UTTAR PRADESH TECHNICAL UNIVERSITY

LUCKNOW

Syllabus
for

B. Tech. Chemical Engineering
of
Second Year

(Effective from the Session: 2014-15)

STUDY AND EVALUATION SCHEME
B. Tech. (Chemical Engineering)
[Effective from the Session 2014 - 15]

B. Tech. (Chem. Engg.) **Year 2nd, Semester - III**

S. No.	Course Code	Subject	Periods			Evaluation Scheme				Subject Total	Credits
						Sessional Exam.			ESE		
			L	T	P	CT	TA	Total			
THEORY SUBJECTS											
1	NAS-301/ NOE-031-NOE-039	Mathematics III/Science Based Open Elective	3	1	0	30	20	50	100	150	4
2	NEE302	Electrical Measurement & Measuring Instruments	3	1	0	30	20	50	100	150	4
3	NCH303	Fluid Mechanics	3	1	0	30	20	50	100	150	4
4	NCH301	Process Calculation	3	1	0	30	20	50	100	150	4
5	NHU301/ NHU302	Industrial Psychology/ Industrial Sociology	2	0	0	15	10	25	50	75	2
6	NCH302	Mechanical Operations	2	1	0	15	10	25	50	75	3
	AUC-001/ AUC-002	*Human Values & Professional Ethics/ Cyber Security*	2	0	0	15	10	25	50	75*	
PRACTICAL/DESIGN/DRAWING											
7	NEE352	Electrical measurement lab	0	0	3	10	10	20	30	50	1
8	NCH352	Fluid Flow Lab	0	0	3	10	10	20	30	50	1
9	NCH351	Mechanical Operation Lab	0	0	2	10	10	20	30	50	1
10	NCH353	Environmental Lab	0	0	2	10	10	20	30	50	1
11	NGP-301	GP						50		50	
		TOTAL	18	5	10					1000	25

Science Based Open Elective:

NOE031 Introduction to Soft Computing (Neural Network, Fuzzy Logic and Genetic Algorithm
NOE032 Nano Sciences
NOE033 Laser Systems and Applications
NOE034 Space Sciences
NOE035 Polymer Science & Technology
NOE036 Nuclear Science
NOE037 Material Science
NOE038 Discrete Mathematics
NOE039 Applied Linear Algebra

*Human values & Professional Ethics /Cyber Security will be offered as a compulsory audit course for which passing marks are 30% in End Semester Examination and 40% in aggregate.

STUDY AND EVALUATION SCHEME
B. Tech. (Chemical Engineering)
[Effective from the Session 2014 - 15]

B. Tech. (Chem. Engg.) **Year 2nd, Semester - IV**

S. No.	Course Code	Subject	Periods			Evaluation Scheme				Subject Total	Credits
						Sessional Exam.			ESE		
			L	T	P	CT	TA	Total			
THEORY SUBJECTS											
1	NOE-041-NOE-049/ NAS-401	Science Based Open Elective/ Mathematics III	3	1	0	30	20	50	100	150	4
2	NME402	Manufacturing Science & Technology I	3	1	0	30	20	50	100	150	4
3	NCH402	Heat Transfer	3	1	0	30	20	50	100	150	4
4	NCH403	Mass Transfer - I	3	1	0	30	20	50	100	150	4
5	NHU401/ NHU402	Industrial Psychology /Industrial Sociology	2	0	0	15	10	25	50	75	2
6	NCH401	Thermodynamics - I	2	1	0	15	10	25	50	75	3
7	AUC-002/ AUC-001	*Cyber Security/ Human Values & Professional*	2	0	0	15	10	25	50	75*	
PRACTICAL/DESIGN/DRAWING											
8	EME452	Manufacturing Science I Lab	0	0	3	10	10	20	30	50	1
9	NCH452	Heat Transfer Operations Lab	0	0	3	10	10	20	30	50	1
10	NCH453	Mass Transfer Operations I Lab	0	0	2	10	10	20	30	50	1
11	NCH454	Analytical Methods	0	0	2	10	10	20	30	50	1
12	NGP-401	GP						50		50	
		TOTAL	18	5	10					1000	25

Science Based Open Elective:

NOE-041 Introduction to Soft Computing (Neural Network, Fuzzy Logic and Genetic Algorithm
NOE-042 Nano Sciences
NOE-043 Laser Systems and Applications
NoE-044 Space Sciences
NOE-045 Polymer Science & Technology
NOE-046 Nuclear Science
NOE-047 Material Science
NOE-048 Discrete Mathematics
NOE-049 Applied Linear Algebra

*Human values & Professional Ethics /Cyber Security will be offered as a compulsory audit course for which passing marks are 30% in End Semester Examination and 40% in aggregate.

