Malaviya National Institute of Technology Jaipur

Curriculum of B.Tech. Chemical Engineering

B.Tech III Semester Chemical Engineering

S.No.	Course Code	Course Title	Category	Type	Credit	L	T	P
1.	CHT-201	Chemical Process Calculations	PC	Theory	4	3	1	0
2.	CHT-203	Momentum Transfer Operations	PC	Theory	4	3	1	0
3.	CHT-205	Chemical Engineering Thermodynamics-I	PC	Theory	4	3	1	0
4.	CHT-207	Energy Resources Utilization	PC	Theory	3	3	0	0
5.	CHT-209	Process Instrumentation	PC	Theory	2	2	0	0
6.	CHT-211	Numerical Methods in Chemical Engineering	PC	Theory	2	2	0	0
1.	CHP-213	Momentum Transfer Operations Lab	PC	Lab	2	0	0	3
2.	CHP-215	Numerical Methods in Chemical Engineering Lab	PC	Lab	2	0	0	3
3.	CHP-217	Simulation Lab	PC	Lab	2	0	0	3
Total					**25**	**16**	**3**	**9**

Syllabus

SEMESTER – III

UG
Course Code: **CHT201**
Credit: **4**
Version: **1**
Prerequisite Course: **Nil**

Department: **Chemical Engineering**
Course Name: **Chemical Process Calculations**
L-T-P: **3-1-0**
Approved on:

Introduction to Chemical Engineering Calculations: Units and dimensions, the mole unit, conventions in methods of analysis and measurement, basis, temperature, pressure, the chemical equation and stoichiometry.

Gases, Vapours, Liquids and Solids: Ideal gas law calculations, real gas relationships, vapour pressure and liquids, saturation, partial saturation and humidity, introduction to vapour-liquid equilibria for multi-component systems, material balances involving condensation and vaporization.

Material Balances: Material balance of physical processes with and without chemical reaction, including recycle, purge and bypass.

Energy Balances: Concept and Units, calculation of enthalpy changes, general balance with and without reactions, heats of solution and mixing.

Unsteady-state material and energy balances.

Solids, liquids and gaseous fuels, some industrial examples of the above, simple estimation of physical properties (transport, thermodynamic) of fluids and mixtures.

Books

Himmelblau, D. M., "*Basic Principles and Calculations in Chemical Engineering*," 6th ed., Prentice-Hall of India.

Bhatt and Vora, "*Stoichiometry*," 3rd ed., Tata McGraw-Hill, New Delhi.

Hougen, Watson and Ragatz, "*Chemical Process Principles*," Vol. 1, Asia Publishing House, New Delhi.

Saha, S. N., "*Fundamentals of Chemical Engineering*," Dhanpat Rai Publishing Co., New Delhi, 2000.

UG Department: **Chemical Engineering**
Course Code: **CHT203** Course Name: **Momentum Transfer Operations**
Credit: **4** L-T-P: **3-1-0**
Version: **1** Approved on:
Prerequisite Course: **Nil**

Continuity equation for compressible and incompressible fluids. Bernoulli's equation, Euler's equation, introduction to Navier-Stokes equation.

Types of flows, steady and unsteady, laminar and turbulent flows; Relationship between shear stress and pressure gradient, Hagen-Poiseuille equation. Prandtl's mixing length theory and eddy diffusivity losses in pipes and fittings, Darcy-Weisbach equation for frictional head loss, Moody diagram. Flow through packed and fluidized beds.

Velocity Profile and boundary layer calculations for turbulent flow.

Pumps and compressors for handling different fluids, types, NPSH and characteristics of centrifugal pumps. Valves, pipe fittings and their standards. Power requirement for flow. Pipe layout and economical pipe diameter.

Flow measuring devices such as orifice meter, venturimeter, rotameter, anemometer, etc.

Vacuum producing devices.

Introduction to Newtonian and non-Newtonian flow.

Books

1. Streeter, V. L. and Wylie, "Fluid Mechanics," 8th ed., McGraw-Hill, New York, 1985.
2. Gupta, S. K., "Momentum Transfer Operations," Tata McGraw-Hill.
3. Coulson, J. M. and Richardson, J. F., "Chemical Engineering," Vol. 1, Asian books, New Delhi.
4. McCabe, W.L., Smith, J.C., and Harriott, P., "Unit Operations of Chemical Engineering", 6th ed., McGraw Hill, 2001.

