NORTH MAHARASHTRA UNIVERSITY,
JALGAON.

Syllabus For
SECOND YEAR ENGINEERING

BIOTECHNOLOGY

(W.E.F.2007-2008)
NORTH MAHARASHTRA UNIVERSITY, JALGAON

STRUCTURE OF TEACHING & EVALUATION

S.E. (BIOTECHNOLOGY) W.E.F.2007-2008

First Term

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Second Term

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(1)
# NORTH MAHARASHTRA UNIVERSITY, JALGAON

## STRUCTURE OF TEACHING & EVALUATION

### T.E. (BIOTECHNOLOGY)  
**W.E.F. 2008-2009**

#### First Term

<table>
<thead>
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<th>Sr. No.</th>
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#### Second Term

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NORTH MAHARASHTRA UNIVERSITY, JALGAON

STRUCTURE OF TEACHING & EVALUATION

B.E. (BIOTECHNOLOGY)                     W.E.F.2009-2010

First Term

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(3)

Subjects:
Elective-I
1) Advanced Biomaterials
2) Plant Tissue Culture & Plant Biotechnology
3) Protein Engineering
4) Food Biotechnology

Elective-II
1) Metabolic Engineering
2) Biosafety & Bioethics
3) Biomedical Fluid Dynamics
4) Applied Genetic Engineering

S.E. BIOTECH. TERM I
1. CONCEPTS IN BIOTECHNOLOGY
Teaching Scheme:  
Lectures: 4 Hrs./ Week  
(3Hrs)  
Examination Scheme:  
Paper: 100 Marks  

UNIT- I  
**Introduction to Biotechnology:**  
**Protein Structure and Engineering:**  

(10 Hrs, 20 Marks)  

UNIT- II  
**Recombinant DNA Technology:**  
Introduction, Tools of rDNA Technology, Making Recombinant DNA, DNA Library, Introduction of Recombinant DNA into host cells, Identification of Recombinants, Polymerase Chain Reaction (PCR), DNA Probes, Hybridization Techniques, DNA Sequencing, Site-directed mutagenesis.  
**Genomics and Bioinformatics:**  
Introduction, Genome Sequencing Projects, Gene prediction and Counting, Genome similarity, SNPs and comparative genomics, Functional Genomics, History of Bioinformatics, Sequences and Nomenclature, Information Sources, Analysis using Bioinformatics tools.  

(10 Hrs, 20 Marks)  

UNIT- III  
**Microbial Culture and Applications:**  
Introduction, Microbial Culture Techniques, Measurement and Kinetics of Microbial Growth, Scale up of Microbial Process, Isolation of Microbial Products, Strain Isolation and Improvement, Applications of Microbial Culture Technology, Bioethics in Microbial Technology.  

(10 Hrs, 20 Marks)  

(5)  

UNIT-IV  
**Plant Cell Culture and Application:**
Introduction, Cell and Tissue Culture Techniques, Applications of Cell and Tissue Culture, Gene Transfer Methods in Plants, Transgenic Plants with Beneficial Traits, Diagnostics in Agriculture and Molecular Breeding, Bioethics in Plant Genetic Engineering.  

UNIT- V

Animal Cell Culture and Applications:

Biotechnology and Society:
Public perception, Role of sciences, Engineering, Arts, Commerce, Patenting - Criterion for patents, Discovery vs Invention, Product and process patent, Reading a patent, National and International Patent Laws, Varietal protection, Patenting of biological systems, Ethical issues in agriculture and health care.

REFERENCES

2. MICROBIOLOGY

Teaching Scheme:  
Lectures: 4 Hrs./ Week  
Practicals : 4 Hrs./ Week

Examination Scheme:  
Paper: 100 Marks (3 Hrs)  
Practical: 50 Marks  
Term Work: 50 Marks

UNIT-I
Microbiology and its scope, microscopy. classification, morphology and physiology of bacteria, yeast, molds, algae and viruses.  

(10 Hrs, 20 Marks)

UNIT-II
Microbial growth kinetics, growth curve, diauxic growth factors influencing growth, continuous and synchronous culture, microbial nutrition and reproduction.  

(10 Hrs, 20 Marks)

UNIT-III
Pure culture techniques – microbial culture media, isolation, identification and maintenance of cultures, characteristics of pure culture, enumeration techniques.  

(10 Hrs, 20 Marks)

UNIT-IV

(6)
Physical and chemical methods of control of microorganisms, immune response, antigen-antibody interaction. Microbial defense mechanisms under adverse conditions. 

