# ASSAM SCIENCE AND TECHNOLOGY UNIVERSITY
# GUWAHATI

**Course Structure and Syllabus**

**(From Academic Session 2018-19 onwards)**

**B.TECH**

**CHEMICAL ENGINEERING**

**6TH SEMESTER**

# ASSAM SCIENCE AND TECHNOLOGY UNIVERSITY

## Guwahati

### Course Structure

### (From Academic Session 2018-19 onwards)

**B.Tech 6th Semester: Chemical Engineering**

**Semester VI/ B. TECH/ChE**

| Sl. No. | Sub-Code | Subject | Hours per Week | | | Credit | Marks | |
|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | C | CE | ESE |
| **Theory** | | | | | | | | |
| 1 | CHE181601 | Chemical Reaction Engineering-II | 3 | 1 | 2 | 5 | 30 | 70 |
| 2 | CHE181602 | Mass Transfer Operations - II | 3 | 1 | 2 | 5 | 30 | 70 |
| 3 | CHE181603 | Process Control and Instrumentation | 3 | 0 | 2 | 4 | 30 | 70 |
| 4 | CHE181604 | Petroleum Refining and Petrochemicals | 3 | 0 | 2 | 4 | 30 | 70 |
| 5 | CHE1816OE2* | Open Elective-2 | 3 | 0 | 0 | 3 | 30 | 70 |
| 6 | HS181606 | Accountancy | 2 | 0 | 0 | 2 | 30 | 70 |
| **TOTAL** | | | **17** | **2** | **8** | **23** | **180** | **420** |
| Total Contact Hours per week : 27 | | | | | | | | |
| **Total Credits: 23** | | | | | | | | |

| OPEN ELECTIVE – 2 SUBJECTS | | |
|---|---|---|
| **Sl. No** | **Subject Code** | **Subject** |
| 1 | CHE1816OE21 | Alternative Energy Resources |
| 2 | CHE1816OE22 | Fluidization Engineering |
| 3 | CHE1816OE2* | Any other subject offered from time to time with the approval of the University |

**N.B. 4-6 weeks Mandatory Industry Internship need to be done in the 6th semester break and the report is to be submitted and evaluated in 7th semester**

**Detailed Syllabus**

| Course Code | Course Title | Hours per week L-T-P | Credit C |
|---|---|---|---|
| **CHE181601** | **Chemical Reaction Engineering-II** | **3-1-2** | **5** |

**MODULE 1: Design for Multiple Reactions:**
Series and parallel reactions, Series-parallel reactions.

**MODULE 2: Temperature and Pressure Effects:**
Single reactions, multiple reactions.

**MODULE 3: Selection of Reactors**

**MODULE 4: Residence Time Distribution (RTD) for Chemical Reactors:**
Measurement of RTD, Characteristics of RTD, RTD for ideal reactors, Predicting Conversion and Exit Concentration; Reactor Modelling by RTD- Zero Parameter Models.

**MODULE 5: Models for Non Ideal Reactors**
Zero Parameter Models. One Parameter Models- Tanks in Series Model, Dispersion Model; Two Parameter Models- Modelling Real Reactors with Combinations of Ideal Reactors.

**MODULE 6: Gas-solid Catalytic Reactions**
Catalysts, Steps of Catalytic Reaction, Synthesizing Rate Law, Mechanism and Rate Limiting Step; Heterogeneous Data Analysis for Reactor Design.

**MODULE 7: Catalyst Deactivation Practical:**

1. Experiments on CSTR
2. Experiments on PFR
3. Experiments on Cascade CSTR
4. Experiments on Combined Flow Reactor
5. Experiments on Packed Bed Reactor
6. Experiments on Adiabatic Batch Reactor
7. RTD Studies in CSTR
8. RTD Studies of Packed Bed Reactor using pulse tracer input

**Textbooks/ Reference Books:**


1. Chemical Reaction Engineering by Levenspiel, WileyEastern.
2. Elements of Chemical Reaction engineering, Fogler, Prenticehall
3. Chemical Engineering Kinetics by D.M. Smith, McGraw Hill Publication.
4. Reaction Kinetics for Chemical Engineers by Wales, McGraw Hill Publication.

| Course Code | Course Title | Hours per week L-T-P | Credit C |
|---|---|---|---|
| CHE181602 | Mass Transfer Operations-II | 3-1-2 | 5 |

**MODULE 1: Solid-Liquid Extraction**
Classification, Rate of solid – liquid extraction, contacting strategy, contacting equipment, Equilibrium, extraction calculation, super critical extraction.