NEE-302: ELECTRICAL MEASUREMENT & MEASURING INSTRUMENTS

L T P 3 1 0

UNIT I

(1) Philosophy of Measurement- Methods of measurement, Measurement system**,** Classification of instrument systems, Characteristics of instruments & measurement systems**,** Errors in measurement & its analysis, Standards. (4)

(2) Analog Measurement of Electrical Quantities- Electrodynamic, Thermocouple, Electrostatic & Rectifier type ammeters & voltmeters, Electrodynamic wattmeter, Three Phase wattmeter, Power in three phase systems, Errors & remedies in wattmeter and energy meter. (5)

UNIT II

Instrument Transformers:CT and PT; their errors, Applications of CT and PT in the extension of instrument range, Introduction to measurement of speed, frequency and power factor. (8)

UNIT III

Measurement of Parameters- Different methods of measuring low, medium and high resistances**,** measurement of inductance & capacitance with the help of AC Bridges, Q meter. (9)

UNIT IV

(1) AC Potentiometers- Polar type & Co-ordinate type AC potentiometers, application of AC Potentiometers in electrical measurement. (4)

(2) Magnetic Measurement- Ballistic galvanometer, Flux meter**,** Determination of hysteresis loop, measurement of iron losses**.** (4)

UNIT V

(1) Digital Measurement of Electrical Quantities- Concept of digital measurement, Block diagram, Study of digital voltmeter, Frequency meter, *Spectrum analyzer,* Electronic multimeter. (3)

(2) Cathode Ray Oscilloscope- Basic CRO circuit (block diagram), Cathode Ray Tube (CRT) & its components**,** Applications of CRO in measurement, Lissajous Pattern, Dual trace & dual beam oscilloscopes. (3)

Text Book:

1. E. W. Golding & F. C. Widdis, "Electrical Measurement &Measuring Instrument", A. W. Wheeler & Co. Pvt. Ltd. India
2. A. K. Sawhney, "Electrical & Electronic Measurement & Instrument", Dhanpat Rai & Sons, India
3. Purkait, "Electrical & Electronics Measurement & Instrumentation", TMH

Reference Books:

4. Forest K. Harris, "Electrical Measurement", Willey Eastern Pvt. Ltd. India
5. M. B. Stout , "Basic Electrical Measurement", Prentice Hall of India
6. W. D. Cooper, "Electronic Instrument & Measurement Technique", Prentice Hall International
7. J. B. Gupta, "Electrical Measurement & Measuring Instrument", S. K. Kataria & Sons

NCH303: FLUID MECHANICS (3:1:0)

UNIT 1

Units Dimensions & Dimensional Analysis, Definitions and Fluid Properties: Viscosity, Newton's Law of viscosity, Rheological Diagram, Kinematic Viscosity, No slip condition, Ideal Fluid, Normal Stresses on Fluid Element, Bulk Stress, Stress Tensor, The Pressure Gradient in the absence of Shear Stresses, Compressible and Incompressible Flows.

UNIT 2
Fluid Statics: Stationary Fluid Bodies, Euler Equation and its application, Derivation of Bernoulli Equation from Euler Equation, Pascal's Law, Hydrostatic Law, Hydrostatic Paradox. Moving Fluid Bodies, Translation, Rotation, A Plane Submerged Surface, Stability of Submerged Bodies. Measurement of Pressure, Definition of Gauge and & Absolute Pressure, Barometer, Various Manometers, Pitot Tube.

UNIT 3
Fluid Dynamics: Eularian & Lagrangian View Point, Stream Lines & Path Lines, Stream Tubes, Substantial Derivative & Acceleration, Stream Function, Angular Velocity of a Fluid Element, Irrotational Flow, Circulation, Properties of Irrotational Flows & Potential Function. Kinetics: System & Control Volume, Extensive & Intensive Properties, Reynolds Transport Theoram.

