, orthologues, paralogues; Sequence patterns and profiles	**8**
II	Sequence Alignment And Database Searching: Introduction, Evolutionary Basis of Sequence Alignment, Optimal alignment method, Statistical Significance of Alignment. Database searching Artifacts; Database similarity searching: FASTA, BLAST, Various versions of basic BLAST and FASTA, Advance version of BLAST: PHI-BLAST and profile-based database searches using PSIBLAST; Multiple sequence alignment: progressive method and Iterative method; Applications of pairwise and multiple sequence alignment; Tools for multiple sequence alignment: CLUSTALW and Pileup (Algorithmic concepts).	**7**
III	Scoring Matrices: Basic concept of a scoring matrix, Similarity and distance matrix, Substitution matrices: Matrices for nucleic acid and proteins sequences, PAM and BLOSUM series, Principles based on which these matrices are derived and Gap Penalty; Predictive Method using Nucleotide Sequence: Introduction, Marking repetitive DNA, Database search, Codon bias detection, detecting functional site in DNA.	**7**
IV	Phylogenetics: Phylogeny and concepts in molecular evolution; nature of data used in taxonomy and phylogeny; definition and description of Phylogenetic trees and various types of trees; Different methods of Phylogenetic tree construction: UPGMA and Fitch-Margoliash Algorithm; case studies in phylogenetic sequence analysis.	**8**
V	Protein identification based on composition, Physical properties based on sequence, Motif and pattern, Secondary structure (Statistical method: Chou Fasman and GOR method, Neural Network and Nearest neighbor method) and folding classes, specialized structure or features, Tertiary structures (Homology Modeling); Structure visualization methods (RASMOL, CHIME etc.); Protein Structure alignment and analysis. Application of bioinformatics in drug discovery and drug designing.	**10**
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DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY, LUCKNOW
B.TECH III YEAR V SEMESTER BIOTECHNOLOGY

SUBJECT CODE: KBT 051	**COURSE TITLE: Pharmaceutical Biotechnology**
EXAM DURATION: 3 HOURS	**SEMESTER : V (ODD)**
L: T: P :: 3 : 0: 0 CREDITS:3	**PREREQUISITES: Basic knowledge of Molecular Biology, Biochemistry**

OBJECTIVES:

- To teach the basic concept of Pharmaceutical products and other therapeutic agents
- To develop understanding of drug manufacturing process, storage packaging and storage of APIs
- To provide knowledge of regulatory knowledge , approval of new drug and economics of drug development
- To develop understanding of marketing, regulation and control and scope of pharmaceutical industry

COURSE OUTCOME:

On completion of this course, the students will be able to:

- Understand concepts and application of pharmaceutical industry,Therapeutic agents, biopharmaceuticals.
- Understand the process off drug manufacturing, processing, preservation, analytical methods and quality management.
- Apply the knowledge of new drug development, GMP and Economics of drug development in pharma industry
- Use knowledge of Drug regulation and control. Scope and applications of biotechnology in pharmacy.

REFERENCE BOOKS

S.NO	**NAME OF AUTHORS/BOOKS /PUBLISHERS**	**YEAROF PUBLICATION/ REPRINT**
1.	Walsh, G., Biopharmaceuticals: Biochemistry and Biotechnology, Wiley (1998).	1988
2.	Leon Lachman et al :Theory and Practice of Industrial Pharmacy, 3 Edition, Lea and Febiger, 1986	1986
3.	Remington's Pharmaceutical Science, Mark Publishing and Co	1971

COURSE DETAILS: Pharmaceutical Biotechnology		
UNITS	**CONTENTS**	**LECTURE HOURS**
I	Introduction to drugs and pharmacy: An overview and history of pharmaceutical industry. Introduction: Therapeutic categories such as Analgesics, Anticancer, Antiviral, Anticoagulant, Analgesics, Antibiotics, Use of therapeuticagents, Biopharmaceuticals.	**5**
II	Bulk drug manufacturers, Type of reactions in bulk drug manufacture and processes. Specialrequirement for bulk drug manufacture.	**3**
III	Compressed table, wet granulation-dry granulation or slugging-direct compression-tablet presses,coating of tablets, capsules, sustained action dosage forms-parental solution-oral liquidsinjections-ointment-topical applications, Preservation, analytical methods and test for variousdrug and pharmaceuticals, packing-packing techniques, quality management.	**15**
IV	New drug development and approval process: Strategies for new drug discovery, finding a lead compound, combinatorial approaches to new drug discovery, pre-clinical and clinical trials, GMP, Economics of drug development.	**9**
V	The business and the future of Biopharmaceuticals. Drug regulation and control.Scope and applications of biotechnology in pharmacy.	**10**
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B.TECH. III YEAR V SEMESTER BIOTECHNOLOGY

SUBJECT CODE: KBT 052	**COURSE TITTLE: Nano Biotechnology**
EXAM DURATION: 3 HOURS	**SEMESTER: V (ODD)**
L: T: P :: 3 : 0: 0 CREDITS: 3	**PREREQUISITE: Basic knowledge of Chemistry and Analytical Techniques.**

OBJECTIVE:

- To teach the concept of nanobiotechnology and nanofabrication techniques.
- To develop understanding synthesis of metallic nanoparticles.
- To provide knowledge of biological synthesis of nanoparticles
- To teach the analytical techniques used in nanotechnology and its application in characterization of nanomataterials of biomedical importance

COURSE OUTCOME:

On completion of this course, the students will be able to:

- Explain and demonstrate the basics of nanoscience, nanobiotechnology and its techniques.
- Understand the synthesise of metal nanoparticles by chemical process.
- Perform the biological synthesis of metal nanoparticles.
- Estimate the toxicity, antibacterial property of metal nanoparticles.
- Understand the synthesize the carbon nanotubes from carbon source
- Explain the nano characterization tools and techniques

REFERENCE BOOKS:

S. NO.	Name of Authors/Books/Publishers	Year of Publication/ Reprint
1.	Nanotechnology by Mark Ratner and Daniel Ratner, Pearson Education.	2003
2.	Guozhong Cao ,"Nanostructures and Nanomaterials , synthesis , properties and applications" , Imperial College Press ,2004.	2004
3.	Hari Singh Nalwa, "Nanostructured Materials and Nanotechnology", Academic Press,2002	2001
4.	Microfabrication and Nanomanufacturing- Mark James Jackson.	2018
5.	MEMS and Nanotechnology – Based sensors and devices communication, Medical and Aerospace applications - A.R.Jha.	2008
6.	Drug Delivery: Engineering Principles for Drug Therapy, M. Salzman,	2001

COURSE DETAILS: Nano Biotechnology

UNITS	CONTENTS	LECTURE HOURS
I	Nanobiotechnology, History, Origin, Fundamental Concepts, Bottom-up versus Top-down approaches, Discussion on Micro and Nanofabrication, Current research, Tool and Techniques,Applications and Implications and Nanofabrication.	**7**
II	Carbon nanotubes and related structures, Properties, Synthesis, Applications, Metal nanoparticles types and their synthesis, Application of Gold, Silver and Zinc oxide nanoparticles and Nano chemicals.	**7**
III	Atomic force microscopy (AFM), Scanning tunneling microscopy (STM), improved nanodiagnostic devices, Drug delivery tools through nanotechnology	**7**
IV	Synthesis and characterization of different classes of biomedical polymers- their uses inpharmaceutical, cardiovascular ophthalmologic orthopedic areas.	**7**
V	Micro and Nano biosensor, Bioavailability, Nanoimaging agents, Tumor Targeting through nanotechnology, Quantam dots technology and its applications	**7**
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B.TECH. III YEAR V SEMESTER BIOTECHNOLOGY

SUBJECT CODE: KBT 053	**COURSE TITTLE: Biomedical Instrumentation**
EXAM DURATION: 3 HOURS	**SEMESTER: V (ODD)**
L: T: P :: 3 : 0: 0 CREDITS:3	**PREREQUISITE: Basic knowledge of Analytical Techniques.**

OBJECTIVES:

- To teach the concept and application of Biomedical instrumentation
- To develop understanding of biomedical instruments and its process involved in cardiovascular measurements.
- To provide knowledge non invasive diagnostic instrumentation, ultrasonic measurement and biotelemetry etc.
- To teach the instruments involved in clinical laboratory, biomedical instruments in surgery and medical imaging

COURSE OUTCOME:

On completion of this course, the students will be able to:

- Explain and demonstrate the instrumentation involved in biomedicals.
- Understand the working and application of plethymography, electrocardiography and pacemakers etc.
- Explain the ultrasonic measurements, biotelemetry and other related instrumentation.
- Applications of Instrumentation for the clinical laboratory .
- Explain the Medical Imaging equipments and electrical safety of medical equipments

REFERENCE BOOKS:

S. NO.	Name of Authors/Books/Publishers	Year of Publication/Reprint
1.	Biomedical Instrumentation and Measurement by Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer	1973
2.	Biomedical Instrumentation: Technology and Applications by Raghbir Singh	2004
3.	Medical Instrumentation for Health Care by Leslie Cromwell	1976
4.	Analysis and Application of Analog Electronic Circuits to Biomedical Instrumentation by Robert B. Northrop	2012
5.	Introduction to Bioinstrumentation: With Biological, Environmental, and Medical Application by Clifford D. Ferris.	1978

COURSE DETAILS: Biomedical Instrumentation

UNITS	CONTENTS	LECTURE HOURS
I	History and development of biomedical instrumentation, biometrics, Basic transducer principles: active and passive transducers, tranducers for biomedical applications; origin of biopotential and its propagation, sources of bioelectric potentials, electrocardiogram, electro encephalogram, electromayogram and other bioelectric potentials. Biopotential Electrodes: types of electrodessurface, needle and microelectrodes, biochemical tranducers.	**9**
II	The Cardiovascular system, Cardiovascular measurements: electrocardiography, measurement of blood pressure, measurement of blood flow and cardiac output, plethymography, measurement of heart sounds; Patient care and monitoring: elements of intensive care unit, pacemakers and defibrillators ,Measurements in the respiratory system: mechanics of breathing, gas exchange and distribution, respiratory therapy equipment.	**6**
III	Non-invasive diagnostic instrumentation: Temperature measurements ultrasonic measurements, the nervous system and neuronal communication measurement in nervous systems,Instrumentation for sensory measurements and the study of behaviors, pshycophysiological measurements, Biotelemetry.	**7**
IV	Instrumentation for the clinical laboratory, Automation of chemical tests, Biomedical instruments for surgery, Haemodialysis machines. X-ray machines and digital radiography.	**6**
V	Medical Imaging equipments, the computer in biomedical instrumentation and applications, microprocessors, Electrical safety of medical equipment, physiological effects of electric current.	**7**
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B.TECH III YEAR V SEMESTER BIOTECHNOLOGY

SUBJECT CODE: KBT 054	**COURSETITLE: Metabolic Engineering**
EXAM DURATION: 3 HOURS	**SEMESTER : V (ODD)**
L : T : P :: 3 : 0: 0 CREDITS: 3	**PRE REQUISITES: Basic knowledge of Biochemistry**

OBJECTIVES:

- To teach the concept and application of metabolic engineering
- To develop understanding metabolites production in different pathways and regulatory mechanism.
- To provide knowledge biosynthesis of metabolites
- To teach the bioconversions, product inhibition and factors affecting bioconversions.
- Concepts of regulation of enzyme production and metabolic pathway manipulations

COURSE OUTCOME:

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

- Explain basic concepts of metabolism and importance of metabolic engineering
- Understand the production of metabolites and its regulatory mechanism
- Explain the applications, specificity and product inhibition of bioconversion.
- Regulation of enzyme production and strain imrovement

REFERENCE BOOKS

S.NO	NAME OF AUTHORS/BOOKS /PUBLISHERS	YEAROF PUBLICATION/ REPRINT
1.	G. Stephanopoulos, A. Aristidou and J. Nielsen, Metabolic Engineering Principles and Methodologies, Academic Press, 1998	1998
2.	Daniel I. C. Wang, Malcolm D. Lilly, Arthur E. Humphrey, Peter Dunnill, Arnold l.Demain, Fermentation and Enzyme Technology,1st edition John Wiley& Sons, Reprint, 2005	1979
3.	Christina Smolke, The Metabolic Pathway Engineering Handbook (Two Volume) Set 1st edition CRC press, 2009.	2009
4.	Stanbury P. F. and Whitaker A., Principles of Fermentation Technology, Pergamon Press,1984.	1984

COURSE DETAILS:

UNITS	CONTENTS	LECTURE HOURS
I	Basic concept of metabolism, anabolism & catabolism, Importance of metabolic engineering General Principles of IntermediaryMetabolism, Regulation of Pathways, Strategies for Pathway Analysis.Understanding the role of Bioinformatics in the study of metabolic pathways	**6**
II	Synthesis of primary metabolites: Amino acid synthesis pathways and its regulation at enzyme level and whole cell level, Alteration of feedback regulation, Limiting accumulation of end products	**8**
III	Biosynthesis of secondary metabolites: Regulation of secondary metabolite pathways, precursor effects, prophase, idiophase relationship, producers of secondary metabolites, applications of secondary metabolites.	**12**
IV	Bioconversions: Applications of Bioconversions, Factors affecting bioconversions, Specificity, Yields, Product inhibition, mixed or sequential bioconversions, Conversion of insoluble substances	**7**
V	Regulation of enzyme production: Strain selection, Genetic improvement of strains, Gene dosage, metabolic pathway manipulations to improve fermentation, Feedback repression, Catabolite Repression, optimization and control of metabolic activities.	**9**
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LUCKNOW B.TECH. III YEAR V SEMESTER BIOTECHNOLOGY

SUBJECT CODE: KBT 055	**COURSE TITTLE: Biofuels & Alcohol Technology**
EXAM DURATION: 3 HOURS	**SEMESTER: V (ODD)**
L: T: P :: 3 : 0: 0 CREDITS:3	**PREREQUISITE: Basic knowledge of Fermentation and Bioconversion**

OBJECTIVE:

- To teach the concept and application biofuels and alcohol technology
- To develop understanding different alcoholic fermentation techniques.
- To provide knowledge Biochemistry of alcohol production, recycling and quality control.
- Concepts of Biomass conversion to heat and power

COURSE OUTCOME:

On completion of this course, the students will be able to:

- Explain basic concepts of metabolism and importance of metabolic engineering
- Understand the production of metabolites and its regulatory mechanism
- Explain the applications, specificity and product inhibition of bioconversion.
- Regulation of enzyme production and strain improvement

REFERENCE BOOKS:

S. NO.	NAME OF AUTHORS/BOOKS/PUBLISHERS	YEAROF PUBLICATION/ REPRINT
1.	Chemical Process Principles – Part I, Material and Energy Balances by Olaf A Hougen, Kwenneth M. Watson, and Roland A Ragatz, CBS Publishers and Distributors (1995).	1995
2.	He alcohol text book by Kathryn AnnJacques, T. P. Lyons, D. R. Kelsall	2003
3.	Product Recovery in Bioprocess Technology ", BIOTOL Series, VCH, 1990	1990
4.	Shreve's Chemical Process Industries , 5th Ed. Reference	1984
5.	Out lines of Chemical Technology by Charles E. Dryden	1973

COURSE DETAILS: Biofuels & Alcohol Technology

UNITS	CONTENTS	LECTURE HOURS
I	Introduction to Alcohol Technology, Raw Material of Alcohol Industry, Storage & handling of Raw material in detail, Study of different yeast strains used in alcohol industries, Study of yeast production as single protein cell.	**9**
II	Study of different alcoholic fermentation techniques, Batch fermentation, Continuous fermentation, Modem techniques of Continuous fermentation, Bio still fermentation, Encillium process, Wet milling of grain for alcohol production, Grain dry milling cooking for alcohol production, Use of cellulosic feed stocks for alcohol production, Scaling in distilleries, Fusel oil separation	**9**
III	Study of different recycling process, Biochemistry of alcohol production, The management of fermentation in the production of alcohol. Alcohol distillation-The fundamental, Parameters & affecting alcoholic fermentations, By product of alcoholic fermentation, Distillery quality control, Alcoholometry	**10**
IV	Various biofuels/ bioenergy from biomass. Biomass conversion to heat and power: thermal gasification of biomass, anaerobic digestion. Biomass conversion to biofuel: thermochemical conversion, syngas fermentation.	**10**
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B.TECH. III YEAR V SEMESTER BIOTECHNOLOGY

SUBJECT CODE: KBT 056	**COURSE TITLE: Descriptive Statistics &Process Control**
EXAM DURATION: 3 HOURS	**SEMESTER: V (ODD)**
L: T: P :: 3 : 0: 0 CREDITS:3	**PREREQUISITE: Elementary knowledge of Mathematics**

OBJECTIVE:

- To teach and demonstrate the representation of numerical data
- To develop understanding different and concept of probability, Binomial distribution and testing of significance..
- Understand the Correlation and Regression analysis
- Concepts of Design of Experiments and statistical process control and capability analysis

COURSE OUTCOME:

On completion of this course, the students will be able to:

- Diagrammatic and graphical representation of numerical data
- Apply concept of probability, binomial distribution and other statistical tools in solving complex scientific problems
- Understand the regression analysis
- Design the experiment using statistical methods.
- Explain statistical process control and capability analysis.