**MODULE 2: Liquid-Liquid Extraction**
Ternary liquid equilibria, solvent selection, single and multi-stage and cross current extraction, design calculation for stage wise extraction.

**MODULE 3: Distillation**
Introduction - Vapour liquid equilibrium, T-x-y diagram, bubble and dew point calculation, concept of volatility, deviation from ideality, minimum and maximum boiling azeotrope mixture, enthalpy – concentration diagram.
Flash vaporization, steam distillation, batch distillation, continuous multistage fractionation of binary mixture, multi stage batch distillation with reflux, minimum and total reflux. Tray efficiency, Reboiler types.
McCabe Thiele method, Ponchon Savarit method, Distillation in packed column.

**Practical:**

1. **Crystallization:**
To prepare crystals of $CuSO_4.5H_2O$ and compare the amount obtained to that theoretically obtained.

2. **Steam Distillation:**
To find the vapour efficiency of carrier steam and to find the amount of carrier steam required.

3. **Solvent Extraction:**
To study solid-liquid extraction process and to plot $N_E$ vs Y and $N_R$ vs X

4. **Ternary Liquid Equilibria:**
To determine the ternary equilibrium data for the system Benzene – Water – Acetic acid system and to plot the data on a triangular graph paper.

5. **Differential Distillation:**
To verify Rayleigh equation by carrying out a differential distillation of a mixture of Toluene and Carbon Tetrachloride.

6. **Drying:**
To obtain dry in grate vs moisture per unit dry solid and moisture content vs. time curve for a given sample.

7. **Absorption with chemical reaction in a packed bed ($CO_2$ absorption NaOH solution):**
To study absorption of $CO_2$ in aqueous NaOH solution in a Packed bed column. To determine the gas phase mass transfer co efficient, $K_Ga$.

**8. Binary distillation in a bubble cap column:**

(i) To operate the column under total reflux condition and estimate the minimum number of theoretical plates required. (ii) To obtain T-x data under total reflux at steady state and compare it with theoretical value. (iii)To estimate total moles of product and time for distillation at particular reflux ratio for a known number of theoretical plates.

**Textbooks/ Reference Books:**


1. Treybal, R.E.," Mass Transfer operation", McGraw Hill International Edition, 3rd Ed,1981.
2. McCabe, W.L., Smith, J, and Harriot, P.," Unit operation of Chemical Engineering", McGraw Hill International Edition, 6th Ed,2001.
3. Geankoplis, C.J., "Transport Process and Unit Operations", Prentice Hall 3rd Ed, India,1993
4. Dutta, B.K., "Principles of Mass Transfer and Separation Processes", Prentice Hall, India,2007.
5. Seader, J.D., Henley, J. E., Separation Process Principles" 2nd Ed, Wiley India edition,2010

| Course Code | Course Title | Hours per week L-T-P | Credit C |
|---|---|---|---|
| CHE181603 | Process Control and Instrumentation | 3-0-2 | 4 |

**MODULE 1:**
Incentive for chemical process control, Process variables, Design elements of a control system, Liquid surge tank, Blending process.

**MODULE 2:**
Development of a Mathematical model, Example of modelling of a stirred tank heater, Input -Output models, Degrees of freedom, Linearization of a non-linear model, Elements of Instrumentation, Steady state and dynamic behavior of instrumentation.

**MODULE 3:**
Solving algebraic equations and integration of ODEs, Laplace Transform, Laplace Transform of derivatives, Response of First order process, Significance of First order process, second order process, features of process response, Interacting and non-interacting processes, Poles and zeroes, Higher order systems.

**MODULE 4:**
Introduction of feedback control, Elements of control loop, Concept of servo and regulatory problems, Types of controller P, PI, PID, on-off, Stability of a closed loop process, Stability analysis, Ziegler Nichols tuning, Bode stability criterion.

**MODULE 5:**
Large dead time, Dead time compensation, Cascade control, Split range control, Feed forward control, Ratio control, Adaptive control, Digital computer control.

**MODULE 6:**
Self-operated, Pneumatic, Hydraulic, Electric Power employed, Actuators, Sensors.

**MODULE 7:**

Measuring Devices for flow, temperature, pressure and level, $P^H$ meter, Spectroscopic methods, colorimetry.