(10 Hrs, 20 Marks)

UNIT-V
Microbial ecology, incidences of microorganisms in soil, water, air, food and sewage, food spoilage organisms, food borne infections and poisoning organisms. 

(10 Hrs, 20 Marks)

REFERENCES:


TERM WORK / PRACTICALS
Term Work Shall be based on any 10 experiments mentioned below.

4. Staining techniques: Simple staining, Gram staining, Endospore staining, Capsule staining.
5-7. Enumeration techniques: Microscopic count using haemocytometer, Viable cell count (By pour plate method) Turbidity measurement as direct expression of growth.
10. Isolation of microorganisms by streak plate method.
11. Isolation by serial dilution method, maintenance & preservation.
14. Microbiological assay of a growth factor.

REFERENCES:


### 3. FLUID FLOW AND SOLID HANDLING

**Teaching Scheme:**

- Lectures: 4 Hrs./Week
- Practicals: 2 Hrs./Week
- Term Work: 25 Marks

**Examination Scheme:**

- Paper: 100 Marks (3 Hrs)
- Oral: 25 Marks

**Unit-I**

**Solids and Their Handling**

Properties of solids, screening, industrial screening equipment. Determination of particle size, screen analysis, size reduction of solids, stages of reduction, operating variables, intermediate and fine size reduction, power requirement and mechanism. Power driven machines: Crushers, grinders, and conveyors.

Problems based on above (10 Hrs, 20 Marks)

**Unit –II**

**Filtration:** Theory, continuous and batch equipments. Flow of solids through fluids, Equipments for classification of solids. Sedimentation.

Problems based on above. (10 Hrs, 20 Marks)

**Unit – III**

**Fluid flow:** Properties of fluids, Flow through pipeline.

Fluid statics: Euler’s equation, Hydrostatic Law and Pressure Measurement. Transport of fluids, energy relationships, pipe fittings, minor losses in pipe flow.

Problems based on above. (10 Hrs, 20 Marks)

**Unit IV**

**Flow measurements:** Orifice meter. Nozzle and Venturi meters, Rotameter and Pitot tube. Other flow measuring devices such as Ultrasonic flow meters, Anemometers, Electromagnetic flow meters, Flow meters using thermistors.

(10 Hrs, 20 Marks)
UNIT-V:

Pumping of fluids:
Pumping equipments for liquid, the reciprocating pump, positive displacement pump, rotary pumps, centrifugal pumps, design & operating characteristics, NPSH calculations, airlift pumps, pumping equipments for gases:
Pumping equipment for gases:
Reciprocating piston compressors, rotary blowers & compressors, centrifugal blowers & compressors including turbo compressors, vacuum-producing equipment.

Power required for compression of gases, clearance volume, multistage compressor efficiency, the power requirement for pumping through pipeline for liquids & gases.

Introduction to fluidization.

(10 Hrs, 20 Marks)

REFERENCES
1. W.L. McCabe & J.C. Smith, Unit Operations in Chemical Engineering, McGraw Hill / Kogakusha Ltd.
2. P.Chattopadhaya. Unit Operations of Chemical Engineering-Volm.I, Khanna Publication New Delhi,
5. R.S.Hiremath & A.P.Kulkarni Unit operation of Chemical Engineering (Mechanical Operations Vol-I) : Everest Publication, Pune

TERM WORK / PRACTICALS

Term Work Shall be based on any 08 experiments mentioned below.

1. To study the separation of solid by sedimentation
2. Sieve Shaker: To ascertain the fineness number and to study the differential & cumulative screen analysis of the sand
3. Ball Mill :To verify the laws of crushing & grinding
4. Jaw Crusher : To verify the laws of crushing & grinding
5. Plate & Frame Filter Press: To determine the rate of filtration ,specific cake resistance and filter medium resistance
6. Rotary Vacuum Filter: To find out the rate of filtration
7. Fluidization : To observe the and study the behavior of the bed during fluidisation and to calculate minimum fluidization velocity
8. To determine the coefficient of Venturimeter
9. To determine the coefficient of Orificemeter
10. To determine the coefficient of Nozzlemeter
11. To Verify Bernoulli equation.
12. Reynolds Experiment

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4. PROCESS CALCULATIONS

Teaching Scheme: 
Lectures: 4 Hrs./Week 
Term Work: 2 Hrs./Week

Examination Scheme: 
Paper: 100 Marks (3 Hrs) 
Term Work: 25 Marks

UNIT-I:
Units and Dimensions:
Basic and derived units, dimensional analysis, dimensional and empirical equations.
Different ways of expressing units of quantities and physical constants.
Properties of Gases, Liquids and Solids:
Ideal and real gas laws, critical properties, properties of mixtures & solutions & plane equilibria, Kay’s rule. 

