

AFFILIATED INSTITUTIONS
ANNA UNIVERSITY, CHENNAI
R - 2008

B. TECH. FOOD TECHNOLOGY

SEMESTER-IV

CODE NO	COURSE TITLE	L	T	P	C
THEORY					
MA3211	<u>Probability And Statistics</u>	3	1	0	4
IB3212	<u>Instrumental Methods of Analysis</u>	3	0	0	3
CH3213	<u>Fundamentals of Heat and Mass Transfer</u>	3	0	0	3
FT3214	<u>Food Microbiology</u>	3	0	0	3
CH3222	<u>Biochemical Engineering</u>	3	0	0	3
GE2021	<u>Environmental Science and Engineering</u>	3	0	0	3
IB3217	<u>Genetics</u>	3	0	0	3
PRACTICALS					
CY3219	<u>Instrumental Methods of Analysis lab</u>	0	0	4	2
IB3220	<u>Chemical Engineering Lab</u>	0	0	4	2
	TOTAL	21	1	8	26

MA3211

PROBABILITY AND STATISTICS

L T P C

3 1 0 4

AIM

This course aims at providing the required skill to apply the statistical tools in engineering problems.

OBJECTIVES

- The students will have a fundamental knowledge of the concepts of probability.
- Have knowledge of standard distributions which can describe real life phenomenon.
- Have the notion of sampling distributions and statistical techniques used in management problems.

UNIT I RANDOM VARIABLES

9 + 3

Discrete and Continuous random variables – Moments – Moment generating functions – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma, Weibull and Normal distributions - Functions of a random variable.

UNIT II TWO-DIMENSIONAL RANDOM VARIABLES

9 + 3

Joint distributions – Marginal and Conditional distributions – Covariance – correlation and Linear regression – Transformation of random variables – Central limit theorem (for independent and identically distributed random variables).

UNIT III TESTING OF HYPOTHESIS

9 + 3

Sampling distributions - Tests for single mean, proportion, Difference of means (large and small samples) – Tests for single variance and equality of variances – χ^2 -test for goodness of fit – Independence of attributes – Non-parametric tests: Test for Randomness and Rank-sum test (Wilcoxon test).

UNIT IV DESIGN OF EXPERIMENTS

9 + 3

Completely randomized design – Randomized block design – Latin square design - 2^2 - factorial design.

UNIT V STATISTICAL QUALITY CONTROL

9 + 3

Control charts for measurements (=and R charts) – Control charts for attributes (p, c and np charts) – Tolerance limits - Acceptance sampling.

L: 45, T: 15, TOTAL : 60 PERIODS

TEXT BOOKS

1. Milton, J. S. and Arnold, J.C., "Introduction to Probability and Statistics", Tata 4th Edition, McGraw Hill, 2007.
2. Johnson, R.A. and Gupta, C.B., "Miller and Freund's Probability and Statistics for Engineers", 7th Edition, Pearson Education, Asia, 2007.

REFERENCES

1. Devore, J.L., "Probability and Statistics for Engineering and the Sciences", 7th Edition Thomson Brooks/Cole, 2008.
2. Walpole, R.E., Myers, R.H., Myers, S.L. and Ye, K., "Probability and Statistics for Engineers and Scientists", 8th Edition. Pearson Education, Asia, 2007.
3. Ross, S.M., "Introduction to Probability and Statistics for Engineers and Scientists," 3rd Edition, Elsevier, 2004.
4. Spiegel, M.R., Schiller, J. and Srinivasan, R.A., "Schaum's Outline of Theory and Problems of Probability and Statistics", Tata McGraw- Hill, 2004.

IB3212

INSTRUMENTAL METHODS OF ANALYSIS

L T P C

3 0 0 3

AIM

To introduce students to the principles and methods of biological instruments.

OBJECTIVE

- To provide to the students the fundamentals of instrument knowledge and their applications in biology.

UNIT I OPTICAL SPECTROSCOPY 10

Design of Experiments – Error Analysis – S/N ratio – Limit of Detection – UV –VIS Spectroscopy, Applications, Instruments – single beam, double beam and Photo-diode array – applications – IR & Raman – Uses – Design – FT-IR, Raman.