UNIT 4
Integral Analysis: Continuity Equation, Linear Momentum Equation, Energy Equation, Engineering Bernoulli's Equation. Flow of Fluids through Pipes: Various Flow Regimes, Calculation of Pressure Drop in a Pipe, Minor Losses in Fittings, Equivalent Length & 'K' factor, Multiple Path Systems.

UNIT 5
Flow Measuring Equipment: Head Flow Meters, Nozzel Meter, Orifice Meter, Venturi Meter, Area Flow Meters, Rotameter. Pumps & Compressors: Positive Displacement Pumps, Reciprocating Pumps, Rotary Pumps, Screw Pumps. Centrifugal Pumps, Characteristic Curves of Centrifugal Pumps, NPSH, Advantages and Disadvantages of Centrifugal Pumps.

Books

1. Gupta, Vijay and S. K. Gupta, "Fluid Mechanics and its Applications", Wiley Eastern, New Delhi (1984).
2. Shames, I. H., "Mechanics of Fluids", McGraw-Hill, Inc.
3. Coulson, J.M. and Richardson, J.F., "Chemical Engineering, Volume I", Pergamon Press.
4. Jain, A. K., "Fluid Mechanics including Hydraulic Machines", Khanna Publishers, Delhi (2007).
5. Geankoplis, C.J., "Transport Processes and Unit Operations", Prentice-Hall Inc.

NCH301: PROCESS CALCULATION (3:1:0)

UNIT 1
Basic and Derived Units, Use of Model Units in Calculations, Methods of Expression, Compositions of Mixture and Solutions, Ideal and Real Gas Laws - Gas constant - Calculations of Pressure, Volume and Temperature using Ideal Gas Law, Use of Partial Pressure and Pure Component Volume in Gas Calculations, Applications of Real Gas Relationship in Gas Calculation.

UNIT 2
Stoichiometric Principles, Application of Material Balance to Unit Operations like Distillation, Evaporation, Crystallization, Drying etc., Material Balance with Chemical Reaction, Limiting and Excess Reactants, Recycle, Bypass and Purging.

UNIT 3
Unsteady State Material Balances, Calculation of Absolute Humidity, Molal Humidity, Relative Humidity and Percentage Humidity, Use of Humidity in Condensation and Drying, Humidity Chart, Dew Point.

UNIT 4
Determination of Composition by Orsat Analysis of Products of Combustion of Solid, Liquid and Gas Fuels, Calculation of Excess Air from Orsat Technique and Problems, Heat Capacity of Solids, Liquids, Gases and Solutions, Use of Mean Heat Capacity in Heat Calculations, Problems involving Sensible Heat and Latent Heats, Evaluation of Enthalpy.

UNIT 5
Standard Heat of Reaction, Heats of Formation, Combustion, Solution, Mixing etc., Calculation of Standard Heat of Reaction, Effect of Pressure and Temperature on Heat of Reaction, Energy Balance for Systems With and Without Chemical Reaction, Unsteady State Energy Balances. Introduction to Computer Aided Calculations - Steady State Material and Energy Balances.

Books:

1. Bhatt, B. L., VORA, S. M., “Stoichiomentry ", Tata McGraw-Hill, 1976.
2. Hougen, O. A., Watson, K. M and Ragatz, R. A., " Chemical Process Principles Part-I ",John Wiley and Asia Publishing, 1970.
3. Himmelblau, D. M., “Basic Principles and Calculations in Chemical Engineering ",Fourth Edition, Prentice Hall Inc., 1982.
4. Whitwell, J. C., Tone, R. K. “Conservation of Mass and Energy ", McGraw-Hill, 1973.
5. Process Calculation for Chemical Engineering, Second Revised Edition, Chemical Engineering Education Development Centre, I.I.T., Madras, 1981.
6. Narayanan K. V. & Lakshmikutty B. “Stoichiometry and Process Calculations” PHI New Delhi

NCH302: MECHANICAL OPERATIONS (2:1:0)

UNIT I

Particle Technology: Particle shape, Particle size, Different ways of Expression of Particle Size, Shape Factor, Sphericity, Mixed Particles Size Analysis, Screens – Ideal and Actual screens, Differential and Cumulative size Analysis, Effectiveness of Screen, Specific Surface of Mixture of Particles, Number of Particles in a Mixture, Standard Screens Industrial Screening Equipment, Motion of Screen, Grizzly, Gyratory Screen, Vibrating Screen, Trommels, Sub Sieve Analysis – Air Permeability Method, Sedimentation and Elutriation Methods.

