Rashtrasant Tukadoji Maharaj Nagpur University

Structure & Syllabus of 7th and 8th Semester B. Tech. (Chemical Engineering)

SCHEME OF EXAMINATION
RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR
SEVENTH SEMESTER B.TECH (CHEMICAL ENGINEERING)

Sr. No.	Code Theory (T) Practical (P)	Subject	Board	Teaching Scheme, hr. per week				Credits				MARKS				**Total Marks**
												Theory		Practical		
				L	P	T	Total	L	P	T	Total	Sessional	University	Sessional	University	
1.	BTCHE 701T	Transport Phenomena	BCHE	3	-	1	4	3	-	1	4	20	80	-	-	**100**
2.	BTCHE 702T	Process Control and Instrumentation	BCHE	3	-	1	4	3	-	1	4	20	80	-	-	**100**
3.	BTCHE 703T	Chemical Reactor Design	BCHE	3	-	1	4	3	-	1	4	20	80	-	-	**100**
4.	BTCHE 704T	Elective-II	BCHE	3	-	1	4	3	-	1	4	20	80	-	-	**100**
5.	BTCHE 705T	Finishing Techniques	BCHE	2	-	-	2	2	-	-	2	50	-	-	-	**50**
6.	BTCHE 706P	Chemical Reactor Design	BCHE	-	3	-	3	-	2	-	2	-	-	25	25	**50**
7.	BTCHE 707P	Seminar	BCHE	-	3	-	3	-	2	-	2	-	-	100	-	**100**
8.	BTCHE 708P	Project/Dissertation - Stage I	BCHE		3		3		2		2	-	-	50	-	**50**
Total				**14**	**09**	**04**	**27**	**14**	**06**	**04**	**24**	**130**	**320**	**175**	**25**	**650**

Elective	Subject Name			
	BOARD			
	BTCHE			
Elective-II	1. Non-Newtonian Flow	2. Chemical Hazards and Safety	3. Nanotechnology	4. Catalysis

SCHEME OF EXAMINATION
RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR
EIGHTH SEMESTER B.TECH (CHEMICAL ENGINEERING)

Sr. No.	Code Theory (T) Practical (P)	Subject	Board	Teaching Scheme, hr. per week				Credits				MARKS				**Total Marks**
												Theory		Practical		
				L	P	T	Total	L	P	T	Total	Sessional	University	Sessional	University	
1.	BTCHE 801T	Computational Chemical Engineering	BCHE	3	-	1	4	3	-	1	4	20	80	-	-	**100**
2.	BTCHE 802T	Process Dynamics and Control	BCHE	3	-	1	4	3	-	1	4	20	80	-	-	**100**
3.	BTCHE 803T	Entrepreneurship and Project Management	BCHE	3	-	1	4	3	-	1	4	20	80	-	-	**100**
4.	BTCHE 804T	Elective -III	BCHE	3	-	1	4	3	-	1	4	20	80	-	-	**100**
5.	BTCHE 805P	Computational Chemical Engineering	BCHE	-	3	-	3	-	2	-	2	-	-	25	25	**50**
6.	BTCHE 806P	Process Control	BCHE	-	3	-	3	-	2	-	2	-	-	25	25	**50**
7.	BTCHE 807P	Project/Dissertation-Stage II	BCHE	-	6	-	6	-	3	-	3	-	-	-	150	**150**
			Total	**12**	**12**	**04**	**28**	**12**	**07**	**04**	**23**	**80**	**320**	**50**	**200**	**650**

Elective	Subject Name			
	BOARD			
	BTCHE			
Elective-III	1. Computational Fluid Dynamics	2. Piping Engineering	3. Polymer Engineering	4. Chemical Process Synthesis and Design

Scheme of Absorption for 7th semester B.Tech. Old Pattern to CBS Pattern of 7th Semester B. Tech. (Chemical Engineering)							
As Per Rashtrasant Tukadoji Maharaj Nagpur University (Old Semester Pattern)					As Per Rashtrasant Tukadoji Maharaj Nagpur University (Credit Based Semester Pattern Scheme)		
7th Semester B. Tech (Chemical Engineering)					7th Semester B. Tech (Chemical Engineering)		
Sr. No.	**Sub Code Theory/ Practical**	**Subject**	**Theory/ Practical**		**Sub Code Theory/ Practical**	**Subject**	**Theory/ Practical**
1	7 S. CE.1	Transport Phenomena	Theory		BTCHE 701T	Transport Phenomena	Theory
2	7 S. C.E. 2	Mass Transfer-II #	Theory			----	
3		----			BTCHE 702T	Process Control and Instrumentation$	Theory
4	7 S. C.E. 3	Chemical Reaction Engineering –II	Theory		BTCHE 703T	Chemical Reactor Design	Theory
5	7 S. C.E. 4	Plant Design – II	Theory			----	
6		----			BTCHE 704T	Elective-II	Theory
					BTCHE 705T	Finishing Techniques	Theory
7	7 S. C.E. 5	Mass Transfer #	Practical			----	
8	7 S. C.E. 6	Process Equipment Drawing	Practical			----	
9		----			BTCHE 706P	Chemical Reactor Design	Practical
10	7 S. C.E.7	Seminar	Practical		BTCHE 707P	Seminar	Practical
11		----			BTCHE 708P	Project/Dissertation- Stage I	Practical

Students will have to appear in University theory and practical examination as per the new scheme.

 # Students have to attend the classes and practicals and appear in University examination (Theory & Practical) of the subject Separation Processes of Sixth semester B. Tech (Chemical Engineering) (CBS) which is equivalent to Mass Transfer-II (Theory) and Mass Transfer (Practical)) of Seventh Semester B.Tech (Chemical Engineering) old Semester pattern respectively.

$ Students are exempted if they have cleared the Process Control –I (Theory) of Sixth Semester B. Tech (Chemical Engineering) old semester pattern.