REFERENCE BOOKS:

S. NO.	**NAME OF AUTHORS/BOOKS/PUBLISHERS**	**YEAR OF PUBLICATION/ REPRINT**
1.	Snedecor G. W. and Chochran W. G., Statistical Methods, 1989.	1989
2.	Douglas C Montgomery: Statistical Quality Control 7thedn.	2013
3.	Douglas C Montgomery: Applied statistics and Probability for engineers, 4thedn.	1994
4.	TT Soong : Fundamentals of probability and statistics for engineers.	2004

COURSE DETAILS: Descriptive Statistics &Process Control

UNITS	CONTENTS	LECTURE HOURS
I	*Descriptive Statistics:* Diagrammatic and graphical representation of numerical data, Formation of frequency distribution, histogram, cumulative frequency distribution, polygon and O-give curve, measures of central tendencies – mean, median, mode. Measures of dispersion: mean deviation, standard deviation, variance, quartile deviation and coefficient variance, Moments (up to 4th), Measures of skewness and kurtosis for grouped and ungrouped data.	**8**
II	*Probability & Hypothesis Testing:* Concept of Probability – Classical definition, Basic theorems of probability, Types of probability, Conditional probability, Theorem of total probability, Normal Distribution, The Central Limit Theorem, Binomial distribution, Poisson's Distribution, The Poisson's approximation to the Binomial Distribution. Testing of significance, large sample test for population mean and proportions, Test of population means-single, two samples, and paired t-test, chi square test. ANOVA	**9**
III	*Correlation and Regression analysis:* Product moment and rank, correlation coefficient, simple regression, method of least squares for estimation of regression coefficients, concept of sampling and sampling distribution, sampling from nominal distribution, standard error	**6**
IV	*Design of Experiments (DOE):* Design of Experiments (DOE) approach to optimization - traditional (linear) approach (OFAT) and multi-dimensional approach (Box-Bhenken Design, central composite design, Plackett-Burman Design, Downhill Method, Full factorial, Fractional factorial design)	**8**
V	*Control Charts:* Introduction to statistical process control and capability analysis: Chance and assignable cause of quality variation, Statistical basis of process monitoring: control chart, choice of control charts, analysis of control chart, variable of control charts, X bar and R chart, Attribute control chart, Determining process and measurement capability	**7**
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DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY, LUCKNOW
B.TECH III YEAR V SEMESTER BIOTECHNOLOGY

SUBJECT CODE: KBT 057	**COURSE TITLE: 3-D PrintingTechniques**
EXAM DURATION: 3 HOURS	**SEMESTER : V (ODD)**
L: T: P :: 3 : 0: 0 CREDITS:3	**PRE REQUISITES: Basic knowledge of instrumentation and statics**

OBJECTIVES:

- To teach the concept and application prototyping fundamental.
- To develop understanding models and specifications, stereo lithography apparatus and layering technology
- To provide knowledge of laminated object manufacturing and related techniques and process.
- Concepts of selective laser sintering, fused deposition modeling

COURSE OUTCOME:

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

- Explain basic concepts of 3-D printing technology.
- Understand the application, case studies, working, principles of 3-D printing technology
- Explain the laminated object manufacturing and fused deposition modeling.
- Apply the knowledge of 3-D Printing techniques to develop novel engineering models

REFERENCE BOOKS

S.NO	NAME OF AUTHORS/BOOKS /PUBLISHERS	YEAR OF PUBLICATION/ REPRINT
1.	Chua C.K., Leong K.F. and LIM C.S Rapid prototyping: Principles and Applications, World Scientific publications, 3rdEd., 2010	1997
2.	D.T. Pham and S.S. Dimov, "Rapid Manufacturing", Springer, 2001	2001
3.	Terry Wohlers, " Wholers Report 2000", Wohlers Associates, 2000	2000
4.	Paul F. Jacobs, " Rapid Prototyping and Manufacturing"–, ASME Press, 1996	1996
5.	Ian Gibson, Davin Rosen, Brent Stucker "Additive Manufacturing Technologies, Springer, 2nd Ed, 2014.	2014

COURSE DETAILS **:PrintingTechniques**		
UNITS	**CONTENTS**	**LECTURE HOURS**
I	Introduction, Prototyping fundamentals, Historical development, Advantages of AMT, Commonly used terms, process chain, 3D modelling, Data Conversion, and transmission, Checking and preparing, Building, Post processing, RP data formats, Classification of AMT process, Applications to various fields	**8**
II	Liquid based systems: Stereo lithography apparatus (SLA): Models and specifications, process,working principle, photopolymers, photo polymerization, layering technology, laser and laser scanning, applications,advantages and disadvantages, case studies. Solid ground curing (SGC): Models and specifications, process, working ,principle, applications, advantages and disadvantages, case studies.	**12**
III	Solid based systems: Laminated object manufacturing(LOM): Models and specifications, Process, Working principle, Applications, Advantages and disadvantages, Case studies.Fused Deposition Modeling (FDM): Models and specifications, Process, Working principle, Applications, Advantages and disadvantages, Case studies, practical demonstration	**10**
IV	Powder Based Systems: Selective laser sintering (SLS): Models and specifications, process, working principle, applications, advantages and disadvantages, case studies. Three dimensional printing (3DP): Models and specification, process, working principle, applications, advantages and disadvantages, case studies.	**12**
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DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY, LUCKNOW
B.TECH III YEAR V SEMESTER BIOTECHNOLOGY

SUBJECT CODE: KBT 058	**COURSE TITLE: Molecular Modeling & Drug Design**
EXAM DURATION: 3 HOURS	**SEMESTER: V (ODD)**
L: T: P :: 3 : 0: 0 CREDITS: 3	**PRE-REQUISITE: Basic knowledge molecular biology, computer& mathematics**

OBJECTIVE:

- To teach the fundamental concept of molecular modeling and drug design.
- To develop understanding molecular mechanisms and protein folding
- To provide knowledge of homology modeling, model optimization & validation of protein models.
- Concepts of drug designing including QSAR modeling and molecular docking

COURSE OUTCOME:

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

- Explain basic concepts and application of molecular modeling and drug development.
- Understand the application of molecular dynamics, molecular mechanism and its application in protein folding
- Explain the concept and application of homology modeling.
- Apply the knowledge of molecular modeling in drug designing and development

REFERENCE BOOKS:

S. NO.	NAME OF AUTHORS / BOOKS / PUBLISHERS	YEAR OF PUBLICATION/ REPRINT
1.	Molecular Modelling: Principles and applications byA. Leach	2013
2.	Molecular Modelling by Hans Peter, Heltje & Gerd Folkens, VCH.	2011
3.	Chemical Applications of Molecular Modelling by Jonathan Goodman.	2000
4. .	Computational Chemistry by Guy H, Grant & W. Graham Richards, Oxford University Press	1995

COURSE DETAILS: Molecular Modeling & Drug Design

UNITS	CONTENTS	LECTURE HOURS
I	Introduction to Molecular Modeling; What are models used for? Areas of application – Single molecule calculation, Assemblies of molecules; Reaction of the molecules; Drawbacks of mechanical models as compared to graphical models; Co-ordinate systems two – matrix, potential energy surface; Postulates of quantum mechanics, Electronic structure calculations, Ab initio, Semi-empirical and Density functional theory calculations, Molecular size versus accuracy; Approximate molecular orbital theories.	**8**
II	Molecular Modeling by Homology, construction of frame work, selecting variable regions, Back bone and side chain placement and refinement, Optimization and validation of protein models. Threading and Ab-initio modeling, Ramchandran plot.	**8**
III	Introduction to QSAR for lead module: Linear and nonlinear modeled equations, Biological activities, Physicochemical parameters and Molecular descriptors, Application of QSAR modeling in drug discovery.	**8**
IV	Molecular Mechanisms: Introduction to Force field, Use of various parameters for force field calculation (Bond length, angle angle, torsion angle, Electrostatic interaction, Vander waals interactions, Miscellaneous interaction); Introduction Molecular Dynamics using simple models, Dynamics with continuous potentials, Constant temperature and constant dynamics, Conformation searching, Systematic search, Applications to protein folding.	**8**
V	3D pharmacophores modeling, molecular docking, De novo Ligand design, Free energies and solvation, electrostatic and non-electrostatic contribution to free energies; 3D data base searching and virtual screening, Sources of data, molecular similarity and similarity searching, combinatorial libraries – generation and utility.	**8**
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DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY, LUCKNOW
B.TECH III YEAR V SEMESTER BIOTECHNOLOGY

SUBJECT CODE: KBT 551	**COURSE TITLE: Genetic Engineering Lab**
EXAM DURATION: 2 HOURS	**SEMESTER: V**
L: T: P :: 0 : 0: 2 CREDIT: 1	**PRE-REQUISITE: Genetic Engineering theory course**

OBJECTIVE:

- To isolate the various bimolecules and genetic materials from cells and tissues
- To develop understanding of estimation of Genetic material
- To provide practical knowledge restriction digestion, transformation, screening and verification of cloning
- Practical knowledge of ligation, blotting and cloning.

