B TECH in BIOTECHNOLOGY

THIRD SEMESTER

Year	Sub. Code	Subject Name	L	T	P	C
	MAT 2153	Engineering Mathematics – III	2	1	0	3
	BIO 2151	Biochemistry	3	1	0	4
	BIO 2152	Bioprocess calculations	3	1	0	4
II	BIO 2153	Cell Biology	2	1		3
	BIO 2154	Fluid flow operations	3	1	0	4
	BIO 2155	Microbiology	2	1	0	3
	BIO 2161	Biochemistry lab	0	0	6	2
	BIO 2162	Microbiology lab	0	0	3	1
			15	6	9	24
		Total Contact Hours (L + T + P)		30		

FOURTH SEMESTER

Sub. Code	Subject Name	L	T	P	C
MAT 2254	Engineering Mathematics – IV	2	1	0	3
BIO 2251	Chemical and Biochemical Engineering Thermodynamics	3	1	0	4
BIO 2252	Downstream processes	3	1	0	4
BIO 2253	Molecular Biology & Genetic Engineering	3	1	0	4
BIO 2254	Principles of Heat and Mass transfer operations	3	1	0	4
*** *****	Open Elective – I				3
BIO 2261	Molecular Biology and Genetic Engineering Lab	0	0	3	1
BIO 2262	Unit Operations Lab	0	0	3	1
		14	5	6	24
	Total Contact Hours (L + T + P) + OE		25 + 3 = 28		

FIFTH SEMESTER

Year	Sub. Code	Subject Name	L	T	P	C
	HUM 3151	Engg Economics and Financial Management	2	1	0	3
	BIO 3151	Bioinformatics	3	1	0	4
	BIO 3152	Bioprocess Engineering	2	1	0	3
III	BIO 3153	Bioreaction Engineering	3	1	0	4
	BIO 3154	Separation processes	3	1	0	4
	*** *****	Open Elective – II				3
	BIO 3161	Bioinformatics lab	0	0	6	2
	BIO 3162	Downstream and separation processes lab	0	0	3	1
			13	5	9	24
		Total Contact Hours (L + T + P) + OE		27 + 3 = 30		

SIXTH SEMESTER

Sub. Code	Subject Name	L	T	P	C
HUM 3152	Essentials of Management	2	1	0	3
BIO 3251	Animal Plant Biotechnology and Bioethics	3	1	0	4
BIO 3252	Bioprocess control and instrumentation	2	1	0	3
BIO ****	Program Elective - I	2	1	0	3
BIO ****	Program Elective - II	2	1	0	3
*** *****	Open Elective – III				3
BIO 3261	Animal,Plant Biotechnology and Bioprocess Engineering lab	0	0	6	2
BIO 3262	Bioreaction Engineering and Bioprocess control Lab	0	0	6	2
		11	5	12	23
	Total Contact Hours (L + T + P) + OE		28 + 3 = 31		

SEVENTH SEMESTER

Year	Sub. Code	Subject Name	L	T	P	C
	BIO ****	Program Elective - III	3	0	0	3
	BIO ****	Program Elective - IV	3	0	0	3
IV	BIO ****	Program Elective - V	3	0	0	3
	BIO ****	Program Elective - VI	3	0	0	3
	BIO ****	Program Elective - VII	3	0	0	3
	*** *****	Open Elective – IV				3
			15	0	0	18
		Total Contact Hours (L + T + P) + OE		15 + 3 = 18		

EIGHTH SEMESTER

Sub. Code	Subject Name	L	T	P	C
BIO 4298	Industrial Training				1
BIO 4299	Project Work/ Practice School				12
BIO 4296	Project Work (Only for B.Tech honour Students)				20
					13

I. Environmental Biotechnology
BIO 4051: Bioremediation
BIO 4052: Design of Biological Treatment Processes
BIO 4053: Microbial Treatment of Wastewater
BIO 4054: Solid Waste Management

II. Pharmaceutical Biotechnology
BIO 4055: Biomaterials
BIO 4056: Biopharmaceutical Engineering
BIO 4057: Immunotechnology
BIO 4058: Molecular Modeling & Drug Design

III. Material Science
PHY 4051: Physics of Low Dimensional Materials
PHY 4052: Physics of Photonic & Energy Storage Devices
CHM 4051: Chemical Bonding
CHM 4052: Chemistry of Carbon Compound

IV. Business Management
HUM 4051: Financial Management
HUM 4052: Human Resource Management
HUM 4053: Marketing Management
HUM 4054: Operation Management

V. Computational Mathematics
MAT 4051: Applied Statistics and Time Series Analysis
MAT 4052: Computational Linear Algebra
MAT 4053: Computational Probability and Design of Experiments
MAT 4054: Graphs and Matrices

Program Electives
BIO 4059: Advanced Bioprocess Engineering
BIO 4060: Biofuels Engineering
BIO 4061: Bioprocess Equipment Design
BIO 4062: Biosensors
BIO 4063: Biostatics and Design of Experiments
BIO 4064: Computational Biology
BIO 4065: Food process Engineering and Technology
BIO 4066: Genomics and Proteomics
BIO 4067: Health Diagnostics
BIO 4068: Metabolic Engineering
BIO 4069: Bioprocess Modelling and Simulation in Biotechnology
BIO 4070: Protein Engineering
BIO 4071: Solid State Fermentation
BIO 4072: Genetics and Applications

Open Electives
BIO 4301: Biological Databases and Biological Data Mining
BIO 4302: Introduction to Biofuels & Biopolymers
BIO 4303: Introduction to Bioinformatics

THIRD SEMESTER

MAT 2153: ENGINEERING MATHEMATICS III [2 1 0 3]
Periodic Functions, odd and even functions, Euler's formulae. Half range expansions, Harmonic analysis. Fourier integrals & transforms, Parseval's identity. Functions of complex variable. Analytic function, C-R equations, differentiation, Integration of complex function, Cauchy's integral formula. Taylor's and Laurent Series, Singular points, Residues, Cauchy's residue theorem. Conformal mappings, bilinear transformations. Gradient, divergence and curl, their physical meaning and vector identities. Line, surface and volume integrals. Green's theorem, divergence and Stokes' theorem, applications. Formation, solutions of equations involving derivatives with respect to one variable only. Solutions by indicated transformations and separation of Variables. Derivation of one dimensional wave equation (vibrating string) and its solution by using the method of separation of Variables. D'Alembert's solution of wave equation. Derivation of one dimensional heat equation using Gauss divergence theorem and solution of one dimensional heat equation. Solution by separation of variables.
References:
1. Erwin Kreyszig. Advanced Engineering Mathematics, (7e), Wiley & Sons Inc.,1993
2. Murray R. Spiegel. Vector Analysis, (2e), Schaum Publishing Co., 2009
3. B.S.Grewal. Higher Engg. Mathematics, (43e), Khanna Publishers, 2014
4. Ramana B.V. Engineering Mathematics, (2e), Tata McGraw Hill, 2007

BIO 2151: BIOCHEMISTRY [3 1 0 4]
Introduction to biochemistry and human biology, Classification of organisms according to their source of energy, Biochemical evolution, Urey-Miller experiment, Molecular organization in the cell, Organic molecules used by living systems, Molecular evolution in vitro – Sol Spiegelman's experiment, RNA as catalysts, The Genetic code, Amino acids, Proteins, Protein structure (primary to higher level). Enzymes: role, specificity and regulation, Carbohydrates, Classification, Bioenergetics, Burning food, Conserving energy for biological needs, by using coupled reactions, Lipids, Classification and metabolism, Metabolism of Nucleic acids, ATP as an energy currency, Citric acid cycle and oxidative phosphorylation, Metabolic pathways, catabolic and anabolic. Glycolysis, Flow of carbon, nitrogen and energy through interconnected pathways.
References:
1. Lehninger, A. L., Nelson, D. L. 1., & Cox, M. M. Lehninger principles of biochemistry (5e). New York ; New Delhi: W.H. Freeman; 2008.
2. Jeremy M Berg, John L Tymoczko, and Lubert Stryer. Biochemistry, (5e). New York: W H Freeman; 2002.
3. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter (Eds) Molecular Biology of the cell (5e), Garland Science, 2008.

BIO 2152: BIOPROCESS CALCULATIONS [3 1 0 4]
Bioprocess Development: An Interdisciplinary Challenge , Biotechnology and Bioprocess Engineering, Biologist and Engineers differ in their approach to research, Introduction to Engineering Calculations, Physical Variables, Dimensions and Units, Unit conversion, Pressure, Standard Conditions and Ideal Gases, Presentation and Analysis of Data, plotting graphs using excel, Stoichiometry of microbial growth and product formation, Steady state material balances, Law of Conservation of Mass, Material Balances With Recycle, By-Pass and Purge Streams, Basic Energy Concepts, Intensive and Extensive Properties, General Energy-Balance Equations, Procedure For Energy-Balance Calculations Without Reaction, Energy-Balance Equation For Cell Culture, Unsteady-State Material-Balance Equations, Unsteady-State Energy-Balance Equation

References:
1. Pauline Doran. Bioprocess Engineering Principles. Academic Press, 1995
2. David M. Himmelblau. Basic Principles and Calculations in Chemical Engineering. Prentice Hall of India (P) Ltd, 2012

BIO 2153: CELL BIOLOGY [2 1 0 3]

Introduction to cell chemistry and biosynthesis, Visualizing cells, Sexual reproduction: Meiosis, The cell cycle, Germ Cells and Fertilization, Development of Multicellular Organism, Specialized Tissues, Stem Cells, and Tissue Renewal, Membrane structure, Transport of small molecules and the electrical properties of membranes, Intracellular compartments and protein sorting, Intracellular vesicular traffic, The cytoskeleton, Apoptosis, Cell junctions, Cell Adhesion, and the Extracellular Matrix, Mechanisms of cell communication, Uncontrolled cell division- Cancer.

References:
1. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter (Eds) Molecular Biology of the cell (5e), Garland Science, 2008.
2. Harvey Lodish, Arnold Berk , Chris A. Kaiser, Monty Krieger, Anthony Bretscher, Hidde Ploegh, Angelika Amon, Kelsey C. Martin. Molecular cell biology, (8e). Scientific American Books, W. H. Freeman, New York, 2016

BIO 2154: FLUID FLOW OPERATIONS [3 1 0 4]

Review of fluid statics, fluid dynamics. Basic equations of fluid flow – continuity equation, Bernoulli's equation. Reynolds number and friction factor, Hagen Poiseuille equation. Flow past immersed bodies – boundary layer. Flow through a bed of solids – Ergun, Kozeny Carmen and Blake Plumer equation. Agitation and mixing of liquids. Transportation and metering of fluid. Dimensional analysis and similitude

References:
1. McCabe & Smith. Unit Operations of Chemical Engineering. McGraw Hill, 1993
2. Coulson and Richardson. Chemical Engineering, Vol. I. ELBS, 2001

BIO 2155: MICROBIOLOGY [2 1 0 3]

Introduction to Prokaryotes and Eukaryotes. Microbiological Techniques – Study of microscopes, Various sterilization techniques. Functions and Replication of Bacteria, Viruses, Fungi, Algae, Protozoans. Common diseases caused by microbes. Microbial insecticides, Microbial enzymes, Microbial polysaccharides. Microbial spoilage of food, food preservatives and food borne infections. Biofertilizers – Nitrogen fixing organisms.

References:
1. Pelczar, Chan and Kreig. Microbiology. W C Brown Pub, 1998
2. Presscot and Dunn. Industrial Microbiology. CBS Publishers, 2004

BIO 2161: BIOCHEMISTRY LAB [0 0 6 2]

This laboratory deals with both qualitative and quantitative analysis of biomolecules such as carbohdrates, proteins, lipids and nucleic acids. The estimation of carbohydrates is done qualitatively by Osazone test and the reducing sugars are analysed using Dinitrosalicylic acid (DNS) method. Besides, the estimation of glucose is done by both DNS method as well as by enzymatic (GOD/POD) method. Simple polysaccharides such as starch is estimated by Iodine method. The specific activity of amylase is also done. Proteins are estimated by Lowry's and Bradford's methods. Amino acids are estimated by Sorenson's titrimetric method. Estimation of cholesterol by Zak's method, and spectrophotometric detection of DNA/RNA are also introduced.

References:
1. Albert Lehninger. Principles of Biochemistry. CBS Publishers. 1996
2. Voet and Voet. Biochemistry. Wiley. 2005

BIO 2162: MICROBIOLOGY LAB [0 0 3 1]

Experiments are based on the preparation of broth and agar media for the growth of bacterial species. Pure culture techniques (streak, pour and spread) are taught to isolate and sub-culture a specimen obtained from natural sources. Experiments are also designed to learn how to stain and view different types of microbes using a compound microscope. A basic set of biochemical tests are also performed to identify and differentiate between certain microbial classes. A biochemical test is also conducted to check the extent of contamination of a milk sample.

References:
1. David Friefelder. Molecular Biology. Jones and Bartlett Publishers Inc. 1987
2. Benjamin Lewin. Genes VII. Oxford University Press. 2003

FOURTH SEMESTER

MAT 2254: ENGINEERING MATHEMATICS – IV [2 1 0 3]

Formation of Linear Programming problem, Graphical method, Simplex method, Penalty cost and two phase methods. Finite sample spaces, conditional probability and independence, Bayes' theorem. One dimensional random variable, mean, variance, Chebyshev's inequality. Two and higher dimensional random variables, covariance, correlation coefficient, regression, least squares principles of curve fitting. Binomial, Poisson, uniform, normal, gamma, Chi-square and exponential. Finite difference expressions for first and second order derivatives (ordinary and partial).Solution of BVP's in ODE. Classification of second order linear partial differential equations. Numerical solutions of two dimensional Laplace and Poisson equations by standard five point formula. Solution of one dimensional heat and wave equations by explicit methods. Crank-Nicolson method. Finite element method, Introduction, simple applications. Difference equations representing physical systems, the z transforms, properties of z transforms, initial and final value theorems, solution of difference equations by the method of z transforms, convolution theorem.

References:
1. Kreyzig E. Advanced Engineering Mathematics, 7th Edition, John Wiley & Sons, Inc., 1993
2. Meyer P.L. Introduction to probability and Statistical applications, (2e), American Publishing Co., 1970
3. Hamdy A Taha. Operation research, (7e), Pearson Education, Inc., 2002
4. Grewal B.S. Higher Engineering Mathematics, (3e), Khanna Publishers, 2014
5. Sastry S.S. Introductory methods for Numerical Analysis, (5e), PHI Learning Private Limited., 2012

BIO 2251: CHEMICAL AND BIOCHEMICAL ENGINEERING THERMODYNAMICS [3 1 0 4]

Introduction – Scope and definition, First law of Thermodynamics, Joule and Joule-Thomson Coefficient. Definition of enthalpy, different thermodynamic processes, Second law of thermodynamics – Statements of second law, Carnot's engine, entropy, entropy change of ideal gas. Thermodynamic properties of fluid – Property relations for homogenous phases, Solution thermodynamics – Fundamental property relation, Chemical potential and Phase Equilibria, Partial molal properties. Ideal gas mixtures, Fugacity, Activity, residual and excess properties. Single component two phase system, two component phase equilibrium. Chemical reaction equilibrium – Reaction Co-ordinate, Standard Gibb's Energy change and Equilibrium constant. Colligative Properties of solutions: freezing point depression, boiling point elevation, Vapor pressure lowering, osmotic pressure. Thermodynamics of Biochemical reactions – Free energy calculations

References:
1. J.M. Smith, H.C. Van Ness and M.M. Abbott. Introduction to Chemical Engineering Thermodynamics, McGraw Hill International (7e) 2010

2. Silbey, Alberty, Bawendi. Physical Chemistry, Wiley India (4e), 2004
3. Donald T. Haynie. Biological Thermodynamics, Cambridge University Press, 2001

BIO 2252: DOWNSTREAM PROCESSES [3 1 0 4]

Role, importance and economics of downstream processing in biotechnological processes; Process design criteria for various classes of bio-products; Different methods of cell disruption–Advantages & Disadvantages; Removal of insoluble, biomass and particulate debris separation; Membrane based separations (Micro-and Ultra-filtration) theory; design and configuration of membrane separation equipment and applications; Precipitation methods with salts, organic solvents, and polymers; colloidal stability of protein solutions; kinetics of protein aggregation; Liquid – liquid extraction of bioproduct and Aqueous Two Phase Extraction.

References:
1. Sivasankar B. Bioseperations: Principles and Techniques, PHI Learning Pvt. Ltd., 2006
2. Belter P.A., Cussler E., Wei Shan Hu. Bioseparation – Downstream processing for biotechnology, Wiley Interscience Pub., 1988
3. Asenjo J. Separation Processes in Biotechnology, Marcel Dekker, 1993
4. BIOTOL Board. Product Recovery in Bioprocess Technology, Butterworth-Heinemann Ltd, 1990

BIO 2253: MOLECULAR BIOLOGY AND GENETIC ENGINEERING [3 1 0 4]

Cell cycle, Proteins associated with cell cycle, Organization and replication of DNA in Prokaryotic and Eukaryotic Chromosomes – Histones, C_ot curves, -mode of Replication, Displacement (D) Loops, Rolling Circle Method (–mode) of DNA Replication, Telomeric Replication in Eukaryotes, Transcription in Prokaryotes and Eukaryotes, Regulation of Gene Expression, Post-transcriptional Modifications – RNA Splicing, Translation in Prokaryotes and Eukaryotes, Post-translational Modifications, Biochemical mechanisms of DNA Repair, Types of Mutations, Biochemical basis of mutants, Modes of Mutagenesis, Reversion.