Scheme of Absorption for 8th semester B.Tech. Old Pattern to CBS Pattern of 8th Semester B. Tech. (Chemical Engineering)							
As Per Rashtrasant Tukadoji Maharaj Nagpur University (Old Semester Pattern)					As Per Rashtrasant Tukadoji Maharaj Nagpur University (Credit Based Semester Pattern Scheme)		
8th Semester B. Tech (Chemical Engineering)					8th Semester B. Tech (Chemical Engineering)		
Sr. No.	**Sub Code Theory/ Practical**	**Subject**	**Theory/ Practical**		**Sub Code Theory/ Practical**	**Subject**	**Theory/ Practical**
1	8 S. CE.1	Mathematical Methods and Computer Aided Design in Chemical Engineering	Theory		BTCHE 801T	Computational Chemical Engineering	Theory
2	8 S. CE.2	Process Control- II	Theory		BTCHE 802T	Process Dynamics and Control	Theory
3	8 S. CE.3	Project Management & Industrial Economics	Theory		BTCHE 803T	Entrepreneurship and Project Management	Theory
4	8 S. CE.4	Elective	Theory		BTCHE 804T	Elective -III	Theory
5		---			BTCHE 805P	Computational Chemical Engineering	Practical
6	8 S. CE 5	Process Control	Practical		BTCHE 806P	Process Control	Practical
7	8 S. CE.6	Dissertation/Project Work	Practical		BTCHE 807P	Project/Dissertation-Stage II	Practical

Students will have to appear in University theory and practical examination as per the new scheme.

Rashtrasant Tukadoji Maharaj Nagpur University

Faculty of Engineering & Technology
Syllabus for
Seventh Semester B.Tech. Chemical Engineering

Subject : BTCHE 701T (BCHE) **Transport Phenomena (Theory)**
Lecture : 3 Hours Tutorial: 1 Hour No. of Credits : 4
University : 80 Marks College Assessment : 20 Marks
Duration of Examination: 3 Hours

Unit 1: Introduction to transport phenomena. Basics of momentum transfer. Newtonian & Non-Newtonian fluids. Overall momentum, heat and mass balance. Substantial derivative, curvilinear coordinates, Differential equation of continuity.

Unit 2: Shell momentum balances for momentum flux & velocity distribution for flow of Newtonian fluids for various situations. Navier-Stokes equation and its applications.

Unit 3: Shell energy balances for heat flux & temperature distribution in solids by conduction with and without heat generation. Temperature distribution in laminar flow. General equation of heat transfer and its applications.

Unit 4: Shell mass balance for concentration distribution in solids & in laminar flow conditions, General equation for Mass transfer and its applications. Diffusion with chemical reaction.

Unit 5: Momentum, Heat and Mass transfer in boundary layers. Analogies of momentum, heat & mass transfer.

Unit 6: Introduction to turbulent transport phenomena. Theories of mass transfer. Introduction to transport phenomena in Bio-systems.

Books Recommended:

1. R. B. Bird, W.E. Stewart, E.W. Lighfoot, Transport Phenomena, 2nd Edition, John Wiley, 2002
2. C. J. Geankoplis, Transport Processes and Separation Process Principles, Prentice- Hall Inc., 4th Edition 2003.
3. C. O. Bennett, J. O. Myers, Momentum, Heat and Mass Transfer, 2nd International Student Edition Mc-Graw Hill, 1983.
4. W.J. Thomson, Introduction to Transport Phenomena , Pearson Education Asia, Singapore, 2000.

Subject : BTCHE 702T (BCHE) **Process Control and Instrumentation (Theory)**
Lecture : 3 Hours Tutorial: 1 Hour No. of Credits : 4
University : 80 Marks College Assessment : 20 Marks
Duration of Examination: 3 Hours

UNIT 1: Control system representation using block diagram, Control configuration representation, Block diagram algebra, Forcing functions, First order system, Examples of first order system, Transfer functions of continuous stirred tank reactor, mercury thermometer , mixing process, liquid level tank, stirred tank heater, pure capacitive system, response equations of first order system to various forcing functions, step response, ramp response, impulse response, sinusoidal response, Dynamic error, time lag.

UNIT 2: Dynamic behaviour of multicapacity systems, Transfer functions of interacting and non-interacting multicapacity systems, Effect of interaction, Linearization, Transportation lag, response of multicapacity systems, Servo and regulator control problems. Offset for servo and regulator control.

UNIT 3: Dynamics of second order systems, response equations of second order system to various forcing functions for under damped. Critically damped and over damped systems. Overshoot, Decay ratio, response time, rise time, period of oscillation, natural period of oscillation.

UNIT 4: Working mechanism and transfer functions of flapper-nozzle Pneumatic, Hydraulic and Electronic proportional, proportional-integral, proportional derivative and proportional-integral – derivative controllers, Functions of different modes of control, On-off two position controller, Working principle and dynamic behaviour of pneumatic control valve, applications of control valve, hysteresis of control valve.

UNIT 5: Microprocessor based digital control system, Hardware elements of control configuration, Transmission lines hold element, multiplexer, Supervisory control, Programmable logic controller, Distributed control system, Direct digital feedback control, examples of direct digital feedback control, stirred tank heater, heat exchanger, continuous stirred reactor with exothermic and endothermic reactions, distillation column, drum boiler, level unit, jacketed kettle, evaporator, extraction column.

Unit 6: Classification of measurement, Classification of instruments, Characteristics of instruments, Classification of transducers, primary and secondary, analog, digital, active and passive transducers Temperature measurement instruments, glass thermometer, pressure thermometer, liquid in metal thermometer, platinum resistance thermometer, thermistors, Thermocouples, Radiation and Optical pyrometer, pressure measurement instruments, Ionization gauge, Pirani gauge, Bell differential pressure gauge, Pneumatic pressure meter, Level measurement instruments , float and shaft ,float and tape, linear and rotary potentiometer , radiation and laser level unit.

Books Recommended:

1. R.P. Vyas, Process control and Instrumentation, Seventh Edition, Denett & Co. publication, 2015.
2. R.P. Vyas, Measurement and Control, Denett & Co. Publication 2010.
3. D. R. Coughanour, Process system analysis and control, 2nd Edition, McGraw Hill publication, 1991.
4. G. Stephanopoulos, Chemical process control: An introduction to theory and practice, Prentice Hall of India private limited, 2008.
5. F.G. Shinskey, Process control systems, 2nd Edition, McGraw Hill book Company publication, 1979.