COURSE OUTCOME:

On successful completion of the course, the student will be able to

- Demonstrate the isolation genetic materials
- Perform experiments related to cloning, ligation, restriction digestion and transformation etc.
- Demonstrate the Southern Blotting for identification of desired DNA in a pool DNA samples
- Perform the bacterial cell competent for transformation

REFERENCE BOOKS:

S. NO.	NAME OF AUTHORS/BOOKS/PUBLISHERS	YEAR OF PUBLICATION/REPRINT
1.	Laboratory manual on Molecular Biology & genetic Engineering-A new approach by R.S. Sengar	2012
2.	Laboratory Manual for Genetic Engineering by S. john Vennison. Prentics hall publication	2009

COURSE DETAILS: Genetic Engineering Lab

S. NO.	LIST OF EXPERIMENT
1	Isolation of RNA and its estimation by orcinol method
2	Isolation of plasmid DNA and its estimation by diphenylamine reaction
3	Elution of plasmid DNA from agarose gel
4	To perform restriction digestion of λ DNA
5	Dephosphorylation of restriction enzyme digested vector pUC18
6	To make bacterial cells competent for transformation
7	To perform of transformation of the desired bacterial strain with plasmid DNA
8	Screening of transformed colonies by X gal and IPTG
9	Verification of cloning by colony PCR and screening of the positive colonies
10	To perform a Southern Blotting for identification of desired DNA in a pool DNA samples
11	To perform ligation of λ EcoRI digest using T4DNA ligase

DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY, LUCKNOW
B.TECH III YEAR V SEMESTER BIOTECHNOLOGY

SUBJECT CODE: KBT 552	**COURSE TITLE: Fermentation Biotechnology Lab**
EXAM DURATION: 2 HOURS	**SEMESTER: V (ODD)**
L: T: P :: 0 : 0: 2 CREDIT:1	**PRE-REQUISITE: Fermentation Biotechnology theory course**

OBJECTIVE:

- To determine the growth pattern of microbial cell.
- Perform the production of antibiotics, enzymes and acids through fermentative process
- To provide practical knowledge for production of ethanol, and down streaming.
- Practical knowledge of solid state fermentation & submerged fermentation

COURSE OUTCOME:

On completion of this course, the students will be able to:

- Demonstrate the growth pattern of E.coli.
- Perform experiments related to production of antibiotics, enzymes and acids through fermentation process.
- Demonstrate the downstream processing of fermentative products.
- Perform the solid state fermentation and submerged fermentation.

REFERENCE BOOKS:

S. NO.	NAME OF AUTHORS/BOOKS/PUBLISHERS	YEAR OF PUBLICATION/REPRINT
1.	Practical Manual on Fermentation Technology by S. Kulandaivelu, S. Janarthanan	2012
2.	J.Jayaraman , "Laboratory Manual in Biochemistry", New Age International Publications	2007
3.	Fermentation-A practical Approach by G T Banks-FEBS Press	1990

COURSE DETAILS: Fermentation Biotechnology Lab

S. No.	LIST OF EXPERIMENTS
1.	1. Determine the growth patterns and specific growth rate of E. coli
2.	Determine the effect of peptone concentration on E .coli growth
3.	Fermentative production of Penicillin Antibiotics using *Peniciliumchrysogenum*.
4.	To study the induction effect of β-galactosidase enzyme in E.coli.
5.	Upstream and Downstream of bioprocess for the production of Citric acid byAspergillusniger
6.	Citric acid production from whey with glucose as supplementary carbon source by Aspergillusniger
7.	Microbial production of citric acid by solid state fermentation process
8.	Microbial production of enzymes by (a) solid state and (b) submerged fermentation.
9.	Fermentative production of Ethanol using Saccharomyces cerevisiae

DR. A.P. J ABDUL KALAM TECHNICAL UNIVERSITY, LUCKNOW
B.TECH. III YEAR V SEMESTER BIOTECHNOLOGY

SUBJECT CODE: KBT 553	**COURSE TITTLE: Bioinormatics –I (Virtual Lab)**
EXAM DURATION: 2 HOURS	**SEMESTER: V (ODD)**
L: T: P :: 0 : 0: 2 CREDIT: 1	**PREREQUISITE: Genetic Engineering theory course**

OBJECTIVE:

- To retrieval of the sequence data
- Demonstration of locating the chromosome and retrieval of gene expression data
- To provide practical knowledge for retrieval of PubMed data.
- Practical knowledge of ORF finding, motif information and retrieval of Gene information

COURSE OUTCOME:

On completion of this course, the students will be able to:

- Demonstrate the retrieval of sequence data
- Perform experiments related to locating chromosome and gene expression data.
- Demonstrate the data retrieval system of PubMed.
- Perform the ORF finding and retrieval of gene information

REFERENCE BOOKS:

S. NO.	NAME OF AUTHORS/BOOKS/PUBLISHERS	YEAR OF PUBLICATION/REPRINT
1	Alphey L. DNA sequencing: from experimental methods to bioinformatics. BIOS scientific publishers Ltd; 1997.	1997
2	Iftekhar M, Ghalib MR. Bioinformatics Practical Manual	2015
3	Karthikeyan M, Vyas R. Practical chemoinformatics. Springer; 2014 May 6	2014

COURSE DETAILS: Bioinormatics –I (Virtual Lab	
S.NO.	**LIST OF EXPERIMENTS**
1.	Retrieving sequence data from Entrez
2.	Locating the chromosome of a Gene
3.	Retrieve gene expression data from GEO
4.	Retrieving articles using PubMed
5.	Finding ORF of a Given Sequence
6.	Retrieving structural data of a protein using PDB database
7.	Retrieving Motif Information of a Protein Using Prosite
8.	Retrieving Gene Information from TAIR database

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B.TECH III YEAR V BIOTECHNOLOGY

SUBJECT CODE:	**COURSE TITLE: MINI PROJECT OR INTERNSHIP ASSESSMENT***
EXAM DURATION: 20 MINUTES PRESENTATION	**SEMESTER: V (ODD)**
L: T: P :: 0 : 0: 2 CREDIT:1	**PRE-REQUISITE: NIL**

OBJECTIVE:

- To inculcate research attitude amongststudents.
- To develop presentationskills.
- To teach how to study and solve practicalproblems

COURSE OUTCOME:

On completion of this course, the students will be able to:

- Understand and workout the projectproblem.
- Gain experience to make a projectreport.
- Acquire the necessary confidence to carry out main project in the finalyear.

COURSE DETAILS:

- Thestudentjointlyorindividuallyisrequiredtoprepareaprojectreportbasedonexperimental or theoretical research work The key features such as literature survey, Problem formulation, solving methodologies and future aspects of industries are the major necessities of the report under the supervision of aguide.
- The project report is to be submitted by the end of the semester and the work will be assessed based on the report and the presentation of thework.
- The assessment of all the mini projects should be done by a committee consisting of three or four faculty members - the students will present their project work before the committee - the relative grading and group average marks for the various projects will be fixed by the committee - the guides will award the marks for the individual students in the project maintaining the groupaverage.
- Eachgroupwillsubmittheprojectreporttothedepartmentthroughtheguide-theheadofthe department will certify the copies and keep one copy in the departmentallibrary.

DR. A.P. J ABDUL KALAM TECHNICAL UNIVERSITY, LUCKNOW
B.TECH. III YEAR VI SEMESTER BIOTECHNOLOGY

SUBJECT CODE: KBT 601	**COURSE TITLE: BIOPROCESS ENGINEERING II**
EXAM DURATION: 3 HOURS	**SEMESTER: VI (EVEN)**
L: T: P :: 3 : 1: 0 CREDITS: 4	**PREREQUISITE: Basic knowledge of fermentation biotechnology, bioprocess engineering I and microbiology**

OBJECTIVE:

- To impart knowledge on fundamentals of bioprocessing and bioreactor operations.
- To explain the principles of bioreactors and their application to upstream and downstream processing.
- To describe the principles and operations of various bioreactor modes.

COURSE OUTCOME:

On successful completion of the course, the student will be able to:

- Understand the kinetics of microbial growth and the associated parameters.
- Utilize sterilization concepts necessary for proper bioreactor operation.
- Discuss the basics of ideal reactor operation.
- Explain the concept and mechanism of mass transfer in bioprocessing.
- Analyze the concept of bioreactor control mechanism and identify suitable control system.