Introduction to cloning, Method of creating recombinant DNA, Cloning Vectors, Expression Vectors, Enzymes in Genetic Engineering, Hybridization and DNA Libraries, Restriction Mapping, Design of Adaptors & Linkers, Polymerases chain reaction (PCR): Types and its applications, Restriction Fragment Length Polymorphisms (RFLP), Methods of Nucleic Acid Sequencing, Applications of Recombinant DNA Technology, Genome editing strategies- CRISPR/Cas9.

References:
1. David Friefelder, Essentials of Molecular Biology, Jones and Bartlett Publishers Inc 2015
2. Benjamin Lewin, Genes IX, Oxford University Press 2006
3. James D.Watson, Amy A. Caudy, Richard M. Myers, Recombinant DNA: Genes and Genomes – A short course, W H Freeman & Co 2006
4. James D Watson, Tania A. Baker, Stephen P. Bell, Alexander Gann and Michael Levine, Molecular Biology of the Gene, Pearson 2013

BIO 2254: PRINCIPLES OF HEAT AND MASS TRANSFER OPERATIONS [3 1 0 4]

Various modes of heat transfer, Conduction –Fourier's law, Convection – Natural and forced convection, Co-current and countercurrent types of flow, LMTD, overall coefficient determination of film coefficients, Dimensional analysis, Analogies, Heat transfer with phase change, boiling and condensation; Radiation; Diffusion, Fick's law of diffusion, Flux for stagnant and equimolal conditions; Mass transfer coefficient; Theories of mass transfer; two film theory; Dimensionless numbers, analogies between momentum heat and mass transfer, equipments for mass transfer, HETP and stage.

References:
1. Pauline M. Doran. Bioprocess Engineering Principles, Academic Press, 1995
2. Robert E. Treybal. Mass Transfer Operations, McGraw-Hill, 1980
3. McCabe & Smith. Unit Operations of Chemical Engineering. McGraw Hill, 1993

BIO 2261: MOLECULAR BIOLOGY AND GENETIC ENGINEERING LAB [0 0 3 1]

Experiments are based on the extraction and electrophoresis of nucleic acids (plasmid and genomic) from bacterial and plant sources. Restriction digestion and ligation of DNA is also performed to understand the concepts of targeted gene modification. Bacterial cells are made competent and transformed with a gene of interest to calculate the transformation efficiency. An experiment is also based on the polymerase chain reaction for large-scale of amplification of target sequence in a given DNA sample.

References:
1. Sandy B. Primrose,Richard M. Twyman and Robert W. Old, Principles of Gene Manipulation, Wiley-Blackwell Publishers, 2002
2. Benjamin Lewin. Genes VII. Oxford University Press, 2003

BIO 2262: UNIT OPERATIONS LAB [0 0 3 1]

Unit operations laboratory curriculum comprises of experiments based on fluid flow and heat transfer. Fluid flow experiments are based on flow measurement, flow dynamics in pipes and fittings and particle dynamics under fluid flow. Heat transfer experiments aim to estimate heat transfer coefficients and thermal conductivity of metals and insulators.

References:
1. Pauline M. Doran. Bioprocess Engineering Principles, Academic Press, 1995
2. McCabe & Smith. Unit Operations of Chemical Engineering. McGraw Hill, 1993

FIFTH SEMESTER

HUM 3151: ENGINEERING ECONOMICS AND FINANCIAL MANAGEMENT [2 1 0 3]

Nature and significance, Micro & macro differences, Law of demand and supply, Elasticity & equilibrium of demand & supply. Time value of money, Interest factors for discrete compounding, Nominal & effective interest rates, Present and future worth of single, Uniform gradient cash flow. Bases for comparison of alternatives, Present worth amount, Capitalized equivalent amount, Annual equivalent amount, Future worth amount, Capital recovery with return, Rate of return method, Incremental approach for economic analysis of alternatives, Replacement analysis. Break even analysis for single product and multi-product firms, Break even analysis for evaluation of investment alternatives. Physical & functional depreciation, Straight line depreciation, Declining balance method of depreciation, Sum-of-the-years digits method of depreciation, Sinking fund and service output methods, Costing and its types – Job costing and Process costing, Introduction to balance sheet and profit & loss statement. Ratio analysis - Financial ratios such as liquidity ratios, Leverage ratios, Turn over ratios, and profitability ratios.

References:
1. Prasanna Chandra., *Fundamentals of Financial Management*, Tata Mc-Graw Hill Companies, New Delhi, 2005.
2. James L Riggs, David D Bedworth and Sabah U Randhawa., *Engineering Economics*, Tata McGraw – Hill Publishing Company Ltd, New Delhi, 2004.
3. T. Ramachandran., *Accounting and Financial Management*, Scitech Publications Pvt. Ltd. India, 2001.

4. Eugene F. B. & Joel F. H., *Fundamentals of Financial Management*, (12e) Cengage Learning Publisher, 2009.
5. M. Y. Khan & P. K. Jain., *Financial Management*, (5e) Tata McGraw Hill Publication, New Delhi, 2008.
6. Thuesen G.J., *Engineering Economics* Prentice Hall of India, New Delhi, 2005.
7. Blank Leland T. Tarquin Anthony J. *Engineering Economy*, McGraw Hill, Delhi, 2002.
8. Chan S. Park, *Fundamentals of Engineering Economics*, (3e), Pearson Publication, 2013.

BIO 3151: BIOINFORMATICS [3 1 0 4]
Internet Basics, Central Dogma of Biology. Databases – Sequence Databases, Retrieving Database Entries and Structure databases. Database Sequence Search & Alignment: The evolutionary basis of sequence alignment, FASTA, BLAST, Low Complexity Regions, Progressive Alignment Methods, Motifs and Patterns, Presentation Methods. Phylogenetic Analysis – Elements of phylogenetic Models, Data Analysis, Phylogenetics on the web. Predictive Methods using Nucleotide sequence – Detecting ORFs, Exons and Introns, DNA Microarray. Predictive Methods using Protein sequences – Physical properties based on sequence, secondary structure and folding classes, specialized structures, tertiary structure. PCR Primer Design – Restriction mapping, design programs and software.

References:
1. Andreas D Baxevanis. BIOINFORMATICS – A practical Guide to the Analysis of Genes and Proteins. Wiley Interscience, 2004.
2. David R. Westhead. Instant Notes: Bioinformatics. BIOS Scientific Publishers Ltd., 2003

BIO 3152: BIOPROCESS ENGINEERING [2 1 0 3]
Introduction to Enzymes and Enzyme catalyzed reactions: Nature and function of enzymes, Michaelis-Menten Equation – derivations, types of enzyme inhibition, kinetics. Media Design and Sterilization: Fermentation processes, Medium requirements for fermentation processes - examples of simple and complex media. Thermal death kinetics of microorganisms; Batch and continuous heat sterilization. Transport Phenomena in Bioreactors: Immobilization methods; Immobilized enzyme/cell kinetics: effectiveness factor derivations. Oxygen transfer in submerged fermentation processes: OTR, OUR calculations, kLa estimations. Kinetics of Microbial Growth and Product Formation: Microbial cell kinetics, Monod model; Growth associated and non-growth associated product formation kinetics.

References:
1. Michael L Shuler and Fikret Kargi. Bioprocess Engineering: Basic Concepts. Prentice-Hall of India Pvt Ltd 2008
2. Pauline M. Doran. Bioprocess Engineering Principles. Academic Press, 1995
3. PF Stanbury, S. Hall, A. Whitaker, Principles of Fermentation Technology, (2e), Elsevier Science Publishers, 2003

BIO 3153: BIOREACTION ENGINEERING [3 1 0 4]
Reaction Kinetics – Rate equation, elementary, non-elementary reactions. Analysis of experimental batch reactor data by integral and differential analysis. Ideal Reactors – Design of batch, stirred tank and tubular flow reactors. Multiple reactor system – size comparison, recycle reactor. Bioreactors– Batch reactor and chemostat with Monod cell growth kinetics, Fed-batch reactor. Non-ideal reactors – E, F curves, RTD for ideal reactors, analysis of RTD data, Micro and Macro fluid.

References:
1. Octave Levenspiel. Chemical Reaction Engineering. John Wiley & Sons, (3e), 2003
2. Harvey W. Blanch and Douglas S. Clark. Biochemical Engineering, CRC Press, 1997

3. John Villadsen. Bioreaction Engineering Principles. (3e), springer publishers 2011

BIO 3154: SEPARATION PROCESSES [3 1 0 4]
Review of VLE–Methods of distillation: Fractionation of binary systems-design calculations, McCabe Thiele method; Theory of absorption, temperature effect in absorption, process design of absorption; Theories of adsorption – Adsorption isotherms and calculations, adsorption in fixed beds; Leaching-Principle, equilibria, calculation; Chromatography – principles of chromatographic separation, different types of chromatographic separations, selection of chromatographic matrices and large-scale chromatographic separation processes; Electrophoretic separations; Size exclusion chromatography; Crystallization, theories of crystallization, calculations; Drying-theory and batch drying curve, different types of dryers and their features

References:
1. Sivasankar B. Bioseperations: Principles and Techniques, PHI Learning Pvt. Ltd., 2006
2. Belter P.A., Cussler E. and Wei Shan Hu. Bioseparation – Downstream processing for biotechnology, Wiley Interscience Pub, 1988
3. Asenjo J. Separation Processes in Biotechnology, Marcel Dekker, 1993
4. BIOTOL Board. Product Recovery in Bioprocess Technology, Butterworth-Heinemann Ltd, 1990
5. McCabe and Smith. Unit Operations of Chemical Engineering, McGraw Hill Inc.,1993
6. Treybal R.E. Mass transfer operations, McGraw Hill, 1980

BIO 3161: BIOINFORMATICS LAB [0 0 6 2]
This laboratory introduces a pragmatic approach on sequence retrieval, alignment, and analysis such as similarity search including pairwise and multiple alignment, basics of PERL programming, primer design, molecular phylogeny with various algorithms such as NJ, UPGMA, FM & ME, secondary structure prediction, structure visualization and analysis, structure alignments to explore homology as well as distant relationship, protein homology-based modeling, and structure validations.

References:
1. Andreas D Baxevanis. BIOINFORMATICS – A practical Guide to the Analysis of Genes and Proteins. Wiley Interscience, 2004
2. David R. Westhead. Instant Notes: Bioinformatics. BIOS Scientific Publishers Ltd, 2003

BIO 3162: DOWNSTREAM AND SEPARATION PROCESS LAB [0 0 3 1]
Experiments are based on aqueous two phase based separation, extraction of intracellular proteins, precipitation of proteins, ultrafiltration, separation of solids from slurry using leaf filter and sedimentation.

References:
1. Belter P. A., Cussler E. and Wei Shan Hu. Bioseparation – Downstream processing for biotechnology, Wiley Interscience Pub, 1988
2. Asenjo J. and Dekker M. Separation Processes in Biotechnology, 1993

SIXTH SEMESTER

HUM 3152: ESSENTIALS OF MANAGEMENT [2 1 0 3]
Definition of management and systems approach, Nature & scope, The functions of managers, Corporate social responsibility. Planning: Types of plans, Steps in planning, Process of MBO, How to set objectives, Strategies, Policies & planning premises, Strategic planning process and tools. Nature & purpose of organising, Span of management, factors determining the span, Basic departmentalization, Line & staff concepts, Functional authority, Art of delegation, Decentralisation of authority. HR planning, Recruitment, Development and training. Theories of

motivation, Special motivational techniques. Leadership - leadership behaviour & styles, Managerial grid. Basic Control Process, Critical Control Points & Standards, Budgets, Non-budgetary control devices. Profit & loss control, Control through ROI, Direct, Preventive control. Managerial practices in Japan & USA & application of Theory Z. The nature & purpose of international business & multinational corporations, unified global theory of management. Entrepreneurial traits, Creativity, Innovation management, Market analysis, Business plan concepts, Development of financial projections

References:
1. Koontz D. Essentials of Management, Mc Graw Hill, New York, 2004
2. Peter Drucker. Management, Task and Responsibility, Allied Publishers, 2006
3. Peter Drucker. The practice of management, Butterworth Hein Mann, 2003

BIO 3251: ANIMAL, PLANT BIOTECHNOLOGY AND BIOETHICS [3 1 0 4]

Plant cell cultivation – Biochemistry of major metabolic pathways, Autotrophic and heterotrophic growth, Plant growth regulators and elicitors. Cell suspension culture development – methodology, kinetics of growth and product formation, Hairy root cultures and their cultivation. Animal cell metabolism, Animal cell growth characteristics, Principles of sterile techniques, Regulation and nutritional requirements for mass cultivation of animal cell cultures. Animal cell cultivation – Substrate and product transport through mammalian cell, Animal cell growth kinetics and shear force. Micro and Macro carrier attached growth, Cell culture in continuous, perfusion and hollow-fiber reactor. Public acceptance issues for biotechnology – Case studies from developing and developed countries. Biotechnology and hunger – Challenges for the Indian Biotechnological research and industries. The legal and socioeconomic impacts of biotechnology. Intellectual property rights (IPR), Plant breeder's rights – Legal implications

References:
1. Dixon R.A. and Gonzales. Plant Cell Culture: A Practical Approach, IRL Press. 1995
2. Lindsey K. and Jones M.G.K. Plant Biotechnology in Agriculture, Prentice Hall, 1990
3. Singh K. Intellectual property rights on biotechnology, BCIL, New Delhi, 2001

BIO 3252: BIOPROCESS CONTROL AND INSTRUMENTATION [2 1 0 3]

Measurement and signal transmission of process parameters – Flow, Pressure, Temperature, Level, pH, DO, density and viscosity; Mathematical modeling of chemical and bioprocesses; Introduction to Laplace Transforms, Development of Transfer functions. Dynamic behavior of first and second order processes; Introduction to feedback controllers, feedforward and ratio controller, final control elements and controller tuning; Block diagram representation, Stability of closed loop control systems -Routh stability criterion, Root locus diagrams.

References:
1. Seborg D.E., Edgar T.F. and Mellichamp D.A. Process Dynamics and control, John Willey & Sons, 2004
2. Stephanopoulos G. Chemical Process Control: An Introduction to Theory and Practice. Prentice Hall International, 1983
3. Riggs J.B. and Nazmul Karim M. Chemical and bioprocess control. Ferret Publisher, 2008

BIO 3261: ANIMAL, PLANT BIOTECHNOLOGY AND BIOPROCESS ENGINEERING LAB [0 0 6 2]

In the Animal and Plant Biotechnology lab experiments are based culture media preparation and the growth of animal and plant cells. In Bioprocess Engineering lab experiments are based on estimation of enzyme kinetics, optimum temperature, pH and evaluation of the type of inhibition during enzyme catalyzed reactions.

Reference books:
1. Dixon R.A. and Gonzales. Plant Cell Culture: A Practical Approach, IRL Press. 1995
2. Lindsey K. and Jones M.G.K. Plant Biotechnology in Agriculture, Prentice Hall, 1990
3. Michael L Shuler and Fikret Kargi. Bioprocess Engineering: Basic Concepts. Prentice-Hall of India Pvt Ltd 2008

BIO 3262: BIOREACTION ENGINEERING AND BIOPROCESS CONTROL LAB [0 0 6 2]

Bioreaction Engineering laboratory experiments are based on the growth kinetics of bacterial species in a shake flask and fed-batch cultures with various carbon sources. Also experiments are designed to evaluate the performance of various bioreactors such as stirred tank reactor (STR) and fluidized bed reactor (FBR) and packed bed reactor (PBR) with immobilized enzymes. In Bioprocess control lab experiments are designed to study about the controllers (P, PI, PD & PID), advanced control system, control valves, first order system & second order system (inherent/multi capacity processes) with different inputs which usually appears in the process industries.

References:
1. Octave Levenspiel. Chemical Reaction Engineering. John Wiley & Sons, (3e), 2003
2. Harvey W. Blanch and Douglas S. Clark. Biochemical Engineering, CRC Press, 1997
3. John Villadsen. Bioreaction Engineering Principles. (3e), springer publishers 2011

SEVENTH SEMESTER

There are five program electives and one open elective with total of 18 credits to be taught in this semester.

EIGHTH SEMESTER

BIO 4298: INDUSTRIAL TRAINING

Each student has to undergo industrial training for a minimum period of 4 weeks. This may be taken in a phased manner during the vacation starting from the end of third semester. Student has to submit to the department a training report in the prescribed format and also make a presentation of the same. The report should include the certificates issued by the industry.

BIO 4299: PROJECT WORK/PRACTICE SCHOOL

The project work may be carried out in the institution/industry/ research laboratory or any other competent institutions. The duration of the project work shall be a minimum of 16 weeks which may be extended up to 24 weeks. A mid-semester evaluation of the project work shall be done after about 8 weeks. An interim project report on the progress of the work shall be submitted to the department during the mid-semester evaluation. The final evaluation and viva-voice will be conducted after submission of the final project report in the prescribed form. Student has to make a presentation on the work carried out, before the department committee as part of project evaluation.