Subject : BTCHE 703T (BCHE) **Chemical Reactor Design (Theory)**
Lecture : 3 Hours Tutorial: 1 Hour No. of Credits : 4
University : 80 Marks College Assessment : 20 Marks
Duration of Examination: 3 Hours

Unit 1: Fluid-Particle Reactions (Non-Catalytic Systems) Selection of a model for gas-solid non catalytic reaction, Un-reacted core model, Shrinking core model, Rate controlling resistances, Determination of the rate controlling steps, Various contacting patterns and their performance equations, Application of models to design problems.

Unit 2: Fluid-Fluid Reactions (Non-Catalytic Systems)

Introduction to heterogeneous fluid - fluid reactions, Rate equation for instantaneous , Fast and slow reaction, Equipment used in fluid- fluid contacting with reaction, Application of fluid -fluid reaction rate equation to equipment design, Towers for fast reaction, Towers for slow reactions

Unit 3: Solid Catalyzed Reactions

The Rate Equation for Surface Kinetics, Pore Diffusion Resistance Combined with Surface Kinetics, Porous Catalyst Particles, Heat Effects During Reaction, Performance Equations for Reactors Containing Porous Catalyst Particles, Experimental Methods for Finding Rates, Product Distribution in Multiple Reactions, The Packed Bed Catalytic Reactor

Unit 4: Gas-Liquid Reactions on Solid Catalyst

Trickle Beds, Slurry Reactors, Three Phase Fluidized Beds, The General Rate Equation, Performance Equations under various conditions, selection of various types of Contactor, Applications

Unit 5: Polymerization Reaction Systems

Pseudo-Steady-State Hypothesis (PSSH), Searching for a Mechanism, Step Polymerization, Free-Radical Polymerization, Development of Rate Laws for the Net Rate of Reaction, Modeling a Batch Polymerization Reactor, Molecular Weight Distribution and Properties of Distribution, Design Aspects

Unit 6: Steady State Non-isothermal Reactor Design

The Energy Balance, Non-isothermal continuous flow reactors, equilibrium conversion, non-adiabatic reactor operations, multiple steady states, non-isothermal multiple chemical reactions

Books Recommended:

1. O. Levenspiel, Chemical Reaction Engineering, 3rd Edition, Wiley India, 2006.
2. H. S. Fogler, Elements of Chemical Reaction Engineering, 4th Edition, PHI, 2005.
3. J.M. Smith, Chemical Engineering Kinetics, 3rd Edition, McGraw Hill, 1981.
4. S.D. Dawande, Principles of Reaction Engineering, Denett & Co, 2007
5. S. M. Walas, Reaction Kinetics for Chemical Engineers, McGraw Hill, 1959.

Subject : BTCHE 704T (BCHE) **Elective-II: Non Newtonian Flow (Theory)**

Lecture	: 3 Hours	Tutorial: 1 Hour	No. of Credits	: 4
University	: 80 Marks		College Assessment	: 20 Marks

Duration of Examination: 3 Hours

Unit 1: Non-Newtonian fluids

Introduction, Classification of fluid: Time-independent, Time-dependent , Visco-elastic . Dimensional considerations for visco-elastic fluids.

Unit 2: Rheometry for non-Newtonian fluids

Introduction, Various viscometers, Yield stress measurements, Normal stress measurements, Oscillatory shear measurements, High frequency techniques, The relaxation time spectrum etc.

Unit 3: Flow in pipes

Introduction, Laminar flow in circular tubes, Criteria for transition from laminar to turbulent flow, Friction factors for transitional and turbulent conditions, Laminar flow between two infinite parallel plates, Laminar flow in a concentric annulus. Gas-non Newtonian liquid two phase flow.

Unit 4: Particulate systems

Introduction, Drag force on a sphere, , Motion of bubbles and drops, Flow of a liquid through beds of particles, Flow through porous media of particles, Liquid-solid fluidization.

Unit 5: Heat transfer characteristics of non-Newtonian fluids in pipes

Introduction, Thermo-physical properties, Laminar flow in circular tubes, Fully-developed heat transfer to power-law fluids in laminar flow, Isothermal tube wall, Constant heat flux at tube wall, etc.

Unit 6: Mixing of Liquids.

Introduction, Liquid mixing, Gas-liquid mixing, heat transfer. Selection of mixing equipments. Mixing in continuous system.

Books Recommended:

1. R.P. Chhabra, J.F. Richardson, Non-Newtonian Flow and Applied Rheology: Engineering Applications, 2nd Edition, Butterworth-Heinemann, 2008.
2. Christopher W. Macosko, RHEOLOGY: Principles, Measurements and Applications, WILEY-VCH, 1994.
3. Alexander Ya. Malkin, Rheology Fundamentals, ChemTech Publishing, 1994.
4. R. B. Bird, W.E. Stewart, E.W. Lighfoot, Transport Phenomena, 2nd Edition, John Wiley, 2002

Subject : BTCHE 704T (BCHE) Elective-II: Chemical Hazards and Safety (Theory)

Lecture : 3 Hours Tutorial: 1 Hour No. of Credits : 4
University : 80 Marks College Assessment : 20 Marks
Duration of Examination: 3 Hours

Unit 1: Introduction

Chemical Process Classification, Process Design and Safety parameters, Chemicals and their hazards, importance of safety consciousness etc.

Unit 2: Chemical Hazards

Hazards in Chemical Process plants, Hazards code, explosive limits, electrical safety, static electricity hazards. LEL, UEL of various compounds, hazards due to leakages, flammable liquid hazards, fire ball hazards. Safety in handling gases, liquids and solids. Case studies.

Unit 3: Disasters and Detectors

Disaster in Chemical process plants, emergencies, explosion, BLEVE, UVCE, On-site and off-site emergency plan, fire detectors, smoke detectors, heat detectors, instruments for monitoring toxic and flammable process areas.

Unit 4: Hazard Assessment and Control

Hazards assessment, F & EI, Safety audit, safety equipments, HAZOP, FTA and ETA, FMEA, Combating Chemical fires, fire fighting foams dry chemical systems etc.

Unit 5: Risk Assessment

Risk assessment, objectives, FAFR, risk identification and analysis, role of communication, crisis communication, systematic maintenance, risk management plan etc.

Unit 6: Personal Safety & Legal Aspects

Personal safety, importance of plant layout, safety checklist, general safety rules, safety checklist during start up and errors, importance of training, role of human errors, protective devices, safety management. Role of Government, safety organizations. Management and trade Unions in promoting Industrial safety..