REFERENCE BOOKS:

S. NO.	NAME OF AUTHORS/BOOKS/PUBLISHERS	YEAR OF PUBLICATION/ REPRINT
1.	Principles of Microbe and cell cultivation- S. John Pirt, John Wiley & Sons	1975
2.	Bioprocess Engineering Principles by P. M. Doran, Academic Press	1995
3.	Hand Book Of Bioengineering- Skalak R &ShuChien, McGraw-Hill.	1986
4.	Biochemical Engineering Fundamentals by Bailey &Ollis, McGraw-Hill College Publishers	1986
5.	Chemical Engineering: An Introduction by Morton Denn, Cambridge University Press	2011
6.	Biochemical & Biological Engg. Science, N. Blakebraugh, Academic Press.	1967

7.	Principles of fermentation technology" by P F Stanbury and A Whitaker, Pergamon press.	1986
8.	Bioprocess Technology - Kinetics & Reactors" by A Moser, Springer-Verlag.	1988
9.	Biochemical Engineering and Biotechnology Handbook" by B. Atkinson & F. Mavituna, 2nd Ed.Stockton Press.	1992
10.	Biochemical Engineering- S. Aiba , A.E. Humphray, University of Tokyo Press.	1973
11.	Bioreactor Design & Product Yield, BIOTOL Series, Butterworth-Heinemann Ltd	1992
12.	Bioreactors in Biotechnology: A Practical approach by Scragg, E. Horwood.	1991
13.	Process Biotechnology Fundamentals by S.N. Mukopadhyay, Viva Books Private Limited	2009
14.	Bioprocess Engineering: Basic Concepts by Shuler &Kargi, Prentice Hall India Learning Private Limited	2002

COURSE DETAILS: BIOPROCESS ENGINEERING II		
UNITS	**CONTENTS**	**LECTURE HOURS**
I	**Microbial growth and Media preparation:** Media Preparation, Media design and optimization. Microbial growth patterns and kinetics in batch culture, Microbial growth parameters, Environmental conditions affect growth kinetics, Kinetics of thermal death of microorganisms, Heat Generation by microbial growth, Quantitative analysis of microbial growth by direct & indirect methods.	**8**
II	**Sterilization:** Concept and methods. Type of Sterilizations, Batch heat sterilization of liquids, Estimation of sterilizer efficiency, Continuous heat sterilization of liquids, Sterilization of air: Methods &Mechanism, Design of depth filter and estimation of its efficiency. Stoichiometric calculations, Theoretical prediction of yield coefficients, Stoichiometry of growth and product formation, Maximum possible yield, Theoretical oxygen demand, Stoichiometry of single-cell protein synthesis. .	**8**
III	**Ideal Reactor Operation:** Batch, Fed Batch & Continuous operation of mixed bioreactors, Microbial pellet formation, Kinetics and dynamics of pallet formation. Chemostate with immobilized cells, Chemostate with cell recycle, substrate utilization and product formation in bioreactor, Scale up of Bioreactors.	**8**
IV	**Role of diffusion in Bioprocessing:** Convective mass transfer, Gas-liquid mass transfer, Oxygen uptake in cell cultures, Factor affecting cellular oxygen demand, Oxygen transfer in bioreactors, Measurement of volumetric oxygen transfer coefficient, Oxygen transfer in large bioreactor.	**8**
V	**Bioreactor control mechanism:** Physical, Chemical and Biological environment of bioreactor, Manual control system, Role of physical, chemical & biological sensors, Advanced control strategies viz. PID controllers, Fuzzy logic based controllers and artificial neural network based Controllers. Basic concepts of computer modeling and optimization in bioprocess applications.	**8**
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DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY, LUCKNOW
B.TECH III YEAR VI SEMESTER BIOTECHNOLOGY

SUBJECT CODE: KBT 602	**COURSE TITLE: PLANT BIOTECHNOLOGY**
EXAM DURATION: 3 HOURS	**SEMESTER : VI (EVEN)**
L: T: P :: 3 : 1:0 CREDITS: 4	**PRE REQUISITES: Basic knowledge of genetic engineering ,biochemistry and elementary biology**

OBJECTIVE:

- To impart the basic concepts of plant tissue culture.
- To develop understanding about tissue culture techniques and involved culturing strategies.
- To impart knowledge about the importance of tissue culture in crop improvement.

COURSE OUTCOME:

After successful completion of the course the students will be able to:

- Understand the principle and basic requirements for plant tissue culture.
- Explain the difference between tissue and organ culture and their applicability.
- Understand haploid culture and in vitro selection of mutants.
- Analyze somaclonal variation for improved crop varieties in vitro cultures.
- Identify suitable cryopreservation and reculture technique for the cultured tissue.
- Understand the development of transgenic plants through genetic manipulations.

REFERENCE BOOKS

S.NO	NAME OF AUTHORS/BOOKS /PUBLISHERS	YEAR OF PUBLICATION/ REPRINT
1.	Hudson T Hartmann: Plant Propagation-Principle and Practices, Pearson Education India; 8 edition	2015
2.	Principles of Plant Biotechnology- An Introduction of Genetic Engineering in Plants by S.H. Mantell, J.W. Mathews and R.A. Mckee, Blackwell Scientific Publications.	1985
3.	Chopra V L, Sharma R P &Swaminathan M S: Agricultural Biotechnology by Science Pub Inc	1996
4.	Hamish A, Collin & Sue Edwards: Plant Cell Culture, BIOS Scientific Publishers	1998
5.	Razdan M K: An Introduction to Plant Tissue Culture, Science Publishers	2003
6.	Plant Tissue Culture: Theory and Practice by S.S. Bhojwani M.K. Razdan, Elsevier Science	1996
7.	H.S. Chawla. Plant Biotechnology, Oxford & IBH Publishing	2020

COURSE DETAILS: PLANT BIOTECHNOLOGY		
UNITS	**CONTENTS**	**LECTURE HOURS**
I	Introductory history of plant biotechnology: Laboratory organization; Principles of Plant Tissue Culture. Concepts of totipotency, explants, inoculums, acclimatization. Nutrition of plant cells; Nutrient media: Composition of commonly used nutrient culture media with respect to their contents like inorganic chemicals, organic constituents. An appraisal of different media, selection of media, Sterilization of the media. Hormones: Auxins, Cytokinins, Gibberellins, Abscisic Acid, Ethylene etc. Explant preparation and Surface sterilization. Basic procedure for Aseptic Tissue transfer.	**10**
II	Culture of plant materials- explants selection and technique of culturing. Organogenesis, Embryogenesis, Somaclonal variation, germiclonal variation. Establishment, growth and maintenance of Callus and cell suspension culture, Methods of sub culturing and transfer of regenerated plants to the field. Tissue and organ culture; Cellular differentiation and regulation of morphogenesis; Somatic embryogenesis; Control of organogenesis and embryogenesis; Single cell culture	**10**
III	Haploid production: Androgenesis; Anther and microspore culture; Gynogenesis; Embryo culture and rescue in agricultural and horticultural corps; Protoplast isolation; Culture– regeneration; Somatic hybrid-cybrids; In vitro selection of mutants – mutants for salts, disease, cold, drought, herbicide and other stress conditions; Micropropagation: Application of micropropagation in agriculture and forestry. Meristem culture and virus elimination; Shoot tip culture.	**8**
IV	Improved crop varieties through somaclonal variation in invitro cultures. Application of tissue culture for crop improvement in agriculture, horticulture and forestry. Cryopreservation and slow growth cultures, Freezing and storage, thawing, reculture. Application of plant tissue culture production of secondary metabolites and other industrial products. .	**8**
V	Genetic transformation using Ti plasmid Manipulation of gene expression in plants; Production of marker free transgenic plants. Developing insect-resistance, disease-resistance, herbicide resistance plants. Genetic manipulation of flower pigmentation, Developing quality of seed storage, Provitamin A, iron proteins in rice, modification of food plant taste and appearance, yield increase in plants.	**8**
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DR. A.P. J ABDUL KALAM TECHNICAL UNIVERSITY, LUCKNOW
B.TECH. III YEAR VI SEMESTER BIOTECHNOLOGY

SUBJECT CODE: KBT 603	**COURSE TITLE: BIOINFORMATICS II**
EXAM DURATION: 3 HOURS	**SEMESTER: VI (EVEN)**
L: T: P :: 3 : 1: 0 CREDITS:4	**PRE-REQUISITE: Elementary knowledge of bioinformatics I , molecular biology and computer**

OBJECTIVE

- To provide knowledge to analyze various computational methods involved in protein modeling, RNA structure prediction and drug designing
- To teach various concepts of machine learning, , Artificial Neural Networks, document clustering

COURSE OUTCOME:

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

- Understand the various tools and techniques related to insilico modeling of biomolecules along with methods of drug designing, protein docking
- Analyze problems related to collection and analysis of biological data
- Develop steady and time dependent solutions along with theirlimitations