BIO 4051: BIOREMEDIATION [2 1 0 3]

Introduction, Advantages and Disadvantages of Bioremediation; Factors influencing Bioremediation; Microbial ecology and metabolism; Biodegradation of common contaminant compounds; Bioremediation processes; Biological Filtration Processes for Decontamination of Air Stream; Biotreatment of Metals; Phytoextraction; Rhizofiltration; Phytostabilization; Biomonitoring; Biomembrane Reactors; Successful and Unsuccessful Case Studies in Bioremediation Process

References:
1. Martin Alexander. Biodegradation and Bioremediation. Academic press. 1999
2. John. T. Cookson, Jr. Bioremediation engineering; design and application. McGraw Hill, Inc. 1995
3. Eweis, Ergas, Chang and Schroeder. Bioremediation Principles. McGraw-Hill Series in Water Resources and Environmental Engineering, 1998

BIO 4052: DESIGN OF BIOLOGICAL TREATMENT PROCESSES [2 1 0 3]

Flow and Mass loading for treatment plants; Various Physical units operations-equalization tank design, sedimentation tank design by solid flux and batch data, dissolved air flotation; Filtration mechanism in water treatment and design of filters, Chemical treatment and precipitation; Activated sludge process and different types of active sludge processes; Mathematical model development for active sludge process, and design, Sequencing batch reactors (SBR), Plug flow aerobic treatment, Rotating Biological contactor and model, Trickling filters and roughing filters and various design parameters, Various pond processes, Disinfection-Mechanisms, Mathematical Models for disinfection, Breakpoint chlorination and calculations; Design considerations in anaerobic processes; Water reuse and reclamation technologies, Risk assessment.

References:
1. Metcalf and Eddy. Wastewater Engineering - Treatment, Disposal and Reuse. Tata McGraw Hill Publishing Co. Ltd, 1991
2. Rao C.S. Environmental Pollution Control Engineering. New Age International (P) Ltd. Publishers, 1991
3. Jordening H.J., and Winter J. Environmental Biotechnology: Concepts and Applications. Wiley-VCH Verlag GmbH & Co., 2005

BIO 4053: MICROBIAL TREATMENT OF WASTE WATER [2 1 0 3]

Need for wastewater treatment; Characterization of wastewater-Biological- BOD, COD, TOC, MPN, and Bacterial count; BOD kinetic parameter fitting by Least square, Fujimoto, Daily difference, Thomas and Moments-Methods; Physical characterization such as solids, Turbidity, and Chemical characterizations. Bacterial metabolism in treatment, Decomposition of organic compounds in Ecosystem, Biology, Mass energy balance for Aerobic respiration, and Anaerobic respiration, General considerations for Aerobic Vs. Anaerobic treatment, Kinetic aspects, Hydrolysis of cellulose-biological aspects, Anaerobic degradation of lignocellulose and cellulose, proteins, fats; Various types of anaerobic treatment reactors-UASB and its variations, calculation of biogas by Buswell equation, Nitrification and denitrification processes, and Anammox process, Biological Phosphorus removal processes.

References:
1. Metcalf and Eddy. Wastewater Engineering - Treatment, Disposal and Reuse. Tata McGraw Hill Publishing Co. Ltd, 1991
2. Rao C.S. Environmental Pollution Control Engg. New Age International (P) Ltd. Publishers, 1991
3. Jordening H.J. and Winter J. Environmental Biotechnology: Concepts and Applications. Wiley-VCH Verlag GmbH & Co., 2005

BIO 4054: SOLID WASTE MANAGEMENT [2 1 0 3]

Integrated solid waste management, operation of waste management systems. Legislative Trends and Impacts; Composition of municipal solid wastes, Properties of MSW; transformations of solid waste; Properties, classification and transformation of Hazardous wastes and its management; Collection of solid waste, Separation, processing and Transformation of solid waste, Transfer and Transport, Disposal; Landfill methods & its design; Biological principles, aerobic composting, Anaerobic digestion, Biological transformation processes. Energy production from biological conversion products, Fermentation and compost processes: design parameters & Applications; Meeting federal and state mandated diversion goals; Recycling, Implementation of solid waste management options; planning, siting and permitting of waste management facilities.

References:
1. George Tchobanoglous. Integrated solid waste management: Engineering principles and management issues, Mcgraw Hill, 1993
2. William D Robinson. The solid waste handbook: A practical guide, John Willy & sons, 1986

BIO 4055: BIOMATERIALS [2 1 0 3]

Properties of materials & classes of materials used in Medicine, Host reaction to biomaterials and their evaluation, testing biomaterials, degradation of materials in the biological environment, application of materials in medicine & dentistry, implants & devices, basics of artificial organs.

References:
1. Buddy Ratner, Allan Hoffman, Frederick Schoen, Jack Lemon. Biomaterial Science: An introduction to materials in medicine, Academic press, Elsevier publication, (3e), 2012
2. Joon Park, Lakes R.S. Biomaterials: An Introduction, Springer publication, (3e), 2007

BIO 4056: BIOPHARMACEUTICAL ENGINEERING [2 1 0 3]

Introduction – Development of drugs and pharmaceutical industry organic therapeutic agents. Drug Metabolism and Pharmaco-Kinetics – physico chemical principles, radioactivity, action of drug on human bodies. Important Unit Processes and Their Applications. Manufacturing Principles of different type of tablets. Analytical methods and test for various drugs and pharmaceuticals, packaging techniques – quality control. Health Biotechnology – health care products, edible vaccines, nutrition value of foods. Health bioinformatics – microbes and human health, biotechnology kits to monitor day to day human health.

References:
1. Heinrich Klefenz. Industrial pharmaceutical biotechnology, Wiley-VCH, 2002
2. Susanna Wu-Pong, Yongyut Rojanasakul, and Joseph Robinson. Biopharmaceutical drug and design and development. Humana Press, 1999

BIO 4057: IMMUNOTECHNOLOGY [2 1 0 3]

Immune system – innate and adaptive immunity, Lymphocytes - origin and differentiation. Humoral Immunity – B-lymphocytes and their activation, structure and function of immunoglobulins, Genetic control of antibody production. Cellular Immunology – T cells classification, APC, mechanisms of phagocytosis. Antigen Antibody interactions – precipitation, agglutination, neutralization. Immunological and antibody based assays. Stem cells – applications to immunology, immunosuppressive drugs. Autoimmunity – Auto antibodies in humans, treatment of auto immune disorders. Molecular Immunology – Preparation of vaccines, application of rDNA technology to production of antibodies.

Refe**rences:**
1. Roitt I. Essential Immunology. Blackwell Scientific Publications, 1991
2. Richard Goldsby, Thomas J. Kindt, Barbara A. Osborn. Kuby Immunology. W H Freeman, 2006

BIO 4058: MOLECULAR MODELING AND DRUG DESIGN [2 1 0 3]

General concepts of Pharmacology – Bioavailability, Compartments and clearance, Drug absorption and transport, Drug metabolism, Pharmacokinetic models, BBB. Drug Structure – Chemoinformatics & Chemical Graphs. Drug Design – Computational Drug Discovery, Binding interactions, Lipinski's rule of five (RO5), SMILES, Molecular Descriptors – chemical, topological and geometrical descriptors. Molecular Modeling – Molecular Orbital theory, 1D, 2D and 3D analyses. Computer Simulation Methods – Molecular Dynamics methods, Binding affinity calculations & conformational analysis, QSAR. Design New Molecules – De novo ligand design, Similarity search - Virtual screening, Molecular docking – SNPs and Pharmacogenomics, Toxicology, Clinical trials, Regulatory affairs & Patenting.

References:
1. Leach A.R. Molecular Modelling Principles and Applications. Longman, 2001
2. Haile J.M. Molecular Dynamics Simulation Elementary Methods. J. Wiley and Sons, 1997

BIO 4059: ADVANCED BIOPROCESS ENGINEERING [2 1 0 3]

Environmental requirements for Animal Cell Cultivation-Oxygen requirement, Formulation of optimum culture media, techniques for increasing cellular productivity. Bioreactor systems for animal cell cultivation-, Air-lift fermenter, bubble column bioreactor, Fixed bed bioreactor with micro carriers, Scale-up strategy for animal cell cultivation. Classification of interactions between two species-Neutralism; Mutualism; Commensalism; Amensalism and competition. The Lotka-Volterra Model of Predator-Prey Oscillations. Design of fermentation processes-steady state operation of CSTR with microbial cultures, Design of recirculation system, Fed-batch reactor operation. Uses of Well-defined Mixed Populations- Spoilage and product manufacture by Spontaneous Mixed Cultures; Microbial Participation in the Natural Cycles of Matter. Bioprocessing of recombinant proteins-Tissue plasminogen activator (TPA), Growth hormone, Interferon, Erythroprotein, Insulin.

References:
1. Harvey W. Blanch and Douglas S. Clark. Biochemical Engineering, CRC Press, 1997
2. Daan J.A. Crommeline, Robert D. Sindelar and Bernd Meibohm. Pharmaceutical Biotechnology, (3e), 2007
3. John Villadsen. Bioreaction Engineering Principles. (3e), Springer publishers, 2011

BIO 4060: BIOFUELS ENGINEERING [2 1 0 3]

Various feedstock for different kinds of Biofuels; Biochemical pathways; Life Cycle Analysis (LCA) of various biofuels, Various process technologies for bioethanol production; Microorganism selection; Comparison of various bioethanol processes; Thermodynamic and kinetic aspects of biodiesel production; Biodiesel from Jatropha and Waste cooking oils, Acid base, enzyme catalyzed esterification process; Biodiesel from Microalgae and various contemporary technologies and their comparisons; Hydrogen production by enzymes and various microorganisms, Inhibition effects of Hydrogen; Biochemical basis of microbial fuel cells; single cell and two cell designs; basic calculations of power and efficiency; Biogas production from various sources.

References:
1. Caye M. Drapcho, Nghiem Phu Nhuan and Terry H. Walker. Biofuels Engineering Process Technology, McGraw Hill Publishers, 2008
2. Jonathan R. Meilenz. Biofuels – Methods and Protocols (Methods in Molecular Biology Series, Humana Press, 2009
3. Lisbeth Olsson. Biofuels (Advances in Biochemical Engineering/Biotechnology Series), Springer-Verlag Publishers, 2007

BIO 4061 BIOPROCESS EQUIPMENT DESIGN [2 1 0 3]

Design of Pressure Vessels: Codes and standards, design factors, design of vessels under internal and external pressure. Design of fermentors: Mixing in Fermenters, Power Requirements. Design criteria for batch fermentor, chemostat and bubble column fermentor, scale up of fermentors. Heat Exchanger Design: Type of heat exchangers, energy balances in heat exchanger, Heat transfer in fermentors, process design of shell and tube heat exchangers. Evaporator design: Evaporation – types of evaporators – Enthalpy balances in single and multiple evaporators – economy and capacity of evaporator. Process design of triple effect evaporators.

References:
1. Richardson, and Sinott R.K. Chemical Engineering Vol. 6, J.F. Pergamon Press, 2005
2. Joshi M.V. Process Equipment Design, McMillan India, 2005
3. Stanbury P.F., Hall S., Whitaker A. Principles of Fermentation Technology, (2e), Elsevier Science Publishers, 2003
4. Bjorn K. Lydersen, Nancy A D'elia and Kim L. Nelson. Bioprocess Engineering-Systems, Equipment and Facilities, A Wiley Interscience Publication, 1994
5. Unfired Pressure Vessel Code BIS 2825
6. Code for Shell & Tube heat exchangers BIS 4503
7. Chemical Engineer's Handbook by Perry

BIO 4062: BIOSENSORS [2 1 0 3]

Principles of Biomolecular Recognition, Surface Sensitization Techniques and Recognition Receptors Immobilization on Biosensors and Microarrays, Analytical Tools for Biosensor Surface Chemical Characterization, Enzyme for Biosensing Applications, Antibodies in Biosensing, Peptides as Molecular Receptors, Carbohydrates as Recognition Receptors in Biosensing Applications, Nucleic Acid Diagnostic Biosensors, Tissue-Based Biosensors, Biosensing with Plants: Plant Receptors for Sensing Environmental Pollution, Bacteriophage-Based Biosensors, Antibody Engineering for Biosensor Applications, Genetically Engineered Proteins as Recognition Receptors, Biosensing Systems Based on Genetically Engineered Whole Cells, Photosynthetic Proteins Created by Computational and Biotechnological Approaches in Biosensing Applications, Oligonucleotides as Recognition and Catalytic Elements, Aptamers: Versatile Tools for Reagentless Aptasensing, Phage Display Technology in Biosensor Development, Molecularly Imprinted Polymer Receptors for Sensors and Arrays.

References:
1. Victor Yang & NGO T.T. Biosensors and their applications. Springer, 2000
2. Mohammed Zourob. Recognition Receptors in Biosensors. Springer, 2010

BIO 4063: BIOSTATISTICS AND DESIGN OF EXPERIMENTS [2 1 0 3]

Introduction to statistics: Descriptive and inferential statistics. Measures of central tendency Measures of spread. Probability distributions, Hypothesis testing. Linear & quadratic models, regression coefficients, estimation using least squares method. Introduction to statistical design: Introduction to factorial designs, 2k factorial design, main effects, interaction effects Screening designs: Fractional factorial designs, Plackett-Burmann screening designs. Model reduction, model assumption checking, residual plots. Optimization designs: Response surface methodology – concepts & methods, central composite designs and Box-Behnken design.

References:
1. Montgomery Douglas C. Design and analysis of experiments, John Wiley, 2012
2. Lawson John & Erjavec John. Modern Statistics for Engineering and Quality Improvement, Thomson, 2001
3. Panda T., Theodore T. and Kumar R.A. Statistical Optimization of Biological Systems. CRC Press, 2015
4. Rosner B. Fundamentals of Biostatistics, (5e), Duxbury Thomson Learning, 2000

BIO 4064: COMPUTATIONAL BIOLOGY [2 1 0 3]

Algorithms and complexity, Biological algorithms versus Computer algorithms, Algorithm design techniques, Data mining, Data storage and retrieval, Machine learning, Biological data mining tools, Introduction to SQL, Bio-Perl and Bio-Java, Sequence alignment: Dynamic Programming algorithm, Multiple sequence alignment methods, Similarity Search Algorithms, Identification of functional sites in molecules, Pattern matching, Profiles and Hidden Markov Models, Gene and promoter prediction, Identification of regulatory elements in promoters, Protein motifs and domain prediction, Restriction Mapping, Clustering, Gene expression analysis through clustering, Phylogenetic analysis, Distance based methods, Character based methods, Protein secondary structure prediction methods and algorithms, RNA structure, RNA secondary structure prediction, Case studies.

References:
1. Neil Jones and Pavel Pevzner. An Introduction to Bioinformatics Algorithms. MIT Press, 2004
2. Heitor Silvério Lopes and Leonardo Magalhães Cruz. Computational Biology and Applied Bioinformatics. InTech, 2011

BIO 4065: FOOD PROCESS ENGINEERING AND TECHNOLOGY [2 1 0 3]

Introduction to Food Processing-: Biotechnology in relation to the food industry; nutritive value of food; types of microorganisms associated with food. Food processing chemistry, Food Spoilage & Preservation-Microbial Spoilage of Vegetables, Fruits, Fresh and Processed Meats, Poultry and Seafood. Food-borne illnesses. Food Preservation-Food Preservation Using Irradiation, Food Preservation with Low Temperatures, Food Preservation with High Temperatures, Preservation of Foods by Drying. Food engineering-Unit operations applied to the food processing industry – Fluid flow applications, Heat transfer applications, Centrifugation, Filtration, Extraction, Membrane separations, Evaporation, Distillation, Absorption, Size reduction, Mixing, Drying, and Crystallization Food Industry- Basal metabolic rate, influences on nutritional status, dietary strategies for individuals, diet for specific groups, Market Place, ecologically sustainable production, risks and benefits of biotechnology to food industry.

References:
1. Roger A., Gordon B. and John T. Food Biotechnology. Cambridge University Press, 1989
2. James Jay. Modern food Microbiology. Kluwer Academic Publishers, 1992
3. Lindsay W. Biotechnology – Challenges for the flavor and food industry. Elsevier Applied Science, 1988
   Earle R.L. Unit operations in food processing. Pergamon Press, 1983

BIO 4066: GENOMICS AND PROTEOMICS [2 1 0 3]

Genes and Proteins, unicellular genomes, Metazoan Genomes, Gene, Evolution of Genomes.Sequencing& Genome Projects – preparing genomic DNA for sequencing, Sanger Dideoxy method, Fluorescence method, shot-gun approach.Genomics– ESTs, SNPs, DNA Chips.Proteomics – protein isolation, purification and quantification.Bioinformatics analysis – clustering Methods, proteome functional information and Protein Chip interaction detection.Genome Management in Eukaryotes – Multicellularity, cell differentiation and gene regulation.Bioinformatics and Functional Genomics – Bioinformatics Approaches to Gene Expression, Microarray data analysis, Human genome and disease identification, OMIM.Comparative genomics.