Books Recommended:

1. S.D. Dawande, Chemical Hazards and Safety, Denett & Co. 2007
2. W. Handley, Industrial Safety Hand Book, 2nd Edition, McGraw-Hill Book Company, 1977.
3. R.K. Sinnott, Coulson & Richardson's Chemical Engineering, Vol. 6, Elsevier India, 2006.
4. Welb G.L. Safety in Process Plant Design, George Godwin Limited, John Wiely & Sons New York 1980..
5. Ridley Safety at Work, VII Edition, Butterworth Heinman 2007.
6. T. Kletz, What Went Wrong?**:** Case Studies of Process Plant Disasters, Gulf Professional Publishing, 1998.
7. H.W. Heinrich, P.E. Dan Peterson, Nester Rood. Industrial Accident Prevention, McGraw-Hill Book Co., 1980
8. H. H. Fawatt, W.S. Wood, Safety and Accident Prevention in Chemical Operation, Interscience, 1965.
9. D.A. Crowl and J.F. Louvar, Chemical Process Safety (Fundamentals with Applications), Prentice Hall 2011.

Subject : BTCHE 704T (BCHE) Elective-II: Nanotechnology (Theory)

Lecture : 3 Hours Tutorial: 1 Hour No. of Credits : 4

University : 80 Marks College Assessment : 20 Marks

Duration of Examination: 3 Hours

Unit 1: Introduction

Nano Scale, history and Scope of Nano Technology., Nanomaterials, Morphology. Enhanced properties at nano scale. Comparison with bulk materials.

Unit 2: Fabrication of Nanomaterials

Top Down Approach, Grinding, Planetary milling and Comparison of particles, Bottom Up Approach, Wet Chemical Synthesis Methods, Micro emulsion Approach, Colloidal Nanoparticles Production, Sol Gel Methods, Sonochemical Approach, Microwave and Atomization, Gas phase Production Methods : Chemical Vapour Depositions.

Unit 3: Introduction to Instrumentation and characterization

Instrumentation Fractionation principles of Particle size measurements, Particle size and its distribution, XRD, Zeta potential, SEM, TEM, AFM, STM, DLS, Spectroscopy. etc.

Unit 4: Kinetics at Nanoscale

Nucleation and growth of particles, Issues of Aggregation of Particles, Oswald Ripening, Stearic hindrance, Layers of surface Charges, Zeta Potential and pH

Unit 5: Carbon Nanomaterials

Synthesis of carbon buckyballs, List of stable carbon allotropes extended fullerenes, metallofullerenes solid C60, bucky onions nanotubes, nanocones Difference between Chemical Engineering processes and nanosynthesis processes.

Unit 6: Applications of Nano Technology.

Applications in Chemical Engineering like nanocatalyst, bio analytical tools, nano/micro arrays, nanodevices, lab-on-a-chip.

Books Recommended:

1. Sulabha K. Kulkarni, Nanotechnology: Principles and Practices, Capital Publishing Company, 2007.
2. Gabor L. Hornyak., H.F. Tibbals, Joydeep Dutta, John J. Moore, Introduction to Nanoscience and Nanotechnology, CRC Press, 2008.
3. Robert Kelsall, Ian Hamley, Mark Geoghegan, Nanoscale Science and Technology, John Wiley & Sons, 2005.
4. Stuart M. Lindsay, Introduction to Nanoscience, Oxford University Press, 2009.
5. Poole C., and Owens F., Introduction to Nanotechnology, John Wiley, New Jersey, 2003.
6. Singh Nalwa, 10 Volume Enclypedia of Nanoscience and NanoTechnology, 2004.Catherine Brechignac, Philippe Houdy, Marcel Lahmani (Editors)Nanomaterials and Nanochemistry, Springer-Verlag Berlin Heidelberg, 2007.
7. Internet resources.

Subject : BTCHE 704T (BCHE) **Elective-II: Catalysis (Theory)**
Lecture : 3 Hours Tutorial: 1 Hour No. of Credits : 4
University : 80 Marks College Assessment : 20 Marks
Duration of Examination: 3 Hours

Unit 1:

Introduction to Catalysis. Biocatalysts – enzymes, lipases and microbes as catalysts, Application to industrial processes – one example from various Chemical and allied industries. Types of catalysts.

Unit 2:

Heterogeneous Catalysis: Introduction, Phase transfer and tri-phase catalysis, liquid – liquid and solid – liquid catalysis, mechanism. Mechanism of participation of enzymes in a few typical reaction, engineering problems, mass transfer considerations. Reactor types etc.

Unit 3:

Gas – solid catalytic reactions. Adsorption theories and concept of active site, Adsorption isotherm and Langmuir – Hinshelwood approach, Diffusion effect, Michaelis – Menten Kinetics for biocatalyst

Unit 4:

Preparation of catalysts – Supported metal and metal oxide catalyst, Major steps involved in catalysts preparation and formation. Physical methods of catalyst characterization for determination of surface area, pore volume and average pore size. BET equation, Inhibition. Reactions and denaturation of two biopolymers

Unit 5:

Zeolites – Structural considerations. Templeted molecular sieves, size and shape selectivity, 4 – 5 industrial applications of zeolites. Modification of zeolites

Unit 6: Recent developments in catalytic processes. Case studies.

Books Recommended:

1. H. S. Fogler, Elements of Chemical Reaction Engineering, 4th Edition, PHI, 2005.
2. J.M. Smith, Chemical Engineering Kinetics, 3rd Edition, McGraw Hill, 1981.
3. C. N. Satterfield, Heterogeneous Catalysis in Industrial Practices, 2nd Edition, McGraw-Hill International Editions, 1993.
4. J. Bailey, D. Ollis, Biochemical Engineering Fundamentals, 3rd Edition, McGraw Hill, 1986.
5. J. J. Carberry, Chemical and Catalytic Reaction Engineering, 2nd Edition, McGraw Hill, New York, 1976.
6. J.M. Thomas, W.J. Thomas, Principles and practice of Heteregenous Catalysis, John Weily & Sons 2nd Edition, 2014.
7. Internet sources.

