PANDIT DEENDAYAL PETROLEUM UNIVERSITY
SCHOOL OF TECHNOLOGY
COURSE STRUCTURE FOR B. TECH. CHEMICAL ENGINEERING

SEMESTER VI			B.TECH. CHEMICAL ENGINEERING										
Sr No	**Course Code**	**Course Name**	**Teaching Scheme**					**Examination Scheme**					
			L	**T**	**P**	**C**	**Hrs/wk**	**Theory**			**Practical**		**Total marks**
								MS	**ES**	**IA***	**LW**	**LE/ Viva**	
1	CH 308T	Chemical Reactor Design	3	1	--	7	4	30	60	10	--	--	100
	CH 308P		--	--	4	2	4	--	--	--	25	25	50
2	CH 309T	Mass transfer II	3	1	--	7	4	30	60	10	--	--	100
	CH 309P		--	--	4	2	4	--	--	--	25	25	50
3	CH 310T	Process Equipment Design	3	--	--	6	3	30	60	10	--	--	100
	CH 310P		--	--	2	1	2	--	--	--	25	25	50
4	CH 311T	Process Dynamics and Control	3	1	--	7	4	30	60	10	--	--	100
	CH 311P		--	--	4	2	4	--	--	--	25	25	50
5	**CH 304**	**Modelling and Optimization**	3	1	--	7	4	30	60	10	--	--	100
6	HS XXXT	Elective - HM	2	--	--	4	2	30	60	10	--	--	100
7		Industrial Training (6 weeks)											
		Total	**17**	**4**	**14**	**45**	**35**						800

MS = *Mid Semester*, **ES** = *End Semester*; * **IA** = *Internal assessment* (like quiz, assignments etc)
LW = *Laboratory work*; **LE** = *Laboratory Exam*

Elective HM: Social Science Approaches to Development; Science & Humanism: Towards a Unified World View; Organizational Psychology, Total Quality Management (Proposed); Engineering Ethics (proposed); Good Manufacturing Practices (proposed)

CH 308 T Chemical Reactor Design										
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total marks
					MS	ES	IA	LW	LE/Viva	
3	1	--	7	4	30	60	10	--	--	100

UNIT I

Non ideal reactors, Basic CONCEPT OF NON-IDEAL BEHAVIOR, Distribution of Residence times for Chemical Reactors - General characteristics, Measurement of RTD, Characteristics of RTD, RTD in ideal reactors, Reactor modeling with RTD, Zero-parameter models, Models for non-ideal reactors –, One-parameter models; tank-in- series model, dispersion model

UNIT II

Catalysis and Catalytic Reactors - Catalysts, Steps in a catalytic reaction, Synthesizing a rate law, mechanism and rate-limiting step, Design of Reactors for gas-solid reactions, Heterogeneous data analysis for reactor design

UNIT III

Non-catalytic fluid –solid reactions, External Diffusion Effects on Heterogeneous Reactions - Mass transfer fundamentals, Binary diffusion, External resistance to mass transfer, The shrinking core model

UNIT IV

Non-catalytic fluid –fluid reaction kinetics, the rate equation for mass transfer and reaction. Kinetic regimes in gas-liquid reactions, Hatta number, contactors design for gas-liquid reactions.

Texts and References

1. H. S. Fogler, “Elements of Chemical Reaction Engineering”, 3rd Ed, New Delhi-Prentice Hall, 2001
2. O. Levenspiel,” Chemical Reaction Engineering” Willey Eastern, 3rd Ed., 2000
3. J. M. Smith, “Chemical Engineering Kinetics”, 3rd Ed., McGraw- Hill, 1988

CH 308P Chemical Reactor Design										
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total marks
					MS	ES	IA	LW	LE/Viva	
--	--	4	2	4	--	--	--	25	25	50

List of Experiments:

1. To study the kinetics of dissolution of benzoic acid.
2. A) To find the RTD data in tube for Pulse Input.

   B) To predict the conversion of given 1st order reaction with known rate constant by applying dispersion model & tank in series model.
3. To determine various curves like E, F, FA & EA for spiral tube reactor & to predict conversion for 1st order irreversible reaction known rate constant
4. To evaluate the effective Mass Transfer relevant to intrinsic kinetics for ethyl acetate – NaOH system conducted in homogeneous & heterogeneous manner.
5. To determine the various curves like E, F, and EQ for the packed bed & to predict conversion for a 1st order irreversible reaction of known reaction rates constant.
6. Calculate dispersion number & co efficient.
7. To study the RTD in CSTR
8. To obtain experimental values of EQ & ET curves and

   a) To verify $\frac{dE\theta}{d\theta} = EQ$

   b) To compare theoretical values ideal CSTR.

CH 309T Mass Transfer II										
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total marks
					MS	ES	IA	LW	LE/Viva	
3	1	--	7	4	30	60	10	--	--	100

UNIT I

Distillation - Vapour liquid equilibria, flash vaporization, batch distillation, differential distillation and extractive distillation, Binary systems, Mc-Cabe Thiele and Ponchon Savarit method calculations with multiple feeds and withdrawal, azeotropic distillation,

Introduction to multi component distillation concept and methods

UNIT II

Adsorption**:** Types of adsorption; Nature of adsorption; Freundlich equation; Stage wise and continuous adsorption. Rate of adsorption in fixed beds, Break through curve, Adsorption wave. Fluidized bed adsorbers.

