JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA – 533 003, Andhra Pradesh, India

INSTITUTE OF SCIENCE AND TECHNOLOGY

COURSE STRUCTURE & SYLLABUS

M.Tech BIO-TECHNOLOGY Programme

(Applicable for batches admitted from 2019-2020)

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA – 533 003, Andhra Pradesh, India

SEMESTER I

S.No	Course No	Category	Course Name	P.Os	L	T	P	C
1	BTI-1	Core1	Advanced Bioprocess Engineering		3	0	-	3
2	BTI-2	Core2	Immuno technology		3	0	-	3
3	BTI-3	Elective I	a) Protein Engineering		3	0	-	3
			b) Advances in Fermentation Technology & Downstream Processing					
			c) Tissue Engineering					
4	BTI-4	Elective II	a) Medical Biotechnology		3	0	-	3
			b)Modelling,Simulation and Optimization of Bioprocess					
			c) Biological treatment of waste water					
5	BTMC		Research Methodology and IPR		2	0	0	2
6	BTPI-1	Laboratory 1	Advanced Bioprocess & Downstream processing Laboratory		-	-	4	2
7	BTPI-2	Laboratory 2	Immunoechnology Laboratory		-	-	4	2
8	BTA-1	Audit Course –1	1. Manuscript writing and Editing 2. Disaster Management 3. Biosafety 4. Value Education 5. Constitution of India 6. Pedagogy Studies 7. Stress Management by Yoga 8. Road map for patent creation.		2	0	0	0
			Total Credits /Marks					**18**

SEMESTER II

S.No.	**Course No**	**Category**	**Course Name**	**P.Os**	**L**	**T**	**P**	**C**
1	BTII-1	Core 3	Molecular Biology & Genetic Engineering		3	0	--	3
2	BTII-2	Core 4	Systems Biology		3	0	--	3
3	BTII-3	Elective III	a) Advances in Bioinformatics		3	0	--	3
			b) Advancements in Bioreactor Design					
			c) Agriculture Biotechnology					
4	BTII-4	Elective IV	a) Membrane Biology & Signal Transduction		3	0	--	3
			b) Biofuels & Bioenergy					
			c) Advanced Biostatistics					
5	BTPII-1	Laboratory 3	Molecular Biology & Genetic Engineering Laboratory		--	--	4	2

6	BTPII-2	Laboratory 4	Bioinformatics laboratory		--	--	4	2
7	BTMP	Core	Mini Project With Seminar		0	0	4	2
8	BTA-2	Audit Course -2	1. Manuscript writing and Editing 2. Disaster Management 3. Biosafety 4. Value Education 5. Constitution of India 6. Pedagogy Studies 7. Stress Management by Yoga 8. Road map for patent creation		2	0	0	0
			Total Credits /Marks					**18**

SEMESTER III **

S.No	Course No	Category	Course Name	P.Os	L	T	P	C
1	BTIII-1	Elective-V	Elective /MOOCS/NPTEL		3	0	--	3
			a)Bioprocess Control and Instrumentation					
			b) Molecular Modelling and Drug Design					
			c) Bio nanotechnology					
2	BTIII-2	Open Elective	Open Elective / MOOCS 1. Business Analytics 2. Industrial Safety 3. Entrepreneurship essentials 4. Cost Management of Engineering Projects 5. Composite Materials 6. Waste to Energy		3	0	--	3
3	DISSERTATION	Core	Dissertation Phase-I / Industrial Project (To be continued and Evaluated next Semester)*		--	--	20	10
			Total Credits /Marks					**16**

*** Evaluated and displayed in 4th Semester marks list**

**** Students Going for Industrial Project / Thesis will complete these courses through MOOCS**

SEMESTER IV

S No.	Course No	Category	Course Name	P.Os	L	T	P	C
1	Dissertation	Core	Dissertation Phase II (Continued from III Semester)		0	0	32	16
			Total Credits /Marks					**16**

I Year - I Semester		L	T	P	C
		3	0	0	3
ADVANCED BIOPROCESS ENGINEERING					

UNIT I- INTRODUCTION

An overview of traditional and modern applications of biotechnology industry, outline of an integrated bioprocess and the various (upstream and downstream) unit operations involved in bioprocesses, generalized process flow sheets. Characteristic properties of biological fluids, Principles and mechanisms of thermal stabilization by filtration, Single and multiple bubbles aeration. On-ideality and RTD in Bioreactors, Analysis of multiple interacting microbial populations.

UNIT II- MEDIA DESIGN & STERILIZATION

Medium requirements for fermentation processes, Carbon, nitrogen, minerals, vitamins and other complex nutrients, oxygen requirements, Medium formulation for optimal growth and product formation, Examples of simple and complex media, Design and usage of various commercial media for industrial fermentations, Surface methodology, Response surface methodology, Plackett Burman Designs, Thermal death kinetics of microorganisms, Batch and continuous heat sterilization, Sterilization of liquid media, Filter sterilization of liquid media, Air. Design of sterilization equipment

UNIT III- MONITORING OF BIOREACTORS

On and off-line sensors for a modern bioreactor, Integrated systems of bioreaction, bioseparation biosensors, Characteristics of bio products, Flocculation and conditioning of broth, Mechanical separation, Filtration, Centrifugation and Membrane based separation; Cell disruption.

UNIT IV- RHEOLOGY

Unit operation and process in the Chemical Industry, Fluid statics and Dynamics, Bernoulli's equation, Newtonian and Non-Newtonian fluids, Materials and energy. Balance on reactive and non-reactive systems, Principles of momentum, Heat and Mass transfer.

UNIT V- STABILITY ANALYSIS

Stability analysis, Stability of recombinant cells, Physiology of immobilized cells, Packed-bed reactors, Fluidized-bed bioreactors, Air-lift bioreactors, Bubble-column bioreactors, Immobilized-enzyme bioreactors, Special reactors for animal and plant cells.

TEXTS BOOKS

1. M. L Shuler and F. Kargi., Bioprocess Engineering, 2nd edition, Prentice Hall Inc., 2002.
2. P.M. Doran, Bioprocess Engineering Principles, 2nd edition, acadamic press, 2012.
3. P. B. Kaufman, L. J. Cseke, S. Warber, J. A. Duke, and H. L. Brielmann, Natural Products from Plants, CRC Press LLC, 2005

REFERENCES

1. H. J. Rehm and G. Reed, Biotechnology-A multi- Volume Comprehensive Treatise, 2/e, Vol 6, Wiley-VCH, 2011.
2. M. Moo-Young, Comprehensive Biotechnology, Vol. 4, 1st edition Pergamon Press, 2011.
3. F. Dicosmo and M. Missawa, Plant Cell Culture Secondary Metabolism:

TowardsIndustrial Application. CRC LLC, 2006.

I Year - I Semester		L	T	P	C
		3	0	0	3
IMMUNOTECHNOLOGY					

UNIT- I IMMUNOLOGY- FUNDAMENTAL CONCEPTS AND ANATOMY OF THE IMMUNE SYSTEM

Components of innate and acquired immunity, Hematopoiesis, Organs and cells of the immune system, Phagocytosis, Inflammatory responses, Immunoglobulins-basic structure, Classes and subclasses of immunoglobulins, Immunoglobulin superfamily, Immunoglobulin gene organization and Generation of antibody diversity.

UNIT II- ANTIGENS AND ADAPTIVE IMMUNITY

Antigens and Immunogens, Factors affecting immunogenicity, Haptens and Adjuvants, B cell maturation, activation and differentiation, B-cell receptor, T-cell maturation, activation and differentiation and T-cell receptors. Major Histocompatibility Complex - MHC genes, Antigen processing and presentation- endogenous antigens, exogenous antigens, non-peptide bacterial antigens and super-antigens.

UNIT III- ANTIGEN-ANTIBODY INTERACTIONS

Affinity and Avidity, Precipitation, agglutination, Advanced immunological techniques - RIA, ELISA, Western blotting, ELISPOT assay, immunofluorescence, Flow cytometry and Immunoelectron microscopy, Cytokines-properties, receptors and therapeutic uses, Complement System.

UNIT IV- VACCINE TECHNOLOGY

Live, killed, attenuated, sub unit vaccines, Role recombinant DNA and protein based vaccines, Plant-based vaccines, Reverse vaccinology, Peptide vaccines, Conjugate vaccines, Hybridoma technology-Production of monoclonal antibodies, Antibody engineering- chimeric, Humanized antibodies, Phage Display library.

UNIT V- CLINICAL IMMUNOLOGY

Hypersensitivity – Types, Autoimmunity- Types of autoimmune diseases, Treatment of autoimmune diseases, Transplantation – Immunological basis of graft rejection, Clinical transplantation and immunosuppressive therapy, Tumor immunology – Tumor antigens, Immune response to tumors and tumor evasion of the immune system, Cancer immunotherapy, Immunodeficiency-Primary immunodeficiency's, Acquired or secondary immunodeficiency's.

TEXT BOOKS

1. Peter J. Delves,Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt Essential Immunology, 12 edition, Wiley-Blackwell, 2011.
2. Judy Owen, Jenni Punt , Sharon Stranford, Kuby Immunology, 7th Edition, W. H. Freeman, 2013.
3. Janeway et al., Immunobiology; 8 edition, Garland Science, 2011.
4. William E. Paul, Fundamental of Immunology, 7th edition, Lippincott Williams & Wilkins, 2012.
5. A. K. Chakravarthy, Immunology&Immunotechnology, 1st edition, Oxford University Press, 2006.

REFERENCES

1. Benjamin E and Leskowitz S, ELISA Immunological Techniques, 5edition, Wiley-Liss, 2003.
2. Abul Abbas and Lichman, Cellular Molecular Immunology; 1st edition; Saunders, 2011.

I Year - I Semester		L	T	P	C
		3	0	0	3
ELECTIVE-I: PROTEIN ENGINEERING					

UNIT I- PROTEIN STRUCTURAL FAMILIES

Introduction; Basic structural principles: amino acids and their conformational accessibilities, Ramachandran Plot, Motifs of protein structures and their packing, Schematic and topology diagrams, Families of protein structures: alpha, alpha/beta, beta small.

UNIT II- PROTEIN FOLDING AND ASSEMBLY

Protein folding pathways in prokaryotes and eukaryotes: Single and multiple folding pathways, Protein folding of single domain and multi-domain proteins, Inclusion bodies and recovery of active proteins; osmolyte assisted protein folding, Structure of chaperones and role of chaperones in protein folding.