REFERENCE BOOKS:

S. NO	NAME OF AUTHORS / BOOKS / PUBLISHERS	YEAR OF PUBLICATION/ REPRINT
1.	Computational Methods in Biotechnology – Salzberg S. L. et al., Elsevier Science	1998
2.	D.W.Mount; Bioinformatics- Sequence and genome analysis; Cold Spring HarbourLabpress	2004
3.	Protein Structure Prediction-A Practical Approach, MJE Sternberg, Oxford University Press.	1996
4.	Statistical Methods in Bioinformatics-Evens & Grants, Springer-Verlag, NY.	2006
5.	Purifing Protein for Proteomics, Richard J. Sinpson, I.K. International Pvt. Ltd.	2004
6.	Computational Molecular Biology- Setubal and Meidanis, PWS publishing Co., 1997. 18/ 24	1997

COURSE DETAILS:

UNITS	CONTENTS	LECTURE HOURS
I	Inference problems and techniques for molecular biology. Overview of key inference problems in biology: Homology identification, Genomic sequence annotation (Genes and ORFs identification), Protein structure prediction (Secondary and Tertiary structure prediction), Protein function prediction, Biological network identification, Next generation sequencing, Microarray data analysis	**10**
II	Basics of RNA Structure prediction and its limitations, Features of RNA Secondary Structure, RNA structure prediction methods: Based on self-complementary regions in RNA sequence, Minimum free energy methods, Suboptimal structure prediction by MFOLD, Prediction based on finding most probable structure and Sequence co-variance method. Application of RNA structure modeling	**8**
III	Machine learning: Decision tree induction, Artificial Neural Networks, Hidden Markov Models, Genetic Algorithms, Simulated Annealing, Support vector machines; The relation between statistics and machine learning; Evaluation of prediction methods: Parametric and Nonparametric tests, cross-validation and empirical significance testing (empirical cycle), Clustering (Hierarchical and K-mean).	**10**
IV	Basic concept of Force field in molecular modeling (Potential energy calculation); Overview of key computational simulation techniques: Introduction to simulation, Computer simulation techniques, Types of computer simulation (Continuous, Discrete-event and Hybrid simulation), Differential equation solvers, Parameter estimation, and Sensitivity analysis.	**6**
V	Overview of key techniques for the management of large document collections and the biological literature: Document clustering, Information retrieval system; Natural Language Processing: Introduction, Major areas of NLP, Natural language information extraction; Insilico Drug Designing: Major steps in Drug Designing, Ligand and Structure based drug designing, Protein-ligand docking, QSAR Modeling, Pharmacodynamics (Efficacy & Potency) &Pharmacokinetics (ADME), Lipinski's rule of five, Pharmacogenomics	**8**
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DR. A.P. J ABDUL KALAM TECHNICAL UNIVERSITY, LUCKNOW
B.TECH. III YEAR VI SEMESTER BIOTECHNOLOGY

SUBJECT CODE: KBT 061	**COURSE TITLE: ANIMAL BIOTECHNOLOGY**
EXAM DURATION: 3 HOURS	**SEMESTER : VI (EVEN)**
L: T: P :: 3 : 0: 0 CREDITS:3	**PREREQUISITES: Basic knowledge of genetic engineering and immunology**

OBJECTIVES:

- To introduce invitro culture techniques of animal cells and tissues
- To learn different types of culture systems and reactors used for culturing of animal cells
- To elaborate various applications of animal tissue cultures with specific reference to transgenic animal production

COURSE OUTCOME:

On completion of this course, the students will be able to:

- Understand basics of animal tissue culture and its importance
- Understand techniques to establish animal cell cultures invitro as well as different types of reactors and their working
- learn the strategies involved in developing clones in lab
- Understand the methods of transgene delivery and production of transgenic animals
- Understand the process of stem cell differentiation and their applications with case studies

REFERENCE BOOKS

S.NO	NAME OF AUTHORS/BOOKS /PUBLISHERS	YEAROF PUBLICATION/ REPRINT
1.	B. Hafez and E.S.E Hafez, Reproduction in farm animals, 7th Edition, Wiley Blackwell	2000
2.	G.E. Seidel, Jr. and S.M. Seidel, Training manual for embryo transfer in cattle (FAO Animal Production and Health Paper-77), 1st Edition, W.D. Hoard and sons FAO	1991
3.	I. Gordon, Laboratory production of cattle embryos, 2nd edition, CAB International	2003
4.	Louis-Marie Houdebine, Transgenic Animals: Generation and Use 5th Edition, CRC Press	1997
5.	Animal cell culture: Ian Freshney	2015

COURSE DETAILS: ANIMAL BIOTECHNOLOGY		
UNITS	**CONTENTS**	**LECTURE HOURS**
I	Basic cell culture techniques, Types of cell culture media; Ingredients of media; Physiochemical properties; CO2 and bicarbonates; Buffering; Oxygen; Osmolarity; Temperature; Surface tension and foaming; Balance salt solutions; Antibiotics growth supplements; Foetal bovine serum; Serum free media; Trypsin solution; Selection of medium and serum; Conditioned media; Other cell culture reagents; Preparation and sterilization of cell culture media, serum and other reagents.	**8**
II	Different tissue culture techniques; Types of primary culture; Chicken embryo fibroblast culture; Chicken liver and kidney culture; Secondary culture; Trypsinization; Cell separation; Continuous cell lines; Suspension culture; Organ culture etc.; Behavior of cells in culture conditions: division, growth pattern, metabolism of estimation of cell number; Development of cell lines; Characterization and maintenance of cell lines, stem cells; Cryopreservation; Common cell culture contaminants	**8**
III	Cell cloning and selection; Transfection and transformation of cells; Commercial scale production of animal cells, stem cells and their application; Application of animal cell culture for in vitro testing of drugs; Testing of toxicity of environmental pollutants in cell culture; Application of cell culture technology in production of human and animal viral vaccines and pharmaceutical proteins	**8**
IV	Cell culture reactors; Scale-up in suspension; Scale and complexity; Mixing and aeration; Rotating chambers; Perfused suspension cultures; Fluidized bed reactors for suspension culture; Scale-up in monolayers; Multisurface propagators; Multiarray disks, spirals and tubes; Roller culture; Microcarriers; Perfused monolayer cultures; Membrane perfusion; Hollow fiber perfusion; Matrix perfusion; Microencapsulation; Growth monitoring	**8**
V	Transgenic animal production; Methods of transgene delivery; Integration of foreign genesand their validation; Gene targeting; Methods and strategies; Improving transgene integration efficiency; Cell lineages and developmental control genes in drosophila and mice; Differentiation of germ layers; Cellular polarity; Stem cell differentiation; Blood cell formation; Fibroblasts and their differentiation; Differentiation of cancerous cells and role of protooncogenes	**8**
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DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY, LUCKNOW
B.TECH III YEAR VI SEMESTER BIOTECHNOLOGY

SUBJECT CODE: KBT 062	**COURSE TITLE: BIOMARKER & DIAGNOSTICS**
EXAM DURATION: 3 HOURS	**SEMESTER : VI (EVEN)**
L: T: P :: 3 : 0: 0 CREDITS:3	**PREREQUISITES: Basic knowledge of molecular biology, Immunology and analytical techniques**

OBJECTIVES:

- To introduce basics of molecular diagnostics, its scope and applications
- To learn various pathways of cell signaling, eukaryotic cell control system and their components
- To learn different molecular mechanisms of generation of metabolic disorders
- To elaborate various applications of biomarkers in disease diagnostics
- To understand advanced molecular techniques: FISH, CGH, flow cytometry, genome mapping methodology

COURSE OUTCOME:

On completion of this course, the students will be able to:

- Understand importance of biomarkers in molecular diagnostics
- Understand molecular oncology with specific emphasis on cancer and its relevant cause
- Learn principles and applications of some of advanced molecular diagnostic techniques

REFERENCE BOOKS

S.NO	**NAME OF AUTHORS/BOOKS /PUBLISHERS**	**YEAROF PUBLICATION/ REPRINT**
1.	Molecular biology of the cell. Bruce Alberts, 6th Edition	2014
2.	Principles of tissue engineering. Robert Lanza. Elsevier Publications	2000
3.	Introduction to Tissue engineering, applications and challenges. Ravi Birla.Wiley Publications	2014
4.	Molecular Cell Biology: Darnell J, Lodish H and Baltimore D	1990
5.	Cell and Molecular Biology: De Robertis EDP and De Robertis EMF	1980
6.	An introduction to Human Molecular Genetics by Pasternak et al., John Wiley & Sons	2005
7.	Human Chromosomes by Miller &Tharman, Springer Publishing Company	2001
8.	Molecular Biology of the cell by Alberts et al., Garland Press	2008
9.	Genes IX, by Lewin B, Pearson India	2007
10.	Cell and Molecular Biology by De Robertis and De Robertis, Lipincott&Wilkins	2007
11.	Genome III by Brown TA, Garland Press	2006
12.	Elements of medical Genetics by Turnpenny and Ellard, Churchill Livingstone	1995
13.	Animal cell culture: Ian Freshney	2015

