# *Chhattisgarh Swami Vivekanand Technical University, Bhilai*

## SCHEME OF TEACHING AND EXAMINATION

SEMESTER VI CHEMICAL ENGINEERING

| S. No | Board of Study | Subject Code | Subject | Period per week | | | Scheme of Exam Theory/ Practical | | | Total Marks | Credit L+(T+P) / 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | ESE | CT | TA | | |
| 1 | Chemical | 319611( 19 ) | Chemical Engg. Thermodynamics | 3 | 1 | - | 80 | 20 | 20 | 120 | 4 |
| 2 | Chemical | 319612( 19 ) | Chemical Reaction Engg. | 3 | 1 | - | 80 | 20 | 20 | 120 | 4 |
| 3 | Chemical | 319613( 19 ) | Separation Processes- I | 4 | 1 | - | 80 | 20 | 20 | 120 | 5 |
| 4 | Chemical | 319614( 19 ) | Organic Process Technology | 4 | - | - | 80 | 20 | 20 | 120 | 4 |
| 5 | Chemical | 319615( 19 ) | Process Equipment Design-I | 4 | 1 | - | 80 | 20 | 20 | 120 | 5 |
| 6 | **Refer Table -I** | | Professional Elective-1 | 4 | - | - | 80 | 20 | 20 | 120 | 4 |
| 7 | Chemical | 319621( 19 ) | Chemical Reaction Engg. Lab | - | - | 3 | 40 | - | 20 | 60 | 2 |
| 8 | Chemical | 319622( 19 ) | Separation Processes- I Lab | - | - | 3 | 40 | - | 20 | 60 | 2 |
| 9 | Chemical | 319623( 19 ) | Organic Process Technology Lab | - | - | 3 | 40 | - | 20 | 60 | 2 |
| 10 | Chemical | 319624( 19 ) | Process Equipment Design-I Viva | - | - | 2 | 40 | - | 20 | 60 | 1 |
| 11 | Management | 300625( 36 ) | Managerial Skills | - | - | 2 | - | - | 40 | 40 | 1 |
| 12 | | | Library | - | - | 1 | - | - | - | - | - |
| **Total** | | | | **22** | **4** | **14** | **640** | **120** | **240** | **1000** | **34** |

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L- Lecture T- Tutorial P- Practical ESE- End Semester Exam TA- Teacher's Assessment

**Note: -** Industrial Training of twelve weeks is mandatory for B.E. students. It is to be completed in two equal parts. The first part must have been completed in summer after IV sem. The second part to be completed during summer after VI sem. after which students have to submit a training report which will be evaluated by college teachers during B.E. VII sem.

**Table – I**

| **Professional Elective-1** | | |
|---|---|---|
| **Board of Study** | **Subject Code** | **Subject** |
| Chemical | 319631 ( 19 ) | Optimization Technique |
| Chemical | 319632 ( 19 ) | Membrane Science and Engineering |
| Chemical | 319633 ( 19 ) | Project Engg. |
| Chemical | 319634 ( 19 ) | Process Safety and Hazard Management |

Note (1)- $1/4^{th}$ of total strength of students subject to minimum of 20 students is required to offer an elective in the college in a particular Academic session.

Note (2)- Choice of elective course once made for an examination cannot be change in future examination.

# CHHATTISGARH SWAMI VIVEKANAND TECHNICAL UNIVERSITY, BHILAI (C.G.)

Semester: VI
Subject: Chemical engineering Thermodynamics
Total Theory Periods: 40
Total Marks in End Semester Exam: 80
Minimum number of class tests to be conducted: 02

Branch: Chemical Engineering
Code : 319611 (19)
Total Tutorial Periods: 12

**Unit I** Application of first law of thermodynamics, Batch Flow Process, Steady & Flow, Reversibility Critical Properties Corresponding State , Compressibility Application of second law of thermodynamics, Entropy of Various Processes Pressure Volume and Temperature Relation

**Unit II** Thermodynamics Equations, Joule Thompson Effect. Effect of Pressure on Specific Heat of fluids, Third Law of Thermodynamics, Maxwell's Relation

**Unit III** Thermodynamics Properties Compression. Expansion of Fluid Single And Multistage Power Requirement And Efficiency, Effect of Clearance, Compression of Real Gases.