UNIT III-PROTEIN ENGINEERING

Strategies for protein engineering; Random and site-directed mutagenesis, Various PCR based strategies, Role of low-fidelity enzymes in protein engineering, Gene shuffling and Directed evolution of proteins, Protein backbone changes, Strategies for protein engineering, Random and site-directed mutagenesis, Various PCR based strategies, Role of low-fidelity enzymes in protein engineering, Gene shuffling and Directed evolution of proteins, Protein backbone changes, Antibody engineering, All topics will deal with case studies.

UNIT IV-PREDICTION AND DESIGN OF PROTEIN STRUCTURES

Similar structure and function of homologous proteins, Role of multiple alignment; Homology and ab-initio method for protein structure prediction, Phage display systems, Structure based drug design and case studies, Rational protein design.

UNIT V- PROTEIN STRUCTURE ON THE WORLD WIDE WEB

Different databases for protein structure and their uses: PDB, SWISS PROT, BLASTp, KEGG, OMIM, Pfam, SCOP.

TEXT BOOKS

1. Introduction to Protein structure, 2nd Ed by Carl Branden and John Tooze, Garland Press, 1999.
2. Protein engineering in Industrial biotechnology, Ed. Lilia Alberghina, Harwood Academic Publishers, 2002.

REFERENCES

1. Structure and Mechanism in Protein Science, Alan Fersht, Freeman, 1999.

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I Year - I Semester		L	T	P	C
		3	0	0	3

ELECTIVE-I: ADVANCES IN FERMENTATION TECHNOLOGY & DOWNSTREAM PROCESSING

UNIT I- INTRODUCTION TO FERMENTATION TECHNOLOGY

Interaction between chemical engineering, Microbiology and Biochemistry, History of fermentation, Introduction to fermentation processes, Microbial culture selection for fermentation processes, Media formulation and process optimization.

UNIT II- REQUIREMENTS FOR FERMENTERS

Isolation, Preservation and Improvement of industrially important microorganisms, Media for industrial fermentations – media formulation, Development of inoculum for industrial fermentations, Gaden's Fermentation classification.

UNIT III- ENVIRONMENTAL CONCERNS ABOUT FERMENTATION

Environmental regulations and technology, laws and regulations, Technology (waste water), Waste water treatment strategy, Air (emissions of concerns), Selecting a Control Technology, Inorganics, and volatile Organic Compound Emission Control.

UNIT IV- DESIGN AND CONTROL OF FERMENTER

Fermenter design and types-basic functions of a Fermenter for microbial and animal cell culture – alternative vessel design, Common measurements and control systems. Sensors – solutions to common problems in fermentation, anaerobic fermentation, Computers in fermentation, modeling, Software sensors, Control and supervision of fermentation processes. – Off-line / online measurements – PID, Production of Organic Acids (Acetic acid and vinegar) its spoilage and prevention, Production of mushroom production, Vitamins- Vitamin B-2 and Riboflavin.

UNIT V- DOWNSTREAM PROCESSING

Fundamental principles of obtaining the product from cell cultures – intracellular vs. extracellular product, Cell disruption – mechanical, enzymatic, and chemical methods, Pre-treatment strategies, Removal and Recovery of cell mass (Precipitation, Filtration and Centrifugation). Purification of Product: Liquid-liquid extraction, Solvent Recovery. Chromatography: Adsorption, Ion-exchange, HPLC. Membrane processes: Ultrafiltration and Reverse Osmosis. Drying and Crystallization.

TEXT BOOKS

1. Fermentation microbiology and biotechnology. Ed. El-mansi. 3rd ed. 2012. Taylor and Francis.
2. Biotechnology: a textbook of industrial microbiology. Crueger and Crueger. 2nd ed.2003.Panima publications.
3. Stanbury P.F., Whitaker A. and Hall S.J (1997) - Principles of Fermentation Technology, Aditya Books Pub., Ltd., New Delhi.

REFERENCES

1. Prescott LM, Harley JP, Klein DA. Microbiology, Wm. C. Brown Publishers, 2013.
2. Davis BD, Dulbecco R, Eisen HN, Ginsberg HS. Microbiology, Harper Intl. Edition. 2005.
3. Pelczar MJ Jr., Chan ECS, Krieg NR. Microbiology, Tata Mc Graw Hill Publishing Co., 5th edition, 2004.
4. Tortora, Funke, Case, Microbiology – An Introduction, Benjamin-Cummings Publications, 12th edition, 2015.

I Year - I Semester		L	T	P	C
		3	0	0	3
ELECTIVE-I: TISSUE ENGINEERING					

UNIT I- INTRODUCTION

Introduction to tissue engineering and its challenges, sources of cells as therapeutic agents to restore the tissue function, Cells used to restore - mechanical defects, metabolic defects, synthetic defects, communication defects, combination defects. bone marrow transplantation, cell numbers and growth rate. Tissue organization, Tissue Components, Tissue types, Functional subunits. Tissue Dynamics, Dynamic states of tissues, Homeostasis in highly prolific tissues and Tissue repair. Angiogenesis. Cellular fate processes, Cell differentiation, Cell migration - underlying biochemical process.

UNIT II- CELL DIVISION AND SIGNAL PROCESSING

Cell division - mitotic cell cycle, Cell death - biological description of apoptosis. Coordination of cellular fate processes - soluble signals, types of growth factors and chemokines, sending and receiving a signal, processing a signal, integrated responses, soluble growth factor receptors, Malfunctions in soluble signaling.

UNIT III- CELL & ECM INTERACTIONS

Cell-extracellular matrix interactions - Binding to the ECM, Modifying the ECM, Malfunctions in ECM signaling. Direct Cell-Cell contact - Cell junctions in tissues, malfunctions in direct cell-cell contact signaling. Response to mechanical stimuli.

UNIT IV- CELL CHARACTERSTICS

Measurement of cell characteristics - cell morphology, cell number and viability, cell-fate processes, cell motility, cell function. Cell and tissue culture - types of tissue culture, media, culture environment and maintenance of cells in vitro, cryopreservation.

UNIT V- BIOMATERIALS AND BIOREACTORS

Biomaterials in tissue engineering - biodegradable polymers and polymer scaffold processing. Growth factor delivery, Stem cells. Bioreactors for Tissue Engineering.

TEXT BOOKS:

1. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, Sixth Edition, R. Ian Freshney, 2011
2. Stem Cell Biology, David Gottlieb, Cold Spring Harbor, 2002
3. Principles of Tissue Engineering, Robert Lanza, Robert Langer and Joseph Vacanti, Elsevier, 2013
4. Tissue Engineering, Academic Press, by Clemens van Blitterswijk, 2008

REFERENCES:

1. Essentials of Stem Cell Biology 3rd Edition, RobertLanza Anthony Atala, 2013

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I Year - I Semester		L	T	P	C
		3	0	0	3
ELECTIVE-II: MEDICAL BIOTECHNOLOGY					

UNIT I- CLASSIFICATION OF GENETIC DISEASES

Chromosomal disorders – Numerical disorders e.g. trisomies & monosomies, Structural disorders e.g. deletions, duplications, translocations & inversions, Chromosomal instability syndromes. Gene controlled diseases – Autosomal and X-linked disorders, Mitochondrial disorders.

UNIT II- PATHOGENESIS OF DISEASES

Pathogenesis of diseases like AIDS, Tuberculosis, Malaria, Cancer; Molecular mechanisms involved in pathogenesis, Diagnosis: Conventional, Molecular diagnosis – antibody based, PCR based; Antibiotics: Susceptibility, resistance and recent advances in antibiotics.

UNIT III- EPIDEMIOLOGY AND DISEASE MONITORING

Epidemiology and disease monitoring, Developmental stages in healthcare products: scientific, technical, legal ethical and social implications; Stages: Conceptualisation, R & D, Pre-clinical and clinical trials; production and marketing; Biosafety guidelines and containment facilities; computer aided statistics: STATVIEW, SPSS, STATISTICA, STATSOFT.

UNIT IV- OVERVIEW OF GENE THERAPY

Approaches, Clinical status, technical issues for gene therapy development; Viral & Non-viral vectors for gene therapy, regulations of human gene therapy.

UNIT V- APPLICATIONS

Biopharming, DNA vaccines; Edible vaccines; DNA fingerprinting; uses in forensic science, preventive medicine and evolution; Drug targeting, antisense oligonucleotides as drugs, biosensors.

TEXT BOOKS

1. Rehm HJ & Reed G, Biotechnology, Vol. 5a. Recombinant Proteins, monoclonal antibodies and therapeutic genes, Wiley – VCH, 2012.
2. **Banga, K.A** Therapeutic Peptides and Proteins: Formulation, Processing, and Delivery Systems, Third Edition, CRC Press, 2015.

REFERENCES

1. Biotechnology by U. Satyanarayana, 2013.

I Year - I Semester		L	T	P	C
		3	0	0	3
ELECTIVE-II: MODELLING, SIMULATION AND OPTIMIZATION OF BIOPROCESS					

4UNIT I- MODELLING PRINCIPLES

Modelling principles, use of models for understanding, design and optimization of bioreactors, general aspects of the modelling approach, general modelling procedure, simulation tools, uncertainty, and scenario and sensitivity analysis.

UNIT II- FORMULATION OF BALANCE EQUATIONS

Formulation of balance equations, types of mass balance equations, balancing procedure, continuous stirred tank bioreactor, tubular reactor, river with eddy current, component balances for reacting systems, constant volume continuous stirred tank reactor, semi-continuous reactor with volume change, steady-state oxygen balancing in fermentation, inert gas balance to calculate flow rates, stoichiometry, elemental balancing and the yield coefficient concept.

UNIT III- INFORMATION FOR BIOREACTOR MODELLING

Information for bioreactor modelling, batch operation, semi continuous or fed batch operation, continuous operation, summary and comparison, biological kinetics, michaelis-menten equation, other enzyme kinetic models, deactivation, sterilization, modelling of mutualism kinetics, kinetics of anaerobic degradation

UNIT IV- BIOREACTOR MODELLING

Bioreactor modelling, the batch fermenter, the chemostat, the fed batch fermenter, biomass productivity, modelling of tubular plug flow bioreactors, gas absorption with bioreaction in the liquid phase, liquid-liquid extraction with bioreaction in one phase, steady-state gas balance for the biological uptake rate, determination of $k_l a$ using the sulfite oxidation reaction determination of $k_l a$ by a dynamic method, model for oxygen gradients in a bubble column bioreactor , model for a multiple impeller fermenter.

UNIT V- SIMULATION EXAMPLES OF BIOLOGICAL REACTION PROCESSES USING BERKELEY MADONNA

Processes using berkeley madonna, batch fermentation (batferm), chemostat fermentation (chemo), fed batch fermentation (fedbat), kinetics of enzyme action (mmkinet), repeated fed batch culture (repfed), lineweaver-burk plot (lineweav), steady-state chemostat (chemosta), variable volume fermentation (varvol and varvold), penicillin fermentation using elemental balancing (penferm), fluidized bed recycle reactor (fbr).