Subject : BTCHE 705T (BCHE) **Finishing Techniques (Theory)**
Theory: 2 Hours No. of Credits : 2
College Assessment : 50 Marks

With a view to meet the trained human resource requirements of the Chemical Process and allied industries, students of B.Tech Chemical Engineering will go through Finishing Techniques. The training of students will be conducted in order to improve their personality. This course has an objective of helping them to find suitable jobs by inculcating soft skills components through appropriate training.

Art of Communication, Importance of internal and external communication. General Communication process, verbal & Non-verbal Communication. Effective Listening skils.

Interpersonal Skills, Effective presentation skills, Self awareness. Dealing with emotions. Team work. Leadership qualities.

Professional etiquettes, Importance of per-placement talks. How to prepare for a Campus interview. Asking right questions during and after pre-placement talks. Collecting relevant information about the visiting company.
Preparation of resume Effective Interview and group discussion techniques. Effective body language. Undestanding psychology of interviewers. NLP (Neuro-linguistic programming) & NAC (Neuro-Associative conditioning) techniques. Mock interviews and Group Discussion.

Effective goal setting. Developing a vision mission and purpose for successful professional life (Designing your career). Creative visualization. Power of positive thinking. Art of Living and leaving for professional success. Eustress & distress. Management of stress and strain through meditation & yoga.

Books Recommended:

1. Stephen R. Covey, The 7 habits of highly effective people, Free Press 1989.
2. Stephen R. Covey, The 8th habit, Free Press 1989.
3. Napoleon Hill, Think and grow rich, The Napoleon Hill Foundation, 2012.
4. Anthony Robins, Awaken the giant within, Free Press; New edition, 1992.
5. Nasha Fitter, You're hired, Penguin India, 2009.

Subject : BTCHE 706P (BCHE) **Chemical Reactor Design (Practical)**
Practical : 3 Hours No. of Credits : 2
University : 25 Marks College Assessment : 25 Marks
Duration of Examination: 6 Hours

LIST OF EXPERIMENTS

Required to perform minimum 8 practicals from the list given below:

1. To calculate value of rate constant 'k' for the saponificaton of ethyl acetate with NaOH in a batch reactor – I (Where M=1)
2. To calculate value of rate constant 'k' for the saponificaton of ethyl acetate with NaOH in a batch reactor – II (Where M=2)
3. Verification of Arrhenius law.
4. To study the kinetics of selected reaction in CSTR
5. To study the kinetics of selected reaction in PFR
6. To study the performance of mixed flow reactor/PFR
7. Study of various combinations of PFR and CSTR in series.
8. Residence time Distribution in CSTR.
9. Residence time Distribution in PFR.
10. RTD studies in a packed Bed reactor.
11. Studies in recycle bed reactor.
12. Studies in Semibatch Reactor.
13. Finding conversion and rate of polymerization reactions using gravimetric method.
14. Studies in Trickle bed reactor.

Subject	**: BTCHE 707P** (BCHE)	**Seminar (Practical)**	
Practical	: 3 Hours	No. of Credits	: 2
		College Assessment	: 100 Marks

Each student has to select the topic of Seminar in Chemical Engineering in consultation with his/her guide. The student will make an oral presentation for 10 to 15 minutes followed by question and answer session in front of an internal assessment committee. Two neatly typed copies of seminar report along with its soft copy should to be submitted.

Reading: Journals, Books, Magazines & Internet sources, etc

Subject	**: BTCHE 708P** (BCHE)	**Project/Dissertation –Stage I (Practical)**	
Practical	: 3 Hours	No. of Credits	: 2
		College Assessment	: 50 Marks

Each student will undertake an independent project/dissertation. The student is required to choose the topic in consultation with his/her Guide. Student should undertake dissertation/project concerning Chemical Engineering applications such as production of chemical, design and development, experimental work, industry based problems, generation of new ideas and concept, modification in the existing process/system, development of computer programs, modelling and simulation etc. A preliminary work is to be carried out in this stage of the project/dissertation. Two neatly typed copies of the Report on the completed work at stage I should be submitted at end on the 7^{th} semester and internal assessment marks will be awarded for this stage of the project/dissertation based on the work and presentation made by them in front of Departmental committee.

Rashtrasant Tukadoji Maharaj Nagpur University

Faculty of Engineering & Technology

Syllabus for

Eighth Semester B.Tech. Chemical Engineering

Subject : BTCHE 801T (BCHE) **Computational Chemical Engineering (Theory)**

Lecture	: 3 Hours	Tutorial: 1 Hour	No. of Credits : 4
University	: 80 Marks		College Assessment : 20 Marks

Duration of Examination: 3 Hours

Unit 1: Introduction to Modeling and simulation, different types of models, application of mathematical modeling, principles of model formulation, chemical system modeling

Unit 2: Numerical methods of solution, (Bisection, False position, Newton-Raphson, Secant method etc.) of non-linear algebraic and transcendental equations applied to Chemical Engineering problems.

Unit 3: Methods of solution of simultaneous linear (Gauss elimination, Gauss-Jordon, Gauss-Seidal etc.) and non-linear algebraic equations. Application to chemical engineering problems

Unit 4: Curve fitting techniques: Least squares regression (linear, polynomial, multiple linear etc.). Interpolation. Application to Chemical Engineering problems.

Unit 5: Formulation and numerical solution of ordinary differential equations with emphasis on chemical process systems. Initial Value Problems (Euler's method, modified Euler's method, 4^{th} order Runge Kutta Method etc), boundary value problems (Shooting Method, Finite Difference method etc.)

Unit 6: Formulation and numerical solution of partial differential equations (Finite difference method, Crank-Nicholson method, methods of lines etc.). Application to chemical engineering problems.

Books Recommended:

1. S.C. Chapra, R.P. Canale, Numerical Methods for Engineers, 6^{th} Edition, Tata-McGraw Hill Publications, 2012.
2. W. L. Luyben, Process Modeling Simulation and Control for Chemical Engineers, McGraw Hill, 1990.
3. B. V. Babu, Process Plant Simulation, Oxford University Press, 2004.
4. B. A. Finlayson, Introduction to Chemical Engineering Computing, Wiley Interscience, New Jersey, 2006.
5. S.K. Gupta, Numerical Methods for Engineers, 2^{nd} Edition, New Age International, 2010.