UNIT-II:
Basic Concept:
Humidity and saturation, Psychometric chart, solubility diagrams.
Thermo Physics:
Concept and calculations of involving energy, heat, work & enthalpy of reversible & irreversible process.

UNIT-III:
Material Balances:
Concept of limiting & excess reactants, Tie element, Recycle, Purging, Bypass etc. in batch, stagewise and continuous operations in systems with and without chemical reactions in unit operations.

UNIT-IV:
Thermo Chemistry:
Heat of formation, combustion, solution, dilution etc. and its effects of pressure and temperature on them. Temp. of reaction, Energy balance for system with and without chemical reaction. Process efficiency.

UNIT-V:
Unsteady material and energy balances in Bioprocesses, Energy balances for nuclear, electro chemical and photo chemical processes
Combustion: Introduction, fuels, calorific value of fuels, air requirements.

REFERENCES
1. Bhat B.I. and Vora S.M; Stoichiometry; Tata McGraw Hill Publication; New Delhi

(10)

TERM WORK
Term Work Shall be based on any 08 assignments on the following.
2. Humidity & Saturation.
3. Thermo physics.
4. Thermo chemistry.
5. Material balances.
7. Nuclear, photo chemical and electro chemical processes.

5. ENGINEERING MATHEMATICS –III

Teaching Scheme:                    Examination Scheme:
Lectures:  4 Hrs./ Week            Paper:  100 Marks (3 Hrs)

UNIT-I:
Liner Differential Equation:
Liner differential equation of order “n” with constant co-efficient, Method of variations, Homogeneous liner differential equation, Legendre’s LDE, Application to chemical engineering. Problems involving batch reactor. (10 Hrs, 20 Marks)

UNIT-II:
Simultaneous Linear Differential Equations of form:
1) f1(D)x + f2(D)y = (t)
   (D)x + (D)y = (t)
   Where, D=d/dt.
2) dx/P = dy/Q = dz/R.
Partial Differential Equations:
Solutions of (i) One dimensional heat flow equation.
   (ii) Two dimensional heat equation (Laplace Equation)
   (iii) Laplace Equation in Polar form. Differential equation of first order & higher degree. (10 Hrs, 20 Marks)
UNIT-III:
Laplace Transform:
Definition of Laplace Transform, Inverse Laplace transform, Properties and theorems,
Laplace transforms of standard functions, Unit step functions, Ramp functions, Impulse
functions, Error functions, Jump functions, Laplace Inverse Transform.
Applications to the solutions of liquid systems, consisting of single tank & two tanks in
series (Interacting & non-Interacting), Second order systems (Damped vibrator).
(10 Hrs, 20 Marks)

UNIT-IV:
Vector Integration:
(i) Line Integral, Surface Integral, Volume Integral.
(ii) Greens Lemma, Stoke’s Theorem, Gausse’s Divergence Theorem.
Finite Fourier Cosine & Sine transforms, Complex Fourier transforms, Infinite Fourier
sine and Cosine transforms, Applications of Fourier transforms to boundary value
problems such as one dimensional and two dimensional heat flow problems
(10 Hrs, 20 Marks)

UNIT-V:
Numerical Solution of Ordinary Differential Equations:
Taylor’s series method, Runga-Kutta method, Piccard’s method, Eulers method and Least
square method
Numerical Integration:
Trapezoidal rule, Simpson’s 1/3rd rule, Simpson’s 3/8th rule and Weddle’s rule.
(10 Hrs, 20 Marks)

REFERENCES
Prakashan, Pune
2. Dr. B.S.Grewal, Higher Engineering Mathematics : Khanna Publications ,New Delhi
Publications.
Delhi

(12)
6. COMPUTER APPLICATIONS

**Teaching Scheme:**
Practicals : 2 Hrs./ Week

**Examination Scheme**
Practical: 50 Marks
Term Work: 25 Marks

**TERM WORK / PRACTICALS**

Term work & practical should be based on following

1. Introduction to computer, O.S, M.S Office, Programming languages
2. History, C editor – C language
3. a+b, a-b ,a*b , a/b , a % b using keyboard
4. Using conditional operator find out largest number
5. If – else – program using if – else
6. For or while or Do while / nesting of for to print table of 1 to 10
7. Addition using function
8. Array - program using array