**MODULE 8:**
Instrumentation symbols, Introduction to Process Flow Diagram and Piping & Instrumentation Diagram (P&ID)

**MODULE 9:**
Introduction to Advance control system(ACS) and Distributed control system (DCS)

**Practical**

1. Determination of time constant of a first order system
2. Determine the response of first and second order instruments
3. Determination of unknown concentration using spectrophotometer
4. Study of conductivity meter & pH meter
5. Study of dynamic response of single and multi-capacity processes when connected in interacting

and non-interacting mode

6. Study of steady state and transient response to P, PI, PD, PID control systems
7. Study of characteristics of control valve
8. Study of flow control trainer

**Text Books / Reference Books:**


1. D. P. Eckman 'Automatic Process Control'.
2. George Stephanopoulos, 'Chemical Process Control'.
3. Coughanuer & Koppel, 'Process System Analysis & Control' -McGraw Hill Publication.
4. A. Suryanarayana, Instrumentation & Process Control, Khanna Publishers, New Delhi
5. W. Bolton, 'Industrial Control and Instrumentation'
6. Peter Harriat, 'Process Control'-McGraw Hill Chemical Engineering Series
7. D. Patranabis, Principles of Industrial Instrumentation

| Course Code | Course Title | Hours per week L-T-P | Credit C |
|---|---|---|---|
| CHE181604 | Petroleum Refining and Petrochemicals | 3-0-2 | 4 |

**MODULE 1: Primary Processing of Crude Oil**
Composition, Classification and evaluation of crude oil, Petroleum products and testing. Dehydration and desalting. Atmospheric distillation. Vacuum distillation of residue-products and distillation practices, Pipe still heater design procedures.

**MODULE 2: Secondary Processing of Crude Oil**
Thermal cracking, Visbreaking, Coking, Catalytic Reforming process, Alkylation and Isomerisation. FCCU and Hydro cracking process, Residue processing (upgradation).

**MODULE 3: Treatment-Techniques**
Upgradation techniques for heavy and waxy oils, Treatment techniques for removal of objectionable gases. Odours to improve performance. Catalytic Desulphurization. Extraction of aromatics, Olefins and recovery operations from petroleum products, Solvent Deasphalting (SDA).

**MODULE 4: Petrochemicals**
Chemicals from Natural and synthesis gas, Chemicals from olefins; Ethylene derivatives, Propylene derivatives and Butylene derivatives, Aromatics, intermediates for synthetic fibers and Plastics.

**MODULE 5: Environmental and Safety Aspects in Refinery and Petrochemicals**
Waste water and effluent gases treatment from Refinery and petrochemical units. Safely aspects in Refinery and petrochemical units.

**MODULE 6:**
Recent advances in Refinery and Petrochemical sectors- (To be taught by Oil & Gas Specialist); Sludge handling.

**Practical:**

1. Determination of Smoke Point of kerosene fraction
2. Determination of Aniline Point & diesel index of Fuel.
3. Penetration Index & softening point of bitumen.
4. ASTM Distillation.
5. Water content by Dean & Stark method.

**Text Books / Reference Books:**


1. W.L. Nelson, "Petroleum Refinery Engineering"' Edn. McGraw Hill, New York1985
2. B. K. Bhaskara Rao, "Modem Petroleum Refining Processes", 2nd' Edn., Oxford and IBH Publishing Company, New Delhi,1990.
3. G.D.Hobsonand W.Pohl.,"ModemPetroleumTechnology",GulfPublishers2nd.Edn.,1990.
4. R. A. Meyers, "Hand book of Petroleum Refining Processes", McGraw Hill, 1st Edn.,1980.
5. F. Hatch md Sumi Malar, "From Hydrocarbons to Petrochemicals", Gulf Publishing Company, 1st Edn.1981.

| Course Code | Course Title | Hours per week L-T-P | Credit C |
|---|---|---|---|
| **CHE1816OE21** | **Alternative Energy Resources** | **3-0-0** | **3** |

**MODULE 1: Energy Crisis**
Present position in India and World. Remedial measures.

**MODULE 2: Energy Resources**
Survey, classification and scope of utilization, Alternative uses of conventional sources of energy, Synthetic liquid fuels.

**MODULE 3: Hydroelectricity**
Small hydropower- [its production and future prospects in India.

**MODULE 4: Nuclear Energy**
Nuclear reaction, materials and reactors, reprocessing of spent nuclear fuels.

**MODULE 5: Solar Energy**
Solar Energy and its effective utilization for room and water heating and other industrial processes, Solar Heat Pump, Silicon cells, storage of solar energy.