Subject : BTCHE 802T (BCHE) **Process Dynamics and Control (Theory)**
Lecture : 3 Hours Tutorial: 1 Hour No. of Credits : 4
University : 80 Marks College Assessment : 20 Marks
Duration of Examination: 3 Hours

UNIT 1: Concept of stability for linear systems, Routh's stability criterion, Root-locus diagram for positive and negative feedback systems. Applications of root-locus diagram, Effect of transportation lag on root locus diagram, Magnitude criterion for root-locus diagram.

UNIT 2: Control system design by frequency response, Bode diagram for controllers and for control systems, Bode stability criterion, Phase and Gain margins, Ziegler- Nichols optimum controller settings, Applications of control system design.

UNIT 3: Discrete time control systems, Block diagram algebra, Routh's stability criterion and root-locus diagram in Z-domain for discrete time control, Transfer functions of Zero order hold, First order hold, Exponential hold, Effect of hold element on root locus diagram an stability of discrete time control.

UNIT 4: Nyquist stability criterion, Nyquist diagram for control systems, Direct digital ratio control, Examples of ratio control, Integral of square error, Integral of absolute value of error, Integral of time weighted absolute value of error, Transportation lag compensation.

UNIT 5: Feed forward control configuration, applications of direct digital feed forward control of stirred tank heater, heat exchanger, continuous stirred tank reactor for exothermic and endothermic reactions, distillation column, drum boiler, level control unit, jacketed kettle, evaporator, extraction column.

UNIT 6: Cascade control configuration, Functions and tuning of primary and secondary controllers, Applications of microprocessor based digital cascade control of stirred tank heater, heat exchanger, continuous stirred tank reactor for exothermic and endothermic reactions, distillation column, level control unit, jacketed kettle, evaporator, furnace.

Books Recommended:

1. R.P. Vyas, Process Dynamics and Control, First Edition Denett & Co. publication, 2015.
2. R.P. Vyas, Process Automation and Modeling, Denett & Co. Publication 2007.
3. D. R. Coughanour, Process system analysis and control, 2nd Edition, McGraw Hill publication, 1991.
4. G. Stephanopoulos, Chemical process control: An introduction to theory and practice, Prentice Hall of India private limited, 2008.
5. F.G. Shinskey, Process control systems, 2nd Edition, McGraw Hill book Company publication, 1979.

Subject : BTCHE 803T (BCHE) **Entrepreneurship and Project Management (Theory)**

Lecture	: 3 Hours	Tutorial: 1 Hour	No. of Credits	: 4
University	: 80 Marks		College Assessment	: 20 Marks

Duration of Examination: 3 Hours

Unit 1. Entrepreneur, Enterprise & Entrepreneurship. Charms of being an entrepreneur. Motivation. Achievement motivation. Need for achievement.
Entrepreneurial competencies. Goal setting. Different types of goals. Planning, decision-making for entrepreneur. Time & stress management.

Unit 2. Emotional Intelligence: what are emotions for? Anatomy of an emotional highjacking. Nature of emotional intelligence. The emotional competence framework. NLP (Neuro Linguistic Programming) & NAC associative Conditioning).

Unit 3. Identification and Selection of good business opportunity (Business opportunity guidance), Searching for an opportunity and selecting the right Product/ Project. Market survey and research. Technoeconomic feasibility assessment: Preliminary and detailed Project Report. Location & Layout.

Unit 4. Soureces of finance. Support from Financial & Non financial , Government & Non Governmet agencies. Managing for production and productivity. Production Planning & Control. Total Quality Management Fixed Assets and working capital management. Break even and sensitivity analysis. Concepts and implications. Estimating product costs, other costs, revenues, profits & earning for process plants, problem situation for estimation. Principle of accounting analysis of financial statement- problem situations for economic decision-making.

Unit 5. Material, management: Classes of materials, Purchasing, objectives of purchasing. Functoins of purchase department. Inventory management and control. Economic Order Quantity(EOQ),ABC analysis.

Unit 6. Marketing for small business, marketing research, Advertising & sales promotion, Channels of distributions. Managing your business for successful growth. Seven business crisis and techniques to beat them.
Monitoring progress through network analysis (PERT & CPM techniques).Evaluation and selection of industrial projects various modern methods of projects evaluation, economic selection of alternatives on the basis of annual costs, present worth, rate of return and payout period etc. problem situation for selection of alternative profile, replacement problem.

Books Recommended:

1. M. Peter, K. Timmerhaus, R. West, Plant Design and economics for Chemical Engineers, 5th Edition, McGraw-Hill Science/Engineering/Math, 2002
2. R. K. Sinnott, Coulson and Richardson's Chemical Engineering, Volume 6, Second Edition: Chemical Engineering Design (Chemical Engineering Technical Series), 2nd Edition, Pergamon, 1993
3. P.C.Jain, Handbook for new entrepreneur, Oxford University Press, 2012.
4. V.G. Patel, The Seven-Business Crisis. How to beat them? Tata McGraw-Hill Co. Ltd, 1995.
5. Daniel Goleman, Working with emotional intelligence, Butam Books, 2000.
6. John Happel, Donald G. Jordan, Chemical process economics, 2nd Edition, Marcel Dekker, Inc., New York, 1976.
7. Ernest E. Ludwig, Applied project management for the process industries, Gulf Pub. Co., 1974.

Subject : BTCHE 804T (BCHE) **Elective –III: Computational Fluid Dynamics (Theory)**

Lecture : 3 Hours Tutorial: 1 Hour No. of Credits : 4
University : 80 Marks College Assessment : 20 Marks
Duration of Examination: 3 Hours

Unit 1: Introduction to CFD
Introduction and basic concepts, overview of CFD, basic transport equations, Application of CFD

Unit 2: Discretization methods
Nature of numerical methods, Methods of deriving the discretization equations, Control volume formulation. Discretization 1-D, 2-D and 3-D equations for steady state and unsteady state conduction. Various methods, Over-relaxation, Under-relaxation, Discretization of convection and diffusion terms, Upwind Scheme, Exact solution, Exponential scheme, Hybrid scheme, Power law scheme, other schemes etc. False diffusion.

Unit 3: Calculation of the Flow Field
Difficulties related pressure gradient term and continuity equation, Staggered grid, Momentum equation, Pressure and velocity correction, Pressure correction equations, SIMPLE, SIMPLER algorithms.