COURSE DETAILS: BIOMARKER & DIAGNOSTICS		
UNITS	**CONTENTS**	**LECTURE HOURS**
I	Introduction to Molecular Diagnostics: History of diagnostics, Age of molecular diagnostics, Significance, Scope, Rise of diagnostic industry in Indian and global scenario, Cellular Complexity: Cell components, Cell Differentiation, Cellular communication – endocrine signaling, paracrine signaling and autocrine signaling, contact dependent and synaptic communications, Intracellular networks – transport pathways, signaling pathways and metabolic networks. Eukaryotic Cell Control System and their Components, Intracellular cell cycle control system, Extracellular Cell Cycle Control System, Regulation of Cell Growth and Apoptosis, Genetic and epigenetic factors that regulate these pathways, their abnormalities that alter the pathways and cellular functions.	**12**
II	Molecular Oncology Mitochondrial disorders: Cancer – Benign and Malignant neoplasms, multifactorial disposition, Cancer pathogenesis, positive and negative mediators of neoplastic development, Proto-oncogenes, Oncogenes and Tumor suppressors. Allele loss and loss of Heterozygosity. Mitochondrial inheritance, Mitochondrial myopathy, lactic acidosis, MELAS, LHONs, identity testing	**8**
III	Biomarkers in disease diagnostics: FDA definition of disease markers, Role of markers in Disease diagnosis. Approaches and methods in the identification of disease markers, predictive value, diagnostic value, emerging blood markers for sepsis, tumour& cancer markers, markers in inflammation and diagnosis of cytoskeletal disorders	**6**
IV	Chromosomes, Human disorders, and Cytogenetic analysis:Structure, types andorganization; Chromosome organization, Euchromatinand heterochromatin and Histone modifications.Chromosome banding and nomenclature; Nomenclature and functional significances of chromosome bands.GC and AT rich isochores.Structural and Numerical aberrations and its consequences.X-chromosome dosage compensation and inactivation mechanism.Sex determination and Y chromosome; function, and diseases.Uniparentaldisomy, Genomic Imprinting and disorders. FISH, CGH, Flow cytometry techniques and clinical diagnostics.	**10**
V	Genomic instability, Chromosome mapping & Genome plasticity: Common fragile sites and methods of induction, Heritable fragile sites and FXS. Genomic Instability, mechanism and diseases. Trinucleotide Repeats; Mechanism of expansion and triplet repeats and related disorders. Genetic linkage maps, Relation to the probability of recombination, Pedigree analysis with genetic markers and overview of human genome project	**10**
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DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY, LUCKNOW
B.TECH III YEAR VI SEMESTER BIOTECHNOLOGY

SUBJECT CODE: KBT 063	**COURSE TITLE: FOOD BIOTECHNOLOGY**
EXAM DURATION: 3 HOURS	**SEMESTER : VI (EVEN)**
L: T: P :: 3 : 0: 0 CREDITS:3	**PREREQUISITES: Basic knowledge of fermentation biotechnology and microbiology**

OBJECTIVES:

- To introduce significance of microbes in food and food industry
- To learn basic principles of the equipment involved in the commercially important food processing methods and unit operations
- To learn different techniques of food preservation
- To impart knowledge about indicators of food safety and HACCP system

COURSE OUTCOME:

On completion of this course, the students will be able to:

- Understand importance of microbes and their products in food industry
- Acquire knowledge of types of foods and their production methodologies
- Learn the Hazard Analysis Critical Control Point System (HACCP system) and Predictive Microbiology/Microbial Modeling.

REFERENCE BOOKS

S.NO	**NAME OF AUTHORS/BOOKS /PUBLISHERS**	**YEAROF PUBLICATION/ REPRINT**
1.	Frazier, W.S. and Weshoff, D.C., 2017. Food Microbiology, 5th Edn., McGraw Hill Book Co., New York.	2017
2.	Mann &Trusswell , 2007. Essentials of human nutrition.3rd edition .oxford university press	2007
3.	Jay, J.M., 1987. Modern Food Microbiology, CBS Publications, New Delhi	1987
4.	Lindsay, 1988. Applied Science Biotechnology.Challenges for the flavour and Food Industry.Willis Elsevier	1988
5.	Roger, A., Gordon, B. and John, T., 1989. Food Biotechnology	1989

COURSE DETAILS: FOOD BIOTECHNOLOGY		
UNITS	**CONTENTS**	**LECTURE HOURS**
I	History of Microorganisms in food: Historical Developments. Role and significance of microorganisms in foods. Intrinsic and Extrinsic parameters of foods that affect microbial growth. Basic principles of the equipment involved in the commercially important food processing methods and unit operations	**8**
II	Microorganisms in food: spoilage of fresh meats and poultry, processed meats, seafood's, fruits and vegetables. Fermented food products, Medical foods, Probiotics and health benefits of fermented milk and foods products. Dehydrated Foods, Enteral Nutrient Solutions (Medical Foods), Single-Cell Protein. Starter cultures, Production process of cheeses, beer, wine and distilled spirits. Process of Brewing, malting, mashing, primary & secondary fermentation. Problems in food industry: catabolic repression, High gravity brewing, B-glucan problem, getting rid of diacetyl.	**10**
III	Determining Microorganisms and/or their Products in Foods: Microbiological Examinationof surfaces, Air Sampling, Metabolically Injured Organisms .Enumeration and Detection of Food-borne Organisms .Bioassay and related Methods. Common Food borne diseases. Nutritional boosts and flavor enhancers: Emerging processing and preservation technologies for milk and dairy products.	**8**
IV	Food Preservation: Food preservation by various methods especially Irradiation, Characteristics of radiations in food preservation, principles underlying the destruction of microorganisms by Irradiation. Application of radiations in food (processing for irradiation).Radappertization, Radicidation, and Radurization of Foods. Effect of Irradiation on Food quality and storage ability. Miscellaneous Food Preservation Methods: High- Pressure Processing, Pulsed Electric Fields, Aseptic Packaging, Manothermosonication (Thermo-ultrasonication).	**8**
V	Indicators of Food Safety and Quality: Indicators of Food microbial quality, product quality and food safety. Fecal Indicator Organisms, Predictive Microbiology/Microbial Modeling.The Hazard Analysis Critical Control Point System (HACCP System), Microbiological Criteria.Food borne intoxicants and mycotoxins.	**6**
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DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY, LUCKNOW
B.TECH III YEAR VI SEMESTER BIOTECHNOLOGY

SUBJECT CODE: KBT 064	**COURSE TITLE: ENTREPRENEURSHIP IN BIOTECHNOLOGY**
EXAM DURATION: 3 HOURS	**SEMESTER : VI (EVEN)**
L: T: P :: 3 : 0: 0 CREDITS:3	**PREREQUISITES: Elementary knowledge of biotechnology and managerial economics**

OBJECTIVES:

- To introduce entrepreneurship opportunities in biotechnology
- To learn concepts of entrepreneurs, business development strategies, market
- To understand role of government schemes in development of Bio-entrepreneurship
- To discuss emerging biotechnology based industries related to drug development, transgenics, environmental biotechnology
- To understand ethics and IPR in biotech industries

COURSE OUTCOME:

On completion of this course, the students will be able to:

- Understand the importance of Bio-entrepreneurship and its scope
- Understand the important aspects of establishing bio-industries
- learn fundamental aspects of Intellectual property Rights to students who are going to playa major role in development and management of innovative projectsin industries
- Pave the way for the students to catch up Bio-entrepreneurship as ancareer option

REFERENCE BOOKS

S.NO	**NAME OF AUTHORS/BOOKS /PUBLISHERS**	**YEAROF PUBLICATION/ REPRINT**
1.	Biotechnology Entrepreneurship1st Edition.Starting, Managing, and Leading Biotech Companies.CraigShimasaki. Academic Press.2014	2014
2.	Introduction to Biotech Entrepreneurship: From Idea to Business. A European Perspective. Matei**,** Florentina**,** Zirra, Daniela (Eds.).Springer nature publication.2019	2019
3.	Biotechnology Entrepreneurship from Science to Solutions -- Start-Up, Company Formation and Organization, Team, Intellectual Property, Financing, Part 1st Edition. Michael L. Salgaller. Logos Press (August 25, 2010)	2010
4.	How to Start a Biotech Company. SourishSaha et.al., Independently published (September 4, 2019)	2019