TEXT BOOKS

1. I. J. Dunn, E. Heinzle, J. Ingham, J. E. Pfenosil “Biological Reaction Engineering: Dynamic Modelling Fundamentals with Simulation Examples” WILEY-VCH Verlag GmbH & Co. KGaA, Weinheitn ,2003
2. J.R. Leigh, Modeling and Control of fermentation Processes, Peter Peregrinus, London, 2000
3. Syam S. Sablani et al. Hand book of food and bioprocess modelling techniques, Taylor & Francis Group, LLC, 2006.

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I Year - I Semester		L	T	P	C
		3	0	0	3
ELECTIVE-II: BIOLOGICAL TREATMENT OF WASTE WATER					

UNIT I- ACTIVATED SLUDGE PROCESS-PROCESS ANALYSIS AND SELECTION
Characteristics of Activated Sludge (aerobic and anaerobic); Analysis of Data – Mass Balance Analysis, Reactors used in waste water treatment- Up Flow Anaerobic Sludge Blanket (UASB), Two-stage, Aerobic UNI Tank System (TSU- System, Route Zone Treatment, Submerged Aerobic Fixed Film (SAFF) Reactor, and Fluidized Aerobic Bio – Reactor (FAB).

UNIT II-AEROBIC FIXED FILM & ANAEROBIC TREATMENT PROCESSES
Biofilm process considerations, Trickling Filters and Biological Towers, Rotating Biological Contactors, Granular – Media Filters, Fluidized – Bed & Circulating Bed- Biofilm reactors. Hybrid Biofilm/suspended growth processes, Anaerobic Processes: Methanogenesis, process chemistry and microbiology, Process kinetics and factors for the design of anaerobic digesters.

UNIT III-ADVANCED WASTE WATER TREATMENT
Technologies used in advanced treatment – Classification of technologies, Removal of Colloids and suspended particles – Depth Filtration – Surface Filtration – Membrane Filtration Absorption – Ion Exchange – Advanced oxidation process - Activated Carbon, Air Stripping, Heavy Metals Removal, Steam Stripping, Chemical Precipitation, and Electrolysis.

UNIT IV-BIOLOGICAL PHOSPHORUS REMOVAL
Nitrification &Denitrification Processes**:** Biochemistry and Physiology of Nitrifying Bacteria, Common process considerations, One – sludge versus two sludge nitrification, Physiology of Denitrifying Bacteria, Tertiary Denitrification, One- sludge denitrification, Normal Phosphorus Uptake into Biomass, Mechanism for Biological Phosphorus Removal, Enhanced Biological Phosphorus Removal by Bacteria and Algae.

UNIT V-ENVIRONMENTAL CONCERNS & RECYCLING OF WASTES
Environmental regulations and technology- Regulatory Concerns, Technology, Laws, regulations and permits- Air, Water, Solid Waste, Environmental Auditing, National Environmental Policy act, Occupational Safety and Health Act (OSHA), Storm Water Regulations, Technology (waste water), Recycling of Industrial wastes : paper, plastics, leather and chemicals.

TEXT BOOKS

1. Wastewater Engineering: Treatment Disposal Reuse by Metcalf & Eddy, 5th edition, 2013.
2. Environmental Biotechnology: Principles and Applications, by Bruce E. Rittmann, 2012.
3. Waste water Engineering Treatment and Reuse: McGraw Hill, G. Tchobanoglous, FI Biston, 2002.

REFERENCES

1. Industrial Waste Water Management Treatment and Disposal by Waste Water McGraw Hill III Edition 2008.
2. Environmental Biotechnology: Principles and Applications by Bruce E. Rittmann, 2012.
3. Biological Wastewater Treatment by C. P. Leslie Grady, Glen T. Daigger, 2011.

I Year - I Semester		L	T	P	C
		2	0	0	2
RESEARCH METHODOLOGY AND IPR					

UNIT I- RESEARCH PROBLEM AND SCOPE FOR SOLUTION

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

UNIT II- FORMAT

Effective literature studies approaches, analysis, Plagiarism, Research ethics. Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

UNIT III- PROCESS AND DEVELOPMENT

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, patenting under PCT.

UNIT IV- PATENT RIGHTS

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

UNIT V- NEW DEVELOPMENTS IN IPR

New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

TEXT BOOKS

1. Stuart Melville and Wayne Goddard, “Research methodology: an introduction for science & engineering students”
2. Wayne Goddard and Stuart Melville, “Research Methodology: An Introduction”
3. Ranjit Kumar, 2nd Edition, “Research Methodology: A Step by Step Guide for beginners”

REFERENCES

1. Halbert, “Resisting Intellectual Property”, Taylor & Francis Ltd ,2007.
2. Mayall, “Industrial Design”, McGraw Hill, 1992.
3. Niebel, “Product Design”, McGraw Hill, 1974.
4. Asimov, “Introduction to Design”, Prentice Hall, 1962.
5. Robert P. Merges, Peter S. Menell, Mark A. Lemley, “ Intellectual Property in New Technological Age”, 2016.
6. T. Ramappa, “Intellectual Property Rights Under WTO”, S. Chand, 2008

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I Year - I Semester		L	T	P	C
		0	0	4	2

ADVANCED BIOPROCESS ENGINEERING & DOWNSTREAM PROCESSING LAB

1. Introduction to GLP guidelines pertaining to upstream and downstream processing.
2. Estimation of proteins by lowry method
3. Estimation of proteins by Bradford method
4. Cell Disruption by ultra sonication method.
5. Chromatographic Techniques.
6. Lab scale fermenter design and operational details.
7. Media formulation and sterilization methods for thermo stable and thermo labile media constituents.
8. Determination of doubling time of given culture.
9. Optimization of recovery process: centrifugation, filtration.
10. Determination of polarity / partition coefficient of bio molecule by aqueous two phase method.
11. Protein enrichment operation: salting out, organic solvent.
12. Protein Precipitation by ammonium sulphite
13. Lyophilisation.
14. SDS PAGE

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I Year - I Semester		L	T	P	C
		0	0	4	2
IMMUNOTECHNOLOGY LAB					

1. Hemocytometry Bleeding, Serum separation, Storage.
2. Antibody titre by ELISA method.
3. Double diffusion, Immuno-electrophoresis and Radial Immuno diffusion.
4. Blood smear identification of leucocytes by Giemsa stain
5. The Red cell count
6. Total leukocyte count
7. Blood grouping
8. Determination of hemato0crit
9. Blood grouping
10. Absolute eosinophil count
11. WIDAL Test
12. latex agglutination
13. Monoclonal antibody production/ IgG Purification from serum/ IgY Purification from Chicken egg.
14. SDS-PAGE.
15. Extraction of proteins by Two-phase separation (PEG 3000 & Ammonium sulphate or Organic solvents)
16. HPLC

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I Year - I Semester		L	T	P	C
		2	0	0	0
AUDIT COURSE 1: MANUSCRIPT WRITING AND EDITING					

UNIT I: INTRODUCTION

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

UNIT II: COMPONENTS

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction

UNIT III: REVIEW OF LITERATURE

Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check. key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature.

UNIT IV: SKILLS

skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

UNIT V: SUBMISSION

Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission

TEXT BOOKS:

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman'sbook.
4. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011

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I Year - I Semester		L	T	P	C
		2	0	0	0
AUDIT COURSE 1: DISASTER MANAGEMENT					

UNIT I- INTRODUCTION

Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types And Magnitude.

UNIT II- REPERCUSSIONS OF DISASTERS AND HAZARDS:

Economic Damage, Loss Of Human And Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

UNIT III- DISASTER PRONE AREAS IN INDIA

Study Of Seismic Zones; Areas Prone To Floods And Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics

UNIT IV- DISASTER PREPAREDNESS AND MANAGEMENT

Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological And Other Agencies, Media Reports: Governmental And Community Preparedness.

UNIT V- RISK ASSESSMENT

Disaster Risk: Concept And Elements, Disaster Risk Reduction, Global And National Disaster Risk Situation. Techniques Of Risk Assessment, Global Co-Operation In Risk Assessment And Warning, People's Participation In Risk Assessment. Strategies for Survival. Disaster Mitigation- Meaning, Concept And Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation And Non-Structural Mitigation, Programs Of Disaster Mitigation In India.

TEXT BOOKS

2. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company.

REFERENCES

1. Sahni, PardeepEt.Al. (Eds.)," Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi.

2 . Goel S. L., Disaster Administration And Management Text And Case Studies",Deep &Deep Publication Pvt. Ltd., New Delhi.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA – 533 003, Andhra Pradesh, India

I Year - I Semester		L	T	P	C
		2	0	0	0
AUDIT COURSE 1: BIOSAFETY					

UNIT I INTRODUCTION

Introduction to biotechnology entrepreneurship: strategies in biotechnology led ventures, biotechnology driven business opportunities, major hurdles and barriers in biotechnology driven ventures and their solutions,

UNIT II COST BUDGET AND INVEST

Understanding company Law and commercial knowhow for biotechnological ventures, costing and capital budgeting in biotechnological ventures. Investing in biotechnology driven business, concept of biotechnology incubation center for knowledge-based industry.

UNIT III INTELLECTUAL ISSUES

Biotechnology and Intellectual issues: Introduction to Biotechnology in agriculture, medicine and industry, Biotechnology and its development in developing countries, patent eligibility issues in life science innovations: case study, checks and balances in biotechnology related patents, the importance of entrepreneurship in biotechnology, Intellectual property issues in agriculture, industrial and Pharmaceutical Biotechnology.

UNIT IV BIOHAZARD IDENTIFICATION

Biohazard identification: microbial flora of human and microbial virulence factors, indigenous and pathogenic agents of research animals, laboratory, growth chamber and green house microbial safety,

UNIT V EPIDEMIOLOGY

Epidemiology of laboratory associated infections, biohazard assessment, risk assessment of biological hazards, biohazard control, administrative control, special considerations for Biosafety.