References:
1. John R.S. Finchman. Genetic Analysis - Principles, Scope and Objectives. Blackwell Science, 1994
2. Malcolm A. Campbell, and Laurie J. Heyer. Discovering Genomics, Proteomics and Bioinformatics. Pearson, 2006

BIO 4067: HEALTH DIAGNOSTICS [2 1 0 3]

Introduction to Health diagnostics, Importance and applications, Biochemical disorders, Immune disorders, Infectious diseases, Parasitic diseases, Genetic disorders, Chromosomal disorders, single cell disorders and complex traits, Chromosomal disorders, autosomal, sex chromosomal, karyotype analysis. DNA based diagnostics methods, Biochemical diagnostics methods, Cell based diagnostics methods, Antibody markers, CD Markers, FACS, HLA typing, Bioassays, Immunodiagnostics methods, Antigen-Antibody Reactions, Conjugation Techniques, Antibody Production, Case studies related to bacterial, viral and parasitic infections , Diagnosis of infectious diseases, respiratory diseases, Viral disease, bacterial diseases, enteric diseases, parasitic diseases and mycobacterium diseases, Phage display, immunoarrays and FACs.

References:
1. Patrinos G.P., Ansorge W.J. and Danielson P.B. Molecular Diagnostics, Academy Press, 2016
2. Burtis C.A. and Bruns D.E. Tietz. Fundamentals of clinical chemistry and molecular diagnostics. Elsevier Health Sciences, 2014
3. Tille P. Bailey & Scott's diagnostic microbiology. Elsevier Health Sciences, 2015
4. Crocker J. and Burnett D. The Science of laboratory diagnosis. John Wiley & Sons, 2005

BIO 4068: METABOLIC ENGINEERING [2 1 0 3]

Introduction – Jacob Monod model, catabolite regulation, glucose effect, cAMP deficiency, feedback regulation. Synthesis of Primary Metabolites –Alteration of feedback regulation, limiting accumulation of end products, metabolites. Biosynthesis of Secondary Metabolites –Precursor effects, prophophase, idiophase relationship, enzyme induction & producers of secondary metabolites. Bioconversions – Advantages, specificity, yields, co-metabolism, avoidance of product inhibition, mixed or sequential bioconversions, conversion of insoluble substances. Regulation of Enzyme Production – Strain selection, improving fermentation, recognizing growth cycle peak, catabolite repression, mutants resistant to repression.

References:
1. Wang D.I.C., Cooney C.L., Demain A.L., Dunnil P., Humphery A.E., Lilly M.D. Fermentation and Enzyme Technology. John Wiley and Sons, 1979
2. Stanbury P.F., and Whitaker A. Principles of Fermentation Technology. Butterworth Heinemann**,** 1999

BIO 4069: BIOPROCESS MODELING & SIMULATION IN BIOTECHNOLOGY [2 0 3 3]

Perspective on modeling of physical, chemical & biological phenomena, uses and limitations of mathematical models; Examples involving algebraic, ordinary differential, difference, cpartial differential, integral & integro-differential equations; Probability theory, stochastic models parameter estimation model forms for parameter estimation. Parameter estimation using moments, design of experiments; Accuracy of parameter estimates. Design of experiments for model discrimination; Non-linear systems; Plane analysis in classical bioreactor models; Nonlinear dynamics; Chaotic behavior, cob web diagrams, stability of fixed point solutions. Bifurcations behavior, Chaos; Lorenz equations; Population balance modeling, Budding of yeast population – Modeling of

cells with dynamic morphology – Modeling for biological populations with correlation between life spans of siblings. Modeling of Industrial sterilization processes.

Laboratory experiments are based on simulation of various bioprocesses using MATLAB.

References:
1. Wayne Bequette B. Process dynamics modeling and analysis and simulation, Prentice Hall Inc., 2004
2. John H. Seinfeld and Leon Lapidus. Mathematical Methods in Chemical Engg., Process Modeling, Estimations and Identification. Prentice Hall, 1974

BIO 4070: PROTEIN ENGINEERING [2 1 0 3]
Structure of Proteins – Primary, secondary structure prediction and determination super secondary structure, protein folding pathways, tertiary structure and domain in proteins, quaternary structure, methods to determine tertiary and quaternary structure, post transnational modification. Protein Engineering and Design – Methods of protein isolation, purification and quantitation, use of peptides in biology, methods of detection and analysis of proteins. Protein database analysis, methods to alter primary structure of proteins, examples of engineered proteins, protein design, principles and examples.

References:
1. Moody P.C.E. and Wilkinson A.J. Protein Engineering, ILR Press, 1990
2. Creighton T.E. Proteins. Freeman, 1993

BIO 4071: SOLID STATE FERMENTATION [2 1 0 3]
Scope of solid State fermentation & applications. Macroscopic and microscopic phenomena. Bioreactor types and Selection – Classification and Criteria. Transport phenomena and the scale up. Unaerated and Unmixed bioreactors -Trays, Forcefully-Aerated Bioreactors without Mixing, Packed beds, Rotating and stirred drum bioreactors, Continuously mixed and intermittently-mixed bioreactors. Fundamentals of Modelling of Bioreactor – Methodology, Kinetic sub model, Modelling of effect of temperature, water activity on growth, Death kinetics, Modelling of Heat and Mass transfer and the estimation of transfer coefficients.

References:
1. Mitchell D.A., Krieger N., Berovic M. Solid State Fermentation Bioreactors Fundamentals of Design and Operation. Springer Publication, 2006
2. Ashok Pandey, Carlos Ricardo Soccol, Christian Larroche. Current Developments In Solid-state Fermentation, Asiatech Publishers, 2007

BIO 4072 GENETICS AND APPLICATIONS [3 0 0 3]
Introduction to genetics and its applications, Mendelian and non mendelian principles, Dominance relations and multiple alleles in diploid organisms- Incomplete dominance, over dominance and codominance. Genetic mapping, tetrad analysis, mitotic recombination, mapping human genome. Development and differentiation. Embryoninc development, imaginal discs. Genetics of cancer- oncogenes, tumor suppressor genes, Transposable elements, Maternal effects and cytoplasmic heredity. Extra nuclear inheritance. Infectious heredity, Exceptions to maternal inheritance. Genetic structure of populations, genotypic frequencies, allelic frequencies. Genetic variation, Mutation, genetic drift, Migration. Applications of genetics.

References:
1. Genetics, Monoroe W. Strickberger, Prentice Hall India,2006
2. Genetics: A Conceptual Approach, Benjamin A. Pierce, W. H. Freeman, 2016
3. Essentials of genetics, Klug William S, Pearson, 2017

BIO 4301: BIOLOGICAL DATABASES AND BIOLOGICAL DATA MINING [3 0 0 3]
Central dogma of biology, Data to information, Information flow, Different types of biological data, Storage of data, Database structures, Data representation, File formats, Biological data life cycle, Data management, Sequence databases, Sequence motif databases, Structural databases, Interaction databases, Enzyme databases, Pathway databases, Molecular disease databases, Biomedical literature database, Gene expression database, Immunological databases, Data retrieval, Search engines, Search algorithms, Biological data for mining, Biological information/treasure, Data mining methods, Machine learning, Biological data mining tools, Comparison through alignment, Scoring methods, Profiles, Pattern recognition and discovery, Pattern matching, Data mining through network construction and analysis, SQL, Bio-Perl, Bio-Java, Introduction to structure visualization and simulation tools.

References:
1. Bryan Bergeron. Bioinformatics Computing. Prentice Hall, 2002
2. Hui-Huang Hsu. Advanced data mining technologies in bioinformatics. Idea Group
3. Publishing, 2006
4. Neil Jones and Pavel Pevzner. An Introduction to Bioinformatics Algorithms. MIT
5. Press, 2004
6. Pierre Baldi, Soren Brunak. Bioinformatics: the machine learning approach. MIT Press, 2001

BIO 4302: INTRODUCTION TO BIOFUELS AND BIOPOLYMERS [3 0 0 3]
Renewable energies and significance of biofuels, feedstocks for various biofuels, Life Cycle Analysis (LCA) of biofuels, ethanol from fermentation and comparison of different technologies, diesel from Jatropha, waste cooking oils, and Microalgae, biogas and biological hydrogen, and basic concepts of microbial fuel cells; introduction to biopolymers, Biopolymers vs. Synthetic polymers; Synthesis of biopolymers such as Starch, Hemicellulose etc, Commercially available biopolymers, uses of biopolymers, Manufacturing technologies, Fillers & Reinforcement, Market & Economics, Biodegradability.

References
1. Mohanty A.K.,et al. Natural Fibers, Biopolymers, and Biocomposites, CRC Press, 2005
2. Johnson R.M., Mwaikambo L.Y. and Tucker, N. Biopolymers, Rapra technology, 2003
3. Caye M. Drapcho, Nghiem Phu Nhuan and Terry H. Walker. Biofuels Engineering Process Technology, McGraw Hill Publishers, 2008

BIO 4303: INTRODUCTION TO BIOINFORMATICS [3 0 0 3]
Introduction to Bioinformatics, Central dogma of biology, Digital code of life, database sequence search & Alignment, The evolutionary basis of sequence alignment, The modular nature of proteins, Optimal alignment methods, Substitution scores and gap penalties, Statistical significance of alignments, Structure file formats; Visualizing structural information, Motifs and Pattern, Protein structure prediction, Searching for trees, Rooting trees, Evaluating trees and Data, Phylogenetic software, Phylogenetics on the web, Some simple practical considerations, Genome annotation, Comparative genomics, Genome compression.

References:
1. Arthur M. Lesk. Introduction to Bioinformatics. Oxford University Press, 2002
2. Stuart M. Brown. BIOINFORMATICS: A biologists guide to biocomputing and the internet. NYU Medical Center, 2000

MCA 4301: INTRODUCTION TO DATABASE SYSTEMS WITH MYSQL [3 0 0 3]

Modeling and Designing Databases, Database Design Process, Entity-Relationship Model, Basic Concepts, Constraints, Design of ER database schema, Reduction of ER to schema, Relational model, Super, candidate, primary ,foreign key, Schema Diagram, Relational Database design, Functional dependencies, Normal forms, Creating a MySQL Database, Table, Modifying table, constraints, indexes, Basic SQL, Inserting Data, Selecting Data, Updating Data, Deleting Data, MySQL Functions, Numeric, String, Date /Time, Advanced Queries, Sorting, Multiple tables, Inner Join, Left Join, Right Join, Natural Join, Nested queries, Generating summaries, COUNT(), MIN(), MAX(), SUM(), AVG(), Group By, Statistical techniques, Calculating Descriptive statistics, Per-Group Descriptive Statistics, Generating frequency distribution, Calculating correlation coefficients, assigning ranks, Stored routines, stored procedure, stored function, Triggers, Events to schedule Database actions, Managing users and privileges, Importing and Exporting data, importing data with LOAD data and mysql import, importing csv files, exporting query results, tables, importing XML.

References:
1. Paul Dubois, MySQL Cookbook, O'REILLY, First Edition, 2007.
2. Larry Ullman, Visual Quick Start guide MySQL, Pearson Education, 2nd Edition, 2007.
3. Seyed M. M, Saied Tahaghoghi and Hugh Williams, Learning MySQL, O'Reilly, 2006.
4. Russell J.T. Dyer, MySQL in a Nutshell, O'REILLY, 2nd Edition, 2008.

MCA 4302: INTRODUCTION TO VR AND AR TECHNOLOGIES [3 0 0 3]

Introduction: Input Devices, Output Devices, Displays, Computing Architectures for VR, The Rendering Pipeline, PC Graphics Architecture, Workstation-Based Architectures, Distributed VR Architectures, Modeling, Geometric Modeling, Physical Modeling, Behavior Modeling, Model Management, VR Programming and other Toolkits. Introduction to Unity 3D Engine, 2D Game concepts and basic scripting, 3D Game concepts and environment creation, Advanced game concepts. Introduction to Unity AR: Foundation and Vuforia, working with Vuforia in Unity, ARCore in unity, Mini project on AR. Introduction to VR, Unity for Google cardboard, Basic VR app development for Cardboard, Develop for a specific VR platform.

References:
1. Jonathan Linowers, Krystian Banbilinski, Augmented Reality for Developers,Packt Publishers, 2017.
2. Edward Lavieri, Getting started with Unity 5, Packt publishing, 2015.
3. Grigore C. Burdea, Philippe Coiffet, Virtual Reality Technology, Wiley-IEEE Press, 2003.
4. Sherman, W.R. & A. Craig, Understanding, Virtual Reality: Interface, Application and Design, Morgan Kaufmann, San Francisco, CA, 2003.
5. Philippe Fuchs, Guillaume Moreau, Pascal Guitton, Virtual Reality: Concepts and Technologies, CRC, Taylor and Francis, 2011.

MCA 4303: INTRODUCTION TO LINUX AND SHELL SCRIPTING [3 0 0 3]

Introduction to UNIX/LINUX Operating System: OS concepts, Linux overview, key features of Linux, pros and cons of Linux. Processes: Processes and Files, I/O redirection and pipes, process creation, process attributes standard process file descriptors. File and Process commands. File systems: Files and directories, file naming and wildcards, file attributes, file permissions. Regular Expressions & filters: find, grep, cut, sort, grep patterns. AWK and SED. Shell and Shell Scripting: The need for shell, types of shells, interactive uses of shell, using shell for creating user commands, functions. Bash shell features: Statements, data structure, built-in commands, environment customization primitives. Linux Editors.

References:
1. Richard Blum and Christine Bresnahan, Linux Command Line Shell Scripting BIBLE, 3rd Edition, Wiley, 2015.
2. Mark Sobel. A Practical Guide to Linux commands Editor and shell programming, Prentice Hall, 2nd Edition, 2010.
3. Stephen G. Kochan. Unix Shell Programming, 3rd Edition, SAMS Publications, 2003.
4. Bash Reference Manual Download able from GNU Project.
5. Brian W Kerningham and Rob Pike. The Unix Programming Environment, PHI Learning Pvt. Ltd., 2009.

MCA 4304: INTRODUCTION TO DATA ANALYTICS [3 0 0 3]

Introduction - data science, need for analytics, steps in data analysis projects, Data- sources of data, data sets, data warehouses, data types, privacy and confidentiality, samples vs. population. Data summarization and visualization – tables and graphs. Data Preprocessing- cleaning, transformation, dimensionality reduction. Data Analysis and Visualization – descriptive, inferential statistics, uni-variate and multi-variate analysis. Grouping – Cluster Analysis- distance measures, partitioning, hierarchical, density based methods. Market Basket Analysis, Association Analysis, Market Basket Analysis. Classifiers-Bayesian, k-nearest neighbor, neural network, Support Vector Machine, Decision Trees. Prediction- Regression models, Evaluating Classification and Predictive performance, ensemble methods. Anomaly Detection. Forecasting models.

References:
1. Glenn J. Myatt, Wayne P. Johnson, Making Sense of Data I: A Practical Guide to Exploratory Data Analysis and Data Mining, 2nd Edition, John Wiley & Sons Publication, 2014.
2. Glenn J. Myatt, Wayne P. Johnson, Making Sense of Data II: A Practical Guide to Data Visualization, Advanced Data Mining Methods, and Applications, John Wiley & Sons Publication, 2009.
3. Galit Shmueli, Nitin R. Patel, and Peter C. Bruce, Data Mining for Business Intelligence, John Wiley & Sons, 2014.
4. Ian H. Witten, Eibe Frank, Mark A. Hall, Data Mining: Practical Machine Learning Tools and Techniques, Morgan Kaufmann, 2011.
5. Pang-Ning Tan, Michael Steinbach, Vipin Kumar, Introduction to Data Mining, Pearson Addison Wesley, 2005.

Minor Specialization: Computational Mathematics

MAT 4051: APPLIED STATISTICS AND TIME SERIES ANALYSIS [2 1 0 3]

Stochastic and deterministic dynamic mathematical models – forecasting and control, transfer function models, models for discrete control systems. Basic ideas in model building- linear and multiple linear regression. Basic concepts in stochastic processes and Markov chains, Mean square distance, mean square error prediction, prediction of covariance stationary process, ergodic theory and stationary process, applications of ergodic theory, spectral analysis of covariance stationary processes, Gaussian systems, stationary point processes, level crossing problems. ARIMA models, Autoregressive models, moving average models, duality, model properties, parameter estimates, forecasts.Volatility models: ARCH and GARCH modelling, testing strategy for heteroscedastic models, volatility forecasts, Black Scholes model.

References:

1. G.E.P. Box, G. M. Jenkins, G. C. Reinsel and G M Ljung, *Time Series Analysis-Forecasting and Control*, (5e), Wiley Series, 2016.
2. Anderson T W, *The Statistical Analysis of Time Series*, John Wiley, New York, 1994
3. Samuel Karlin, Howard M Taylor, *First Course in Stochastic process*, Academic Press, New York,
4. C. Chatfield, *The Analysis of Time Series – An Introduction*, Chapman and Hall / CRC, (4e), 2004
5. David Ruppert, *Statistics in Finance*, Springer Publications, 2004

MAT 4052: COMPUTATIONAL LINEAR ALGEBRA [2 1 0 3]

Matrix Analysis: Basic Ideas from Linear algebra, vector norms, matrix norms, orthogonality and SVD, Projections and CS decomposition, the sensitivity of square linear systems. General Linear Systems: Triangular systems, The LU factorization, Round off analysis of Gausian elimination, Pivoting, Improving and estimating accuracy. Orthogonalization and least squares: Householder and Givens matrices, The QR factorization, The full rank LS problem, Other orthogonal factorizations, The rank deficient LS problem, Weighing and iterative improvement, square and underdetermined systems.The symmetric Eigen value problem: Eigen values properties and decompositions, Power iterations, the symmetric QR algorithm, Jacobi methods, Tridiagonal Methods, Computing the SVD, some generalized eigen value problems.