UNIT II CHROMATOGRAPHY 10

Distribution coefficients – solid-liquid, liquid-liquid and gas chromatography – theory of chromatography-normal phase & reverse phase chromatography – gel permeation – ion exchange & affinity chromatography – HPLC- Instrumentation & case studies.

UNIT III STRUCTURAL ELUCIDATION 10

Nuclear Magnetic Resonance – Introduction-spin states – ¹H, ¹³C NMR – Instrumentation-use in structural elucidation. Electron Paramagnetic Resonance-concept & instrumentation – use in metal containing proteins & membrane studies. X-Ray : X-ray spectroscopy –Auger – EELS Instrumentation & applications in Biology- X-ray diffraction- Instrumentation –small molecule & macromolecular crystallography.

UNIT IV MASS SPECTROMETRY 10

Introduction – Instrumentation – CI, EI-Methods of Ionization- Methods for separation of Ions – Method for Detection. MALDI - TOF, ESI and FT-MS.

UNIT V ELECTROCHEMICAL MEASUREMENTS 5

Different types of electrochemical apparatus – Measuring Electrode potentials- Red-Ox proteins – Porous Silicon.

TOTAL : 45 PERIODS

TEXTBOOKS

1. Skoog, D.A., f.J. Holler and S.R. Crouch “Principles of Instrumental f Analysis”.6th Edition, Thomson/Brooks/Cole, 2002.
2. Willard, H.H. etal., “Instrumental Methods of Analysis”.7th Edition. CBS Publishers, 1986.
3. Braun, Robert D. “Introduction to Instrumental Analysis” Pharma Book Syndicate, 1987.
4. Ewing, G.W. “Instrumental Methods of Chemical Analysis” 5th Edition, Tata McGraw-Hill, 1985

CH3213

FUNDAMENTALS OF HEAT AND MASS TRANSFER

L T P C

(Common for Food and Pharmaceutical Technology)

3 0 0 3

AIM

To understand the principles and applications of heat and mass transfer operations.

OBJECTIVES

- To understand and apply the principles in heat transfer phenomena
- To understand and apply the principles in mass transfer phenomena
- To design heat and mass transfer equipments.

UNIT I	HEAT TRANSFER	11
Phenomena of heat transfer by conduction-concept of heat conduction resistances – application of heat conduction in series – heat transfer coefficient –heat convection phenomena- application for different situations –combined conduction and convection-overall heat transfer coefficient –application to design of heat exchangers- Principles of radiation heat transfer – Laws in radiation- View factor concepts – application.		
UNIT II	DIFFUSION & MASS TRANSFER COEFFICIENTS	8
Diffusion in Mass Transfer –gas, liq, solid diffusion and mass transfer-Diffusion in biological solutions-measurement of diffusion Coefficients – concept of mass transfer Coefficients-application for different situations.		
UNIT III	ABSORPTION	9
Interphase mass transfer and overall mass transfer Coefficients – Absorption equipments-Hydraulics of Packed Absorbers-Process Design of Packed Absorbers-Concept of height of transfer units and number of transfer units in design.		
UNIT IV	DISTILLATION	9
Vapour Liquid equilibrium and distillation-simple Distillation, Steam distillation, Flash distillation-Staged distillation Column-Design by Mc Cabe-Thiele method-Enthalpy-Concentration diagrams and use in Distillation Column design.		
UNIT V	LIQUID EXTRACTION & LEACHING	8
Principles of liq-extraction-Equilibrium –staged extraction calculation – continuous extraction equipments. Principles of Leaching –equilibrium-staged leaching – Leaching equipments. Principles of adsorption -Design of packed adsorber.		

TOTAL: 45 PERIODS

TEXT BOOKS

1. Treybal, R.E. "Mass-Transfer Operations" 3rd Edition, McGraw-Hill, 1981.
2. Dutta, Binay, K. "Principles of Mass Transfer and Separation Process", PHI, 2007.
3. Nag, P.M. "Heat and Mass Transfer", 2nd Edition, Tata McGraw-Hill, 2007.
4. Geankoplis, C.J. "Transport Processes and Separation Process Principles (Includes unit Operations) 4th Edition, PHI, 2003.