Unit 4: Turbulence Modeling
Introduction to turbulence, Mean flow equations, Nature of turbulence, Classification, Zero order equation models, One equation models, Two-equation models, Turbulent stress models, other models, Problems.

Unit 5: Reactor Engineering and Flow Modelling
Introduction to reactor engineering and flow modelling, Reactive flow processes, Multiphase flow processes, Reactor Engineering Methodology, Introduction to various CFD softwares.

Unit 6: CFD Case Studies
Design of stirred tank reactor, jet mixed tanks, bubble column, fluidized bed, submerged jets, flow in curved pipe, turbulent flow and heat transfer in finned tubes, melting around a vertical pipe, transient combined mixed convection and radiation from vertical aluminium fin, heat transfer in rotary kiln reactors, heat transfer in metal and alloy solidification, membrane reactors etc.

Books Recommended:

1. J.D. Anderson, Computational Fluid Dynamics: The Basics with Applications, McGraw Hill, 1995.
2. S. V. Patankar, Numerical heat transfer and fluid flow, Mc Graw-Hill Book Company, 1st Edition, 1980.
3. P. S. Ghoshdastidar, Computer simulation of flow and heat transfer, Tata McGraw-Hill Publishing, 1st edition, 1998.
4. V.V. Ranade, Computational Flow Modeling for Chemical Reactor Engineering, Academic Press, 2002.
5. H. K. Versteeg and W. Malalasekera, "An introduction to CFD", Longman Scientific and Technical, 1st edition, 1995.
6. E. S. Oran and J. P. Boris, Numerical Simulation of Reactive Flow, Cambridge University Press, 2nd edition, 2001.
7. J. H. Ferriger, M. Peric, Computational methods for fluid dynamics, Springer, 1st edition, 1996.
8. K. Muralidhar and T. Sundararajan, Computational Fluid Flow and Heat Transfer, Narosa Publications, 2nd Edition, 2003.

Subject : BTCHE 804T (BCHE) **Elective –III: Piping Engineering (Theory)**

Lecture : 3 Hours Tutorial: 1 Hour No. of Credits : 4

University : 80 Marks College Assessment : 20 Marks

Duration of Examination: 3 Hours

Unit 1: Introduction to piping, piping fundamentals, applications, codes and standards. Review of friction factor, pressure drop for Incompressible and Compressible fluid, pipe sizing, and economic velocity. Analysis of pipe line networks for flow in branches. Pipe line design on fluid dynamic parameter.

Unit 2: Line size calculation; details and types of pressure relief valve / safety valve; control valves, gaskets, Pipe fittings and pipe connectors. Desirable properties of Material of Construction (MOC) for pipe, valves, flanges, gaskets etc.

Unit 3: Unit plot plan, process P&ID, utility P&ID, equipment layout and utility layouts within battery limits. Isometrics (2D, 3D), material-take-off (MTO), piping spool drawings, Piping insulation, colour codes and hazardous area classification details.

Unit 4: Common ASME, ASTM and IS specifications for seamless/ ERW pipes, pipe fitting flanges and fasteners, gasket, and valve materials, types of gaskets and their selection etc.

Unit 5: Design of flanges and gaskets; design of nuts & bolts; applications of NFPA codes in piping system design; Standards for piping insulation (detail engineering). Gas Pipe stress analysis (internal and external pressure). Selection & codes for pipe supports.

Unit 6: Design of piping systems and accessories: Crude oil, natural gas, pressurised steam, condensate, hazardous chemicals etc.

Books Recommended:

1. McAllister E.W., Pipeline Rules of Thumb Handbook, 7th Edition, Gulf Publication, 2009
2. Kellogg, Design of piping System, 2nd Edition, M.W. Kellogg Co. 2009
3. Weaver R., Process Piping Design Vol. 1 and 2 ., Gulf Publication, 1989
4. G. A. Antaki, Piping and Pipeline Engineering: Design, Construction, Maintenance, Integrity, and Repair (Mechanical Engineering), 1st Edition, CRC Press, 2003.
5. Ed Bausbacher, Roger Hunt, Process Plant Layout and Piping Design, 1st Edition, Prentice Hall, 1993.
6. Robert A. Rhea, Roy A Parisher, Pipe Drafting and Design, 3rd Edition, Gulf Professional Publishing, 2011.
7. John McCketta, Piping Design Handbook, 1st Edition, CRC Press, 1992.
8. Crane Co. Staff, Flow of Fluids Through Valves, Fittings and Pipe, Crane Co.1985.
9. Peter Smith**,** Piping Materials Guide, Gulf Publishing, 2005.
10. Mohinder Nayyar, Piping Data Handbook, 1st Edition, McGraw-Hill Professional, 2002.

Subject : BTCHE 804T (BCHE) **Elective –III: Polymer Engineering (Theory)**

Lecture : 3 Hours Tutorial: 1 Hour No. of Credits : 4
University : 80 Marks College Assessment : 20 Marks
Duration of Examination: 3 Hours

Unit 1: Introduction to polymers, Molecular Weight Determination

Introduction and Classification of Polymers. Thermosets, Thermoplastics, Linear Branch, Cross Linked Polymers. Factors influencing the polymer properties. Monomers used for polymer synthesis.

Molecular Weights, Mn, Mw, Mv, Polydispersity Index. Different Methods of determination of Molecular weight. Effect of Molecular weight on Engg. Properties of Polymers, Numerical based on theory

Unit 2: Polymerization Processes and Techniques

Addition & Condensation polymers, Polymerization Techniques, Bulk, Solution, Emulsion, Suspension, Interfacial Polymerization with their merits & Demerits.

Unit 3: Kinetics and Mechanism of Polymers Synthesis

Kinetics of free radical polymerization (initiation propagation & termination.) Kinetic of Step growth polymerization. Copolymers & its Kinetics Coordination Polymerization. Ziegler Natta polymerization Processes, Chain transfer agents. Smith Ewart Kinetics for emulsion polymerization.

Unit 4: Polymerization reactors

Polymerization reactors, types and mode of operation. Polymerization reactor design, control of polymerization, Post polymerization unit operations and unit processes High Performance and Specialty Polymers, Polymer additives, compounding. Fillers plastisizers lubricants colourants Different moulding methods of polymers,

Unit 5: Polymers Testing and Waste Management

Mechanical Properties of Polymers, Thermodynamics of Polymer Mixtures, ASTM and ISO methods for testing of polymers. Plastic waste management.