UNIT 2

Size Reduction: Introduction – Types of Forces used for Communition, Criteria for Communition, Characteristics of Communited Products, Laws of Size Reduction, Work Index, Energy Utilization, Methods of Operating Crushers – Free Crushing, Choke Feeding, Open Circuit Grinding, Closed Circuit Grinding, Wet and Dry Grinding, Equipment for Size Reduction – Blake Jaw Crusher, Gyratory Crusher, Smooth Roll Crusher, Tooth Roll Crusher, Impactor, Attrition Mill, Ball Mill, Critical Speed of Ball Mill, Ultra Fine Grinders, Fluid Energy Mill, Colloid Mill, Cutters – Knife Cutter

UNIT 3

Flow of Fluid Past Immersed Bodies: Drag, Drag Coefficient, Pressure Drop – Kozeny – Carman Equation, Blake-Plummer, Ergun Equation, Fluidization, Conditions for Fluidization, Minimum Fluidization Velocity, Types of Fluidization, Application of Fluidization, Slurry Transport, Pneumatic Conveying.

Motion of Particles Through Fluids: Mechanics of Particle Motion, Equation for One Dimensional Motion of Particles through a Fluid in Gravitational and Centrifugal Field, Terminal Velocity, Drag Coefficient, Motion of Spherical Particles in Stoke’s Region, Newton’s Region and Intermediate Region, Criterion for Settling Regime, Hindered Settling, Modification of Equation for Hindered Settling, Centrifugal Separators, Cyclones and Hydro Cyclones.

UNIT 4

Sedimentation: Batch Settling Test, Application of Batch Settling Test to Design of Continuous Thickener, Coe and Clevenger Theory, Kynch theory, Thickener Design, Determination of Thickener Area.

Filtration: Introduction, Classification of Filtration, Cake Filtration, Clarification, Batch and Continuous Filtration, Pressure and Vacuum Filtration Constant Rate Filtration and Cake Filtration, Characteristics of Filter Media, Industrial Filters, Sand Filter, Filter Press, Leaf Filter, Rotary Drum Filter, Horizontal Belt Filter, Bag Filter, Centrifugal Filtration – Suspended Batch Centrifuge, Filter Aids, Application of Filter Aids, Principles of Cake Filtration, Modification of Kozeny – Carman Equation for Filtration.

UNIT 5

Agitation And Mixing: Application of Agitation, Agitation Equipment, Types of Impellers – Propellers, Paddles and Turbines, Flow Patterns in Agitated Vessels, Prevention of Swirling, Standard Turbine Design, Power Correlation and Power Calculation, Mixing of Solids, Types of Mixers - Change Can Mixers, Muller Mixers, Mixing Index, Ribbon Blender, Internal Screw Mixer, Tumbling Mixer.

Sampling, Storage and Conveying of Solids: Sampling of Solids, Storage of Solids, Open and Closed Storage, Bulk and Bin Storage, Conveyors – Belt Conveyors, Chain Conveyor, Apron Conveyor, Bucket Conveyor, Bucket Elevators, Screw Conveyor.

Books:

1. Momentum transfer operation: S. K. Gupta, TMC, 1979.
2. Unit Operations of Chemical Engineering: McCabe and Smith, TMC
3. Chemical Engineering Vol. I: Coulson & Richardson, Pergamon Press, 1979

NEE-352: ELECTRICAL MEASUREMENT LAB (0:0:3)

Note: Minimum of nine experiments from the following:

1. Calibration of ac voltmeter and ac ammeter
2. Measurement of form factor of a rectified sine wave and determine source of error if r.m.s. value is measured by a multi-meter
3. Measurement of phase difference and frequency of a sinusoidal ac voltage using C.R.O.
4. Measurement of power and power factor of a single phase inductive load and to study effect of capacitance connected across the load on the power factor
5. Measurement of low resistance by Kelvin's double bridge
6. Measurement of voltage, current and resistance using dc potentiometer
7. Measurement of inductance by Maxwell's bridge
8. Measurement of inductance by Hay's bridge
9. Measurement of inductance by Anderson's bridge
10. Measurement of capacitance by Owen's bridge
11. Measurement of capacitance by De Sauty bridge
12. Measurement of capacitance by Schering bridge
13. Study of Frequency and differential time counter
14. College may add any two experiments in the above list