UG   Department: **Chemical Engineering**
Course Code: **CHT205**   Course Name: **Chemical Engineering Thermodynamics-I**
Credit: **4**   L-T-P: **3-1-0**
Version: **1**   Approved on:
Prerequisite Course: **Nil**

Introduction: Definitions and Concepts: System, Surroundings, Property, Energy, Work, Thermodynamic equilibrium, stability of equilibrium states.

Zeroth Law of Thermodynamics, Perfect gas scale.

First Law of Thermodynamics: First law of Thermodynamics and Its Applications, First law analysis of processes, Control mass and control volume analysis, Steady state and Transient state flow processes

Volumetric Properties of Pure Fluids: PVT behavior of pure substances, virial equation and its applications, cubic equations of state, generalized correlations for gases and liquids.

Heat Effects: Sensible heat effects, heat effects accompanying phase changes of pure substances, standard heats of reaction, formation and combustion, effect of temperature on the standard heat of reaction.

Second law of Thermodynamics: Limitation of First Law, Kelvin-Planck and Clausius Statements, Reversible and Irreversible Processes, Carnot cycle, Entropy, Second Law analysis of a control volume.

Books

1. Smith, J. M., Van Ness, H. C. and Abbott, M. M*., "Introduction to Chemical Engineering Thermodynamics"*, 6th Ed., McGraw-Hill, 2001.
2. Rao, Y. V. C., "*An Introduction to Thermodynamics,*" John Wiley, 1993.
3. Kyle, B.G., "Chemical and Process Thermodynamics", 3rd ed., PHI New Delhi

UG   Department: **Chemical Engineering**
Course Code: **CHT207**   Course Name: **Energy Resources Utilization**
Credit: **3**   L-T-P: **3-0-0**
Version: **1**   Approved on:
Prerequisite Course: **Nil**

Introduction: Synthetic fuels and their manufacture, Introduction and Classification of Fuels, Fundamentals, Units and their conversions, Properties of coal, oil shale, and Tar Sands.
Solid Fuels: Wood, Wood charcoal and Peat. Origin, Composition, Characteristics, and Significance of constituents of coal, Petrography of coal, Washing of coal, Storage of coal. Pulverised fuel/coal, Uses of coal, Comparison of Solid, Liquid, and Gaseous fuels. Selection of coal, Mineral matters in coal ash, and clinker formation; Properties and Testing of coal, Classification of coal, Carbonisation of Coal-coke making and Byproducts recovery, Characteristics and distribution of Indian coals, Briquetting of Solid fuels/Coal.
Liquid Fuels/Petroleum Refining: Origin, Composition, Classification, and Constituents of Petroleum: Indian crudes. Processing of Crude oil: Distillation, Cracking – Thermal and Catalytic, Reforming - Thermal and Catalytic, Polymerisation, Alkylation, and Isomerisation. Purification of Petroleum products, Antiknock value and Requisites of good quality gasoline, Diesel and fuel oil, Liquid fuels from Coal by hydrogenation/ liquefaction, Other liquid fuels – Benzol, Shale oil, alcohol, and Colloidal fuels. Storage and Handling of Liquid Fuels/Fuel oils
Gaseous Fuels: Methane, Wood gas, Gobar gas, Sewage gas, Gas from underground gasification of coal, Natural gas, LPG, Refinery gases, Producer gas, and Water gas.
Furnaces: Introduction, Waste heat recovery in furnaces, Classification of furnaces.
Nuclear Fuels and their Utilization: Introduction, nuclear fuel resources in India, Nuclear reactors- introduction. Classification of nuclear reactors, Types of nuclear reactors.

Books
1. Gupta, O.P., "*Fuels, Furnaces & Refractories*", Khanna Publishers, Delhi, 2000.
2. Probstein, R. F. and Hicks, R. E., "*Synthetic Fuels*," McGraw Hill, NY, 1985.
3. Sarkar, S., "*Fuels and Combustion*," 2nd ed., Orient Longman, Bombay, 1990.

UG   Department: **Chemical Engineering**
Course Code: **CHT209**   Course Name: **Process Instrumentation**
Credit: **2**   L-T-P: **2-0-0**
Version: **1**   Approved on:
Prerequisite Course: **Nil**

Introduction to Instruments and Their Representation: Application of instrument systems, functional elements of a measurement system, classification of instruments, standards and calibration.