**Unit IV** Carnot and reversed Carnot cycle, air cycle for refrigeration, bi-fluid refrigerant cycle, cascade system refrigeration Absorption cycle. Application Brayton cycle or Bell coleman air cycle Numerical, Reversed brayton cycle Vapor compression refrigeration cycle. Multistage refrigeration, dry ice.

**Unit V** Chemical equilibrium, Fugacity , Calculation Free Energy, work Function, Free Energy relation ship Condition of Equilibrium; Variation of Energy Numerical Application of Gibbs-Helmotz Equation Temperature Dependence of Free Energy, Chemical Potential in Ideal Gas Mixture, Chemical Equilibrium and its application.

**Name of Text Books**:

(1) J. M. Smith," Chemical Engineering Thermodynamics".
(2) Y. V. C. Rao," Theory Thermodynamics".

**Name of Reference Books:**

(1) Balani," Thermal Engineering".
(2) R. Yadav," Engineering Thermodynamics".
(3) B.F.Dogde ," Introduction to Chemical Engineering Thermodynamics".

# CHHATTISGARH SWAMI VIVEKANAND TECHNICAL UNIVERSITY, BHILAI (C.G.)

Semester: VI
Subject: Chemical Reaction Engineering
Total Theory Periods: 40
Total Marks in End Semester Exam: 80
Minimum number of class tests to be conducted: 02

Branch: Chemical Engineering
Code : 319612 (19)
Total Tutorial Periods: 12

**Unit I** Kinetics and thermodynamics; Chemical Kinetics; Rate theories; Rate Expressions from Mechanism & experiments.

**Unit II** Irreversible Reaction (0, I, II, III, order), Reversible Reaction; Analysis of rate of Reaction; Deferential Method; Integral Method; Least square Method; Half Life Method; Initial Value; Constant volume Method Reaction; Variable Volume Method Reaction; Total Pressure Method; Liquid Phase Reaction; Analysis of Complex Reaction: Series, Parallel, Auto catalytic.

**Unit III** Behavior of Chemical Reactors: Ideal & Non-Ideal Flow; Classification of Reactors: Isothermal, Ideal batch, CSTR, PFR, Multiple Reactors, Non-isothermal Reactors, Multiplicity, Non-ideal reactors, Fluid Solid Non-Catalytic reactions, Fluidized Beds.

**Unit IV** Adsorption; Catalysis & Catalysts; General characteristic Properties; Preparation & characterization of catalysts; Kinetic Models; Reaction & Diffusion in Catalysts; Heterogeneous Catalysis; Heterogeneous Catalytic Reactors.

**Unit V** Catalysts' Deactivation; Fluid-Fluid Heterogeneous reactions; Enhancement Factor. Gas-Liquid Reactors; Multiphase Reactors; Determination of Surface Area Pores Volume; Kinetics of Fluid –Solid Catalyst reaction.

**Name of Text Books**:

1. J.M. Smith "Chemical Engineering Kinetics"
2. Octave Levenspiel "Chemical Reaction Engineering."

**Name of Reference Books:**

1. H.Scott Fogler "Chemical Reaction Engineering."
2. S.D.Dawande, Principles of Reaction Engineering, Central Techno Publications.
3. Coulson and Richardson, Chemical Engineering, Volume IV.

# CHHATTISGARH SWAMI VIVEKANAND TECHNICAL UNIVERSITY, BHILAI (C.G.)

Semester: VI
Subject: Separation Process –I
Total Theory Periods: 50
Total Marks in End Semester Exam: 80

Branch: Chemical Engineering
Code : 319613 (19)
Total Tutorial Periods: 12

**Unit I** Crystallization Principles, Equilibrium relationship, yield of crystals, super saturation curve, crystal growth equipment, application of principles to design

**Unit II** Humidification Equilibria for humidification, Dehumidification, humidity charts and its use , wet bulb temperature and its theory and use in measurements of humidity and calculation of humidity operations , adiabatic humidification equipments.

**Unit III** Drying Principles,equilibrium relationship in drying, Equipment, mechanism and theory of drying, Calculation of drying time.