TEXT BOOKS:

1. Craig Shimasaki, Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies, Academic Press, 2014
2. James F. Jordan, Innovation, Commercialization, and Start-Ups in Life Sciences, CRC Press; 1 edition 2014
3. Frank S. David, The Pharmagellan Guide to Biotech Forecasting and Valuation, Pharmagellan; 1st edition, 2017
4. Harikesh Bahadur Singh, Intellectual Property Issues in Biotechnology, CABI 1st edition, 2016

5. Kshitij Kumar Singh, Biotechnology and Intellectual Property Rights: Legal and Social Implications, Springer Nature; 2015 edition
6. Matthew Rimmer, Intellectual Property & Biotechnology: Biological Inventions, Edward Elgar, 2008
7. Goel and Parashar, IPR, Biosafety and Bioethics, Pearson Education India; First edition 2013 Diane O. Fleming (Editor), Debra L. Hunt, Biological Safety: Principles And Practices, ASM Press, 4th Edition

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I Year - I Semester		L	T	P	C
		2	0	0	0
AUDIT COURSE 1: VALUE EDUCATION					

UNIT I- INTRODUCTION

Values and self-development –Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non- moral valuation. Standards and principles. Value judgements

UNIT II- VALUES

Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism.Love for nature,Discipline

UNIT III- PERONALITY DEVELOPMENT

Personality and Behavior Development - Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness. Avoid fault Thinking. Free from anger, Dignity of labour. Universal brotherhood and religious tolerance. True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature

UNIT IV- COMPETENCE

Character and Competence –Holy books vs Blind faith. Self-management and Good health. Science of reincarnation. Equality, Nonviolence,Humility, Role of Women.

UNIT V- IMPLEMENTATIONS

All religions and same message. Mind your Mind, Self-control. Honesty, Studying effectively

TEXT BOOKS

1. Chakroborty, S.K. “Values and Ethics for organizations Theory and practice”, Oxford University Press, New Delhi

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KAKINADA – 533 003, Andhra Pradesh, India

I Year - I Semester		L	T	P	C
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AUDIT COURSE 1: CONSTITUTION OF INDIA					

UNIT I- INTRODUCTION

History of Making of the Indian Constitution: History Drafting Committee, (Composition & Working**).** Philosophy of the Indian Constitution: Preamble Salient Features

UNIT II- CONTOURS OF CONSTITUTIONAL RIGHTS & DUTIES:

Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies Directive Principles of State Policy, Fundamental Duties.

UNIT III- ORGANS OF GOVERNANCE:

Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions

UNIT IV- LOCAL ADMINISTRATION:

District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. Pachayati raj: Introduction, PRI: ZilaPachayat. Elected officials and their roles, CEO ZilaPachayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy

UNIT V- ELECTION COMMISSION:

Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners. State Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and women.

TEXT BOOKS

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.

REFERENCES:

1. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

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KAKINADA – 533 003, Andhra Pradesh, India

I Year - I Semester		L	T	P	C
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AUDIT COURSE 1: PEDAGOGY STUDIES					

UNIT I- INTRODUCTION AND METHODOLOGY:
Aims and rationale, Policy background, Conceptual framework and terminology. Theories of learning, Curriculum, Teacher education. Conceptual framework, Research questions**.** Overview of methodology and Searching.

UNIT II- THEMATIC OVERVIEW
Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries. Curriculum, Teacher education.

UNIT III- EVIDENCE ON THE EFFECTIVENESS OF PEDAGOGICAL PRACTICES.
Methodology for the in depth stage: quality assessment of included studies. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? Theory of change. Strength and nature of the body of evidence for effective pedagogical practices. Pedagogic theory and pedagogical approaches. Teachers' attitudes and beliefs and Pedagogic strategies.

UNIT IV- PROFESSIONAL DEVELOPMENT:
Alignment with classroom practices and follow-up support.Peer support Support from the head teacher and the community. Curriculum and assessment. Barriers to learning: limited resources and large class sizes

UNIT V- RESEARCH GAPS AND FUTURE DIRECTIONS
Research design, Contexts, Pedagogy, Teacher education, Curriculum and assessment. Dissemination and research impact

TEXT BOOKS

1 Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.
3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282.

REFERENCES:
1. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
2. Chavan M (2003) Read India: A mass scale, rapid, 'learning to read' campaign.
3. www.pratham.org/images/resource%20working%20paper%202.pdf.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA – 533 003, Andhra Pradesh, India

I Year - I Semester		L	T	P	C
		2	0	0	0
AUDIT COURSE 1: STRESS MANAGEMENT BY YOGA					

UNIT I- INTRODUCTIONS
Definitions of Eight parts of yog. (Ashtanga)

UNIT II- PARTS
Yam and Niyam.

UNIT III- DO`S AND DON'T'S IN LIFE.
i) Ahinsa, satya, astheya, bramhacharya and aparigraha
ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan

UNIT IV- BREATHING EXERCISES
Asan and Pranayam

UNIT V- TYPES
i) Various yog poses and their benefits for mind & body
ii) Regularization of breathing techniques and its effects-Types of pranayam

TEXT BOOKS
1. 'Yogic Asanas for Group Tarining-Part-I" :Janardan Swami Yogabhyasi Mandal, Nagpur

REFERENCES:
1. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, AdvaitaAshrama (Publication Department), Kolkata

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I Year - I Semester		L	T	P	C
		2	0	0	0
AUDIT COURSE 1: ROAD MAP FOR PATENT CREATION					

UNIT I INTRODUCTION
Introduction to patent – Defination and concepts

UNIT II- ANALYTICS
Patent analytics- Introduction, How to a read patent?

UNIT III RESEARCH GAP AND PLANNING
Use of patent data for research gap analysis Identification of potential patent - various tools Research planning and patent -ling activity

UNIT IV TYPES AND MAINTENANCE
Types of patent and patent timelines Maintenance of laboratory notebook and patenting activity

UNIT V INTERACTIONS
Interaction with patent attorney at various stages of patenting and related timelines to be followed

TEXT BOOKS:
1. Petherbridge, L. (2007). Road map to revolution-patent-based open science. *Me. L. Rev.*, *59*, 339.

I Year - II Semester		L	T	P	C
		3	0	0	3
MOLECULAR BIOLOGY & GENETIC ENGINEERING					

UNIT I- BASIC CONCEPTS AND CLONING VECTORS IN GENETIC ENGINEERING

Prokaryotic and eukaryotic cells, Nuclear structure, nucleolus, nuclear transport and chromatin packing , Methods to manipulate protein, DNA and RNA and methods to visualize cells, Restriction Enzymes, DNA ligase, Klenow enzyme, T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphatase, Labeling of DNA: Nick translation, Random priming. Plasmids, Bacteriophages, M13 mp vectors, PUC19, Phagemids, Lambda vectors, Cosmids, Artificial chromosome vectors (YACs; BACs), Animal Virus derived vectors-SV-40, Plant based vectors: Ti as vectors, Yeast vectors, Shuttle vectors.

UNIT II- CLONING METHODOLOGIES

Ligation techniques: Cohesive and blunt end ligation; Linkers, Adaptors, Homopolymeric tailing, Southwestern and Far-western cloning, Gene transfer techniques: Cacl2 transformation, Electroporation, Liposome mediated transformation, Microinjection, Biolistic method. Selection of clones, Blue white screening, Colony in-situ hybridization, Insertional Inactivation, Eukaryotic Screening: Thymidine kinase method, Green fluorescent protein, Construction of libraries: c DNA and genomic libraries, cDNA and genomic cloning, Jumping /hopping libraries, Protein-protein interactive cloning and Yeast two hybrid system.

UNIT III- MANIPULATION OF GENE EXPRESSION AND HYBRIDIZATION TECHNIQUES

Promoter Selection, Ribosomal Binding Sites, Translational signals, Fusion Proteins, Codon Selection, O_2stress,tandemrepeats,proteinfolding,metabolic load, Protein purification, His-tag, GST-tag, Inclusion bodies-Methodologies to reduce formation of inclusion bodies, Northern, Southern, Western Blotting, Fluorescence, In situ hybridization, Heterologous protein production in eukaryotes-vectors,markers,promoters.

UNIT IV- PCR AND ITS APPLICATIONS

Types of PCR – multiplex, nested, reverse transcriptase, real time PCR, hot start PCR, colony PCR, cloning of PCR products, PCR in gene recombination, Deletion; addition, PCR in molecular diagnostics, Viral and bacterial detection, PCR based, mutagenesis, Mutation detection: SSCP, DGGE, RFLP, Oligo Ligation Assay (OLA), MCC (Mismatch Chemical Cleavage, ASA (Allele-Specific Amplification), PTT (Protein Truncation Test).

UNIT V- SEQUENCING METHODS AND GENE TECHNOLOGIES

DNA sequencing –chemical cleavage and Sanger's di-deoxy methods, Automated DNA sequencing, RNA sequencing, Site-specific and oligonucleotide directed mutagenesis, genetic diagnosis. DNA finger printing and their applications, gene therapy: Somatic cell gene therapy, Germline Gene therapy.

TEXT BOOKS

1. B. R. Glick and J. J. Pasternak, Molecular Biotechnology: Principles and Applications of Recombinant DNA, 3rdEdition, ASM Press, 2003.
2. S. Primrose, R. Twyman, B. Old, and G. Bertola, Principles of Gene Manipulation and Genomics, 7th Edition, Blackwel Publishing Limited, 2006.

REFERENCES

1. B. Alberts, A. Johnson, J. Lewis, M. Raff, K and R. P. Walter, Molecular Biology of the Cell, 4th Edition, Garland, 2002.
2. J. Hammond, P. Mc Garvey and V. Yusibov, Plant Biotechnology: New Products and Applications, 1stedition, Springer, 2010

I Year - II Semester		L	T	P	C
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SYSTEMS BIOLOGY					

UNIT I- SYSTEMS BIOLOGY

Fundamentals Overview of Gene Control –Working of Genetic Switches – Introductory Systems Biology The biochemical paradigm, genetic paradigm and the systems paradigm.

UNIT II- KINETICS

Equilibrium Binding and Co-operativity – Michaelis Menten Kinetics – identical and independent binding sites – Identical and interacting binding sites, non interacting binding sites. Genetic switch in Lambda Phage -Noise-based Switches and Amplifiers for Gene Expression. Synthetic genetic switches –Ecoli chemotaxis – biological oscillators- genetic oscillators -The Origin and Consequences of Noise in Biochemical Systems.

UNIT III- DEVELOPMENTAL SYSTEMS BIOLOGY

Building an Organism Starting From a Single Cell -Quorum Sensing – Programmed Population Control by Cell-Cell Communication and Regulated KillingDrosophila Development. Establishment of Developmental Precision and Proportions in the Early Drosophila embryo.

UNIT IV- DEVELOPMENTAL SYSTEMS BIOLOGY-II

Establishment of Developmental Precision and Proportions in the Early Drosophila embryo.

UNIT V- GENE EXPRESSION NETWORKS

Gene regulation at a single cell level- Transcription Networks -basic concepts -coherent Feed Forward Loop (FFL) and delay gate -The incoherent FFL - Temporal order, Signaling networks and neuron circuits -Aspects of multi-stability in gene networks.