NCH 352: FLUID FLOW LAB (0:0:3)

1. To find the cake and filter medium resistance of Plate and Frame Filter press.
2. To find the filter medium resistance of a Vacuum Leaf Filters.
3. To find the flow rate using a V notch
4. To find the friction losses in a Straight pipe
5. To find the friction losses in a Bend pipe
6. Study of Pipe fittings and Valves
7. To study the principle of a hydro-cyclone and find out the efficiency of separation.
8. To study the Reynolds apparatus and verify experimentally
9. To study the working principle of a reciprocating pump and to determine the percentage of slip.
10. To study the working principle of a centrifugal pump and determine its efficiency experimentally.
11. To determine the cake resistance of a batch basket centrifuge.
12. To find out the flow profile of water from hook's gauge and determination of coefficient of velocity, coefficient of discharge, coefficient of resistance, coefficient of contraction
13. To determine the pressure drop in a packed bed by Leva"s and Ergun"s equation and verify experimentally.
14. To determine the minimum fluidization velocity in a fluidized bed and verify experimentally.
15. To determine the minimum fluidization velocity and pressure drop in a tapered fluidized bed.
16. Determination of discharge coefficient with Reynolds Number in case of an orifice meter and a venturi meter.
17. Determination of the minimum fluidization velocity and pressure drop in a square bed.
18. Study of D"e laval Centrifuge and to find out its efficiency using it as a Clarifier and Purifier.
19. Study and verification of the flow pattern in a Bernoulli's apparatus.
20. Determination of the mixing and segregation index of the given sample of bed materials in a fluidized bed.
21. Determination of the fluidization index of the given sample of bed materials in a fluidized bed.

NCH351: MECHANICAL OPERATIONS LAB (0:0:2)

1. Determination of average particle size of a mixture of particles by sieve analysis.
2. Study and operation of Jaw crusher and thereby verification of Ritinger's constant.
3. Determination of reduction ratio, maximum feed size and theoretical capacity of crushing rolls.
4. Determination of the effect of no. of balls on grinding in a Ball mill and comparison of its critical speed with the operating speed.
5. To find out the effect of time on grinding and amount of undersize at zero time of grinding in a ball mill and to compare its operating speed with the critical speed.
6. To find out enrichment of the coal sample using a froth flotation cell.
7. Determination of the effectiveness of a vibrating screen.
8. To find the efficiency of Wilfley Table and the effect of water flow rate on efficiency of separation.
9. Study and operation of a Hammer mill thereby finding its reduction ratio.
10. Study and operation of a Pulverizer and thereby finding its reduction ratio.
11. Study and operation of a cyclone separator and thereby finding its efficiency of separation.
12. Study and operation of a Magnetic separator and thereby finding its efficiency of separation.
13. Study and operation of a Gyratory Crusher and thereby finding its reduction ratio

NCH353: ENVIRONMENTAL LAB (0:0:2)

1) To determine the Biochemical Oxygen Demand of a Given Sample of Wastewater
2) To determine Dissolved Oxygen in a Given Sample by Azide Modification Method
3) To find Alkalinity of Water Sample by Indicator Method
4) To determine Suspended Solids of Given Water Sample
5) To determine the Total Hardness of Water using EDTA Method
6) To determine the Turbidity of Water Sample using Nephelometric Method
7) To determine pH Value of a Given Water Sample
8) To determine the COD of Waste Water Sample by using Close Reflux Method.
9) To determine the COD of Waste Water Sample by using Open Reflux Method

NME- 402 : MANUFACTURING SCIENCE & TECHNOLOGY-I **L T P**

3 1 0

Unit-I

Introduction :
Importance of manufacturing. Economic & technological considerations in manufacturing. Classification of manufacturing processes. Materials & manufacturing processes for common items.

2

Metal Forming Processes :
Elastic & plastic deformation, yield criteria(Mises' and Tresca's). Hot working versus cold working.