REFERENCES

1. Coulson, J.M. and etal. "Coulson & Richardson's Chemical Engineering", 6th Edition, Vol. I & II, Butterworth – Heinman (an imprint of Elsevier), 2004
2. McCabe, W.L., J.C. Smith and P.Harriot "Unit Operations of Chemical Engineering", 6th Edition, Mc Graw Hill, 2003.

FT3214

FOOD MICROBIOLOGY

L T P C

3 0 0 3

AIM

The course aims to develop the knowledge of students in the basic area of Food Microbiology. This is necessary for effective understanding of food processing and technology subjects as well as food safety. This course will enable students to appreciate the role of microbes in food spoilage, preservation of foods and food borne infections.

OBJECTIVES

On completion of the course the students are expected to

- Be able to understand and identify the various microbes associated with foods and food groups.
- Be able to understand and identify the role of these microbes in food spoilage, food preservation.
- Understand the role of pathogens in food borne infections.
- Understand the methods used to detect pathogens in foods.

UNIT I ROLE OF MICROBES IN SPOILAGE OF FOODS 9

Factors affecting spoilage of foods, Microbial flora associated with various food groups their spoilage potential. Microbiological spoilage problems associated with typical food products.

UNIT II CONTROL OF MICROBES IN FOODS 9

Use of antimicrobial chemicals- organic acids, sugars, sodium chloride, nitrites, phosphates, sulphites, Benzoates, Sorbates / Propionates naturally occurring antimicrobials; Physical methods- Low and high temperatures, drying, radiation and high pressure; Tolerance of microbes to chemical and physical methods in various foods.

UNIT III MICROBES IN FOOD FERMENTATIONS 9

Microbes of importance in food fermentations, – Homo & hetero-fermentative bacteria, yeasts & fungi; Biochemistry of fermentations – pathways involved, Lactic acid bacteria fermentation and starter cultures, Alcoholic fermentations -Yeast fermentations - characteristics and strain selection, Fungal fermentations. Microbes associated with typical food fermentations- yoghurt, cheese, fermented milks, breads, idli, soy products, fermented vegetables and meats.

UNIT IV MICROBIAL AGENTS OF FOOD BORNE ILLNESS 9

Food borne infections and food poisoning, Microbial toxins, Gram Negative and Gram positive food borne pathogens; Toxigenic algae and fungi; Food borne viruses; helminths, nematodes and protozoa.

UNIT V MICROBIAL EXAMINATION OF FOODS 9

Detection & Enumeration of microbes in foods; Indicator organisms and microbiological criteria; Rapid and automated microbial methods - development and impact on the detection of food borne pathogens; Applications of immunological, techniques to food industry; Detection methods for E. coli, Staphylococci, Yersinia, Campylobacter, B. cereus, Cl. Botulimum & Salmonella, Listeria monocytogenes Norwalk virus, Rotavirus, Hepatitis A virus from food samples.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Frazier, William C. "Food Microbiology" 4th Edition. Tata McGraw-Hill, 1988.
2. Banwart, G.J. "Basic Food Microbiology" 2nd Edition. CBS Publishers, 1998.
3. Vijaya Ramesh. " Food Microbiology". MJP Publishers, Chennai, 2007.
4. Jay, J.M. "Modern Food Microbiology". 4th Edition. CBS Publishers, 2003.
5. Adams, M.R. and M.O. Moss." Food Microbiology". New Age International, 2002
6. Khetarpaul, Neelam. "Food Microbiology" Daya Publishing House, 2006.

REFERENCES

1. Montville, Thomas J. and Karl R. Matthews " Food Microbiology : An Introduction". ASM Press, 2005.
2. Ray, Bibek and Arun Bhunia. "Fundamental Food Microbiology" 4th Edition, CRC Press, 2008
3. Pawsey, R. K. "Case Studies in Food Microbiology for Food Safety and Quality". The Royal Society of Chemistry, 2001.
4. Forsythe, S.J. "The Microbiology of Safe Food". Blackwell Science, 2000.
5. Doyle, Michael P. "Food Microbiology : Fundamentals and Frontiers". 2nd Edition, ASM Press, 2001.
6. Parry, Thelma J. and R.K. Pawsey. "Principles of Microbiology : For Students of Food Technology". 2nd Edition, Hutchinson Education, 1984.