References:

1. Gene H. Golub and Charles F. Van Loan, *Matrix Computations*, (4e), Johns Hopkins University Press, 2013.
2. Gilbert Strang, *Linear Algebra and its applications*, (4e), Wellesley Cambridge press, 2009.
3. David S. Watkins, *Fundamentals of Matrix Computations*,(3e), Wiley, New York, 2010.
4. Roger a Horn, *Matrix Analysis*, (2e), Cambridge University Press, 2013.

MAT 4053: COMPUTATIONAL PROBABILITY AND DESIGN OF EXPERIMENTS [2 1 0 3]

Sampling and sampling distributions, Most powerful tests, Uniformly most powerful tests, Likelihood ratio tests, The sequential probability ratio test, Randomized Designs, Inferences about the differences in Means, Paired Comparison Designs, Inferences about the variance of normal distributions, Monte Carlo estimation methods.The analysis of variance, RCBD, LSD and Related Designs, The Graeco - Latin square Design, Balanced Incomplete Block Designs, PBIBD   Introduction to Factorial Designs, The Two Factor factorial design, Blocking in a factorial design, 2^k Factorial Design, Blocking and Confounding in the 2^k Factorial Design, Partial Confounding. Two level fractional factorial designs, three level and mixed level factorial and fractional factorial designs, 3^k Factorial Design, Confounding in the 3^k Factorial Design, Fractional replication of the 3^k Factorial Design, Factorials with mixed levels.

References:

1. Robert V Hogg and Allen Craig, *Introduction to Mathematical Statistics*, (4e), Macmillan
2. M N Murthy, *Sampling Theory and Methods*, Statistical Publishing Society, 1967
3. C Radhakrishna Rao, *Linear Statitical Inference and its applications*, (2e), Wiley Series.
4. Douglas C Montgomery, *Design and Analysis of Experiments*, (8e), Wiley Series, 2012,
5. D D Joshi, Linear Estimation and Design of Experiments, New Age International Publishers, 2009

MAT 4054: GRAPHS AND MATRICES [2 1 0 3]

Graphs and subgraphs, walks, paths and connectedness, distance as a metric, degrees, regular graphs, cubic graphs, bipartite graphs, self-complementary graphs, operations on graphs, extremal graphs, cut points, bridges and blocks, block graphs and cut point graphs.Trees and their characterizations, centres and centroids, block-cut point trees, spanning trees, independent cycles and cocycles, connectivity and line connectivity, graphical variations of Menger's theorem. Traversability: Eulerian graphs and Hamiltonian graphs. Line graphs and total graphs. Line graphs and traversability, coverings and independence, critical points and lines. Planarity: Plane and planar graphs, outer planar graphs, Kuratowski's theorem, vertex colouring.Incidence Matrix: Rank, minors, path matrix, 0-1 incidence matrix. Adjacency Matrix: Eigen values of some graphs, determinant, bounds, energy of a graph, antiadjacency matrix of a directed graph, non-singular trees. Laplacian Matrix: Basic properties, computing Laplacian eigen values, matrix tree theorems, bounds for Laplacian spectral radius, edge-Laplacian of a tree.

References:

1. F. Harary, *Graph Theory*, Narosa Publishers, 1988.
2. J.A Bondy and U.S.R Murthy, *Graph Theory with Applications*, (5e), Elsevier Publishing Co., 1982.
3. D.B. West, *Introduction to Graph Theory*, Pearson Education, Inc., 2001.
4. R.B Bapat, *Graphs and Matrices*, Hindustan Book Agency, 2010.
5. Lowell W Beineke and Robin J Wilson, *Topics in Algebraic Graph Theory*, Cambridge University Press, 2005.

OPEN ELECTIVES
MAT 5301: APPLIED GRAPH THEORY [2 1 0 3]

Graphs and applications of the theorems by Havel and Hakimi, Erdos and Gallai. Cut points, bridges and blocks, block graphs and cut point graphs. Trees and their characterizations, centre and centroids, block-cut points trees, spanning trees, independent cycles and cocycles, connectivity and line connectivity, Whitney's theorem. Traversability-Eulerian, Hamiltonian, line graphs and total graphs. Traversability, coverings and independence, theorem of Gallai, critical points and lines. Planarity, genus, thickness, crossing number. Colorability, chromatic number and its bounds, Nordhaus Gaddum theorems, the four and five colour theorems, chromatic polynomial. Matrix Representation -Incident matrix, Adjacency matrix, cycle matrix, cutset matrix, path matrix, Digraphs, Matrix - tree theorem on number of spanning trees. Tournament. Graph theoretic Algorithms: Computer representation of graphs-Input and output, Algorithms for connectedness, Spanning Tree, Fundamental Circuits, Directed Circuits and Shortest paths.

References:
1. F. Harary, *Graph theory*, Narosa Publishers
2. Narsingh Deo, *Graph theory with applications to Engineering and Computer Science*, Prentice Hall.
3. Robin J.Wilson, *Introduction to Graph theory*, Logman

MAT 5302: APPLIED LINEAR ALGEBRA [2 1 0 3]

Finite dimensional vector spaces, subspaces, linear independence, basis and dimension. Sum and intersection of subspaces. Algebra of linear transformations, range and null space of a linear transformation, Inner-product spaces, metric spaces and banach spaces, Gram Schmidt orthogonalization, linear operators and their adjoint, self adjoint, unitary and normal transformations, polar decomposition. Matrix algebra, simultaneous equations, Eigen values, characteristic vectors, Cayley-Hamilton theorem, minimal polynomial, Application of eigen values to solve simultaneous difference and differential equations. Quadratic forms and their classification, constrained optimization. Somecomputational methods of linear algebra.

References:
1. Gantmocher F.R., *The Theory of Matrices*, Cheisea.
2. Gilbert Strang , *Linear Algebra and its applications*,Thomson learning
3. David C. Lay, *Linear Algebra and its applications*, Pearson Education

MAT 5303:APPLIED NUMERICAL METHODS [2 1 0 3]

Matrix Algebra : Solution for linear system of equations – Direct methods: Gauss elimination method, Gauss Jordon method, Crouts (LU decomposition) method. Iterative methods, Jacobi Gauss Seidal and successive over relaxation methods. Computation of inverse of a matrix: Jordan method, Triangularization method, Choleski's method, partition method. Eigen value & Eigen vectors: Given's method for real symmetric matrices, Jocobi's method for real symmetric matrices, Power method. Numerical Solution of Ordinary Differential Equations: Single step methods, Runge- Kutta method, Adam Bashforth's predictor corrector method, Milne's predictor and corrector method. Numerical Solution of Partial Differential Equations: Finite difference approximation to derivatives of Parabolic, Elliptic. Explicit finite difference method, implicit method.

References:
1. Jain, Iyengar and Jain: *Numerical methods for Scientific and Engineering Computations*, New Age Publishers
2. Carnahan, Luther and Wikes: *Applied Numerical Methods*, John Willey
3. Conte S.D and Be Door, *Introduction to Numerical analysis*, McGraw Hill.

MAT 5304:MATHEMATICAL MODELLING [2 1 0 3]

Introduction, Techniques, classification and characteristics of mathematical models, mathematical modeling through algebra, ordinary differential equations of first order. Mathematical modeling through systems of ordinary differential equations of first order, Prey- Predator model Mathematical modeling through systems of ordinary differential equations, modeling in medicine A model for diabetic mellitus. Modelling on population dynamics Mathematical modelling through difference equations. Some simple models. Modelling of economics and finance through difference equations, population dynamics and generation of models through difference equations, modeling in probability theory, examples. Optimization models: Mathematical modeling through linear programming. Mathematical modelling through graphs: elements of graphs, digraphs. Mathematical models for blood flow. Mathematical model for Peristaltic transport of two layered.

References:
1. J N Kapur, *Mathematical Modelling*, New age international publishers,(2e), 2015.
2. J N Kapur *Mathematical Models in biology and medicine*, East- West press.
3. J N Kapur *Mathematical models of environment*, INS Academy, New Delhi

MAT 5305:OPTIMIZATION TECHNIQUES [2 1 0 3]

Formulation, Linear programming-simplex method, Penalty coase methods, 2-phase method. Dual Simplex method. Duality theory .Transportation problem-Volgel's approximation method, MODI method, Assignment problem-Hungarian method.Project Management - Networks, Project planning and control using PERT and CPM. Project crashing. Game theory - 2persons zero sum games, Minimax principle, games with mixed strategies. Dominance theory, solution using Linear programming.

References:
1. Bronson Richard - *Theory and Problems of Operations Research*-Schaum series- MGH
2. P.K.Gupta& Man Mohan - *Operations Research* - Sultan Chand & Sons
3. HamdyA.Taha - *Operations Research* PHI

MAT 5306: STOCHASTIC PROCESSES AND RELIABILITY [2 1 0 3]

Static probabilities: Review and prerequisites generating functions, difference equations.Dynamic probability: definition and description with examples. Markov chains, transition probabilities, Chapmen Kolmogrov equations. Classification of states, chains of Markov process. Stability of Markov systems, limiting behaviour, random walk. Poisson Processes : assumptions and derivations, related distributions, birth and death processes. Queueing System, general concepts, Model M/M/1 and M/M/S, steady state behaviour, transient behaviour. Wiener processes and Gaussian processes. Differential equations of a wiener process, Kolmogrov equations, Ornstein – Unlenbeck Process. White note. Reliability Theory : Definition of Reliability, types of failure, Hazard rate, Laws of failure - normal, exponential & Weibull failure laws - System reliability - in series, in parallel series - parallel system, Paralled - series system & related problems.

References:
1. Medhi. J., *Stochastic Processes*, Wiley Eastern.
2. Bhat U R, *Elements of Applied Stochastic Processes*, John Wiley.
3. A Papoulis, *Probability, Random Variables and Stochastic Procesess*, McGraw Hill.

HUM 4051: FINANCIAL MANAGEMENT [2 1 0 3]

Introduction and objectives of financial management, Evolution of corporate finance, responsibilities. Types of accounts, Golden rules of accounting, Preparation of Journal, Ledger, Trial balance and final accounts. Sources of long term finance, Characteristics of equity capital, Preference capital, Debenture capital & Term loans. Valuation of securities, Concepts, Bond valuation and related models, Bond value theorems, Yield to maturity. Equity valuation; Dividend capitalization approach, Leverage, Operating leverage, Financial leverage, Total leverage, Indifference point analysis. Working capital management, Capital budgeting: appraisal criteria, pay-back period, Average rate of return, Net present value, Benefit cost ratio and Internal rate of return. Risk analysis in capital budgeting, Cost of capital: introduction, cost of debt capital, Preference capital and Equity capital, Weighted average cost of capital, Determination of proportions, Cash management, Dividend decisions.

References:

1. Prasanna Chandra., Fundamentals of Financial Management, Tata McGraw Hill Education Pvt Ltd., New Delhi, 2006.
2. I M Pandey, Financial Management, Vikas Publishing House Pvt Ltd.,, New Delhi, 2015.
3. N Ramachandran & Ram Kumar Kakani, Financial Accounting for Management, 3/e, Tata McGraw Hill Education Pvt Ltd., New Delhi, 2011.
4. Eugene F Brigham & Michael C E, Financial Management: Theory and Practice. 12e, Cengage Learning, India, 2008.
5. Maheshwari S.N., Financial Management, Sultan Chand & Co., New Delhi, 2002.

HUM 4052: HUMAN RESOURCE MANAGEMENT [2 1 0 3]

Introduction, Scope of HRM, Objectives of HRM, Functions, Activities, Roles, HRD organization and responsibilities. Evolution of HRM, Influence of various factors on HRM. Human resource planning: Introduction, Strategic considerations, Nature and scope, Human Resources Inventory, Job analysis, Job design, Job description, Job specification and Job evaluation. Employee Recruitment & Selection: Policy, Process, Tests, modern methods, Interview, Provisional selection, Medical/Physical examinations, Placement, Induction programs and socialization. Training and development: Basic concepts, Employees training Process, Planning, Preparation of trainees, Implementation, Performance evaluation and Follow-up training. Competency Mapping and Career development programmes. Performance appraisal and Merit rating, Promotion, transfers and separations, Wages and salaries administration, Discipline and grievances. Industrial and labour relations and Trade Unionism Overview: Collective bargaining and maintaining Industrial health.

References:

1. Michael Armstrong ., A Handbook of Human Resource Management Practice: 10th Edition, New Delhi, Kogan Page India,2006
2. Gary Dessler& BijuVarkey .,Human Resource Management:12th Edition Dorling Kindersley(India),Noida,2011
3. T.V. Rao and Pereira D F., Recent experiences in Human Resources Development, Oxford and IBH Publishing, 1986.
4. Subbrao A., Essentials of Human Resource Management and industrial Relations, Himalaya Publishing House, 1999.
5. Aswathappa K,Human ResourceManagement,Text&Cases McGrawHill 7th Edition,2006
6. N G Nair and Latha Nair., Personnel Management and Industrial Relations, S. Chand Company, 1995.

HUM 4053: MARKETING MANAGEMENT [2 1 0 3]

Marketing definition, scope and concepts, Adapting marketing to the New Economy, Marketing strategic planning. Market Demand, Marketing Environment, Marketing Information System, Marketing Research. Segmentation, Targeting and Positioning, Buying Behaviour: Consumer Markets and Business Markets, Competition: Identifying competitors, analysing competitors. Product Life Cycle: Product life-cycle marketing strategies. New Market Offerings: New product development and challenges, Branding. Designing and Managing Services, Price Strategies, Retailing, Wholesaling, Integrated Marketing Communications, Digital Marketing and Trends, International Marketing

References:

1. Philip Kotler, Kevil Keller, Abraham Koshy & Mithileshwar Jha, Marketing Management – A South Asian Perspective, Pearson Education Inc, New Delhi, 2012.
2. Arun Kumar & N Meenakshi, Marketing Management, Vikas Publishing House Pvt Ltd, New Delhi, 2011.
3. Varshney R L and Gupta S L., Marketing Management, Sultan Chand & Sons, New Delhi, 2004.
4. Adrian Palmer., Principles of Marketing, Oxford University Press, New York, 2000.

HUM 4054: OPERATIONS MANAGEMENT [2 1 0 3]

Introductions to operations management – process view and supply chain view, types of production activities, competitive priorities and capabilities. Break-even analysis, evaluating services or products, evaluating processes - make or buy decision, decision making under risk, and decision trees. Introduction to forecasting, importance and uses of forecasting, demand patterns, demand management options, judgement methods, causal methods - linear regression, time series method – naïve method, moving average, weightage moving average, and exponential smoothing curve. Planning long-term capacity, measures of capacity and utilization, economies of scale, diseconomies of scale, capacity timing and sizing strategies, sizing capacity cushions, timing and sizing expansion – expansionist strategy, wait and see strategy, and a systematic approach to long term capacity decision. Levels inoperations planning and scheduling across the organization, sales and operation planning strategies- chase strategy, level strategy, operations planning using linear programming technique, scheduling job and facility scheduling, and work for scheduling. Theory of constraints, managing bottle necks in manufacturing and service processes, identifying bottle necks, relieving bottle necks, drum buffer rope system, and managing constraints in a line system. Supply chain design across the organization, supply chains for services and manufacturing, measures of supply chain performance - inventory measures, financial measures, inventory and supply chains - pressures for small inventories, pressures for large inventories, types of inventory, inventory reduction tactics, and inventory placement. Costs of quality, total quality management, acceptance sampling, statistical process control - control charts, and process capability. Continuous improvement using lean systems, different types of wastes, strategic characteristics of a lean system, designing lean system layout, and Kanban system.

References:

1. Krajewski L. J., Ritzman L. P., Malhotra M., and Srivastava S. K., *Operations Management*, 11th edition, Pearson Education (Singapore) Pvt. Ltd., Delhi, 2016.
2. Heizer J. and Render B., *Operations Management*, 11th edition. Pearson Education India, 2016.
3. Khanna R. B., *Production and Operations Management*, 2nd edition, PHI Learning Private Limited, 2015.

HUM 4301: COMMUNICATIVE ENGLISH [3 0 0 3]
(Offered for Lateral Entry Students only)

Common Errors in English: Subject Verb Agreement; Uses of Tenses / Sequence of Tense; Prepositions; Articles; Special Usages; Creative Writing Essay: Types of Essays, Argumentative Essay, Descriptive/ Expository/Narrative Essays; Reading Comprehension; Dynamic text; Critical Evaluation; Group Discussions; Presentation Skills; Essay writing.; Audio texts/speeches -Practice listening skills- summary, commentary, listening exercises. Video Speeches -T h e m e b a s e d s p e e c h e s - motivational, informative, technical, and persuasive, discussions. Speech - Elements of a good speech, types of speeches, model speech, Speech exercises, individual presentations, peer and facilitator feedback. Formal/Informal communication. Communication Styles- formal and informal, standard English and variations in usages, examples and analysis of faulty usages; Correspondence: formal/informal letters and emails .