TEXT BOOKS

1. Uri Alon, An Introduction to Systems Biology: Design Principles of Biological Circuits, Chapman & Hall/CRC Press, Mathematical and Computational Biology, 2nd edition, 2006.

I Year - II Semester		L	T	P	C
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ELECTIVE-III: ADVANCES IN BIOINFORMATICS					

UNIT I- INTRODUCTION

Introduction to Genomic data and Data Organization: Sequence Data Banks – Introduction to sequence data banks –protein sequence data bank, NBRF-PIR, SWISSPROT, Signal peptide data bank, Nucleic acid sequence data bank –GenBank, EMBL nucleotide sequence data bank, AIDS virus sequence data bank.

UNIT II- PROTEIN STRUCTURE PREDICTION

Fold libraries, Protein folding Fold recognition (threading), Protein structure predictions: Comparative modeling (Homology), Advanced topics, Protein ligand interactions, Molecular Modeling & Dynamics, Secondary Structure predictions, Prediction algorithms, Chao-Fausman algorithm, Hidden-Markov model, Neural Networking, Tertiary Structure predictions, Prediction algorithsms, Chao-Fausman algorithm.

UNIT III- PROTEOMICS

Introduction to proteomics and protein engineering - Protein pre-fractionation and sample preparation - Two dimensional electrophoresis (2-D PAGE)- Protein identification Post translational modification, Proteome analysis: The impact of stable isotope labeling: Sample preparation, 2-D gel separation and analysis, Mass spectrometry: protein identification using MS data, Gel matching, Protein chips and applications. Functional Proteomics tools.

UNIT IV- GENOMICS

Functional Genomics and analysis of gene expression- Reverse genetics, Comparing transcriptomes- subtractive hybridization, differential display, SAGE, Microarrays Genetic diseases in humans, Human Genome project, Genetic counseling, Genetics and society, Functional genomics tools, Functional Genomes-Pharmacogentics-Genomics in relation to molecular Diagnosis -Molecular Therapeutic technologies, Genomics in Biopharmaceutical Industry.

UNIT V- PHYLOGENY

Phylogeny: Concepts of systematic, Molecular evolution, Definition and Different types of phylogenetic trees, Dendograms and interpretations, phylogenetic analysis.

TEXT BOOKS

1. Lesk, Introduction to Bio Informatics, 3rd edition, OUP Oxford, 2013.
2. Attwood, Introduction to Bioinformatics, 1st edition, Pearson Education, 2007.

REFERENCES

1. H.D. Kumar, Molecular Biology, 2nd edition, Vikas Publishing House pvt ltd, 2001.
2. B.Alberts,D.Bray, J.Lewis et al, Molecular Biology of the Cell, 5th edition Garland Pub. N.Y, 2010.
3. S.Sahai, Genomics and Proteomics, "Functional and Computational Aspects, 2nd edition, Plenum Publications, 2011.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA – 533 003, Andhra Pradesh, India

I Year - II Semester		L	T	P	C
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ELECTIVE-III: ADVANCEMENTS IN BIOREACTOR DESIGN					

UNIT I- INTRODUCTION

Bioreactor function, utility, types of Bioreactors. Modes of Bioreactor operations, Main components of the Bioreactor and their function. Introduction Methods of Aeration, Surface Aeration, shake flasks, Mechanical stirred Bioreactors, Enzyme catalysis in CSTR. Cell death in batch reactor, endogenous metabolism, maintenance, product and substrate inhibition on chemostat.

UNIT II- BIOREACTORS AND DESIGN FEATURES

Batch reactor, chemostat CSTR, Plug flow Reactor, Fed batch Reactor, Bubble column, Bubble generation at an orifice, bubble coalescence and breakup, gas holdup, interfacial area, immobile and mobile gas liquid interface, regimes of bubbles, design of bubble columns, Cascade Reactor, air lift reactor, Fluidized bed bioreactors, trickle bed reactors, immobilized bioreactors, recycle bioreactors.

UNIT III- GAS-LIQUID MASS TRANSFER IN CELLULAR SYSTEMS

Basic mass transfer concepts, solubility of gases (O_2, CO_2) in biological media, mass balances for two- phase Bioreactor. Mass transfer-introduction to mass transfer between phases, mass transfer in porous solids, quantifying mass transfer, mass transfer & experimental design, oxygen transfer process, factor effecting kLa, Determination of oxygen transfer rates- static method, Dynamic method, Chemical method and Electrochemical method, correlations with kLa in Newtonian and non-Newtonian liquid.

UNIT IV- MASS TRANSFER

Mass transfer for freely rising or falling bodies, forced convection mass transfer, Mass transfer in agitated tanks ,power requirements for sparged and agitated non agitated tanks for Newtonian and Non Newtonian fluid, mass transfer across free surfaces, Heat transfer correlations thermal death kinetics of microorganisms, batch and continuous heatsterilization, sterilization of liquid media, filter sterilization of liquid media, Air. Design of sterilization equipment batch and continuous.

UNITV-AERATIONANDAGITATIONINANIMALCELLBIOREACTORS

Introduction, cell damage in animal cell bioreactors, shear damage, bubble damage, methods of minimizing cell damage. Laminar & Turbulent flow in stirred tank bioreactors, turbulent eddies, kolmogrov eddy size, preventing vortex formation, off centre impellers, Baffles. Control of bioreactor, strategy, online and offline monitoring of bioreactors, computerized bioprocess control, scaling up and scale down of mass transfer equipment and bioprocess, Direct regulatory control and cascade control mechanism. Bioprocess design considerations for plant and animal cell cultures.

TEXT BOOKS

1. Bailey JE, Ollis DF, Biochemical Engineering fundamentals, 2nded, Tata McGraw-Hill Education 2010.
2. Blanch HW and Clark DS, Biochemical Engineering Marcel Decker, 2nded,CRC Press, 1997.
3. DG Rao, Introduction to Biochemical Engineering, 2nded, Tata Mc Graw Hill, 2010.

REFFERENCES

1. Wiseman A, Handbook of Enzyme Biotechnology, 1st ed, Pharma Med Press/BSP Books Year of Publication 2010.
2. Moser A, Bioprocess technology, kinetics and reactors; 1st ed, Springer,Year of Publication 2011.
3. Schugerl K: Bellagart K H;Bioreaction Engineering, Modeling and control, 1st edition, Springer, year of Publication 2003
4. Pauline M DORAN, Bioprocess engineering, 2nded, Elsevier India, Year of Publication 2012.

I Year - II Semester		L	T	P	C
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ELECTIVE-III: AGRICULTURE BIOTECHNOLOGY					

UNIT I INTRODUCTION

An introduction, role of biofertilizers and bio-pesticides in sustainable agriculture. Mass cultivation of microbial inoculants, plant growth promoting rhizobacteria, diazotrophic microorganism.

UNIT II MOLECULAR ASPECTS

Free living and symbiotic nitrogen fixing microbes, Molecular basis of legume *rhizobium* symbiosis. Molecular aspects of abiotic stress responses and genetic engineering for drought, salinity and Temperature.

UNIT III GENES FOR RESISTANCE

Insect resistance – bt genes. Structure and function of cry proteins – mechanism of action, critical evaluation of its impact on insect control. Non -bt like protease inhibitors, alpha amylase inhibitors and lectins. Virus resistance – coat protein mediated, nucleocapsid gene and RNAi approach.

UNIT IV FUNGAL RESISTANCE

Fungal resistance – PR proteins-1- chitinase, -3 beta glucanases. Nematode resistance - Nematode infestation and engineering for nematode resistance. Long shelf-life of fruits and flowers: use of ACC synthase, polygalacturanase, ACC oxidase. Male sterile lines: barstar and barnase systems. Genetic improvement of nutritional quality of oils-Molecular approaches, Molecular Pharming,

UNIT V ETHICS IN BIOTECHNOLOGY

Biotechnology and Society – Social, ethical and legal aspects of Biotechnology and national level policies on Biotechnology. Implications of Biotechnology on health, environment, food and sustainable agriculture. Regulatory mechanisms in releasing GMOs. Plant breeders rights

TEXT BOOKS:

1. Agricultural Biotechnology by Arie Altman. Marcel Dekker, Inc. 2012
2. S.B. Primrose. 1994. Molecular Biotechnology (2nd Edn), Blackwell ScietificPub. Oxford.
3. J.A. Davies and WS Reznikoff. 1992. Milestones in Biotechnology. Classic papers on Genetic Engineering.Butterworth-Heinemann, Boston, 1992.
4. D. Balasubramanian 2005. Concepts of Biotechnology new edition..
5. A. Old and S.B. Primrose. 2002. Principles of Gene Manipulation by Blackwell, Oxford

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA – 533 003, Andhra Pradesh, India

I Year - II Semester		L	T	P	C
		3	0	0	3
ELECTIVE-IV: MEMBRANE BIOLOGY AND SIGNAL TRANSDUCTION					

UNIT I-MEMRANE STRUCTURE

Structure of biological membranes, lipids and lipid modification, membrane proteins, transmembrane proteins, pumps, channels, transporters, receptors.

UNIT II-TRANSPORT OF PROTEINS

Passive transport – facilitated diffusion, uniport, symport, antiport. Active transport. Artificial membrane –liposome and erythrocyte ghost.

UNIT III- CELL CYCLE REGULATION

Regulation of mitosis, Meiosis, Cell cycle checkpoints, Protein modifications and intracellular transport, glycosylation, vesicular transport, receptor mediated endocytosis, lysosomes, organelle biogenesis, Protein modifications and intracellular transport.

UNIT IV-SIGNAL TRANSDUCTION

Detailed molecular mechanisms, Nerve cells, ion channels, synapse, Ca^{++} regulated events, Immunity and host pathogen interactions, actin-myosin cytoskeleton, extracellular matrix, stem cells and cloning.

UNIT V- SIGNALLING PATHWAYS

G Protein Coupled Receptor Signaling, Receptor and Non-Receptor Tyrosine Kinases, Serine / Threonine Kinase Coupled Receptors, Mitogen-Activated Protein Kinases, Phospholipid Mediated Signaling, Nuclear Receptors, Ions and ion channels, Redox Signaling.

TEXT BOOKS

1. Signal Transduction. 2014. Cold Spring Harbor Laboratory Press. Lewis Cantley, Tony Thunter, Richard Sever and Jeremy Thorner.
2. Molecular Biology of the Cell. 2014. Garland Science. Bruce Alberts and Alexander Johnson
3. Cellular Signaling Processing. 2008. Garland Science. Friedrich Marks, Ursula Klingmuller and Karin Muller-Decker.