**REFERENCES**

   Publication.
5. Wool E.J. Microcomputers in Biochemical Education.
S.E. BIOTECH. TERM II

1. BIOCHEMISTRY

Teaching Scheme:
Lectures: 4 Hrs./ Week
Practicals: 2 Hrs./ Week

Examination Scheme:
Paper: 100 Marks (3 Hrs)
Practical: 50 Marks
Term Work: 25 Marks

UNIT I
Structure and function of biomolecules; carbohydrates, proteins, lipids and nucleic acids.
Biochemical separation methods. Vitamins, enzymes and coenzymes.
(10 Hrs, 20 Marks)

UNIT-II
(10 Hrs, 20 Marks)

UNIT-III
Lipid metabolism; transport and oxidation of fatty acids in animal tissues, glycerol metabolism, biosynthesis of fatty acids and triacylglycerol.
Protein metabolism; outline of amino acid metabolism and their significance.
(10 Hrs, 20 Marks)

UNIT-IV
Nucleic acid metabolism; mechanism and biosynthesis of DNA and RNA, reverse transcription. Protein biosynthesis, inhibitors of protein synthesis, transport of proteins and signal peptides.
(10 Hrs, 20 Marks)

UNIT-V
Typical metabolic pathways of microbes; Entner-Duodoroff pathway, glyoxilate cycle, phosphoketolase pathway.
Biochemical aspects of Hormone Action.
(10 Hrs, 20 Marks)

REFERENCES:
TERM WORK / PRACTICALS

Term Work Shall be based on any 10 experiments mentioned below.

1. Estimation of carbohydrates.
2. Estimation of proteins.
4. Isoelectric precipitation.
5. Separation of amino acids by paper chromatography.
7. Extraction of Lipids.
8. Thin layer Chromatography.
9. Gel Electrophoresis.
12. Identification and estimation of an intermediate of EMP pathway.

REFERENCES


2. CHEMISTRY

Teaching Scheme:                                                                 Examination Scheme:
Lectures:   4 Hrs./ Week            Paper:  100 Marks (3 Hrs)
Term Work : 2 Hrs./ Week            Term Work : 25 Marks

UNIT- I:

Reaction Mechanism:

Study of reactions with reference to the mechanism involved:
Aldol condensation, Cannizzaro & cross Cannizzaro reactions, Claisen ester condensation, Reimer Tiemann reaction, Grignard reagents & reactions.
SN₁ & SN₂ reactions.
Electrophilic substitution in aromatic rings: Nitration, Sulphonation, Halogenations, Friedel Crafts alkylation & acylations.
Elimination reactions: E₂, E₁ mechanism.

(10 Hrs, 20 Marks)
UNIT-II:
Stereochemistry:

(10 Hrs, 20 Marks)

UNIT-III:
Chemical kinetics:
Objective of chemical kinetics, rate of reaction, velocity constant of a reaction, elementary reaction steps & rate expressions, order & molecularity of reaction, factors influencing the reaction rates, integrated rate expressions for 1st, 2nd, 3rd, & zero order reaction (with example), methods for determining order of reactions, experimental investigation of reaction kinetics. Arrhenius equation, relationship between chemical kinetics & thermodynamics, problem based on above topics. Fast reactions, Set up for study of Fast reactions

(10 Hrs, 20 Marks)

UNIT-IV:
Classical chemical thermodynamics:
Objective & scope, definition of thermodynamic systems. Heat work reversibility, maximum work, isothermal & adiabatic process, 1st law of thermodynamics, 2nd law of thermodynamics, entropy, entropy changes, enthalpy & free energy, Gibbs Helmholtz equation, Third law of thermodynamics. Problems based on above topics. Criteria of chemical equilibrium, Le Chatelier’s theorem, its application to some systems likes ammonia, sulphuric acid, and nitric acid.

(10 Hrs, 20 Marks)

UNIT-V:
Surface phenomenon:
Surface tension of liquids, adsorption, adsorption of gases by solids, adsorption isotherm, Freundlich adsorption isotherm, the Langmuesirs adsorption isotherm, application of adsorption. Colloids & emulsion: Types, methods of preparation, determination of particle size, properties, solution of micro molecules, properties of micro molecular solutions.

(10 Hrs, 20 Marks)
REFERENCES
1. Glasstone, Thermodynamics for chemist : McMillan India Ltd.
3. Puri & Sharma, A textbook of physical chemistry : S. Chand & Co. Delhi
4. B.S.Behl, Physical Chemistry, S. Chand & Co. Delhi

TERM WORK
Term Work Shall be based on any 08 experiments mentioned below.