2

Analysis (equilibrium equation method) of Forging process for load estimation with sliding friction, sticking friction and mixed condition for slab and disc. Work required for forging, Hand, Power, Drop Forging.

5

Unit-II

Metal Forming Processes (continued):
Analysis of Wire/strip drawing and maximum-reduction, Tube drawing, Extrusion and its application.

3

Condition for Rolling force and power in rolling. Rolling mills & rolled-sections.

2

Design, lubrication and defects in metal forming processes.

2

Unit-III

Sheet Metal working :
Presses and their classification, Die & punch assembly and press work methods and processes. Cutting/Punching mechanism, Blanking vs. Piercing. Compound vs. Progressive die. Flat-face vs Inclined-face punch and Load(capacity) needed.

4

Analysis of forming process like cup/deep drawing. Bending & spring-back.

3

Unit-IV

Casting (Foundry)
Basic principle & survey of casting processes. Types of patterns and allowances. Types and properties of moulding sand, sand testing. Elements of mould and design considerations, Gating, Riser, Runnes, Core. Solidification of casting,. Sand casting, defects & remedies and inspection. Cupola furnace.

7

Die Casting, Centrifugal casting, Investment casting, Continuous casting, CO_2 casting and Stir casting etc.

3

Unit-V

Unconventional Metal forming processes :
Unconventional metal forming or High Energy Rate Forming (HERF) processes such as explosive forming, electromagnetic, electro-hydraulic forming.

2

Powder Metallurgy :
Introduction to Powder metallurgy manufacturing process. Application and, advantages.

1

Jigs & Fixtures :
Locating & Clamping devices & principles. Jigs and Fixtures and its applications.

2

Manufacturing of Plastic components :

Review of plastics, and its past, present & future uses. Injection moulding. Extrusion of plastic section. Welding of plastics. Future of plastic & its applications. Resins & Adhesives.

2

Books and References :

1. Manufacturing Science by Ghosh and Mallik
2. Production Engg. Science by P.C. Pandey
3. Manufacturing Engineering & Technology by Kalpakjian, Pearson
4. Manufacturing Technology by P.N. Rao., TMH
5. Manufacturing Processes by Shan, Pearson.
6. Manufacturing Processes foe Engineering materials by Kalpakjian, Pearson
7. Materials and Manufacturing by Paul Degarmo.
8. Manufacturing Processes by Kaushish , PHI
9. Principles of Foundry Technology, Jain, TMH
10. Production Technology by R.K. Jain

NCH402: HEAT TRANSFER (3:1:0)

UNIT 1

Introduction to heat transfer and general concepts of heat transfer by conduction, convection and radiation. Few industrial applications of these phenomenon. Conduction: Basic concepts of conduction in solids, liquids, gases, steady state temperature fields and one dimensional conduction without heat generation through plain walls, cylindrical and spherical surfaces and composite layers. Insulation materials, forms of insulation, critical and optimum insulation thickness. Extended surfaces and types of fins and their applications. Introduction to unsteady state heat transfer.

UNIT 2

Convection: Fundamentals of convection, Basic concepts and definitions, natural and forced convection, hydrodynamic and thermal boundary layers, dimensional analysis and its utility in convective heat transfer coefficients, laminar and turbulent heat transfer coefficients inside and outside tubes, determination of individual and overall heat transfer coefficients, heat transfer in molten metals.

UNIT 3

Condensation heat transfer: Condensation of pure vapours, film wise and drop wise condensation, loading in condensers, types of condensers, basic calculation on condensers.
Boiling heat transfer: Heat transfer in boiling liquids, boiling heat transfer coefficients, types of reboilers.

UNIT 4

Evaporation: Elementary principles, types of evaporators, Single and multiple effect evaporators and their calculations.
Radiation: Basic laws of heat transfer by radiation, black body and gray body concepts, view factors, Kirchhoff's law, solar radiations, combined heat transfer coefficients by convection and radiation.

UNIT 5

Heat transfer equipment: Classification, different heat exchangers i.e., double pipe, shell and tube, finned tube, design criteria and preliminary sizing of different heat exchangers including multi-pass shell and tube type, classification of furnaces and application.