REFERENCES

1. Biochemistry of Signal Transduction and Regulation. 2014. Wiley-VCH. Gerhard Krauss. 2009
2. Signal Transduction. Academic Press. Bastien D. Gomperts, Ijsbrand M. Kramer and Peter E. R. Tatham.2015

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I Year - II Semester		L	T	P	C
		3	0	0	3
ELECTIVE-IV: BIOFUELS AND BIOENERGY					

UNIT I- INTRODUCTION TO BIOETHANOL PRODUCTION

Historical Development of Bioethanol as a Fuel, Starch as a Carbon Substrate for Bioethanol Production, The Promise of Lignocellulosic Biomass, Thermodynamic and Environmental Aspects of Ethanol as a Biofuel, Effects on emissions of greenhouse gases and other pollutants, Ethanol as a First-Generation Biofuel: Present Status and Future Prospects Chemistry, Biochemistry, and Microbiology of Lignocellulosic Biomass, Biomass as an Energy Source.

UNIT II- CELLULASES AND ITS ROLE IN ETHANOL PRODUCTION

Cellulases: Biochemistry, Molecular Biology, and Biotechnology, Enzymology of cellulose degradation by cellulases, Cellulases in lignocellulosic feedstock processing, Molecular biology and biotechnology of cellulase production, Hemicellulases: New Horizons in Energy Biotechnology, A multiplicity of hemicellulases, Hemicellulases in the processing of lignocellulosic biomass, Lignin-Degrading Enzymes as Aids in Saccharification,

UNIT III- BIOTECHNOLOGY OF BIOETHANOL PRODUCTION FROM LIGNO-CELLULOSIC FEEDSTOCKS

Traditional Ethanologenic Microbes, Yeasts, Bacteria, Metabolic Engineering of Novel Ethanologens, Comparison of industrial and laboratory yeast strains for ethanol production, Improved ethanol production by naturally pentose-utilizing yeasts, Assembling Gene Arrays in Bacteria for Ethanol Production, Metabolic routes in bacteria for sugar metabolism and ethanol formation, Genetic and metabolic engineering of bacteria for bioethanol production

UNIT IV-BIOCHEMICAL ENGINEERING AND BIOPROCESS MANAGEMENT FOR FUEL ETHANOL

Biomass Substrate Provision and Pretreatment, Wheat straw — new approaches to complete saccharification, Switchgrass, Corn stover, Softwoods, Sugarcane bagasse, Other large-scale agricultural and forestry, biomass feedstocks, Fermentation Media and the “Very High Gravity” Concept, Fermentation media for bioethanol production, Highly concentrated media developed for alcohol fermentations, Fermenter Design and Novel Fermenter Technologies, Continuous fermentations for ethanol production, Fed-batch fermentations, Immobilized yeast and bacterial cell production designs, Contamination events and buildup in fuel ethanol plants

UNIT V- GENETIC MANIPULATION OF PLANTS FOR BIO ETHANOL PRODUCTION

Bioengineering increased crop yield, Optimizing traits for energy crops intended for biofuel production, Genetic engineering of dual-use food plants and dedicated energy crops,Vegetable oils and chemically processed biofuels, Biodiesel composition and production processes, Biodiesel economics, Energetics of biodiesel production and effects on greenhouse gas emissions and Issues.

TEXT BOOKS

1. David M. Mousdale, Biofuel-Biotechnology, Chemistry, and sustainable Development, 1st Ed., CRC Press Taylor & Francis Group, 2008.
2. AyhanDemirbas, Green Energy and Technology, Biofuels, Securing the Planet's Future Energy Needs, 1st edition, Springer, 2009.

REFERENCES

1. P.M. Doran, Bioprocess Engineering Principles, 2nd edition, acadamic press, 2012

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I Year - II Semester		L	T	P	C
		3	0	0	3
ELECTIVE-IV: ADVANCED BIOSTATISTICS					

UNIT I- INTRODUCTION

Introduction to the course, Data representation and plotting, Arithmetic mean, Geometric mean, Measure of Variability, Standard deviation. SME

UNIT II- PROGRAMMING

Z-Score, Box plot, Kurtosis, R programming, R programming, Correlation. Correlation and Regression, Interpolation and extrapolation, Nonlinear data fitting,

UNIT III- PROBABILITY

Concept of Probability: introduction and basics. Counting principle, Permutations, and Combinations, Conditional probability, Conditional probability and Random variables, Random variables, Probability mass function, and Probability density function,

UNIT IV- DISTRIBUTIONS

Expectation, Variance and Covariance. Expectation, Variance and Covariance, Binomial random variables and Moment generating function, Probability distribution: Poisson distribution and Uniform distribution, Uniform distribution and Normal distribution, Normal distribution and Exponential distribution. Sampling distributions and Central limit theorem.

UNIT V- ANALYSIS

Central limit theorem Part-III and Sampling distributions of sample mean, Central limit theorem - IV and Con-dence intervals, Con-dence intervals Part- II. Test of Hypothesis - 1, Test of Hypothesis - 2 (1 tailed and 2 tailed Test of Hypothesis, p-value) - (Type -1 and Type -2 error), T-test. 1 tailed and 2 tailed T-distribution, Chi-square test, ANOVA, ANOVA for linear regression, Block Design

TEXT BOOKS:

1. Fundamentals of Biostatistics. by Irfan A Khan.
2. An introduction to Biostatistics. by PSS Sunder Rao.
3. Introduction to the Practice of Statistics by Moore and McCabe

REFERENCES:

1. Principles of Biostatistics. Marcello Pagano.
2. Course Manuals: S-PLUS Command Line Essentials, The Analysis of Microarrays.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA – 533 003, Andhra Pradesh, India

I Year - II Semester		L	T	P	C
		0	0	4	2
MOLECULAR BIOLOGY & GENETIC ENGINEERING LAB					

1. Isolation of plant DNA by CTAB method
2. Isolation of plasmid DNA from bacteria
3. Isolation of genomic DNA from bacteria
4. Primer Designing
5. Amplification of bacterial gene by PCR
6. Isolation of human DNA from blood
7. Cloning of amplified gene to pUC 18 or pUC 19 plasmid
8. Transformation of recombinant clone to bacteria
9. Recombinant screening of clone (blue white screening or colony PCR)
10. Restriction Digestion
11. Transformation of DNA to Yeast cell
12. ELISA
13. Analysis of reporter gene expression by enzymatic assay
14. Western blot

I Year - II Semester		L	T	P	C
		0	0	4	2
BIOINFORMATICS LAB					

1. Identification of biologically relevant protein using PSI – BLAST.
2. Database similarity search using WU – BLAST.
3. Genome annotation using ARTEMIS.
4. Protein homology modeling by Swiss Model.
5. Construction of phylogenetic tree by phylodraw.
6. Microarray Data Analysis.
7. Clustering, Biclustering Techniques for gene functional analysis.
8. Sequence and Genome Analysis.
9. Gene Network Analysis.
10. Protein Structure classification.

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I Year - II Semester		L	T	P	C
		0	0	4	2
MINIPROJECT WITH SEMINAR					

The mini projects ensures preparedness of students to undertake major projects/dissertation.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
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I Year - II Semester		L	T	P	C
		2	0	0	0
AUDIT COURSE 2: MANUSCRIPT WRITING AND EDITING					

UNIT I: INTRODUCTION

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

UNIT II: COMPONENTS

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction

UNIT III: REVIEW OF LITERATURE

Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check. key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature.

UNIT IV: SKILLS

skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

UNIT V: SUBMISSION

Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission

TEXT BOOKS:

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman'sbook.
4. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011

I Year - II Semester		L	T	P	C
		2	0	0	0
AUDIT COURSE 2: DISASTER MANAGEMENT					

UNIT I- INTRODUCTION

Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types And Magnitude.

UNIT II- REPERCUSSIONS OF DISASTERS AND HAZARDS:

Economic Damage, Loss Of Human And Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

UNIT III- DISASTER PRONE AREAS IN INDIA

Study Of Seismic Zones; Areas Prone To Floods And Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics

UNIT IV- DISASTER PREPAREDNESS AND MANAGEMENT

Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological And Other Agencies, Media Reports: Governmental And Community Preparedness.

UNIT V- RISK ASSESSMENT

Disaster Risk: Concept And Elements, Disaster Risk Reduction, Global And National Disaster Risk Situation. Techniques Of Risk Assessment, Global Co-Operation In Risk Assessment And Warning, People's Participation In Risk Assessment. Strategies for Survival. Disaster Mitigation- Meaning, Concept And Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation And Non-Structural Mitigation, Programs Of Disaster Mitigation In India.

TEXT BOOKS

3. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company.

REFERENCES

1. Sahni, PardeepEt.Al. (Eds.)," Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi.

2 . Goel S. L., Disaster Administration And Management Text And Case Studies",Deep &Deep Publication Pvt. Ltd., New Delhi.

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I Year - II Semester		L	T	P	C
		2	0	0	0
AUDIT COURSE 2: BIOSAFETY					

UNIT I INTRODUCTION

Introduction to biotechnology entrepreneurship: strategies in biotechnology led ventures, biotechnology driven business opportunities, major hurdles and barriers in biotechnology driven ventures and their solutions,

UNIT II COST BUDGET AND INVEST

Understanding company Law and commercial knowhow for biotechnological ventures, costing and capital budgeting in biotechnological ventures. Investing in biotechnology driven business, concept of biotechnology incubation center for knowledge-based industry.

UNIT III INTELLECTUAL ISSUES

Biotechnology and Intellectual issues: Introduction to Biotechnology in agriculture, medicine and industry, Biotechnology and its development in developing countries, patent eligibility issues in life science innovations: case study, checks and balances in biotechnology related patents, the importance of entrepreneurship in biotechnology, Intellectual property issues in agriculture, industrial and Pharmaceutical Biotechnology.

UNIT IV BIOHAZARD IDENTIFICATION

Biohazard identification: microbial flora of human and microbial virulence factors, indigenous and pathogenic agents of research animals, laboratory, growth chamber and green house microbial safety,

UNIT V EPIDEMIOLOGY

Epidemiology of laboratory associated infections, biohazard assessment, risk assessment of biological hazards, biohazard control, administrative control, special considerations for Biosafety.