CH3222

BIOCHEMICAL ENGINEERING

L T P C
3 0 0 3

UNIT I INTRODUCTION TO ENZYMES 9

Classification of enzymes. Mechanisms of enzyme action; concept of active site and energetics of enzyme substrate complex formation; specificity of enzyme action; principles of catalysis – collision theory, transition state theory; role of entropy in catalysis.

UNIT II KINETICS OF ENZYME ACTION 9

Kinetics of single substrate reactions; estimation of Michelis – Menten parameters, multisubstrate reactions- mechanisms and kinetics; turnover number; types of inhibition & models –substrate, product. Allosteric regulation of enzymes, Monod changeux wyman model, ph and temperature effect on enzymes & deactivation kinetics.

UNIT III ENZYME IMMOBILIZATION 6

Physical and chemical techniques for enzyme immobilization – adsorption, matrix entrapment, encapsulation, cross-linking, covalent binding etc., - examples, advantages and disadvantages.

UNIT IV OVERVIEW OF FERMENTATION PROCESSES 9

Overview of fermentation industry, general requirements of fermentation processes, basic configuration of fermentor and ancillaries, main parameters to be monitored and controlled in fermentation processes.

UNIT V RAW MATERIALS AND MEDIA DESIGN FOR FERMENTATION PROCESS 12

Criteria for good medium, medium requirements for fermentation processes, carbon, nitrogen, minerals, vitamins and other complex nutrients, oxygen requirements, medium formulation of optimal growth and product formation, examples of simple and complex media, design of various commercial media for industrial fermentations – medium optimization methods

TOTAL: 45 PERIODS

TEXT BOOKS

1. Bailey, J.E. and Ollis, D.F. "Biochemical Engineering Fundamentals", 2nd Edition, McGraw-Hill, 1986.
2. Blanch, H.W. and D.S. Clark "Biochemical Engineering", Marcal Dekker, Inc., 1997.
3. Lee, James M. "Biochemical Engineering", Prentice – Hall, 1992.

REFERENCES

1. Palmer, Trevor "Enzymes : Biochemistry, Biotechnology, Clinical Chemistry", Affiliated East-West Press Pvt. Ltd., 2004.
2. Stanbury, P.F., A. Whitaker and S.J. Hall "Principles of Fermentation Technology", 2nd Edition, Butterworth – Heinemann (an imprint of Elsevier), 1995.
3. Wiseman, Alan "Handbook of Enzyme Biotechnology", 3rd Edition, Ellis Harwood Publications, 1999.
4. Hartmeier, Winfried "Immobilized Biocatalysts : An Introduction", Springer –Verlag, 1986.

AIM

- The aim of this course is to create awareness in every engineering graduate about the importance of environment, the effect of technology on the environment and ecological balance and make them sensitive to the environment problems in every professional Endeavour that they participates.

OBJECTIVE

- At the end of this course the student is expected to understand what constitutes the environment, what are precious resources in the environment, how to conserve these resources, what is the role of a human being in maintaining a clean environment and useful environment for the future generations and how to maintain ecological balance and preserve bio-diversity. The role of government and non-government organization in environment managements.

UNIT I ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY

14

Definition, scope and importance of environment – need for public awareness - concept of an ecosystem – structure and function of an ecosystem – producers, consumers and decomposers – energy flow in the ecosystem – ecological succession – food chains, food webs and ecological pyramids – Introduction, types, characteristic features, structure and function of the (a) forest ecosystem (b) grassland ecosystem (c) desert ecosystem (d) aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) – Introduction to biodiversity definition: genetic, species and ecosystem diversity – biogeographical classification of India – value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values – Biodiversity at global, national and local levels – India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ conservation of biodiversity.
Field study of common plants, insects, birds
Field study of simple ecosystems – pond, river, hill slopes, etc.