1. Preparation of p-nitro acetanilide by nitration.
2. Preparation of Quinone.
3. Determination of rate constant of Hydrolysis of Methyl Acetate.(1st Order)
4. Determination of rate constant of Saponification of Ethyl Acetate.(2nd Order)
5. Determination of surface tension liquids by Stalagmometer.
6. Preparation of colloidal solution of starch.
7. To verify Freundlich adsorption Isotherm
8. Estimation of Acetone
9. Estimation of Aniline
10. Stability of emulsions

REFERENCES
1. S.S.Dara, Experiments and Calculations in Engineering Chemistry, S. Chand & Co. Delhi

3. IMMUNOLOGY

Teaching Scheme:  
Lectures: 4 Hrs./ Week  
Practicals: 2 Hrs./ Week

Examination Scheme:  
Paper: 100 Marks (3 Hrs)  
Practical: 50 Marks  
Term Work: 25 Marks

UNIT-I
Introduction to Immunology: Properties of immune response, Innate and acquired immunity, active and passive immunity.
Cells & Tissues of Immune System: Lymphocytes, Classes of lymphocytes, antigen presenting cells, NK Cells, Mast Cells, Dendritic Cell, Organs of the Immune System, Bone marrow, Thymus, Lymph node, Spleen, CALT, MALT.

(10 Hrs, 20 Marks)
UNIT-II
Molecular Immunology: - Molecular structure of antibody, Classification, Isotypes, Synthesis assembly and expression of immunoglobulin molecules, Nature of antigens, function and diversity, Generation of anti-body diversity.
Antigens: Different characteristics of antigens, mitogens, Hapten, Immunogen, Adjuvants.

UNIT-III
MHC: Discovery of MHC complex, Role of MHC, Structure of MHC molecule, Binding of peptides to MHC molecules, MHC restriction.
Effecter Mechanism of Immune Response: Cytokines, T- cell receptors, cell activation, complement system, antigen processing and presentation, regulation of immune response.

UNIT-IV
Immunological Techniques:- antigen- antibody reactions, Immuno diffusion, immunoelectrophoresis, ELISA, RIA, fluorescence activated cell sorter.

UNIT-V
Applied Immunology:- Immune system in health and disease, autoimmunity, hypersensitivity, tumor immunity, tissue and organ transplant, Synthetic vaccines.
Hybridoma technology: - Fusion of myeloma cells with lymphocytes, production of monoclonal antibodies and their application.

REFERENCES

TERM WORK / PRACTICALS
Term Work Shall be based on any 08 experiments mentioned below.
1. Immunelectrophoresis
2. Radial immunodiffusion
3. Antigen –Antibody interaction: The Ouchterlony procedure
4. Introduction to ELISA reactions
5. AIDS KIT-1: Simulation of HIV-1 detection
6. Western Blot Analysis – demo
7. Immunology of pregnancy test – demo
8. Viral antigen detection by rapid immuno-chromatographic cassette assay
9. Latex agglutination test
10. Precipitin reaction
11. Antibody titer test
12. Agglutination reaction

REFERENCE

4. BIOSTATISTICS

Teaching Scheme: Examination Scheme:
Lectures: 4 Hrs./ Week Paper: 100 Marks (3 Hrs)
Term Work : 2 Hrs./ Week Term Work : 25 Marks

UNIT-I
Presentation of Data: Frequency distribution, graphical presentation of data by histogram, frequency curve and cumulative frequency curves.
Measure of Location and Dispersion: Mean, Medium, Mode and their simple properties (without derivation) and calculation of median by graphs: range, mean deviation, Standard deviation, Coefficient of variation.

(10 Hrs, 20 Marks)

UNIT-II
Probability and Distribution: Random distributions, events-exhaustive, mutually exclusive and equally likely, definition of probability (with simple exercises), definition of binomial, Poisson and normal distributions and their inter-relations, Simple properties of the above distributions (without derivation).

(10 Hrs, 20 Marks)

UNIT-III
Correlation and Regression: Bivariate data – simple correlation and regression coefficients and their relation, Limits of correlation coefficient, Effect of change of origin and scale on correlation coefficient, Linear regression and equations of line of regression, Association and independence of attributes.
Sampling: Concept of population and sample, Random sample, Methods of taking a simple random sample.