TEXT BOOKS:

1. Craig Shimasaki, Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies, Academic Press, 2014
2. James F. Jordan, Innovation, Commercialization, and Start-Ups in Life Sciences, CRC Press; 1 edition 2014
3. Frank S. David, The Pharmagellan Guide to Biotech Forecasting and Valuation, Pharmagellan; 1st edition, 2017
4. Harikesh Bahadur Singh, Intellectual Property Issues in Biotechnology, CABI 1st edition, 2016
5. Kshitij Kumar Singh, Biotechnology and Intellectual Property Rights: Legal and Social Implications, Springer Nature; 2015 edition
6. Matthew Rimmer, Intellectual Property & Biotechnology: Biological Inventions, Edward Elgar, 2008
7. Goel and Parashar, IPR, Biosafety and Bioethics, Pearson Education India; First edition 2013 Diane O. Fleming (Editor), Debra L. Hunt, Biological Safety: Principles And Practices, ASM Press, 4th Edition

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA – 533 003, Andhra Pradesh, India

I Year - II Semester		L	T	P	C
		2	0	0	0
AUDIT COURSE 2: VALUE EDUCATION					

UNIT I- INTRODUCTION

Values and self-development –Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non- moral valuation. Standards and principles. Value judgements

UNIT II- VALUES

Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism.Love for nature,Discipline

UNIT III- PERONALITY DEVELOPMENT

Personality and Behavior Development - Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness. Avoid fault Thinking. Free from anger, Dignity of labour. Universal brotherhood and religious tolerance. True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature

UNIT IV- COMPETENCE

Character and Competence –Holy books vs Blind faith. Self-management and Good health. Science of reincarnation. Equality, Nonviolence,Humility, Role of Women.

UNIT V- IMPLEMENTATIONS

All religions and same message. Mind your Mind, Self-control. Honesty, Studying effectively

TEXT BOOKS

1. Chakroborty, S.K. “Values and Ethics for organizations Theory and practice”, Oxford University Press, New Delhi

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I Year - II Semester		L	T	P	C
		2	0	0	0
AUDIT COURSE 2: CONSTITUTION OF INDIA					

UNIT I- INTRODUCTION

History of Making of the Indian Constitution: History Drafting Committee, (Composition & Working**).** Philosophy of the Indian Constitution: Preamble Salient Features

UNIT II- CONTOURS OF CONSTITUTIONAL RIGHTS & DUTIES:

Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies Directive Principles of State Policy, Fundamental Duties.

UNIT III- ORGANS OF GOVERNANCE:

Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions

UNIT IV- LOCAL ADMINISTRATION:

District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. Pachayati raj: Introduction, PRI: ZilaPachayat. Elected officials and their roles, CEO ZilaPachayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy

UNIT V- ELECTION COMMISSION:

Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners. State Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and women.

TEXT BOOKS

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.

REFERENCES:

2. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA – 533 003, Andhra Pradesh, India

I Year - II Semester		L	T	P	C
		2	0	0	0
AUDIT COURSE 2: PEDAGOGY STUDIES					

UNIT I- INTRODUCTION AND METHODOLOGY:

Aims and rationale, Policy background, Conceptual framework and terminology. Theories of learning, Curriculum, Teacher education. Conceptual framework, Research questions**.** Overview of methodology and Searching.

UNIT II- THEMATIC OVERVIEW

Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries. Curriculum, Teacher education.

UNIT III- EVIDENCE ON THE EFFECTIVENESS OF PEDAGOGICAL PRACTICES.

Methodology for the in depth stage: quality assessment of included studies. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? Theory of change. Strength and nature of the body of evidence for effective pedagogical practices. Pedagogic theory and pedagogical approaches. Teachers' attitudes and beliefs and Pedagogic strategies.

UNIT IV- PROFESSIONAL DEVELOPMENT:

Alignment with classroom practices and follow-up support.Peer support Support from the head teacher and the community. Curriculum and assessment. Barriers to learning: limited resources and large class sizes

UNIT V- RESEARCH GAPS AND FUTURE DIRECTIONS

Research design, Contexts, Pedagogy, Teacher education, Curriculum and assessment. Dissemination and research impact

TEXT BOOKS

1 Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.

2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.

3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID.

4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282.

REFERENCES:

1. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.

2. Chavan M (2003) Read India: A mass scale, rapid, 'learning to read' campaign.

3. www.pratham.org/images/resource%20working%20paper%202.pdf.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA – 533 003, Andhra Pradesh, India

I Year - II Semester		L	T	P	C
		2	0	0	0
AUDIT COURSE 2: STRESS MANAGEMENT BY YOGA					

UNIT I- INTRODUCTIONS
Definitions of Eight parts of yog. (Ashtanga)

UNIT II- PARTS
Yam and Niyam.

UNIT III- DO`S AND DON'T'S IN LIFE.
i) Ahinsa, satya, astheya, bramhacharya and aparigraha
ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan

UNIT IV- BREATHING EXERCISES
Asan and Pranayam

UNIT V- TYPES
i) Various yog poses and their benefits for mind & body
ii) Regularization of breathing techniques and its effects-Types of pranayam

TEXT BOOKS
1. 'Yogic Asanas for Group Tarining-Part-I" :Janardan Swami Yogabhyasi Mandal, Nagpur

REFERENCES:
1. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, AdvaitaAshrama (Publication Department), Kolkata

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KAKINADA – 533 003, Andhra Pradesh, India

I Year - II Semester		L	T	P	C
		2	0	0	0
AUDIT COURSE 2: ROAD MAP FOR PATENT CREATION					

UNIT I INTRODUCTION
Introduction to patent – Defination and concepts

UNIT II- ANALYTICS
Patent analytics- Introduction, How to a read patent?

UNIT III RESEARCH GAP AND PLANNING
Use of patent data for research gap analysis Identification of potential patent - various tools Research planning and patent -ling activity

UNIT IV TYPES AND MAINTENANCE
Types of patent and patent timelines Maintenance of laboratory notebook and patenting activity

UNIT V INTERACTIONS
Interaction with patent attorney at various stages of patenting and related timelines to be followed

TEXT BOOKS:
1. Petherbridge, L. (2007). Road map to revolution-patent-based open science. *Me. L. Rev.*, *59*, 339.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
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II Year - I Semester		L	T	P	C
		3	0	0	3
ELECTIVE-V: BIOPROCESS CONTROL AND INSTRUMENTATION					

UNIT I- INTRODUCTORY CONCEPTS:

Representative process control problems -Liquid Surge Tank, Blending Process. Incentives for Chemical Process Control. Classification of variables and design elements of a control system.

UNIT II- MODELING CONSIDERATIONS:

Rationale for process modeling. General modeling principles; balance equations - mass, energy, momentum; Thermodynamics and reaction kinetics; degrees of freedom analysis. State variables, State equations; input-output models. Lumped and distributed parameter systems. Steady state and dynamic behavior. Examples – liquid serge tank, isothermal chemical reactor.

UNIT III- DYNAMIC BEHAVIOR OF CHEMICAL PROCESSES:

Solving algebraic equations and integration of ODEs. Concept of nonlinearity; linearization of nonlinear processes; deviation variables. Concept of Laplace Transform (LT); the LT of basic functions - step, impulse, pulse, ramp, exponential, integral, derivative, time delay; initial and final value theorems. Solution of differential equation using LT techniques - Partial fraction expansion, direct division. Transfer function of Single Input Single Output (SISO) process; Transfer function matrix of Multi Input Multi Output (MIMO) process. Properties of transfer function; Poles and Zeros of a transfer function; stability issues, unstable and non minimum phase behavior. Dynamic response of a first order process, first order plus dead time process, second order process, pure capacitive process, pure dead time, higher order process; inverse response; Padé approximation. Interacting and non-interacting processes. Development of Empirical model - Model development using linear and nonlinear regression, fitting first and second order models using step test results. Frequency response analysis - Bode and Nyquist plot.

UNIT IV- FEEDBACK CONTROLLER:

Introduction to feedback control. Elements of Control loop - controller, measuring device, final control element, transmission lines, transducers, transmitters, block diagram. Concept of servo and regulatory problems. Selection of measured, manipulated and controlled variables.

UNIT V- FEEDBACK CONTROLLER II:

Types of controller - P, PI, PID, on-off. Effects of proportional, integral and derivative actions. Notion of stability - characteristic equation, RouthHurwitz criteria, root-locus analysis. Design of feedback controller - performance criteria, controller tuning methods, Cohen-Coon method, 1/4th 12 decay ratio method, direct synthesis methods, gain and phase margins, Ziegler-Nichols method, Bode & Nyquist stability criteria, robustness analysis. Compensation for large dead time and inverse response, Smith Predictor.

TEXT BOOKS:

1. Stephanopoulos, G., " Chemical Process Control: An Introduction to Theory and Practice ", Prentice-Hall, New Jersey, 1984.
2. Coughanowr, D. R. and L. B. Koppel, " Process systems Analysis and Control ", Mc-Graw-Hill, 2nd. Ed., 1991.
3. Luyben, W. L.," Process Modelling Simulation and Control for Chemical Engineers ", McGraw Hill, 1990.

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II Year - I Semester		L	T	P	C
		3	0	0	3
ELECTIVE-V: MOLECULAR MODELLING & DRUG DESIGN					

UNIT I- QUANTUM MECHANICS & CONCEPTS IN MOLECULAR MODELING

Introduction – coordinate systems – potential energy surfaces – introduction to quantum mechanics – postulates – Schrodinger wave equation - Time independent Perturbation theory – hydrogen molecule – Born-Oppenheimer approximation,Huckel molecular orbital theory

UNIT II- MOLECULAR MECHANICS AND ENERGY MINIMIZATION

Empirical force field models – Bond stretching – angle bending – torsional term – Nonbonding interactions – The hydrogen bond, hydrophobic effect and solvation energy, Introduction to Force fields. – derived and non-derived energy minimization method - Parameterization of a force field, polarizable force fields, steepest descent method – conjugate gradient method.

UNIT III- MOLECULAR DYNAMICS & MOLECULAR DOCKING

Introduction to Molecular Dynamics, Density Functional Theory, Molecular Dynamics at Constant Temperature and Pressure. Metropolis Method. Monte Carlo Simulation of Molecules.Introduction to molecular docking, Rigid docking, Flexible docking, manual docking, Scoring Functions, Simple Interaction Energies

UNIT IV- HOMOLOGY MODELING & PHARMACOPHORE

Comparative modeling of proteins – comparison of 3D structure – Homology, steps in homology modeling, tools, databases, side chain modeling, loop modeling. Pharmacophores - Validation and Usage, Automated Pharmacophore Generation Methods, Pharmacophores for Hit Identification, Pharmacophores for Human ADME/Tox-related Proteins.