UNIT II ENVIRONMENTAL POLLUTION

8

Definition – causes, effects and control measures of: (a) Air pollution (b) Water pollution (c) Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards – solid waste management: causes, effects and control measures of municipal solid wastes – role of an individual in prevention of pollution – pollution case studies – disaster management: floods, earthquake, cyclone and landslides.
Field study of local polluted site – Urban / Rural / Industrial / Agricultural.

UNIT III NATURAL RESOURCES

10

Forest resources: Use and over-exploitation, deforestation, case studies- timber extraction, mining, dams and their effects on forests and tribal people – Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies – Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies – Energy resources: Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources. case studies – Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification – role of an individual in conservation of natural resources – Equitable use of resources for sustainable lifestyles.
Field study of local area to document environmental assets – river / forest / grassland / hill / mountain.

UNIT IV SOCIAL ISSUES AND THE ENVIRONMENT 7

From unsustainable to sustainable development – urban problems related to energy – water conservation, rain water harvesting, watershed management – resettlement and rehabilitation of people; its problems and concerns, case studies – role of non-governmental organization- environmental ethics: Issues and possible solutions – climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, case studies. – wasteland reclamation – consumerism and waste products – environment protection act – Air (Prevention and Control of Pollution) act – Water (Prevention and control of Pollution) act – Wildlife protection act – Forest conservation act – enforcement machinery involved in environmental legislation- central and state pollution control boards- Public awareness.

UNIT V HUMAN POPULATION AND THE ENVIRONMENT 6

Population growth, variation among nations – population explosion – family welfare programme – environment and human health – human rights – value education – HIV / AIDS – women and child welfare – role of information technology in environment and human health – Case studies.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Gilbert M.Masters, 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education (2004).
2. Benny Joseph, 'Environmental Science and Engineering', Tata McGraw- Hill, New Delhi, (2006).

REFERENCES BOOKS:

1. R.K. Trivedi, 'Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards', Vol. I and II, Enviro Media.
2. Cunningham, W.P. Cooper, T.H. Gorhani, 'Environmental Encyclopedia', Jaico Publ., House, Mumbai, 2001.
3. Dharmendra S. Sengar, 'Environmental law', Prentice hall of India PVT LTD, New Delhi, 2007.
4. Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press (2005)

IB3217

GENETICS

**L T P C
3 0 0 3**

AIM

To introduce students to the principles of classical genetics and to emphasize the role of genetics in modern biology.

OBJECTIVES

- To provide to the students the fundamentals of classical genetics and ability to solve problems in genetics.
- To help students understand sex determination mechanisms.
- To enable students appreciate genetic recombination and mapping techniques.

UNIT I CLASSICAL GENETICS 9

Mendelian genetics, symbols and terminology, monohybrid crosses, ratios, dominance, recessiveness, backcross, testcross, codominance, incomplete dominance, lethals Principles of segregation, Punnett square, dihybrid cross, ratios, trihybrids,, genic interaction, epistasis, forked line method for genetic problems. Pedigrees, probability and statistics for geneticists.

UNIT II SEX DETERMINATION, SEX LINKAGE AND PEDIGREE ANALYSIS 9

Sex determination, patterns, sex chromosomes, dosage compensation, Lyon's hypothesis, dosage compensation in Drosophila, sex determination in humans, SRY, XX-XY mechanism, Y chromosome and sex determination in mammals. Balance concept of sex determination in Drosophila. Identification of sex chromosomes.

Sex Linkage- human sex-linked disorders hemophilia, Fragile X, Lesh-Nyhan and Hunter syndrome. Pedigree analysis, penetrance, expressivity, dominant, recessive and sex-linked inheritance. Sex limited, sex influenced traits, mosaics and gynandromorphs.

UNIT III STRUCTURE OF CHROMOSOMES AND VARIATION IN CHROMOSOME STRUCTURE AND NUMBER 9

Organization of prokaryotic and eukaryotic chromosomes. Proof that DNA is genetic material. Cytogenetic variation, human karyotypes, polytene chromosomes, polyploidy, sterile polyploids, polyteny. Aneuploidy- monosomy, trisomy in humans, deletions and duplications in chromosome number. Rearrangements of chromosome structure, inversion, translocation, compound chromosomes, phenotypic effects of chromosome rearrangements.