**Unit IV** Leaching Liquid solid equilibria, Equipment principles of leaching, calculations of no. of ideal stages, plate efficiency

**Unit V** Liquid Liquid Extraction Liquid extraction, liquid liquid equilibria equipment principles of extraction, Ponchon Savorit method, counter current extractions, using reflux applications of McCabe Thiele Method, extraction in packed and spray column.

**Name of Text Books:**

1. McCabe & Smith, Unit operation of chemical engineering.
2. Treybal , Mass transfer operation

**Name of Reference Books:**

1. Badger & Banchero, Introduction to Chemical engineering

# CHHATTISGARH SWAMI VIVEKANAND TECHNICAL UNIVERSITY, BHILAI (C.G.)

Semester: VI
Branch: Chemical Engineering.
Subject: Organic Processe Technology
Code: 319614 (19)
Total Theory Periods: 50
Total Tutorial Periods: Nil
Total Marks in End Semester Exam: 80
Minimum number of class tests to be conducted: 02

A study of some of the unit processes employed in organic industries with regards to their chemistry, Equipment, Process manufacture, flow sheet, economics and present status.

**Unit I** Esterification: by organic acids, operation of esterification column.
Technology of – oil, fats and waxes, soap and detergents industries.

**Unit II** Sulfonaiton and sulfation : Agents, principles, equipments.
Technology – (i) Pulp and Paper.

**Unit III** Nitration: Nitrating agents, liquid and vapor phase nitrations, process Equipments, mixed and preparations.
Technology - Dyes and intermediates.

**Unit IV** Halogenation: Types of halogenation reactions, halogenating agents.
Technology - Pesticides and insecticides

**Unit V** Polymerization Engineering properties of polymers.
Technology - Plastic, Rubber.

**Name of Text Books:**

1. Groggins P.H., Unit processes in organic synthesis
2. Shreve R.N., Austin G.T., Chemical Process Industries

**Name of Reference Books:**

1 M Gopala Rao Dryden's Outlines of Chemical Technology
2. Engineering - P. Chattopadhyay, Unit Operations of Chemical Engineering.
3. Dawande S.D., Introduction to Polymer Science & Technology, Central Techno Publications.

# CHHATTISGARH SWAMI VIVEKANAND TECHNICAL UNIVERSITY, BHILAI (C.G.)

Semester: VI
Subject: Process Equipment Design–I
Total Theory Periods: 50
Total Marks in End Semester Exam: 80
Minimum number of class tests to be conducted: 02

Branch: Chemical Engineering
Code : 319615 (19)
Total Tutorial Periods: 12

**Note:** Use of code book and relevant data book is permitted in the examination.

**Unit I -** General Design considerations, Loads, stresses, welding and joint efficiency, factor of safely, corrosion allowance, theories of failure, compensation for opening in the vessel design, fabrication methods.

**Unit II -** Design of storage vessel – bottom, shell and roof design.

**Unit III-** Design of Heads & Closures (Torrispherical Head, Hemispherical Heads, Elliptical Head, Conical Head) Design of Internal & External Pressure Vessel,

**Unit IV-** Design of Tall Vertical Vessel,

**Unit V -** Design of Flanges, Design of Supports (Skirt support, Bracket support, Lug supports, Saddle Supports)

**Name of Text Books:**

1. M.V.Joshi , Process Equipment Design.
2. B.C.Bhattachrya , Introduction to Chemical Equipment Design.
3. IS Code – 2825 for unfired pressure vessel
4. IS Code – 803 for material specification, storage vessel

**Name of Reference Books:**

1. J.H. Perry, Chemical Engineers Hand book.
2. F.Molyneux : Chemical Plant Design – I (Butterworths , 1963)
3. Brownell & Young, Process Equipment Design.
4. Robin Smith, Chemical Plant Design.
5. Dawande S.D., Process Design of Equipment, 4$^{th}$ Ed., Central Techno Publications.

# CHHATTISGARH SWAMI VIVEKANAND TECHNICAL UNIVERSITY, BHILAI (C.G.)

Semester: VI
Subject: Optimization Techniques
Total Theory Periods: 50
Total Marks in End Semester Exam: 80
Minimum number of class tests to be conducted: 02

Branch: Chemical Engineering
Code: 319631 (19)
Total Tutorial Periods: Nil

**Unit I** Introduction to optimization and its scope in chemical processes: Essential features of optimization problems, General procedure for solving optimization problems. Fitting models to data: Classification of models, How to select and build a model, Method of least squares.