UNIT V- DRUG DESIGN

Stages of drug discovery, identification, validation and diversity of drug targets, Molecular recognition in Ligand- Protein Binding. Structure – Based and Ligand – Based Drug Design. Binding site identification. Forces involved in Drug- Receptor Interaction. Receptor polymorphism

TEXT BOOKS

1. A. R.Leach - Molecular Modeling Principles and Application, 2nd edition, Longman Publications, 2001
2. Textbook of Drug Design and Discovery, Fourth Edition, Author: PovlKrogsgaard-Larsen, Ulf Madsen, Kristian Stromgaard. 2009
3. Modern methods of drug discovery: 1st edition. Hillisch, A., and Hilgenfeld, R. E. J. Wood. 2003

REFERENCES

1. Modern Biopharmaceuticals: Design, Development and Optimization, 1st edition, Editor(s): JorgKnablein. Wiley – VCH, 2005.
2. Satya Prakash Gupta, QSAR and Molecular Modeling, Springer - Anamaya Publishers, 2008

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KAKINADA – 533 003, Andhra Pradesh, India

II Year - I Semester		L	T	P	C
		3	0	0	3
ELECTIVE-V: BIONANOTECHNOLOGY					

UNIT I- INTRODUCTION

Introduction to Nano Biotechnology**:** Background and Definition of Nano biotechnology-Significance. Supramolecular Chemistry: Definition and examples of main intermolecular forces used in supramolecular chemistry. Self-assembly processes in organic systems. Main supra molecular structures.

UNIT II- NANO SCALED BIOMOLECULES

Chemical approaches to nano structured materials-Molecular Building Blocks to Nanostructures. Nano scaled Biomolecules-Nucleic Acids and Proteins. Chemical Synthesis of Artificial Nanostructures. Structural Control to Designed Properties and Functions. Molecular nano scale engineered devices.

UNIT III- NANOFABRICATION

Nanofabrication: Introduction, Basic techniques, MEMS fabrication techniques, nanofabrication techniques-Equipment and processes needed to fabricate nano devices and structures such as bio-chips.

UNIT IV- NANO ENGINEERING SYSTEMS

Biologically-Inspired nanotechnology basic biological concepts and principles for the development of nano engineering system.

UNIT V- INSTRUMENTATION

Instrumentation for nanoscale characterization, Instrumentation required for characterization of properties on the nanometer scale, the technique, with an emphasis on measurements in the nanometer range.

TEXT BOOKS

1. Jean-Marie Lehn, Supramolecular Chemistry, 1st edition, Wiley VCH, 2006.
2. Ramesh Malothu, Nanotechnology: Biomedical Applications,Siri Publicatins,2015
3. Jonathan Steed & Jerry Atwood, Supramolecular Chemistry, 2nd edition, John Wiley & Sons, 2009.
4. Jacob Israelachvil, Intermolecular and Surface Forces, 3rd edition, Academic Press, London, 2011.

REFERENCES

1. Good Sell, BioNano Technology, 1st edition, Wiley Liss Publications, 2004.
2. Charles. P.Poole Jr and Frank J. Owens Introduction to Nanotechnology, 1st edition, Wiley India Pvt Ltd, 2003.

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II Year - I Semester		L	T	P	C
		3	0	0	3
OPEN ELECTIVE: BUSINESS ANALYTICS					

UNIT I- INTRODUCTION

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

UNIT II- LIFE CYCLES

Life Cycles: Systems Development Life Cycles, Project Life Cycles, Product Life Cycles, Requirement Life Cycles.

UNIT III- REQUIREMENTS

Forming Requirements: Overview of Requirements, Attributes of Good Requirements, Types of Requirements, Requirement Sources, Gathering Requirements from Stakeholders, Common Requirements Documents.

UNIT IV- TRANSFORMING REQUIREMENTS

Transforming Requirements: Stakeholder Needs Analysis, Decomposition Analysis, Additive/Subtractive Analysis, Gap Analysis, Notations (UML & BPMN), Flowcharts, Swim Lane Flowcharts, Entity-Relationship Diagrams, State-Transition Diagrams, Data Flow Diagrams, Use Case Modeling, Business Process Modeling

UNIT V- FINALIZING REQUIREMENTS

Finalizing Requirements: Presenting Requirements, Socializing Requirements and Gaining Acceptance, Prioritizing Requirements. Managing Requirements Assets: Change Control, Requirements Tools. Recent Trands in: Embedded and colleborative business intelligence, Visual data recovery, Data Storytelling and Data Journalism.

TEXT BOOKS

1. Business Analysis by James Cadle et a2. Wayne Goddard and Stuart Melville, “Research Methodology: An Introduction”

REFERENCES

1. Project Management: The Managerial Process by Erik Larson and, Clifford Gray

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II Year - I Semester		L	T	P	C
		3	0	0	3
OPEN ELECTIVE: INDUSTRIAL SAFETY					

UNIT I- INDUSTRIAL SAFETY:
Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

UNIT II- FUNDAMENTALS OF MAINTENANCE ENGINEERING:
Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

UNIT III- WEAR AND CORROSION AND THEIR PREVENTION:
Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

UNIT IV- FAULT TRACING:
Fault tracing-concept and importance, decision treeconcept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic,automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

UNIT V- PERIODIC AND PREVENTIVE MAINTENANCE:
Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

TEXT BOOKS

1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.
2. Maintenance Engineering, H. P. Garg, S. Chand and Company.

REFERENCES

1. Pump-hydraulic Compressors, Audels, Mcgrew Hill Publication.
2. Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London.

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II Year - I Semester		L	T	P	C
		3	0	0	3
OPEN ELECTIVE: ENTREPRENEURSHIP ESSENTIALS					

UNIT I-

Defination, Innovation and entrepreneurship, Contributions of entrepreneurs to the society, risk-opportunities perspective and mitigation of risks. Corporate entrepreneurship or intrapreneurship

UNIT II-

Opportunity Identification, factors determining competitive advantage, Market segment, market structure, blue ocean strategy, Marketing research, Demand-supply analysis

UNIT III-

Value proposition, Business Model Canvas, Developing an Elective Business Model, Legal forms of business. Design Thinking, Design-Driven Innovation, TRIZ (Theory of Inventive Problem Solving), Zero-based design, Systems thinking, SPRINT Lean product development, Lean entrepreneurship, Lean manufacturing, Go-to-market strategy

UNIT IV-

Balance team and its importance, Recruiting early employees, Writing a business plan, Pitching. Preparing financial statements, analysis of opportunities based on financials, break-even & margin of safety analysis

UNIT V-

Government incentives for entrepreneurship, Incubation, acceleration, Funding new ventures, Legal aspects of business

TEXT BOOKS

1. Hisrich R., Peters M.P. Shepherd D.A. (2008) Entrepreneurship McGraw hill. New Delhi
2. Wickham (2001) Strategic Entrepreneurship Prentice Hall: Harlow
3. Zimmerer, T.W. Scarrborough, N.M. and Wilson, D. (2008) Essentials of Entrepreneurship and Small Business Management – Pearson and Prentice Hall. New Jersey.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA – 533 003, Andhra Pradesh, India

II Year - I Semester		L	T	P	C
		3	0	0	3
OPEN ELECTIVE: COST MANAGEMENT OF ENGINEERING PROJECTS					

UNIT I- INTRODUCTION

Introduction and Overview of the Strategic Cost Management Process

UNIT II- COST CONCEPTS IN DECISION-MAKING

Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision- Making.

UNIT III- PROJECT

Meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities. Detailed Engineering activities. Pre project execution main clearances and documents Project team: Role of each member. Importance Project site: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process

UNIT IV- COST BEHAVIOR AND PROFIT PLANNING MARGINAL COSTING

Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector. Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints. Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.

UNIT V- TECHNIQUES FOR COST MANAGEMENT

Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.

TEXT BOOKS

1. Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi
2. Charles T. Horngren and George Foster, Advanced Management Accounting
3. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting

REFERENCES

1. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher
2. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd.

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II Year - I Semester		L	T	P	C
		3	0	0	3
OPEN ELECTIVE: COMPOSITE MATERIALS					

UNIT I- INTRODUCTION

Definition – Classification and characteristics of Composite materials. Advantages and application of composites. Functional requirements of reinforcement and matrix. Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

UNIT II- REINFORCEMENTS

Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers. Properties and applications of whiskers, particle reinforcements. Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures. Isostrain and Isostress conditions.

UNIT III- MANUFACTURING OF METAL MATRIX COMPOSITES

Casting – Solid State diffusion technique, Cladding – Hot isostatic pressing. Properties and applications. Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving. Properties and applications.

UNIT IV- MANUFACTURING OF POLYMER MATRIX COMPOSITES

Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding. Properties and applications.

UNIT V- STRENGTH

Strength: Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

TEXT BOOKS

1. Material Science and Technology – Vol 13 – Composites by R.W.Cahn – VCH, West Germany.
2. Materials Science and Engineering, An introduction. WD Callister, Jr., Adapted by R. Balasubramaniam, John Wiley & Sons, NY, Indian edition, 2007.

REFERENCES

1. Hand Book of Composite Materials-ed-Lubin.
2. Composite Materials – K.K.Chawla.
3. Composite Materials Science and Applications – Deborah D.L. Chung.
4. Composite Materials Design and Applications – Danial Gay, Suong V. Hoa, and Stephen W. Tasi.

II Year - I Semester		L	T	P	C
		3	0	0	3
OPEN ELECTIVE: WASTE TO ENERGY					

UNIT I INTRODUCTION TO ENERGY FROM WASTE

Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors

UNIT II BIOMASS PYROLYSIS

Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods – Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

UNIT III BIOMASS GASIFICATION

Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

UNIT IV BIOMASS COMBUSTION

Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

UNIT V BIOGAS

Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion – Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion – Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.

TEXT BOOKS

1. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
2. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.

REFERENCES

1. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.

II Year - I Semester		L	T	P	C
		0	0	20	10
DISSERTATION					

*** Evaluated and displayed in 4th Semester marks list**

**** Students Going for Industrial Project / Thesis will complete these courses through MOOCS**

The dissertation/major project work of PG programme of one-year duration is given strong weight age in the curriculum. It is expected to undertake industrially relevant problem to develop an optimal solution through extensive research work. The students and faculty can design the research project in consultant with industry preferably in the region. The planning of laboratory work/ modelling/ computational work with execution schedule is suggested at the being of the programme to ensure expected outcome. This will lead to creation of patents from the result of the programme.

II Year - II Semester		**L**	**T**	**P**	**C**
		0	**0**	**32**	**16**
DISSERTATION					

The dissertation/major project work of PG programme of one-year duration is given strong weight age in the curriculum. It is expected to undertake industrially relevant problem to develop an optimal solution through extensive research work. The students and faculty can design the research project in consultant with industry preferably in the region. The planning of laboratory work/ modelling/ computational work with execution schedule is suggested at the being of the programme to ensure expected outcome. This will lead to creation of patents from the result of the programme.