Books:

1. McCabe, W. L., Smith, J.C., Harriott, P. "Unit Operations of Chemical Engineering ", McGraw - Hill
2. Holman, J. P., "Heat Transfer", McGraw-Hill.
3. Coulson, J. M. & Richardson, J. F., "Chemical Engineering: Vol-1", Butterworth – Heinemann
4. McAdams, W. H., "Heat Transmission", McGraw - Hill.
5. Kern, D. Q., "Process Heat Transfer", McGraw-Hill.
6. Badger, W. L. & Bancharo, J. T., "Introduction to Chemical Engineering", Tata McGraw Hill.
7. Rudramoorthy, R. & Mayilsamy, K. "Heat and Mass Transfer". Pearson.

NCH403: MASS TRANSFER – I (3:1:0)

UNIT 1

Diffusion: Molecular and turbulent diffusion, diffusion coefficient, Fick's Law of diffusion,
Dependence of diffusion coefficient on temperature, pressure and composition; measurement and estimation of diffusivity. Diffusion in multi-component gas mixtures. Diffusion in Solids: molecular, Knudsen & surface diffusion; Inter- phase mass transfer: Mass transfer coefficients, Diffusion between phases, Equilibrium solubility of gases in liquids, Mass transfer theories, Mass transfer in fluidized beds, Simultaneous heat and mass transfer.

UNIT 2

Absorption & Stripping: Equipments, Gas-liquid equilibria, Henry's law, Selection of solvent, Absorption in tray column, Graphical and analytical methods, Absorption in packed columns, HTU, NTU & HETP concepts, Design equations for packed column, Absorption with chemical reaction and mass transfer.

UNIT 3

Humidification & Dehumidification: Vapour liquid equilibrium and enthalpy for a pure substance, vapour pressure temperature curve, Vapour gas mixtures, Definition and derivations of relationships related with humidity Fundamental concept of humidification, Dehumidification and water cooling, Wet bulb temperature, Adiabatic and non-adiabatic operations, Evaporative cooling ,Classification and design of cooling towers.

UNIT 4

Drying: Solid-gas equilibria, Different modes of drying operations, Definitions of moisture contents, Types of batch and continuous dryers, Rate of batch drying, Time of drying, Mechanism of batch drying, Continuous drying, Design of continuous dryers.

UNIT 5

Crystallisation: Equilibrium Yield of Crystallization, Heat and Mass Transfer rates in crystallization, Theories of crystallization, Factors governing nucleation and crystal growth rates,
Controlled growth of crystal, Classification and design of crystallizers.

Text Books:

1. Treybal, R "Mass Transfer Operations", 3rd ed. New York: McGraw-Hill, (1980).
2. Sherwood T. K., Pigford R. L. and Wilke P. "Mass Transfer" McGraw Hill (1975)
3. Foust A. S. et. al., "Principles of Unit Operations" John Wiley (1980).
4. Geankoplis, C. J.. "Transport Processes and Unit Operations", 3rd ed. Prentice Hall. (1993)
5. Richardson & Colson, Volumes - I, II, IV, V
6. Sinha A. P. & Parameswar De "Mass Transfer Principles and Operations" PHI New Delhi

NCH401: THERMODYNAMICS – I (2:1:0)

UNIT 1

Fundamental concepts in Thermodynamics: Heat and Work, the First Law of Thermodynamics, Joule's Experiment, Internal Energy, State Functions, Enthalpy, Steady – State, Steady – Flow processes, Equilibrium and the Phase rule, Reversible processes, Processes at Constant Volume and Constant Pressure, Heat Capacities, Thermodynamic Analysis of Control Volume, Unsteady Flow Processes, Charging and Discharging of Vessel.

UNIT 2

Volumetric properties of pure fluids, P-V-T diagrams, Ideal gas, Virial equations and its Applications, Cubic Equations of State, Generalized Correlations for Gases and Liquids.

UNIT 3

Thermal effects: Sensible Heat and Latent Heat. Standard Heat of Formation, Heat of Reaction and Heat of Combustion, Effect of the Temperature on the Heat of Reaction, the Second Law of Thermodynamics, Statement of the Second Law, Heat Engines, Carnot Cycle, Thermodynamic Scale of Temperatures, Entropy, the Third Law of Thermodynamics.