**Unit II** Formulation of objective functions: Investment costs and operating costs in objective functions. Basic concepts of optimization: Continuity of functions, Unimodal vs. multimodal functions, Convex and concave functions, convex region.

**Unit III** Unconstrained single variable optimization: Numerical methods for one dimensional search, Newton, Quasi-Newton and Secant methods, Region elimination methods, Polynomial approximation methods.

**Unit IV** Linear programming: Basic concepts, Degenerate LP problems, Linear constraints, Simplex method, Standard LP form, Duality in linear programming.

**Unit V** Optimization applications: Heat transfer and energy conservation, Separation processes, Fluid flow systems.

**Name of Text Books:**


(1) F.Edgar and D.M.Himmelblau, Optimization of chemical processes
(2) T, McGraw-Hill Book Co.Peter Englezos, Nicolas Kalogerakis, Applied Parameter estimation for Chemical Engineers,


**Name of Reference Books:**


(1) Chapra & Canal, Numerical methods for engineers
(2) S. S. Rao, Optimization

# CHHATTISGARH SWAMI VIVEKANAND TECHNICAL UNIVERSITY, BHILAI (C.G.)

Semester: VI
Subject: Membrane Science and Engineering
Total Theory Periods: 50
Total Marks in End Semester Exam: 80
Minimum number of class tests to be conducted: 02

Branch: Chemical Engineering
Code : 319632 (19)
Total Tutorial Periods: Nil

**Unit I** Introduction, Classification and Type of Membrane. Methods of manufacturing Membranes. Membrane module. Diffusions models.

**Unit II** Reverse Osmosis Mechanism Modules Design and Applications.

**Unit III** Ultra Filtration and Micro Filtration Mechanism Modules Design and Applications

**Unit IV** Ion exchange and Electro Dialysis. Mechanism and Applications

**Unit V** Gas Separation Mechanism Modules Design and Applications

**Name of Text Books:**

1. Coulson & Richardson, Chemical Engineering, Volume 1.
2. James W. Baker, Membrane Separation

**Name of Reference Books:**

1. J H Perry, "Chemical Engineers Hand Book " 3rd Edition
2. McCabe & Smith, Unit Operation of Chemical Engineering.

# CHHATTISGARH SWAMI VIVEKANAND TECHNICAL UNIVERSITY, BHILAI (C.G.)

Semester: B. E. Sixth
Subject: Project Engineering
Total Theory Periods: 50
Total Marks in End Semester Exam: 80
Minimum number of class tests to be conducted: 02

Branch: Chemical Engineering
Code : 319633 (19)
Total Tutorial Periods: Nil

**Unit I** Origin of chemical project; Feasibility studies;

**Unit II** Techno-economic report; Plant location and site selection; Capital cost estimation; Working capital estimation;

**Unit III** Profitability indices, Discounted cash flow, Cost-benefit analysis, Sensitivity analysis

**Unit IV** Process development, Process Selection, Process Design, Utilities, Scale up;

**Unit V** Optimization; Project Construction, Project scheduling, Network analyses; Project report; Plant and Equipment specification. Problem solving by using PERT & CPM technique.

**Name of Text books:**

1. J H Perry, Chemical Engineers Hand Book, 3rd Edition
2. Peter Timmer Hauss, Plant Design and Economics.

**Name of Reference Books:**

1. O.P. Kharbanda, Process plant and Equipment Costing.

# CHHATTISGARH SWAMI VIVEKANAND TECHNICAL UNIVERSITY, BHILAI (C.G.)

Semester: VI
Subject: Process Safety and Hazard Management
Total Theory Periods: 50
Total Marks in End Semester Exam: 80
Minimum number of class tests to be conducted: 02

Branch: Chemical Engineering
Code: 319634 (19)
Total Tutorial Periods: Nil

**Unit I** Introduction: Safety programs, Engineering ethics, Accident and loss statistics, Acceptable risk, Public perceptions, Nature of accidents, Three significant disasters

**Unit II** Toxicology: Effect of toxicants, Toxicological studies, Relative toxicity, Threshold limit values, Industrial hygiene: Government regulations, Identification, evaluation and control, Source models: Flow of liquids and vapors through pipes, flashing liquids, Liquid pool evaporation or boiling.