COURSE DETAILS: ENTREPRENEURSHIP IN BIOTECHNOLOGY		
UNITS	**CONTENTS**	**LECTURE HOURS**
I	Entrepreneur - Meaning of Entrepreneur, Evolution of the Concept, Functions of an Entrepreneur, Types of Entrepreneur, Development of Entrepreneurship steps in entrepreneurial process, Biotech Entrepreneurship in India, Identification of Business Opportunities, Qualities, skills and attributes that successful biotech entrepreneurs possess. Case studies of successful and unsuccessful bio-entrepreneurs	**8**
II	Business development in biotechnology - Factors affecting biotech business: (finance, infrastructure, equipment, manpower , resources , project location, end product, quality issues, etc) Basic principles and practices of management - Definition, concepts and application; Organization types, coordination, control and decision making in management	**8**
III	Core concept of Market: Identification and evaluation of market potential of various bioentrepreneur sectors. Marketing, Marketing research- concept and techniques, Considerations in establishment of biotechnological start-up - Different models of biotechnological start-ups .The budget for a biotechnological start-up company. Seed capital raising for a biotechnological startup company	**8**
IV	Role of government and schemes, financial institutions in fostering Bio-entrepreneurship, Skills in bio-entrepreneurship-Personality and attitude, Organizational behavior, Leadership, Principles of effective communication Body language, public speaking, presentations, business proposal writing.	**8**
V	Biotechnology: emerging industries with examples from Transgenic, Environmental biotechnology, New drug development, DNA chip technology, Stem cell research, Tissue engineering. Contract Research Organization, marketing consultancy, bio-learning module. Ethics and IPR in biotech-Industries - Fundamentals of ethics in business, Ethical dilemmas in biotech industry, IPR- Introduction, Forms of IPR.	**8**
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DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY, LUCKNOW
B.TECH III YEAR VI SEMESTER BIOTECHNOLOGY

SUBJECT CODE: KBT 651	**COURSE TITLE: BIOPROCESS ENGINEERING II LAB**
EXAM DURATION: 2 HOURS	**SEMESTER: VI (EVEN)**
L: T: P :: 0 : 0: 2 CREDIT: 1	**PRE-REQUISITE: Bioprocess Engineering theory course**

OBJECTIVE:

- To impart knowledge about the basic fundamental principles of bioprocess engineering by performing differentexperiments
- To make them correlate theory and practical process byexperimentation.

COURSE OUTCOME:

On successful completion of the course, the student will be able to

- Analyze the data on growth kinetics of *E.coli*.
- Discuss the upstream and downstream bioprocessing for citric acid and α- amylase production.
- Analyze the volumetric liquid mass transfer coefficient (KLa) using sodium sulphite method.
- Perform immobilization of enzymes and cells.
- Develop computational design for fermentative production of L- lysine.

REFERENCE BOOKS:

S. NO.	**NAME OF AUTHORS/BOOKS/PUBLISHERS**	**YEAR OF PUBLICATION/REPRINT**
1.	Practical Manual on Fermentation Technology by S. Kulandaivelu, S. Janarthanan	2012
2.	J.Jayaraman , "Laboratory Manual in Biochemistry", New Age International Publications	2007
3.	Eisenthal, R. &Danson N.J. (Eds) Enzyme Assays: "A Practical Approach", IRI Press, Oxford, UK	1992

COURSE DETAILS: BIOPROCESS ENGINEERING II LAB

S. NO.	LIST OF EXPERIMENT
1	Determine the growth patterns and specific growth rate of *E.coli*
2	Determine the effect of peptone concentration on *E.coli* growth
3	Determination of specific thermal death rate constant (Kd) for *E.Coli*

4	Determine the effects of temperature & pH on *Psuedomonasputida*
5	Upstream and Downstream of bioprocess for the production of Citric acid by *Aspergillusniger*
6	Citric acid production from whey with glucose as supplementary carbon source by *Aspergillusniger*
7	Upstream and Downstream of bioprocess for the production of α-amylase by *Aspergillusnudulans*
8	Estimation of volumetric liquid mass transfer coefficient (KLa) using sodium sulphite method
9	Preparation of immobilized enzymes & cells and evaluation of kinetic parameters.
10	Computational Design of Fermentative Process for L-lysine production.

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B.TECH III YEAR VI SEMESTER BIOTECHNOLOGY

SUBJECT CODE: KBT 652	**COURSE TITLE: PLANT BIOTECHNOLOGY LAB**
EXAM DURATION: 2 HOURS	**SEMESTER: VI (EVEN)**
L: T: P :: 0 : 0: 2 CREDIT:1	**PRE-REQUISITE: Plant Biotechnology theory course**

OBJECTIVE:

- To provide knowledge to apply fundamental principles of plant tissue culture.
- To teach concepts behind culturing techniques from different explants.
- To inculcate the hands on practice attitude in students to perform explants selection, media preparation, sterilization and callus culture initiation.

COURSE OUTCOME:

On completion of this course, the students will be able to:

- Operate and handle the plant biotechnology lab equipments.
- Perform tissue culture media preparation, sterilization and explants selection.
- Understand in vitro cultures through axillary bud induction
- Analyze plant secondary metabolites from selected medicinal plants.

REFERENCE BOOKS:

S. NO.	NAME OF AUTHORS / BOOKS / PUBLISHERS	YEAR OF PUBLICATION/ REPRINT
1.	Plant Biotechnology: Practical Manual by C.C. Giri, ArchanaGiri I. K. International Publications.	2007
2.	A Practical Manual For Plant Biotechnology by Tejovathi G, CBS Publishers and Distributors.	1996
3.	Plant Biotechnology: Laboratory Manual For Plant Biotechnology by H.S. Chawla, Oxford and IBH Publishing	2004

COURSE DETAILS: PLANT BIOTECHNOLOGY LAB	
S. No.	**LIST OF EXPERIMENTS**
1.	Preparation of Stocks solution for plant tissue culture media.
2.	Preparation of MS/B5 medium (semi-solid) and sterilization.
3.	Explant selection, preparation and surface sterilization.
4.	To learn culturing, sub culturing and maintenance using selected explants.
5.	Initiation of in vitro cultures through axillary bud induction.
6.	Initiation of callus cultures from different explants.
7.	Preparation of artificial seed/synthetic seed for conservation of germplasm.
8.	Extraction of DNA/RNA from plants and its estimation.
9.	Isolation and characterization of plant secondary metabolites from selected medicinal plants.
10.	Extraction of proteins from plants and its estimation.

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B.TECH III YEAR VI SEMESTER BIOTECHNOLOGY

SUBJECT CODE: KBT 653	**COURSE TITLE: BIOINFORMATICS II LAB**
EXAM DURATION: 2 HOURS	**SEMESTER: VI(EVEN)**
L: T: P :: 0 : 0: 2 CREDIT: 1	**PRE-REQUISITE:Bioinformatics theory course**

OBJECTIVE:

- To introduce the fundamental principles of bioinformatics
- To make them correlate theory and practical processes throughexperimentation.

COURSE OUTCOME:

After successful completion of this course, the students will be able to:

- Understand the basic software and tools used in structure prediction of biomolecules
- Conduct experimental procedure for Ramachandran plot and its analysis
- Construct and analyse of restriction maps, QSAR model and homology model
- Identify and structurally modify a natural product, to design a compound with the desired properties and to assess its therapeutic effects, theoretically .
- Enhance their practical knowledge and thus theiremployability

REFERENCE BOOKS

S.NO	NAME OF AUTHORS/BOOKS /PUBLISHERS	YEAR OF PUBLICATION/ REPRINT
1	Alphey L. DNA sequencing: from experimental methods to bioinformatics. BIOS scientific publishers Ltd; 1997.	1997
2	Iftekhar M, Ghalib MR. Bioinformatics Practical Manual	2015
3	Karthikeyan M, Vyas R. Practical chemoinformatics. Springer; 2014 May 6	2014
4	Brown FK. Chemoinformatics: what is it and how does it impact drug discovery. Annual reports in medicinal chemistry. 1998 Jan 1;33:375-84	1998

COURSE DETAILS: BIOINFORMATICS II LAB

S. No.	LIST OF EXPERIMENTS
1	Identification of Distantly related homologous sequences of a given query protein sequence using PSI-BLAST
2	Construct Phylogenetic tree of five evolutionary related protein/nucleotide sequences
3	Prediction of secondary structure of RNA using any web server.
4	Construction and analysis of Ramachandran Plot using any suitable web server
5	Align two homologous protein structure and calculation the RMSD for the superposition result
6	Comparative assessment of best available tools for genome annotation
7	Construction of restriction maps for various vectors used in genetic engineering using tool "NEB cutter".
8	Primer Design: Construct primers for the given DNA sequence using any suitable web based tool
9	Generate 2D QSAR model of a set of legend descriptor data