UNIT 4

Thermodynamic Properties of Pure Fluids, Maxwell's Equations, Helmholtz and Gibbs Functions. Residual Properties. Two - Phase Systems, Tables and Diagrams of Thermodynamic Properties of Gases and Liquids.

UNIT 5

Cycles for Conversion of Heat into Power, Refrigeration and Liquefaction, Absorption Refrigeration, Rankine Cycle, Otto cycle, Diesel cycle, Gas Turbine Engine, Rocket Engine, Multistage Compression.

Books:

1. Smith, J. M.; "Introduction to chemical engineering thermodynamics" Tata McGraw Hill, New Delhi
2. Cengel, Yunus A. & Boles Michael A., "Thermodynamics An Engineering Approach." McGraw Hill.
3. Koretsky, Millo D., "Engineering and Chemical Thermodynamics" John Wiley & Sons (2004)
4. Pradeep Ahuja "Chemical Engineering Thermodynamics" PHI New Delhi

NME452: **MANUFACTURING SCIENCE - I LAB (0:0:3)**

Experiments: Say minimum 8 experiments out of following (or such experiment)

1. Design of pattern for a desired casting (containing hole)
2. Pattern making
3. Making a mould (with core) and casting.
4. Sand testings (at least one such as grain fineness number determination)
5. Injection moulding with plastics
6. Forging hand forging processes
7. Forging - power hammer study & operation
8. Tube bending with the use of sand and on tube bending m/c.
9. Press work experiment such as blanking/piercing, washer, making etc.
10. Wire drawing/extrusion on soft material.
11. Rolling-experiment.
12. Bending & spring back.
13. Powder metallurgy experiment.
14. Jigs & Fixture experiment.
15. Any other suitable experiment on manufacturing science / process / technique.

NCH452: HEAT TRANSFER OPERATIONS LAB (0:0:3)

Experiments can be planned as per the following list;

1. To study heat transfer through lagged pipe.
2. To find out the thermal conductivity of liquid.
3. To study heat transfer in composite wall and find equivalent thermal conductivity.
4. To find out the convective heat transfer co-efficient of vertical cylinder in natural convection.
5. To determine convective heat transfer coefficient in forced convection.
6. To find out the overall heat transfer co-efficient of a double pipe heat exchanger.
7. To find out the overall heat transfer co-efficient of 1-2 shell & tube heat exchanger.
8. To study the heat transfer coefficient during drop wise and film wise condensation.
9. To study the heat transfer coefficient in a vertical and a horizontal condenser.
10. To find out the emissivity of a surface.
11. To find out the Stefan-boltzman constant and compare with the theoretical value.
12. Study and operation of a batch evaporator.

NCH453: MASS TRANSFER OPERATIONS I LAB (0:0:2)

1. Determination of diffusivity of acetone in air.
2. Determination of mass transfer coefficient in an agitated vessel.
3. Determination of mass transfer coefficient for steady state surface evaporation of water at different temperature.
4. Determination of mass transfer coefficient in a wetted wall column.
5. Determination of T-x-y diagram for a binary batch distillation.
6. Verification of *Rayleigh equation* in a binary batch distillation process.
7. Verification of steam distillation equations.

NCH454: ANALYTICAL METHODS LAB (0:0:2)

1. To determine the available chlorine in bleaching powder by Idometric titration method.
2. To determine the vitamin C table by Idometric titration method.
3. To determine the amount of nitrite in wastewater by Spectrophotometric method.
4. To determine the amount of sulphate in the sample by Nephlometric method.
5. To determine the % manganese dioxide in pyrolusite by Redox Titration method.
6. To determine the % of sodium hydroxide and sodium carbonate in the commercial caustic soda by Acid-Base Titration method.
7. To determine the amount of dissolved oxygen in waste water by Idometric Titration method.
8. To determine total, temporary (carbonate) and permanent (non carbonate) hardness of water sample by complex metric titration (EDTA) method.
9. To determine the amount of glucose in the given sample by Di-nitrosaliclic Acid reagent (DNS) method.
10. To determine the point of zero charge of activated by solid addition method.
11. To determine the Fe^{3+} content in given waste water sample.
12. To determine the Cr^{6+} content in given waste water sample.
13. To determine K_La (volumetric mass transfer coefficient) of O_2 in given waste water sample.
14. To determine COD, BOD in given waste water sample