**Unit III** Fires and explosions, Flammability characteristics of liquids and vapors, Minimum Oxygen Concentration (MOC) and Inerting, Ignition energy, Designs to prevent fires and explosions: controlling static electricity, explosion proof equipments and instruments, Reliefs and rupture disks.

**Unit IV** Hazards identification: Process hazards checklists, Hazard surveys, Hazard and Operability studies (HAZOP), Safety reviews, other methods.

**Unit V** Accident investigations, Learning from accidents, Investigation process, Case studies: static electricity, Chemical reactivity, System designs, procedures.

**Name of Text Books:**

1 D.A.Crowl and J.F.Louvar, Chemical Process Safety: Fundamentals with Applications, Prentice Hall PTR.

1. R.E.Sanders, Chemical Process Safety: Learning from Case Histories, Butterworth-Heinemann.

**Name of Reference Books:**

1. Ralph King and Ronald Hirst, King's Safety in the Process Industries, Wuerz Publishing Ltd., Canada.

**CHHATTISGARH SWAMI VIVEKANAND TECHNICAL UNIVERSITY, BHILAI (C.G.)**

Semester: VI
Branch: Chemical Engg
Subject: Chemical Reaction Engg. Lab
Practical Code: 319621 (19)
Total Practical Periods: 40
Total Marks in End Semester Exam: 40

Experiments to be performed (Minimum 10)

1. Kinetics of Irreversible reaction in Batch Reactor.
2. Kinetics of Reversible reaction in Batch Reactor.
3. Kinetics of Irreversible reaction in Isothermal Plug Flow Reactor.
4. Kinetics of Reversible reaction in Isothermal Plug Flow Reactor.
5. Kinetics of Irreversible reaction in Adiabatic Plug Flow Reactor.
6. Kinetics of Reversible reaction in Adiabatic Plug Flow Reactor.
7. Kinetics of Irreversible reaction in CSTR.
8. Kinetics of Reversible reaction in CSTR.
9. Performance of combined reactor (CSTR+PFR).
10. Performance of combined reactor (PFR+CSTR).
11. Kinetics of Irreversible reaction in Heterogeneous Catalytic reactor.
12. Kinetics of Irreversible reaction in Biochemical Reactor.
13. Study of Residence Time Distribution.
14. **Kinetics of Irreversible reaction in Semi batch Reactor**

**List of Equipments/Machines Required**

(i) Batch Reactor
(ii) Plug Flow Reactor (PFR)
(iii) Adiabatic Reactor
(iv) Mixed Flow Reactor (MFR)
(v) Heterogeneous Catalytic Reactor
(vi) Biochemical Reactor
(vii) Semi batch Reactor

**Recommended Books**:


1. O. Levenspiel , Chemical Reaction Engg.
2. H. Scott Fogler , Chemical Reaction Engg.

# CHHATTISGARH SWAMI VIVEKANAND TECHNICAL UNIVERSITY, BHILAI (C.G.)

Semester: VI Branch: Chemical Engg
Subject: Organic Processe Tech. Lab Practical Code: 319623 (19)
Total Practical Periods: 40
Total Marks in End Semester Exam: 40

Experiments to be performed: (Minimum 10)

1. To determine the Acid Value of given oil sample
2. To determine the Saponification value of given oil sample
3. To determine the % of total fatty material present in given soap.
4. To determine the free alkali content in given soap sample.
5. To determine the Moisture content of the given soap sample
6. To determine the Esterification Value of the given oil sample.
7. Preparation of phenol-Formaldehyde Resin
8. To determine the Iodine value of the given oil sample.
9. Manufacture of Toilet soap
10. Manufacture of Detergent.
11. Manufacture of Phenyl.
12. Manufacture of Paint.
13. Solvent Extraction of oil from oilseed in Sohxlet apparatus.
14. To determine the % of oil in given oil bearing seed sample.
15. Esterification of given sample & determination of % esterification achieved.