References:

1. Green David., *Contemporary English Grammar, Structures and Composition* Chennai: Macmillan Publications.
2. Thompson AJ & Martinet AB., *A Practical English Grammar*, OUP.
3. Turton N D , Heaton J B., *Longman Dictionary of Common Errors*, 1998.
4. Meenakshi Raman & Sangita Sharma., *Technical Communication; Principles and Practice*, Oxford University Press, 2011.

HUM 4302: FILM STUDIES [2 1 0 3]

History of invention of motion pictures - Daguerre, Muybridge, Edison, SkaldanowskyBrothers,Lumieres; Evolution of film – Lumieres, Melies, Porter, Griffith, Basic techniques – Mise-en-scene, Mise-en-shot, Deepfocus Photography, Longtake, Continuity, Editing, Montage, German Expressionism; French Impressionism; Soviet Montage cinema; Hollywood cinema, Italian Neo-realism; French Nouvelle Vague, Documentary, Directors – Eisenstein, Kurosawa, Godard, Chaplin, Bergman; Mohsen Makmalbakf, Majid Majidi, Keislowski, Zhang Yimou, Kim Ki Duk, "New Wave" Cinema in India - Bengali; Malayalam; Kannada; Hindi, To be screened- Bicycle Thieves, The 400 blows, Rashomon, Wild strawberries, Battleship Potemkin, Cabinet of Dr.Caligari, The kid, Children of heaven, Hero, Ghatashraddha, PatherPanchali, Mathilukal.

References:

1. Bordwell, David and Thompson, Kristin., *Film Art: an Introduction, 7th ed*. New York: McGraw-Hill Co., 2004.
2. Kawin, Bruce., *How Movies Work*. Berkeley and Los Angeles: University of California Press, 1992.
3. Cook, David A., *A History of Narrative Film*, 4th ed. New York: W.W. Norton & Co., 2004.

HUM 4303:GERMAN FOR BEGINNERS [3 0 0 3]

Text selections, dialogue and exercises which have been designed to give the absolute beginner grounding in the rudiments of the German language, as well as providing background information about the history, life and culture in Germany.Introduction to the German alphabet and the German language – dialogues & conversations – pronunciation, basic vocabulary lists - key points of grammar - background information about the history and culture of Germany - exercises on vocabulary, grammar and German culture - reading & listening comprehension.

References:

1. Sally Johnson, Natalie Braber., *Exploring the German Language*, (2E), Cambridge University Press. 2008.
2. Charles Russ., *The German Language Today: A Linguistic Introduction*, Routledge. 1994.

HUM 4304: BUILDING BRIDGES: INDO-EUROPEAN INTERCULTURAL DYNAMICS [3 0 0 3]

The challenges of Intercultural communication - interacting in a diverse world, understanding cultures, alternative views of reality, cultural stereotyping. Foundational Theories in Intercultural Communication - Edward Hall, Samovar, G Hofstede, Understanding cultural Dimensions and Cultural Stereotyping- collectivism/ individualism, power distance, masculine/feminine, cultural metaphors, Intercultural Business Communication Competence - The Role of Language in Intercultural Business Communication , Nonverbal Language in Intercultural Communication, Cultural influence on interpersonal communication, Intercultural Dynamics in the multicultural organizations.

References:

1. Dodd, Carley H. *Dynamics of Intercultural Communication*, McGraw-Hill, Boston. 1998.
2. Gannon M J and Pillai R. *Understanding Global Cultures*, Sage Publications, California. 2010.
3. Hall, E. T. *The dance of life: The other dimension of time*, Random House, New York. 1983.
4. Hofstede, Geert., *Cultures' Consequences, Comparing Values, Behaviors, Institutions, and Organizations across Nations*, Sage Publications, Thousand Oaks, CA. 2001.
5. Martin, J.N. & Nakayama, T.K., *Intercultural communication in contexts*. 4th Edition. Mountain View, CA: Mayfield. 2007.
6. Samovar, L A and Porter, R., *Communication between Cultures*, Cengage Learning, Wadsworth, CA. 2007.

HUM 4305: INTERPRETATION OF LITERARY TEXTS [3 0 0 3]

Texts-static, dynamic, cryptic and delphic ; Language of literature; Form and structure; Literature verses popular fiction; Text and discourse; Authors and critics; Theories and approaches to literary texts; Formalism, Structuralism, Marxism, Feminism, Deconstruction; Ideational functions and textual Functions; Class, gender and texuality; Race and nationality; Genre, phonological deviations –sound patterns and figures of speech ; Pragmatic approach to literature; Understanding syntax, Lexical and syntactic analysis of literary texts; Point of view in literary texts and foregrounding; Prediction and making sense of a text; Stylistic analysis of a novel; Kinds of meaning, Rhetorical structure; Pragmatics and discourse analysis; Interpreting cohesive devices and complex functional values; Stylistic approach to literature ; Elements of literary style; Stylistic analysis of selected short stories, Poems, Novels and Plays; Genre, the plot setting, characterization, tone and themes; Stylistics and its implications on narrative techniques; Intertextuality and conceptual blending; Identifying patterns in the texts; Meaning making process in literature; Imagery, metaphor as a mode of thought; Coherence and Cohesion; Context, turn taking and Adjacency Pair; Pro-forms, Discourse markers, Lexical cohesion and presupposition; Recognizing text organization; Critical texts, Shared assumptions on critical texts; The role of schema and the concept of speech acts in literary texts.

References:

1. Austin, J.L., *How to do Things with Words*, Longman, London, 1992.
2. Barthes. R., *Introduction to the Structural Analysis of Narratives*, Fontana, London, 1977.
3. Blake.N.F., *An Introduction to the Language of Literature*, Macmillan, London. .1990.
4. Carter, R. (ed.)., *Language and Literature: An introductory Reader in Stylistics*, Allen and Unwin, London, 1982.
5. Cook, G., *Discourse and Literature*, Oxford University Press, London, 1994.
6. Harold, C.M.(ed.)., *Style in Prose Fiction*, Columbia University Press, New York.
7. Leech, G.N., *A Linguistic Guide to English Poetry*, Longman, London, 1969.

HUM 4306: PUBLIC SPEAKING [3 0 0 3]

Public Speaking -Introduction to Public speaking- Voice modulation, Sounds/accent (basics), Articulation, Anxiety management, Logical arguments, Concept of purpose, Audience, Smart use of Body language. Types of speech-Informative speeches - designing and delivery-Persuasive speeches – designing and delivery- Impromptu speeches – designing and delivery -Special occasion speeches- designing and delivery, Presentations - planning and execution -Types of presentation - Informative-Planning and delivery - Persuasive - Planning and delivery - Motivational - Planning and delivery, Other forms of speaking – Debates, Seminars, Panel Discussion, Group Discussion, Tall Tales, Turn Coat, Art of Evaluation-Providing feedback- planning, designing and delivering constructive feedback - Receiving feedback – making use of relevant feedback -Techniques of providing feedback- Speech analysis –Role of the Evaluator.

References:

1. Duarte Nancy., *Resonate: Present Visual Stories that Transform Audiences*, John John Wiley and Sons, 2010.
2. Minto Barbara., *The Pyramid Principle: Logic in writing, thinking and Problem Solving*, Financial Times Prentice Hall, 2002.
3. Berkun Scott., *Confessions of a Public Speaker*, O'Reily Media, 2009.
4. Goodale Malcolm., *Professional Presentations*, Cambridge University Press, 2005.
5. Carnegie Dale., *The Art of Public Speaking*, 1905.

HUM 4307: INTRODUCTION TO PSYCHOLOGY [3 0 0 3]

Psychology - Meaning, Nature and Scope, Defining Psychology, Meaning of the term Behavior, Nature of Psychology, Scope of Psychology: Branches and fields of Psychology. Development of Psychology - Historic Sketch of Psychology, Modern Age of Psychology, Gestalt Psychology, Psycho Analysis, Contemporary Psychology. Systems of Psychology- The Nervous System, Nature V/s Nurture, Sensation and perception, States of Consciousness. Methods of Psychology - Classical Conditioning, Introspection Method, Naturalistic Method, Experimental Method, Differential Method, Clinical Method, Psycho Physical Method. Personality- Personality types, Personality Disorders, Abnormal psychology, Treatment of personality disorders. Thinking - Nature of Thinking, Types of Thinking, Language and Intelligence. Discussion, Presentation and Assignments.

References:

1. Boring, E.G., Langfield,H.S. &Weld,H.P., *Foundations of Psychology, Asia* Publishing House, Calcutta, 1963.
2. Carson, R.C., Butcher, J.N. & Coleman, J.C., *Abnormal Psychology & Modern Life*, (8th ed) Scoff, Foresman&Co. 1988.
3. Lahey, B.B.,Psychology: *An Introduction*, 6th Ed., Tata McGraw Hill, New York, 1965.
4. Olson, M.; Hergenhahn, B.R., *Introduction to the Theories of Learning*, Prentice-Hall India, 2009.

HUM 4308: INTRODUCTION TO PHILOSOPHY, RELIGION AND CULTURE [3 0 0 3]

Notions of Philosophy; The Origin and Development of Philosophy; Ancient Philosophy; Medieval Philosophy; Modern Philosophy; Contemporary Philosophy; Indian Philosophy; Comparative Religion; Western Philosophy; The Relevance of Philosophy; Branches of Philosophy; Methods of Philosophy; Philosophy and other Branches of Study; Some Problems of Philosophy; Themes of Philosophy; Mind and Body, and the Problem of Universal; Change/Movement time and place; Existence of God and Evolution; Indian Culture; Social Ethics; Logic and Scientific Methods; Philosophy of Language.

References:

1. Aquinas, Thomas., *On Being and Essence. Trans. Armand Maurer*. Canada: Pontifical Institute of Mediaeval Studies, 1968.
2. John-Terry, Chris., *For the Love of Wisdom: An Explanation of the meaning and Purpose of Philosophy*. New York: Alba House, 1994.
3. Maritain, Jacques., *An Introduction to Philosophy*, London: Sheed and Ward. 1979.
4. Radhakrishnan, S. (Ed)., *History of Philosophy Eastern and Western Vol.II* George Allen and Unwin Ltd., London, 1953.
5. Wallace, William., *The Elements of Philosophy*. New York: Alba House, 1990.

HUM 4309: CREATIVE WRITING [3 0 0 3]

Various literary/prose forms and their characteristics; techniques and strategies for reading; nuances of language and meaning in reading and writing; Writing Exercises - techniques and strategies of writing creatively; Critical Concepts and Terms in Literary Writing; Writing Exercises; creative writing output.

References:

1. Milan Kundera ., *The Art of the Novel*.
2. The Art of Fiction: Illustrated from Classic and Modern Texts, David Lodge

HUM 4310: GRAPHIC NOVELS: HISTORY, FORM AND CULTURE [3 0 0 3]

Part I:The History of Comic Books, Part 1: Developing a Medium Defining comic books as a medium-Relationships between comic books and other forms of sequential art-The (continental) roots of comics as an art form -The ways in which comic strips and pulps contributed to the emergence of the comic book. The History of Comic Books, Part 2: The Maturation of the Medium-Influence of underground movement, ways in which mainstream publishers began to address more relevant topics, proliferation of independent comics, the increase in the profile and prominence of the medium due to ambitious projects. Part II: Creating the Story: Graphic Storytelling and Visual Narrative-Some narrative structures commonly found in comic books -The types and techniques of encapsulation-The nature of the relationship between the pictorial and linguistic elements of comic books Experiencing the Story: The Power of Comics -   About diegetic images that show the world of the story-About interpretive images that comment on the story-The impact art style has on the emotional reactions of the reader; and how the   meaning of each image is affected by the relationship to other images in that particular book, in other texts, and in the reader's personal experience-Part III: Comic Book Genres-the definition of genre and the role it plays in shaping the creation of comics products- the characteristics of genres, including character types, narrative patterns, themes, and other conventions-how the example genres of teen humor, romance, funny animals, horror, and memoir developed in comics, and what characterizes each-how the hybridization of genres helps experimentation and expansion of narrative possibilities.

References:

1. Roger Sabin., *Comics, Comix and Graphic Novels*.
2. Robert Petersen, Allan Moore., *Comics, Manga and Graphic Novels: A History of Graphic Narrative3. Comics as Performance*, Fiction as Scalpel.
3. JeetHeer, Kent Worcester., *Arguing Comics: Studies in Popular culture*.

HUM 4311: MANAGEMENT INFORMATION SYSTEMS [3 0 0 3]

Management information system: Introduction to management, information and system. System concepts, general model of a system and types of systems. Evolution of MIS , models and resources used in the MIS model. Structure of MIS, operating elements of an information system, synthesis of the structure. Information systems for different applications: Transaction processing systems, Human resource management systems and Marketing-application areas. Production planning and Office automation systems. Role of management information in decision making: Concepts of decision making, Decision making process and information needs at different levels of management. Herbert. A. Simon model. Phases in the decision making process, Programmed vs non-programmed decisions, General model of human as an information processor, Allen Newell Simon model. Decision support systems -structure, elements and working. Information as a strategic resource. MIS as a technique for making programmed decisions: Behavioral models of the decision maker and methods. MIS support for decision making. Role of MIS in Organizations -recent trends and e-commerce applications. Development of customized management information system approaches: SDLC -phases in SDLC, Strategic and project planning for MIS, conceptual design and detailed design phases: general business planning and MIS response. MIS Planning and planning cycle. Conceptual system design and Detailed System design. MIS System Implementation, and Pit falls: Pit Falls in MIS development, Fundamental weaknesses, soft spots in planning, design problems and review.

References:

1. Gordon B. D. and Margrethe H. O., (2005), "Management Information Systems", McGraw-Hill, New York.
2. Kenneth L. and Price J. P., (2003), "Management Information Systems", Macmillan.
3. Jawadekar W. S., (2000) "Management Information System", Tata McGraw Hill.
4. Senn J. A., (2003), "Analysis & Design of Information System", McGraw Hill International Student Edition.
5. Mudrick; Ross (1997) "Information Systems for Modern Management " Prentice Hall of India.
6. James A. O.Brien (1995) "Management Information Systems, Galgotia Publications.

HUM 4312: ENTREPRENEURSHIP [3 0 0 3]

Entrepreneur: Meaning of entrepreneur, evolution of the concept, functions of an entrepreneur, types of entrepreneur, and intrapreneur. Concept of entrepreneurship - evolution of entrepreneurship, development of entrepreneurship, stages in entrepreneurial process, role of entrepreneurs in economic development, entrepreneurship in India, barriers for entrepreneurship. Small scale industry: Definition, characteristics, need and rationale. Objectives, scope, role of Small Scale Industries (SSI) in economic development, advantages of SSI, steps to start an SSI - government policy towards SSI, different policies of SSI, impact of liberalization, privatization, and Globalization. Effect of WTO/GATT and supporting agencies of government for SSI. Institutional support: Different Schemes: TECKSOK, KIADB; KSSIDC; KSIMC; DIC Single Window Agency: SISI, NSIC, SIDBI, and KSFC, New schemes and support for start-ups and new venture under Govt. of India. Preparation of Business plan and project report: components of a successful plan. Meaning of project, project identification, project selection, project report, need and significance of report, contents, formulation, guidelines by planning commission for project report. Network analysis, errors in project report, project appraisal. Identification of business opportunities, market feasibility study, technical feasibility study, financial feasibility study and social feasibility study and documentation and evaluation.

References:

1. Vasant Desai., Dynamics of Entrepreneurial Development & Management, Himalaya Publishing House, 2007.
2. David H. Holt Entrepreneurship: New Venture Creation, Published by prentice Hall,1991.
3. Poornima. M. Charantimath., Entrepreneurship Development, Pearson Education, 2006.
4. S.S. Khanka., Entrepreneurship Development, S.Chand& Co, 2007.

Minor Specialization: Material Science

PHY 4051: PHYSICS OF LOW DIMENSIONAL MATERIALS [3 0 0 3]

Thin films: Thick and Thin Film Materials, preparation by physical and chemical methods. Thickness measurement techniques. Theories of nucleation - Capillarity and atomistic theory, effect of deposition parameters on nucleation and growth of thin films. Epitaxial growth. Reflection and Transmission at interface between isotropic transparent media. Reflectance and Transmittance in thin films. Antireflection coatings. Electrical conduction in discontinuous metal films - Quantum mechanical tunneling model. Conduction in continuous metal and semiconducting films. Thermoelectric power in metal films. thin film resistors, thermopiles. Quantum well devices.

Nanomaterials: Chemical Synthesis of Nanoparticles: Bottom up approach. Functionalized nanoparticles in different medium. Size control. Self assembly. Nanoparticle arrays. Semiconductor nanoparticles- synthesis, characterization and applications of quantum dots. Magnetic nanoparticles- assembly and nanoastructures. Manipulation of nanoscale biological assemblies. Carbon nanotubes and fullerene as nanoclustures. Nanostructured films. Physical Methods of Nanostructure Fabrication: Top down approach. Nanopatterning-Lithography- Optical, X-ray and Electron beam lithography. Ion- beam lithography.