Temperature Measurement: Temperature Scales, temperature measuring instruments: liquid in glass thermometer, bimetallic thermometer, resistance temperature detectors (RTD), thermocouples, pyrometry.

Pressure Measurement: Measurement of moderate pressure, high pressure and low pressure (vacuum), calibration and standardization.

Flow Measurement: Positive displacement meters, variable head meters, variable area meters (rotameters), weirs and notches, pitot tube, electromagnetic flow meter, hot wire anemometer, ultrasonic flow meters, laser Doppler anemometer.

Miscellaneous Measurements: Liquid level, pH, viscosity, conductivity, humidity, gas composition,   and nuclear radiation.

Static and Dynamic characteristics of instruments: Errors and uncertainties in performance parameters, propagation of uncertainties in compound quantities, static performance parameters, formulation of system equations, dynamic response, compensation.

Transducers.

Building blocks of an instrument.

Control centre, Instrumentation diagram, On line instrumentation in modern plants.

Introduction and use of Labview Software

Books

1. Eckman, D. P., "*Industrial Instrumentation*," Wiley Eastern , 1978.
2. Nakra, B.C. and Chaudhry, K.K., "*Instrumentation, Measurement and Analysis,*" 2nd ed., Tata McGraw Hill, New Delhi, 2004.
3. Patranabis, D., "*Principles of Industrial Instrumentation,*" Tata McGraw Hill, New Delhi, 1999.
4. Lipták, B.G., "*Instrument Engineers' Handbook: Process Measurement and Analysis*," Vol 1 & 2, CRC Press, 2003.
5. Andrew, W. G., et al., "*Applied Instrumentation in the Process Industries,*" Gulf Pub. 1993.
6. Wightman, E. J., "*Instrumentation in Process Control*," Butterworths, 1972.
7. Doebelin, E., "*Measurement Systems: Applications and Design*," 4th ed., McGraw-Hill, 1990.

UG   Department: **Chemical Engineering**
Course Code: **CHT211**   Course Name: **Numerical Methods in Chemical Engineering**
Credit: **2**   L-T-P: **2-0-0**
Version: **1**   Approved on:
Prerequisite Course: **Nil**

Linear Algebraic Equations: Introduction, Gauss-Elimination, Gauss-Siedel and LU Decomposition methods, Thomas' algorithm.

Eigen Values and Eigen Vectors of Matrices: Introduction, Fadeev-Leverrier's method, Power method, Householder's and Givens' method.

Nonlinear Algebraic Equations: Single variable and multivariable successive substitution method, single variable and multivariable Newton-Raphson technique, Polynomial root finding methods.

Function Approximation: Least squares curve fit, Newton's interpolation formulae, Lagrangian interpolation, Pade approximation, Cubic spline approximation. Integration formulae: Trapezoidal rule, Simpson's rule.

Ordinary Differential Equations - Initial Value Problems: Explicit Adams-Bashforth technique, Implicit Adams-Moulton technique, Predictor-corrector technique, Runge-Kutta methods, Stability of algorithms.

Ordinary Differential Equations - Boundary Value Problems: Finite difference technique, Orthogonal Collocation (OC), Shooting Techniques.

Partial Differential Equations: Partial Differential Equations (PDE) - Classification of PDE, Finite difference technique (Method of lines), Orthogonal collocation.

Case Studies. Use of spreadsheets and MATLAB in Chemical Engineering.

Books

1. Gupta, S. K., "*Numerical Methods for Engineers*," New Age International Ltd., New Delhi, 1995.
2. Constantinides, A., and Mostoufi, N., "Numerical Methods for Chemical Engineers with MATLAB Applications," Prentice Hall, 1999.
3. Hanna, O.T. and Sandall,O.C., *"Computational Methods in Chemical Engineering,"* Prentice-Hall, 1995.
4. Davis, M.E., *"Numerical Methods & Modeling for Chemical Engineers,"* John Wiley, 1984.
5. Press, W. H., Teukolsky, S. A., Vellerling, W. T., Flannery, B. P., "*Numerical Recipes in C*," 2nd ed., Cambridge University Press, New Delhi, 1992.