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**List of Equipments/Machines Required**

1. Sohxlet apparatus
2. Oven
3. Weighing Balance
4. Hot Plate
5. Water bath
6. Agitator
7. Distillation Unit

**Recommended Books**:


1. Groggings P.H., Unit process in organic synthesis
2. Shreve. G T Austin, Chemical Process Industries.
3. M Gopala Rao, Dryden's Outlines of Chemical Technology
4. Chattopadhyay P.,Unit Operations of Chemical Engg.

**CHHATTISGARH SWAMI VIVEKANAND TECHNICAL UNIVERSITY, BHILAI (C.G.)**

Semester: VI Branch: Chemical Engg.
Subject: Separation Processe I Lab Practical Code: 319622 (19)
Total Practical Periods: 40
Total Marks in End Semester Exam: 40

**Experiments to be performed** (Minimum 10)

(i) To determine the Diffusivity coefficient of Acetone in air by Forced diffusion
(ii) To determine the rectification characteristics of binary liquid system.
(iii) Study of Bubble cap distillation column
(iv) Study of absorption Column
(v) Study of Wetted Wall Column
(vi) Determine the diffusivity of Acetone by forced diffusion
(vii) Determination the diffusivity of Acetone through natural diffusion by Traveling Microscope
(viii) Draw the vapor liquid equilibrium diagram through vapor liquid eqillibria apparatus
(ix) Calculation of relative volatility benzene toluene mixture by steam distillation
(x) Calculation of relative volatility benzene toluene mixture by simple distillation
(xi) Study of the Rayleigh's equations

**List of Equipments/Machines Required**

(i) Bubble cap distillation column
(ii) Absorption Column
(iii) Wetted Wall Column
(iv) Traveling Microscope
(v) Vapor liquid equillibria apparatus
(vi) Refractometer

**Recommended Books:**


1. McCabe & Smith, Unit Operation of Chemical Engineering.
2. Treybal , Mass Transfer Operations
3. Badger & Banchero, Introduction to Chemical Engineering

**CHHATTISGARH SWAMI VIVEKANAND TECHNICAL UNIVERSITY, BHILAI (C.G.)**

Semester: VI
Branch: Chemical Engg.
Subject: Process Equipment Design - I Viva
Practical Code: 319624 (19)
Total Practical Periods: 40
Total Marks in End Semester Exam: 40

Viva- voce examination based on syllabus for Process Equipment Design – I Theory, to be conducted.

# *Chhattisgarh Swami Vivekanand Technical University, Bhilai (C.G.)*

Semester: VI
Subject: Managerial Skills
Total Practical Periods: 28
Total Marks in End Semester Exam: 40
Minimum number of class test to be conducted: 2

Branch: Common to all Branches
Code: 300625 (36)
Total Tut Periods: NIL

**Unit-I**

Managerial Communication Skills: Importance of Business Writing: writing business letters, memorandum, minutes, and reports- informal and formal, legal aspects of business communication, oral communication- presentation, conversation skills, negotiations, and listening skills, how to structure speech and presentation, body language.

**Unit-II**

Managerial skills: Leadership: Characteristics of leader, how to develop leadership; ethics and values of leadership, leaders who make difference, conduct of meetings, small group communications and Brain storming, Decision making, How to make right decision, Conflicts and cooperation, Dissatisfaction: Making them productive.

**Unit-III**

Proactive Manager: How to become the real you: The journey of self-discovery, the path of self-discovery, Assertiveness: A skill to develop, Hero or developer, Difference between manager and leader, Managerial skill check list, team development, How to teach and train, time management, Stress management, Self assessment.

**Unit-IV**

Attitudinal Change: Meaning of attitude through example, benefits of positive attitude, how to develop habit of positive thinking, what is fear? How to win it? How to win over failure? How to overcome criticism? How to become real you? How to Motivate?

**Unit-V**

Creativity – a managerial skill, Trying to get a grip on creativity.
Overview of Management Concepts: Function of Management: Planning, organizing, staffing, controlling.

**Text & Reference Books:**


1. Basic Managerial skills for all by E.H. McGrawth, Prentice Hall India Pvt Ltd,2006
2. How to develop a pleasing personality by Atul John Rego, Better yourself bools, Mumbai, 2006
3. The powerful Personality by Dr. Ujjawal Patni & Dr. Pratap Deshmukh, Fusion Books, 2006
4. How to Success by Brian Adams, Better Yourself books, Mumbai, 1969