References:
1. Chopra K. L., *Thin Film Phenomena*, Mc Graw Hill, 1969
2. Milton Ohring, *Materials Science of Thin Films*, Elsevier, 2001
3. Heavens O. S., *Optical Properties of Thin Solid Films*, Dover, 1955
4. Liz-Marzan L. M. and Kamat P. V. (Eds), *Nanoscale Materials*, Kluwer, 2003
5. Nalwa H. S. (Ed), *Nanostructured Materials and Nanotechnology*, Academic, 2002

PHY 4052: PHYSICS OF PHOTONIC AND ENERGY STORAGE DEVICES [3 0 0 3]

Semiconductors: Direct and indirect band gaps. Carrier concentrations at thermal equilibrium. Fermi level. Degenerate and non-degenerate semiconductors. Semiconductor Crystal growth techniques Contact phenomenon- semiconductor-semiconductor, metal-semiconductor contacts. Schottky and Ohmic contacts. Preparation of semiconductor devices. IC technology, elements of lithography.

Photonic Devices: LED and semiconductor lasers: Radiative and non-radiative transitions, diode laser, population inversion, laser operating characteristics, efficiency, photoconductor, photodiode, avalanche photodiode, phototransistor, material requirement for solar cells, theory and types of solar cells.

Fuel cells: Hydrogen energy – merits as a fuel – production of hydrogen, Hydrogen Fuel cells – introduction – difference between batteries and fuel cells, components of fuel cells, principle of working of fuel cell, fuel cell stack, fuel cell power plant: fuel processor, fuel cell power section, power conditioner, Advantages and disadvantages of fuel cell power plant. Types of fuel cells. Application of fuel cells – commercially available fuel cells.

References:
1. Neamen Donald A., *Semiconductor Physics and Devices, basic principles*, Tata McGraw-Hill, 2002
2. Sze S. M., *Physics of Semiconductor Devices*, John Wiley & Sons, 2007
3. Larminie J. and Dicks A., *Fuel Cell Systems Explained*, Wiley, 2003
4. Xianguo Li, *Principles of Fuel Cells*, Taylor and Francis, 2005
5. S. Srinivasan, *Fuel Cells*: From Fundamentals to Applications, Springer, 2006

OPEN ELECTIVES

PHY 4301: FUNDAMENTALS OF ASTRONOMY AND ASTROPHYSICS [3 0 0 3]

Introduction to astronomy and astrophysics. Properties of ordinary stars: Brightness of starlight; the electromagnetic spectrum; Colours of stars; stellar distances; absolute magnitudes; HR diagram. Stellar evolution: Formation of star; the main sequence; stellar structure; evolution off the main sequence; planetary nebulae; white dwarfs. The death of high mass stars: Supernovae; neutron stars; pulsars; stellar black holes. Normal Galaxies: Types of galaxies; Dark matter in galaxies. Cosmology: The scale of universe; expansion of the universe; open or closed universe; the big bang; the cosmic background radiation; big bang nucleosynthesis. Astronomical instruments.

References:
1. Marc L Kutner, *Astronomy: A physical Perspective (2e)* Cambridge University Press, 2003
2. BaidyanathBasu, *An Introduction to Astrophysics (2e)*, PHI Learning Pvt. Ltd, 2011.
3. Michael Zeilik, *Introductory Astronomy and Astrophysics (4e)*, Saunders College Pub. 1992.

PHY 4302: PHYSICS OF ENGINEERING MATERIALS [3 0 0 3]

Types of magnetism, ferromagnetic domains, soft and hard magnetic materials, ferrites, magnetic storage, Superconducting materials, Applications of superconductors, Nano-materials, bottom-up and top-down methods, Quantum dots and nano-carbon tubes, Composite materials, micromechanics of composites - Density, Mechanical and Thermal properties, Semiconductors, Metals, semiconductors and insulators, Direct and indirect band-gap semiconductors, Intrinsic and extrinsic semiconductors, Diffusion and drift processes, Crystal growth techniques, Preparation of semiconductor devices.

References:
1. William F. Smith, *Principles of Materials Science and Engineering (2e)*, McGraw-Hill International Edition, 1990.
2. Nalwa H.S., *Nanostructured Materials and Nanotechnology (2e)*, Academic, 2002.
3. Chawla K. K. *Composite Materials- Science & Engineering (3e)*, Springer-Verlag, 2012.
4. Streetman Ben G. and Banerjee Sanjay Kumar, *Solid State Electronic Devices (6e)* PHI learning Private Limited, 2012.

PHY 4303: RADIATION PHYSICS [3 0 0 3]

Radiation Sources: Fast electron sources-Heavy charged particle sources-Sources of electromagnetic radiation-Neutron sources. Radiation Interaction: Photoelectric and Compton process -pair production. Interaction of heavy charged particles-stopping power-Energy loss characteristics- Bragg curve-Particle range-range straggling- stopping time-energy loss in thin absorbers-Interaction of fast electrons-absorption of beta particles-interaction of gamma rays-gamma ray attenuation-Interaction of neutrons-neutron cross section-neutron induced nuclear reactions. Radiation Detectors and Instrumentation: Semiconductors diodes-JFET-MOSFET-Integrated Circuits-OPAMP and their characteristics-Differential Amplifier-Operational amplifier systems-Pulse Amplifiers. Principles of radiation detection and measurements-Gas filled detectors-Ionisation chambers-Proportional counters-GM counters-Scintillation detectors-Semiconductor detectors-Thermo luminescent Dosimeters-Radiation spectroscopy with scintillators-Gamma spectroscopy-Multichannel pulse analyzer-Slow neutron detection methods-Reactor instrumentation. Industrial uses of nuclear measurements: Radiation detection in industrial environments-Measuring systems for industrial problems-Determination of physical material characteristics by nuclear measurements-Level height determination-Density measurements-Quantity measurements-Thickness measurement-coating thickness measurement.

References:
1. Knoll G. F., *Radiation Detection and Measurement (3e)*, Wiley 2010
2. Boylestad R. L., *Electronic Devices and Circuit theory (11e)*, Pearson Education 2016
3. Malvino A. P., *Electronic Principles (7e)*, TMH 2010
4. Foldiak G., *Industrial Applications of Radioisotopes*, Elsevier Science Ltd 1986

PHY 4304: SOLID STATE PHYSICS [3 0 0 3]

Review of Crystal structure: Lattice, basis and unit cell, crystal system, symmetry, crystal planes and miller indices, reciprocal lattice, Bragg's law, experimental methods of x-raydiffraction, types of crystal binding, analysis of stress and strain in crysals. Electrical conduction: Free electron gas model, Sommerfield quantum theory, Fermi energy, parameters of free electron gas at absolute zero, electrical conductivity, Drude-Lorentz theory and Sommerfield theory of electrical conductivity, Band theory of solids, electrical conduction in metals, insulators and semiconductorsDielectrics: Static dielectric constant, polarization and polarizability, local field, ferro electricity, piezo electricity, frequency dependence of polarizability (electronic, ionic and dipolar), dielectric losses, requirements of insulating materials, applications of dielectric materialsMagnetism: Classification of magnetic materials, classical theory of diamagnetism and paramagnetism, Weiss theory of ferromagnetism, ferrites, hard and soft magnetic materials, garnets, magnetic bubbles, ceramic magnets, applications of magnetic materials

References:
1. Kittel C., *Introduction to Solid State Physics (7e)*, Wiley 1996.
2. Rao A., *A first course Solid State Physics*, Asiatech publications 2000.
3. Pillai S.O., *Solid State Physics (6e)*, New age international publications 2006.
4. Wahab M. A., *Numerical problems in Solid State Physics*, Alpha science international publications 2011.
5. Gupta H. C., *Solid State Physics*, Vikas publishing house Pvt. Ltd. 1996.

PHY 4305: MODERN OPTICS [3 0 0 3]

Optics: Review of geometrical and physical optics, Dual nature of light, Electromagnetic spectrum, Optical devices, mirrors, lenses, prisms, grating, beam splitters, zone plate, polaroids. Light sources, emission profile. Elements of lasers: Basic requirements in a laser, characteristic properties of lasers. Q-switched and mode locked lasers. CO2, Nd: YAG lasers. Applications. Introduction to Non-linear optics. Optoelectronic devices and its application: Photo diodes, solar cells, LED, and diode lasers. DBR and DFB lasers, CCD. Optical Communication: Conceptual picture of the optical communication system, Modulation and Detection Schemes, properties of optical fibers, discussion on device requirements, OEICS. Optical storage devices: Data recording and read out from optical discs. Holographic data storage systems.

References:
1. Ghatak A., *OPTICS (4e)*, Tata McGraw Hill Publishing Company Ltd. 2009.
2. Singh J., *Optoelectronics: An Introduction to Materials and Devices*, TATA McGraw- Hill Companies, Inc. 2014.
3. Wilson & Hawkes, *LASERS*, Prentice-Hall of India Pvt. Ltd. 1987.
4. Hugh Bennett, *Understanding Recordable & Rewritable DVD*, OSTA.org.
5. Hugh Bennett, *Understanding CD-R & CD-RW*, OSTA.org.

PHY 4306: INTRODUCTORY QUANTUM MECHANICS [3 0 0 3]

Review of certain basics : Limitations of classical physics, wave-particle duality, De Broglie's hypothesis, matter as wavepacket, Heisenberg's uncertainty principle, Mathematical Formalism : operators; commutation relation; orthonormal functions; eigenvalues and eigenfunctions; the Dirac notation; the postulates of quantum mechanics.The Schrödinger Equation : Introduction, wavefunctions , time dependent Schrödinger equation, conservation of probability, expectation values, Ehrenfest's theorem, time independent Schroedinger equation, stationary states, Schroedinger equation in one dimension : the infinite square potential well; the finite square potential well; the potential barrier; tunneling; the harmonic oscillator.Quantum mechanics in three dimensions: Schrödinger equation in spherical coordinates, separation of variables, the angular equation, the radial equation, Applications (energy eigenvalues and eigenfunctions): the rigid rotator; the hydrogen atom; angular momentum. Identical Particles.Some applications of quantum mechanics in nuclear physics, condensed matter physics, and spectroscopy: alpha decay, nanostructures, STM, vibrational and rotational spectra of molecules etc.

References:
1. Verma H.C., *Quantum Physics (2e)*, Surya Publications. 2016.
2. Gasiorowicz S., *Quantum Physics (3e)*, Wiley India Pvt Limited. 2007.
3. Jain M. C., *Quantum Mechanics: A Textbook for Undergraduates*, PHI Learning Private Limited 2012.
4. Griffiths D. J., *Introduction to Quantum Mechanics (2e)*, Pearson Education.
5. Eisberg R. and Resnick R., *Quantum Physics of Atoms, Molecules, Solids, Nuclei, and Particles (2e)*, Wiley-India Pvt Limited. 2009.

Minor Specialization: Material Science

CHM 4051: CHEMICAL BONDING [3 0 0 3]

Introduction to bonding, Classification. Ionic bond- Lattice energy, Born Haber cycle, Radius-ratio rules, Properties of ionic compounds, Covalent character in ionic bonds. Covalent bond-Covalency, Valence bond theory, Sigma and pi bond, Hybridization, VSEPR Theory, Molecular orbital theory, Bond order, Properties of covalent compounds. Coordination bond - Primary and Secondary valencies, ligands, Valence bond theory of complexes, Crystal field theory of octahedral and tetrahedral complexes, Low and high spin complexes. Metallic bond- Band theory of metals, Conductors, semiconductors and insulators. Secondary bonding- Hydrogen bonding, London forces and dipole-dipole interactions.

References:

1. J D Lee, "Concise Inorganic chemistry", Wiley India, 2012
2. B R Puri , L R sharma and K C Kalia, "Principle of Inorganic chemistry", Vishal Publishing Co., Punjab, 2017.
3. D F Shriver, P W Atkins, "Inorganic chemistry", Oxford India, 2014
4. A F Cotton, "Basic Inorganic chemistry", Wiley Publishers, 2007

CHM 4052: CHEMISTRY OF CARBON COMPOUNDS [3 0 0 3]

Introduction to Organic Compounds: Classification, Nomenclature; Alkanes: Homologous series, Preparation; Cycloalkanes: Ring size and strain, Applications; Alkenes: Markovnikov and anti-Markovnikov addition reactions, Reduction, applications; Alkynes: Acidity, preparation, Reduction of alkynes, applications; Alkyl halides: SN1, SN2, E1 and E2 reaction mechanisms; Alcohols: Classification, Acidity, organo-metallic reagents; Aromatic compounds: Electrophilic and nucleophilic substitution reactions; Mechanism of some named reactions; Carbonyl compounds: aldehydes and ketones, carboxylic acids and carboxylic acid derivatives; Heterocyclic compounds: Nomenclature, synthesis and reactivity of thiophene, pyrrole and furan; Carbon materials: Fullerenes, carbon thin films, nanotubes and carbon fibers; Carbon nanotubes: SWNT, MWNT, synthesis, properties and applications; Carbon nanomaterials applications.

References:

1. B S Bahl and Arun Bahl, "Advanced Organic Chemistry", S Chand, New Delhi, 2012.
2. Robert T. Morrison and Robert N. Boyd, "Organic Chemistry", Pearson, New Delhi, 2016.
3. P.S. Kalsi, "Organic Reactions and Their Mechanisms", New Age International Private Limited, New Delhi, 2017.
4. Ashutosh Tiwari and S. K. Shukla, "Advanced Carbon Materials and Technology", John Wiley & Sons, 2013.
B. Bhushan ed., "Springer Handbook of Nanotechnology", Springer Publishers, Berlin, 2004.

OPEN ELECTIVES

CHM 4301: ANALYTICAL METHODS AND INSTRUMENTATION [3 0 0 3]

Spectroscopic methods of analysis: Properties of EMR, General features of spectroscopy, Types of molecular spectra, Interaction of EMR with matter, Instrumentation, Applications, Theory, Instrumentation and applications of Microwave, Raman, Infrared, UV-Visible, NMR spectroscopic techniques. Chromatographic Techniques: General concepts, Classification, Principles, Experimental techniques of CC, HPLC, TLC, GC and their applications. Electroanalytical methods: Basic principles and applications of conductometric, potentiometric titrations.

References:

1. D.A. Skoog, J. Holler, F.T.A. Nieman, *Principles of Instrumental Analysis*, 5thEdn, Saunders, Philadelphia, 1992
2. D. A. Skoog, D. M. West and F. J. Holler, *Fundamentals of Analytical Chemistry*, 5thEdn, Saunders College Publishing, Philadelphia, 1988
3. *Vogel's Textbook of Quantitative Chemical Analysis*, GH Jeffery, John Wiley & Sons Inc, 5thEdn, 1989

CHM 4302: FUNDAMENTALS OF INDUSTRIAL CATALYTIC PROCESSES [3 0 0 3]

Adsorption & Catalysis: Physisorption and chemisorption, Adsorption isotherms, Factors influencing adsorption, Adsorption of gases by solids, Adsorption from solution, Introduction to catalysis, Energetics, Catalytic cycles Solutions & Solubility: Ideal and non-ideal solutions, Raoult's law, Thermodynamics of ideal solutions, Vapor pressure and boiling point composition curves, Distillation behaviour of completely miscible & immiscible liquid systems, Azeotropes Colligative Properties: Determination of molar masses from vapor pressure lowering, Osmotic pressure, Boiling point elevation and Depression of freezing point, Vant Hoff's factor Colloids: Types, Preparation and purification of sols, General properties, Optical, Electrical & Kinetic properties of sols, stability of sols, Application of colloids, Emulsions & Gels- Types, Preparation, Properties and their applications.

References:

1. *Principles of Physical Chemistry*, B.R. Puri, L.R. Sharma, M.S. Pathania, Vishal Publications, New Delhi, (23e), 2008
2. *Principles of Physical Chemistry*, S.H. Maron, C.F. Prutton, IBH Publishing co. New Delhi, (4e), 1985
3. *Fundamentals of Analytical Chemistry*, D.A. Skoog, D.M. West, F.J. Holler, R. Crouch, (4e),Thomson-Brooks, 2007

CHM 4303: SUSTAINABLE CHEMICAL PROCESSES AND PRODUCTS [3 0 0 3]

Introduction and principles of green chemistry, Examples, Atom economy, carbon efficiency, life cycle analysis, sustainable products, process and synthesis catalysis and green chemistry, examples of fine and bulk chemicals production, catalysts for clean technology. Application of ecofriendly approach to waste treatment. Cleaner production processes, clean synthesis in lab Scale, industrial examples, use of ecofriendly energies. Bio-pesticides, polymers & pharmaceutical products. Electrochemical synthesis, Alternate reaction media using water and other green solvents, ionic liquids & supercritical fluids; phase transfer catalysis.

References:

1. P.T. Anastas, J. C. Warner, *Green Chemistry: Theory and Practice*, Oxford Univ. Press, Oxford, 2008
2. A.S. Matlack, *Introduction to Green Chemistry*, Marcel Dekker, New York, 2001
3. P. T. Anastas, R. H. Crabtree, *Handbook of Green Chemistry and Catalysis*, Wiely-VCH, Weinheim, 2009

Inter Institute Open Electives

Centre for Creative and Cultural Studies (CCCS), Manipal

IIE 4301: ART APPRECIATION [3 0 0 3]

How to read a visual, how to enjoy or feel an art form, what is Creative Thinking? Indian Art: Heritage & Culture; Art Appreciation: Western Art, Artist & Art Movements: Raja Ravi Verma, Tagore, Da Vinci, Van Gogh; Aesthetics: Beauty, Feel & Expression; Art & Science; Art & Film; Art: Freedom & Society, to be an art literate. A journey to immerse in the world of Art.