(10 Hrs, 20 Marks)
UNIT-IV
Tests of Significance: Sampling distribution of mean and standard error, Large sample tests (test for an assumed mean and equality of two population means with known S.D.); small sample tests (t-test for an assumed mean and equality of means of two populations when sample observations are independent, Paired and unpaired t-test for correlation and regression coefficients, T-test for comparison of variances of two populations, Chi-square test for independence of attributes, Goodness of fit and homogeneity of samples. (10 Hrs, 20 Marks)

UNIT-V
Experimental Designs: Principles of experimental designs, Completely randomized, Randomized block and latin square designs, Simple factorial experiments of 22, 23, 24 and 32 types, Confounding in factorial experiments (mathematical derivations not required); Analysis of variance (ANOVA) and its use in the analysis of RBD. (10 Hrs, 20 Marks)

REFERENCES

TERM WORK
Any eight assignments based on the following.

1. Mean, Median, Mode and their properties
2. Calculation of median by graphs, range, mean deviation, standard deviation and coefficient of variation.
3. Exercises on probability, binomial distribution, Poisson and normal distribution.
4. Problems on coefficient of correlation and regression.
5. Problems on line of regression.
6. Sampling distribution of mean and standard error and Problems on large sample tests.
7. Problems on small sample tests and t-tests for correlation and regression coefficients.
8. T-tests for comparison of variances and goodness of fit.
10. Problems on analysis of variances (ANOVA) and its use in R.B.D.
5. PROCESS HEAT TRANSFER

Teaching Scheme:                                                                 Examination Scheme:
Lectures:  4 Hrs./ Week                  Paper:  100 Marks (3 Hrs)
Practicals: 2 Hrs. / Week                Oral: 25 Marks

TERM WORK: 25 Marks

UNIT- I:
Heat transfer by conduction in solids;
Fourier’s law of heat conduction, steady state heat conduction through walls (single and multilayer), heat flow through cylinder, unsteady state heat conduction, Derivation of Fourier’s heat conduction equation in three dimensions, equation for one dimensional conduction, heat conduction through a semi infinite slab, lumped capacity method of unsteady state conduction. Principles of heat flow in fluids.

(10 Hrs, 20 Marks)

UNIT-II:
Typical heat exchange equipment, counter current and parallel flows, energy balances, overall heat transfer coefficient, log mean temperature difference, individual heat transfer coefficient, calculation of overall coefficient from individual coefficients, transfer units in heat exchangers. Heat transfer to fluids without phase change.

(10 Hrs, 20 Marks)

UNIT- III:
Regimes of heat transfer in fluids, heat transfer by forced convection in laminar and turbulent flow, dimensional analysis method, use of imperials equations heat transfer by forced convection outside tubes, natural convection. Heat transfer to fluids with phase change. Dropwise and film type condensation, coefficient for film type condensation, practical use of Nusselt’s equations, application to petroleum industries.

(10 Hrs, 20 Marks)

UNIT- IV:
Heat transfer to boiling liquids:
Boiling of saturated liquids maximum flux and critical temperature drop, maximum Flux and film boiling. Radiation heat transfer:
Fundamental of radiation, black body radiation, Kirchoff’s law, radiant heat exchange between non black surfaces. Combined heat transfer by conduction, convection, radiation.

(10 Hrs, 20 Marks)

(21)
UNIT- V:
Heat exchange equipments:
Heat exchanger single pass 1-1 exchanger, 1-2 shell and tube heat exchanger, correction for LMTD for cross flow, design calculation (Kern Method) in heat exchanger.
Evaporation:
Liquid characteristics and types of evaporator, single effect evaporator calculation, pattern of liquor flow in multiple effect evaporators.

(10 Hrs, 20 Marks)

REFERENCES
1.W.L.McCabe and J.C.Smith , Unit operations in chemical engineering. McGraw Hill/Kogakusha Ltd.
4.D.S.Kumar, Process Heat Transfer, S.K.Kataria and Sons Publisher, New Delhi

TERM/PRACTICALS
Term Work Shall be based on any 08 experiments mentioned below.
1) Conductivity of metals and / or insulator.
2) Experiment on Pin fins.
3) Experiment on forced convection apparatus.
4) Experiment on natural convection apparatus.
5) Determination of emmisivity of test plate.
6) Stefan Boltzman apparatus .
7) Parallel / counter flow heat exchanger.
8) Study of pool boiling phenomenon and critical heat flux.
9) Study of heat transfer in evaporator .
10) Temperature profile in a rod .
11) Study of evaporators .
12) Dropwise and filmwise condensation .

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