**MODULE 6: Energy from Biomass**
Animal and vegetable wastes, Utilization of Municipal Solid Waste as a renewable source of energy.

**MODULE 7: Geothermal, Wind and Tidal Energy**
Energy from geothermal, tidal and ocean thermal sources, Energy from high velocity winds and high pressure gases.

**MODULE 8:** Developments in energy routes, Fuel cells. Energy carriers**.**

**MODULE 9:** Conservation of energy, Energy Audit.

**Textbooks / Reference Books:**


1. Renewable Energy Resources and their Environmental Impact, S A abbasi and Naseemaabbasi, Prentice Hall India
2. Solar Energy: Principles of Thermal Collection and Storage, S. P. Sukhatme, McGraw-Hill.
3. Energy Resource, Demand and Conservation in India, C. Kashkari, TataMcGraw-Hill.
4. Energy Resources and Economic Development in India, Tyner, Allied Publishers.
5. Principles of Energy Conservation, Jr. Culp, McGraw-Hill.
6. Fuels and Combustion, S. Sarkar, Orient Longman.
7. Fuel Combustion Energy Technology, S N Saha, Dhanpat Rai Publishing Company
8. Non-Conventional Energy Resources, Third edition, B.H. khan, McGraw-Hill Education (India) Private limited.

| Course Code | Course Title | Hours per week L-T-P | Credit C |
|---|---|---|---|
| **CHE1816OE22** | **Fluidization Engineering** | **3-0-0** | **3** |

**MODULE 1: Introduction and Applications**
Introduction to Fluidized bed systems. Fundamentals of fluidization. Industrial applications of fluidized beds - Physical operations. Synthesis reaction, cracking and reforming of hydrocarbons. Gasification, Carbonization, Gas - solid reactions, calcining and clinkering.

**MODULE 2: Gross Behavior of Fluidized Bed**
Gross behavior of fluidized bed. Minimum and terminal velocities in fluidized beds. Types of fluidization. Mapping of fluidization regimes, Design of distributors. Voidagein fluidized beds. TDH, variation in size distribution with height, Power consumption.

**MODULE 3: Analysis of Bubble and Emulsion Phase**
Davidson's model. Frequency measurements, bubbles in ordinary bubbling bed. Flow model in bubbling bed. Emulsion phase: Experimental findings. Bubbling bed model for emulsion phase.

**MODULE 4: Flow Pattern of Gas in Fluidized Beds**
Flow pattern of gas through fluidized beds. Experimental findings. The bubbling bed model for gas inter change.

**MODULE 5: Entrainment**
Entrainment of or above TDH, model for Entrainment and application of the entrainment model to elutriation.

**Textbooks / Reference Books:**

1. D. Kunii and O. Levenspiel, 'Fluidisation Engineering " 2nd. Edn., John Wiley& Sons, 1992.

| Course Code | Course Title | Hours per week L-T-P | Credit C |
|---|---|---|---|
| **HS181606** | **Accountancy** | **2-0-0** | **2** |

**MODULE 1:**
Concept and classification of Accounts, Transaction, Double Entry system of Book Keeping, Golden rules of Debit and Credit, Journal- Definition, advantages, Procedure of Journalising, Ledger, advantages, rules regarding Posting, Balancing of Ledger accounts, Trial Balance- Definition, objectives, procedure of preparation.

**MODULE 2:**
Name of Subsidiary Books, Cash Book-definition, advantages, objectives, types of Cash Book, preparation of different types of cash books, Bank Reconciliation Statement, Regions of disagreement between Cash Book with Pass Book balance, preparation of Bank Reconciliation Statement

**MODULE 3:**
Final Account: Preparation of Trading Account, Profil and Loss Account with adjustments.

**MODULE 4:**
Concept of Capital Expenditure and revenue Expenditure, Baddebts, Provision for Bad and Doubtful debts, Provision for discount on Debtors, Outstanding expenses, Prepaid expenses, Accrued Income

**MODULE 5:**
Introduction to Depreciation Accounting- Meaning, causes, factors, methods of charging depreciation etc.

**Textbooks/Reference Books:**


1. Theory and Practice of accountance- KR Das, KM Sinha, KS Pal Choudhury, Dr. A Rahman, PK Pujary
2. Book- Keeping & Accountancy- C Mohan Juneja, J R C Chawla, KK Sakseena
3. Double Entry Book- Keeping & Accountancy- JR Batliboi


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