UNIT IV LINKAGE, CROSSING OVER AND CHROMOSOME MAPPING IN EUKARYOTES 9

Linkage, Crossing over, recombination, exception to Mendelian principles, frequency of recombination, evidence of crossing over, chiasmata, chromosome mapping with two-point and three-point testcrosses. Recombination mapping and map distance, linkage analysis in humans, detection of linked loci by pedigree analysis and somatic cell genetics. Human gene map.

UNIT V GENETICS OF BACTERIA AND VIRUSES 9

Structure and life cycle of bacterial viruses, mapping the bacteriophage genome, deletion mapping. Genetic exchange in Bacteria. Transformation, process and mapping, Conjugation, $F^+X F^-$ mapping, HFR, sexduction, conjugation and gene mapping, mapping closely linked genes, origin of plasmids. Transduction – Generalized, Specialized and gene mapping in bacteria significance of sexuality in bacteria.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Gardner, E.J., M.J. Simmons and D.P. Snustad "Principles of Genetics". 8th Edition. John Wiley & Sons, 1991.
2. Sinnott, E.W., L.C. Dunn. "Principles of Genetics". 5th Edition, Tata McGraw-Hill, 1973.
3. Tamarin, R.H. "Principles of Genetics" 7th Edition, Tata McGraw-Hill, 2002.
4. Sambamurthy, A.V.S.S. "Genetics". 2nd Edition, Narosa, 2005.

REFERENCES

1. Klug, William S. and M.R. Cummings. "Essentials of Genetics". 5th Edition, Pearson Education, 2005.
2. Russell, Peter J. "I Genetics : A Molecular Approach". 2nd Edition, Pearson Education, 2006.
3. Brooker, R.J. "Genetics : Analysis and Principles". 2nd Edition, McGraw-Hill, 2004.

CY3219 INSTRUMENTAL METHODS OF ANALYSIS LAB
(Common for IBT, Food and Pharmaceutical Technology)

L T P C
0 0 4 2

1. Precision and validity in an experiment using absorption spectroscopy.
2. Validating Lambert-Beer's law using $KMnO_4$
3. Finding the molar absorptivity and stoichiometry of the Fe (1,10 phenanthroline)₃ using absorption spectrometry.
4. Finding the pKa of 4-nitrophenol using absorption spectroscopy.

5. UV spectra of nucleic acids.
6. Chemical actinometry using potassium ferrioxalate.
7. Estimation of SO_4^{2-} by nephelometry.
8. Estimation of Al^{3+} by fluorimetry.
9. Limits of detection using aluminium alizarin complex.
10. Chromatography analysis using TLC.
11. Chromatography analysis using column chromatography.

TOTAL : 60 PERIODS

TEXTBOOKS

1. Skoog, D.A. et al. "Principles of Instrumental Analysis", 5th Edition, Thomson / Brooks – Cole, 1998.
2. Braun, R.D. "Introduction to Instrumental Analysis", Pharma Book Syndicate, 1987.
3. Willard, H.H. et al. "Instrumental Methods of Analysis", 7th Edition, CBS, 1986.
4. Ewing, G.W. "Instrumental Methods of Chemical Analysis", 5th Edition, McGraw-Hill, 1985.

IB3220

CHEMICAL ENGINEERING LAB

L T P C

(Common for IBT, Food and Pharmaceutical Technology)

0 0 4 2

1. Flow measurement a) Orifice meter b) Venturimeter, c) Rotameter
2. Pressure drop flow in pipes
3. Pressure drop in flow through packed column
4. Pressure drop in flow through fluidized beds
5. Characteristics of centrifuge pump
6. Plate and frame filter press
7. Filtration in leaf filter
8. Heat transfer characteristics in heat exchanger
9. Simple and steam distillation
10. HETP in packed distillation
11. Ternary equilibrium in liquid-liquid extraction
12. Adsorption isotherm
13. Drying characteristics in a pan dryer

TOTAL : 60 PERIODS TEXT

BOOKS

1. McCabe, W.L., J.C. Smith and P. Harriot "Unit Operations of Chemical Engineering", 6th Edition, McGraw Hill, 2001.
2. Geankoplis, C.J. "Transport Processes and Separation process Principles", 4th Edition, PHI, 2006.