IIE 4302: INDIAN CULTURE AND CINEMA - AN INTRODUCTION [3 0 0 3]

Introduction to Idea of Culture, Identity and tradition, Indian Cultural History, Indian cultural history, Time and space, Indian Art and heritage, Indus valley civilization – Indian Independence, Post-colonial India, Modern India, Indian Cinema, Body, language and feel, Film and culture, Evolution, Interpretation and Reflection, Indian Cinema, Media and the medium, Pioneers and classical films, Culture and art of cinema, Culture, Cinema and Society, Revolutions, ideas, innovations, Culture, Cinema and Peace, Message, purpose and the challenge.

Manipal Institute of Management, Manipal

IIE 4304: CORPORATE FINANCE [3 0 0 3]

Introduction to Corporate Finance, Financial Goal, Agency Problems, Managers vs Shareholders Goals, Concepts of Value and Return, Capital Budgeting Decisions, Cost of Capital, Calculation of the Cost of Capital in Practice, Financial and Operating Leverage, Capital Structure, Relevance of Capital Structure, Irrelevance of Capital Structure, Relevance of Capital Structure, Dividend Theory, Dividend Relevance, Dividend Relevance, Dividend and Uncertainty, Dividend Irrelevance, Principles of Working Capital Management.

References:
1. Brealey, R., Myers, S., Allen, F., & Mohanty, P. (2014). Principles of Corporate Finance (11e). New Delhi : Mc Graw Hill Education (India) Private Limited,.
2. Pandey, I. M. (2014). Financial Management (10e). New Delhi: Vikas publishers.
3. Ross, S. A., Westerfield, R. W., Jaffe, J., & Kakani, R. K. (2014). Corporate Finance (10e). New Delhi: Mc Graw Hill Education (India) Private Limited.
4. Parasuraman, N. R. (2014). Financial Management - A Step-by-Step Approach (1e.). New Delhi: Cengage Learning India Private Limited.

IIE 4305: INTERNATIONAL BUSINESS MANAGEMENT [3 0 0 3]

Historical perspective of international business, International business environment, Modes of entering international business, Cross-Culture and dynamic market understanding, Differences in Culture, Theories of international business, World Bank, World trade organization, Multinational Corporations and their involvement in International Business, Tariffs and quotas, Balance of Payment Account.

References:
1. Hill Charles, W. L., & Jain Arun, K. (2011). International Business: Competing in the Global Marketplace. (8e), Tata McGraw Hill.
2. Kumar, S. P., & Sanchari, S. (2012). International Business Management-A Global Perspective. New Delhi: Excel Books.

IIE 4306: BRAND MANAGEMENT [3 0 0 3]

Introduction to brand management, Developing a brand strategy, Brand resonance and brand value chain, Designing and implementing brand marketing programs to build brand equity, Measuring and interpreting brand performance, Designing and implementing brand architecture strategies, Managing brands.

References:
1. Keller, K. L., Parameswaran, M. G., Jacob, I. (2015). Strategic Brand Management (4e). Noida, India: Pearson Prentice Hall Publication.
2. Rowles, D., (2014). Digital Branding (1e.). UK: Kogan Page Limited.
3. Kapferer, J. N., (2012). The New Strategic Brand Management: Advanced Insights and Strategic Thinking (5e). UK: Kogan Page Limited

Centre for Integrative Medicine & Research (CIMR)

IIE 4307: YOGA [3 0 0 3]

Aim, Objectives, Meanings and Definitions of Yoga, History of Yoga, Concepts and misconcepts of Yoga, Schools of Yoga, Ashtanga Yoga

Subjects by Industry Experts

IIE 4308: HEALTH ECONOMICS [3 0 0 3]

Economics: Understanding Economics, Efficiency, Rational decision making, Opportunity costs, Supply and demand, Price discovery, Health economics: Defining health, Human capital, what does supply and demand mean in the context of health? Arrow on the uncertainty and welfare economics, The Moral hazard, DALY and QALY, Efficiency: The Production possibility frontiers. The production function for health care. Health policy, Defining equity, Standards of healthcare provision Epidemiology, The Healthcare sector, The demand for health, Disease prevalence, The pharmaceuticals market, Cross country case studies.

References:
1. Sloan, Frank A., and Chee-Ruey Hsieh. Health economics. MIT Press, 2012
2. Annemans, L. Health economics for non-economists. An introduction to the concepts, methods and pitfalls of health economic evaluations. Academia Press, 2008
3. Jeffery, Roger. The politics of health in India. University of California Press, 1988.

IIE 4309: DIGITAL MEDICINE [3 0 0 3]

Present day practice of medicine. Limitations of scalability in the present framework. Introduction to computing, algorithms, big data, semantic web, mobility. Communication-WAN/LAN, 3G/4G and 5G. Patient/Electronic Health records. Experience with these records elsewhere Wearables, the physics of data capture. Practical demonstration of wearables Genomics, an introduction. Computational genomics including the software. Imaging –an introduction-ionizing and non-ionizing. Imaging software and science of diagnosis. How all the four 4 pillars-PHR/EHR, Wearables, Genomics and Imaging come together with software as the glue to change the world of medicine.

References:
1. David Mount. Bioinformatics: Sequence and Genome Analysis. CSHL, 2001
2. Durbin, Richard, Sean Eddy, Anders Krogh, and Graeme. Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids. Cambridge University Press, 1999

Manipal College of Nursing Manipal

IIE 4310: MEDICAL EMERGENCY AND FIRST AID [3 0 0 3]

Principles of First Aid, First aid kit and equipment, emergency drugs, scene assessment, safety and identifying hazards, patient assessment, Basic Life Support and AED, triage, extrication/stretchers, ambulance. Describe the causes, signs and symptoms and management of respiratory emergencies, acute gastro-intestinal emergencies, musculoskeletal emergencies, dental, ENT and eye emergencies, renal emergencies, nervous system emergencies, hematological emergencies, endocrine emergencies, toxicological emergencies, environmental emergencies, pediatric emergencies, psychiatric emergencies, obstetrical emergencies

References:

1. Pollak, A.N. (2005). Emergency care and transportation of the sick and injured. Massachusetts: Jones and Bartlett publishers.
2. Keen, J. H. (1996). Mosby's Critical Care and Emergency Drug Reference. Missouri: Mosby's year book.
3. Walsh, M. (1990). Accident and emergency nursing. A new approach. Oxford: Butterworth Heinemann Ltd.
4. Sbaih, L. (1992). Accident and emergency Nursing. A nursing model. London: Chapman and Hall.
5. Sbaih, L. (1994). Issues in accident and emergency Nursing. London: Chapman and Hall.
6. Bourg, P., & Rosen, S. P. (1986). Standardized nursing care plans for emergency departments. Missouri: The C. V. Mosby Company.
7. Howard, P.K., &Steinmann, R. A. (2010). Sheehy's Emergency Nursing principles and practice. Missouri: Mosby Elsevier.
8. Sira.S, (2017). First Aid Manual for Nurses (First ed.), New Delhi: CBS Publishers & Distributors Pvt. Ltd.

IIE 4311: LIFE STYLE MODIFICATION AND COMPLEMENTARY AND ALTERNATIVE THERAPIES [3 0 0 3]

Principles and concepts of life style modification and various complementary and alternative therapies, Demonstrate skill in performing different yoga aasanas, guided imagery/Progressive muscle relaxation, meditation & Pranayama, reflexology, massage therapy, aerobics, laughter therapy

References:

1. Bhat Krishna K. The power of yoga. Suyoga publications; DK, 2006
2. M.M.Gore. Anatomy & Physiology of yogic practices; (5e), New age book.
3. K N Udupa. Stress and its management by yoga. (2e). Motilal Banarsidas publishers Pvt. Ltd, Delhi, 2007.
4. Yoga and total health. A monthly journal on the yoga a way of life.
5. Swami Satyananda Saraswati. Dynamics of yoga. (2e), Bihar school of yoga, Bihar 1997.

Welcomegroup Graduate School of Hotel Administration, Manipal

IIE 4312: INDIAN CUISINE AND CULTURE PRACTICAL [3 0 0 3]

Introduction to Indian cuisine, Basic Indian gravies, Rice cooking, Preparation of various rice products, Tandoor Cooking, Indian sweets, Comfort Food, Regional and sub-regional cuisine.

IIE 4313: FOUNDATION COURSE IN BAKING AND PATISSERIE PRACTICAL [3 0 0 3]

Introduction to Patisserie and Baking Principles, Special emphasis placed on the study of ingredient functions, Students will have the opportunity to apply basic baking techniques, Understanding fundamentals of yeast dough production, Emphasis on the application of ingredient functions, product identification and recipe interpretation occurs throughout the course, Pastry Basics and Pie dough, The fundamental production of classical European pastry based desserts are included, Techniques of Cake Making, Techniques of Cookie making, The course emphasizes the preparation and makeup techniques of various cookies.

References:

1. Wayne Gisslen – Professional Baking, (5e), John Wiley USA.
2. Haneman L.J. Bakery: Flour Confectionery HEINMAN.
3. Mermaid Books The Book Of Ingredients DOWELL PHILIP.
4. John Wiley Understanding Baking AMENDOLA JOSEPH.
5. New Age International, A Professional Text to Bakery and Confectionery, KINGSLEE JOHN.
6. Virtue And Company Ltd., The New International Confectioner: WILFRED J. FRANCE.
7. Charrette Jacques, Great Cakes and Pastries, TEUBNER CHRISTIAN.
8. Joseph Amendola, Baker's Manual, (5e), NICOLE REES.
9. Joseph Amendola, Understanding Baking, (3e), NICOLE REES.
10. Culinary Institute Of America, Baking and Pastry: Mastering the Art and Craft, JOHN WILEY.

IIE 4314: GLOBAL CUISINE & CULTURE- PRACTICAL [3 0 0 3]

European Cuisine: Familiarization of ingredients, recipes and preparation of different countries. North American Cuisine: Familiarization of ingredients, recipes and preparation of different countries. South American Cuisine: Familiarization of ingredients, recipes and preparation of different countries. Asian Cuisine: Familiarization of ingredients, recipes and preparation of different countries. Australian Cuisine: Familiarization of ingredients, recipes and preparation of different countries. African Cuisine: Familiarization of ingredients, recipes and preparation of different countries. Molecular Gastronomy: Additives, Tools, and Recipes. Processed Food: Comparison and Critiquing. Mediterranean and European cuisine: Familiarization of ingredients, recipes and preparation of different countries.

References:

1. The Professional Chef - The Culinary Institute of America
2. Practical Cookery - Kinton, Ceserani and Foskett
3. Food Production Operation - Parvinder S. Bali
4. Professional Cooking - Wayne Gisslen
5. Cookery for the Hospitality Industry - Dodgshun Peters
6. Modern Cookery - Thangam E Phillips

School of Communication, Manipal

IIE 4315: REPORTING AND WRITING [3 0 0 3]

Introduction to news writing news in different media, news, definition of news, news values; types of news other theoretical issues relating to news writing. News Reporting Basic of news writing: structure of news reports; writing the lead; the changes in the composition of the lead; techniques of news gathering; sources of news. Reporting various types of reporting (Objective, Interpretative, Investigative,) General assignment reporting/working on a beat. Reporting for news agency, periodicals and magazines. Interviewing: doing the research, conducting the interview, types and formats of interviews, writing interviews

References:

1. Mencher, Melvin (2006): News Reporting and Writing, Mac-Graw Hill, Boston.
2. Scalnan, Christopher (2000): Reporting and Writing: Basics for the 21st Century, Harcourt College Publishers.
3. Harrington Walt (1997) Intimate Journalism: The Art and Craft of Reporting Everyday Life, Sage Publications.
4. Carole, Rich (2007), Writing and Reporting News: A Coaching Method, Thomson Learning Inc.Kamath, K.V. (1993): Journalists' Handbook, Vikas Publishing House.
5. Aggarwal, Vir Bala (2006): Essentials of Practical Journalism, Concept Publishing Company.

IIE 4316: INTRODUCTION TO ADVERTISING & PUBLIC RELATIONS [3 0 0 3]

Introduction to advertising; Evolution and history of advertising; Influence of advertising on society and ethics. Advertising as part of marketing mix; Structure and types of ad agencies; Advertising planning; creative strategy and implementation (media strategy). The essentials of advertising on different media platforms – print, broadcast, internet and new media; discuss the difference in planning and execution using examples or campaign case studies. Public Relations-scope; definition; evolution; establish difference between PR and advertising; Identifying stakeholders and various Public Relation tools. Steps in developing a PR program/campaign-stating the problem, planning and programming, action and evaluation; Crisis communication; Ethical issues in Public Relations.

References:
1. Butterick, K (2012): Introducing Public Relations: Theory and Practice. New Delhi: SAGE Publications India Pvt. Ltd.
2. Cutlip, Center & Broom, (2000): Effective Public Relations.USA: Prentice Hall International.
3. Jaishri Jethwaney and Shruti Jain, (2012): Advertising Management. New Delhi: Oxford University Press
4. Reddi, C.V.N. (2009): Effective Public Relations and Media Strategy. New Delhi: PHI Learning Pvt. Ltd.
5. Sharma, S. & Singh, R. (2009): Advertising Planning and Implementation. New Delhi: PHI Learning Pvt. Ltd.

IIE 4317: BASIC PHOTOGRAPHY [3 0 0 3]

Photo Journalism: History of Photography and Photo Journalism. Photo Journalism: Definition, Nature, Scope and Functions of Photo Journalism – Qualification and Responsibilities of Photo Journalists, News Photographers and News Value, Types and Sources. Selection, Criteria for News Photographs – Channels of News Pictures – viz., Wire, Satellite, Agency, Stock, Picture Library, Freelancer, Photo Editing, Caption Writing, Photo – Presentation. Legal and Ethical aspects of Photography – Professional Organizations – Camera – Components and Types of Camera – Types of Lens, Types of Films, Types of Filters – Importance of Light and Lighting Equipments – Camera Accessories – Picture appreciation. Digital Camera – Digital Technology and its future – Darkroom Infrastructure – Film developing and Printing

References:
1. Basic Photography – Newnes
2. The Hamlyn Basic Guide to Photography – Hamlyn
3. Hamlyn Encyclopedia of Photography – Hamlyn
4. Photographing People – Guglielmezei
5. History of Photography – Cyernshem G R
6. Photo Journalism – Rothsteline
7. Techniques of Photo Journalism – Milten Feinberg
8. Freelance Photography – Jechsend Gedsey
9. Picture Editing – Stanley E Kalish and Clifton C Edom
10. News Photography – Jack Price
11. 1000 Ideas for better News Picture – High Sidley and Rodney Fox

IIE 4318: MEDIA PRODUCTION TECHNIQUES [3 0 0 3]

Print design elements – typography, colours, spacing, pictures, logos, graphics, principles of layout and design – basic writing skills. Photography – SLR camera, Lenses, Apertures and Shutter speeds, Exposure, Understanding light, Filters and assessories, composing a picture, developing and printing, creating special effects. Digital photography – digital camera – digital technology and its future. Television – Introduction to AV Media-pre-production, production, post-production. Show packaging-Camera-characteristics, parts and functions; Mounting accessories and movements. Shots-Types and Uses; Basic composition. Practical video recording process. Radio – Introduction to Radio-Microphone types, characteristics and uses; Cables and Connectors. Recording device-Types and Characters, Audio editing, Programme formats-news, drama, feature and PSA's and Advertising.

References:
1. Gerald Millerson, "Effective TV production"
2. Peter Jarvis, "The Essential TV director's Handbook
3. Hamlyn "Basic guide to photography"
4. Ralph Milton "Radio programming – a basic training manual"
5. Tomlinson Holman "Sound for film and television"
6. Reporting and writing by Melwin Mencher

IIE 4319: GRAPHIC & SKETCHING [3 0 0 3]

Basic Art Principles: Element of Art & Design, Contour Drawing, Composition Principles, Pencil shading, creating geometry model and shading. Basic Perspective: Still life sketching & Drawing, Styles of shading, Introduction to colors, color still life painting, Layout Design, Creating concepts for Design. Skeleton System, Body Proportions, Upper Body, Lower Body, Back, Hands and Legs. Text: Human Anatomy by Victor Perard, Dynamic Anatomy by Burne Hogarth. Gesture Drawing Tips, Line of Action, Dynamic Poses, Body Weight and Gravity, Clothing. Text: Figure Drawing by Anthony Ryder.

List of Practical's:
▸ 10 Drawings of Human Anatomy Study In Pencil
▸ 50 Drawings of Gesture Drawing In Pencil
▸ 5 Contour Drawing
▸ 2 Still Life Pencil Shading
▸ 2 Color Still Life
▸ 2 Layout Design

References:
1. Mastering Composition: Techniques and Principles to Dramatically Improve Your Painting (Mastering (North Light Books)) Hardcover – 25 Jan 2008 by Ian Roberts
2. Layout Essentials: 100 Design Principles for Using Grids (Design Essentials) Paperback – 1 by Beth Tondreau
3. Pencil Drawing: Learn how to develp drawings from start to finish with techniques for shading, contrast, texture, and detail (Artist's Library) Paperback – 1 Jan 1988 by Gene Franks
4. Drawing the Head and Figure – Jack Hamm
5. Dynamic Anatomy – Burne Hogarth
6. The artists complete guide to Human figure Drawing – Anthony Ryder
7. Human Anatomy – Victor Perard