Unit 6: Manufacturing of polymers with flow-sheet, properties & applications

PE, PP, Polyesters, Nylons, Polystyrene, ABS, Thermosets like Epoxies, unsaturated polyesters, phenolics.; etc.

Books Recommended:

1. G. Odian, Principals of Polymerization, Wiley-Interscience, 4th Edition, 2004.
2. V.R. Gowarikar, N.V. Vishwanathan, J. Sreedhar Polymer Science, New Age International, 2010.
3. J. Fried, Polymer Science and Technology, Prentice Hall, 2nd edition, 2003.
4. J.A.Brydson, Plasitc Materials, Butterworth-Heinemann, 7th edition, 1999.
5. R. Sinha, Outlines of Polymer Technology: Manufacture of Polymers, Prentice Hall of India Pvt. Ltd., New Delhi, 2002.
6. S.D. Dawande, Introduction to Polymer Science & Technology, Denett & Co. 2006.

Subject : BTCHE 804T (BCHE) **Elective –III: Chemical Process synthesis And Design (Theory)**

Lecture : 3 Hours Tutorial: 1 Hour No. of Credits : 4
University : 80 Marks College Assessment : 20 Marks
Duration of Examination: 3 Hours

Unit 1: Introduction of Chemical Process and Product Design

Introduction, Approach to Process Development, Different Considerations, development of Particular Process, Overall Process design, Onion Model, Case studies of product design.

Unit 2: Choice of Reactor

Reaction Path, Types of Reaction Systems, Performance of Reactor, Idealized Reactor Models, Effect of various process variables.

Unit 3: Choice of Separator

Separation of Homogeneous and Heterogeneous Mixtures, Distillation, Azeotropic Distillation, Absorption, Evaporation, Drying etc.

Unit 4: Heat Exchanger Networks

Energy Targets, Composite Curves, Heat Recovery Pinch, Threshold Problems, Problem Table Algorithm, Process Constraints, Utility Selection, Furnaces, Combined Heat and Power, Integration of Heat Pump, Integration of Refrigeration Cycles, Overall Heat Exchanger Network and Utilities

Unit 5: Distillation Sequencing

Distillation Sequencing using simple columns, Heat Integration of Sequences of Simple Distillation Columns, Distillation Sequencing using thermal coupling, Optimization of Reducible Structure reactions

Unit 6: Safety and Health Considerations

Toxic Release, Fire, Explosion, Intensification of hazardous Materials, Attenuation of Hazardous Materials, Quantitative Measures of Inherent Safety, Overall Safety and Health Considerations. Malfunctions in columns leading to potential hazards. Safety factors used in design of columns

Books Recommended:

1. Robin Smith, Chemical Process design and Integration, Wiley-Blackwell, 2 Sub edition, 2005.
2. J. Douglas, Conceptual Design of Chemical Processes, New York, NY: McGraw-Hill, 1988.
3. L. Biegler, I. E. Grossmann, A. W. Westerberg, Systematic Methods of Chemical Process Design, Upper Saddle River, NJ: Prentice Hall PTR, 1997.
4. W. D. Seider, J. D. Seader, D. R. Lewin, Product and Process Design Principles: Synthesis, Analysis, and Evaluation, 2nd ed. New York, NY: Wiley, 2003.
5. D. F. Rudd, G. J. Powers, J. J. Siirola, Process Synthesis, Englewood Cliffs, NJ: Prentice Hall, Inc., 1973.
6. R. Turton, R. C. Bailie, W. B. Whiting, J. A. Shaeiwitz, Analysis, Synthesis, and Design of Chemical Processes, Upper Saddle River, NJ: Prentice Hall PTR, 1997
7. P.H. Grogins, Unit process in organic synthesis, McGraw-Hill, Second Edition, 1938.

BTCHE 805P (BCHE) **Computational Chemical Engineering (Practical)**

Practical	: 3 Hours	No. of Credits	: 2
University	: 25 Marks	College Assessment	: 25 Marks

Duration of Examination: 6 Hours

Before starting the practical sessions students will be made acquainted with theoretical aspects of mathematical softwares and commercial simulators.

Students have to perform minimum eight practicals using MS-Excel, MATLAB/Scilab, POLYMATH, Mathcad, ASPEN PLUS/HYSYS/ CHEMCAD software for design/simulation of chemical engineering problems.

Subject : BTCHE 806P (BCHE) **Process Control (Practical)**

Practical : 3 Hours No. of Credits : 2
University : 25 Marks College Assessment : 25 Marks
Duration of Examination: 6 Hours

LIST OF EXPERIMENTS

Required to perform minimum 8 practicals from the list given below:

List of experiments:

1. To determine the time constant of mercury in glass thermometer.
2. To determine the time constant of thermocouple sensor.
3. To determine the time constant of RTD (PT100) sensor.
4. To determine the time constant of thermister sensor
5. To determine damping coefficient, decay ratio, overshoot and characteristics time for step response of mercury manometer.
6. To study the dynamic response of liquid level in single tank system.
7. To study the dynamic response of liquid level in two tanks non-interacting liquid level system and to compare experimental and theoretical responses.
8. To study the dynamic response of liquid level in two tank interacting liquid level system and to compare experimental and theoretical responses.
9. To study the characteristic of PID controller by estimating time required to reach PV and to estimate the offset.
10. To study the transient response of a P control.
11. To study the transient response of a P +D control.
12. To study the transient response of a P+I control.
13. To study the transient response of a P+I+D control.
14. To determine the characteristics pneumatic control valve.
15. To study the tuning of PID controller by open loop method, using Zeigler-Nichols tuning rule.
16 Use of MATLB/Scilab for control Experiments .

Subject : BTCHE 807P (BCHE) **Project/Dissertation-Stage II (Practical)**

Practical : 6 Hours/week No. of Credits : 3
University : 150 Marks

Project/dissertation work undertaken in the first stage in Seventh semester will be continued and completed at the end of Eighth semester. Two neatly typed and bound copies of the report consisting of stage I and Stage II combined together along with its soft copy should be submitted at the end of Eighth semester. Assessment would be made on the basis of the submitted report and the presentation cum viva-voce examination conducted by the board of examiners.