UNIT III

Humidification - Vapour liquid equilibrium, enthalpy for pure substances, vapour gas contact operation. Psychrometric charts and measurement of humidity,

Dehumidification and Cooling Tower Design **-** Adiabatic and non adiabatic operations evaporative cooling, cooling tower design and dehumidification methods.

UNIT IV

Drying - Drying equilibrium and rate of drying, drying operation batch and continuous number of transfer units., types of dryers and selection criteria

Crystallisation - Theories of crystallization nucleation and crystal growth. Factors affecting the crystal growth rare, principles of super saturation. Types of industrial crystallizers.

Text and References

1. R. E. Treybal, Mass transfer operations, 3ed ed. McGraw Hill, 1980.
2. S. Foust et al. Principles of Unit Operations
3. J. M. Coulson and J. F. Richardson, “Chemical Engineering”, Vol. 1 ELBS, Pergaman press, 1970
4. J. M. Coulson and J. F. Richardson, “Chemical Engineering” Vol. 2 ELBS, Pergaman press, 1970

CH 309P Mass Transfer II										
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total marks
					MS	ES	IA	LW	LE/Viva	
--	--	4	2	4				25	25	50

List of Experiments

1. To study and verify the Freundlich's Adsorption Isotherm Adsorbing Oxalic Acid and Charcoal
2. To study the Characteristics of Adsorption for Silica Gel
3. To find out Crystal Yield without Seeding
4. To study the Crystallization of Boric acid and to find Percentage Yield at Different Temperature.
5. To measure the vapor pressure of acetone and calculate latent heat of vaporization.
6. To study the humidification operation and calculate all the terminology's used for air – water contact operation.
7. To determine pressure drop data and values of Kg for various air and liquid velocities in a counter cooling tower.
8. A) To Verify Rayleigh's Equation for Differential Distillation

   B) To plot Fraction of Charge of Distillates V/S Residue Components & temperature of distillations
9. To verify the Equilibrium Relationship for n-Butanol Water System
10. To verify Henry's Law for Steam Distillation.
11. To Find Out The Critical Moisture Content Of A Given Material & Find Out Its Equation For Constant And Filling Rate Period
12. To study the Construction and Working of Tray Drier.
13. To study the Construction and Working of a Rotary Drier

CH 310T Process Equipment Design										
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total marks
					MS	ES	IA	LW	LE/Viva	
3	--	--	6	3	30	60	10	--	--	100

UNIT I

General design considerations, codes, consideration of design parameters such as pressure, temperature etc.

Material behavior under stresses. Stress concentration, Theories of failure. Design methods for atmospheric storage vessels, unfired pressure vessels subjected to internal and external pressure. Types of closures , types of flanges

UNIT II

Design considerations for Vessels for high pressure operations, agitated vessels, and tall columns. Types of support and design

UNIT III

Complete design and preparation of working drawings for typical process equipment such as heat exchangers, evaporators

Complete design and preparation of working drawings for typical process equipment such as absorption and distillation columns, reactors, extractors, and crystallizers.

UNIT IV

Preparation of piping and instrumentation diagrams for a typical process.

Design of process equipment accessories and process piping.

Text and References

1. J. M. Coulson, J. F. Richardsona R. K. Sinnott, Chemical Engineering Vol. 6, Pergaman press International Ed., 1989.
2. L. E. Brownell and E. H. Young, Process equipment design, John Wiley and Sons, New York, 1968.
3. S. Walas, "Chemical Process Equipment Selection and Design", Butterworth, 1988.
4. M. V. Joshi, Process Equipment Design, McMillan, India, 1976.
5. Relevant Design Codes BS, IS and ASME

CH 310P Process Equipment Design										
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total marks
					MS	ES	IA	LW	LE/Viva	
--	--	2	1	2				25	25	50

List of Experiments

1. Design Preliminaries
2. Design of Reactor
3. Problem on design of reactor
4. Design of Agitator
5. Design of Tall vertical vessel
6. Testing of Equipment
7. Pressure Vessel design
8. Storage Tank design
9. Design of heads and closures
10. Design of Supports

CH 311T Process Dynamics and Control										
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total marks
					MS	ES	IA	LW	LE/Viva	
3	1	--	7	4	30	60	10	--	--	100

UNIT I

Introduction to Block diagrams, closed loop and open loop control systems, Basic control actions.

Open loop response of simple systems**:** Dynamics of first order systems using transfer functions; Various first order responses such as a thermometer bulb. General response to step, ramp, impulse, and sinusoidal inputs; Concentration and temperature responses of a stirred tank;

UNIT II

Linearization of liquid level systems; Response of a pressure system, second order systems, the manometer; Response of interacting and non interacting systems.

Transient response of control systems**:** Servo and regulated operation, General equations for the transient response, proportional control of a signal capacity process; Integral control, Proportional-integral control and derivative action.

UNIT III

Control Stability and analysis**:** Concept of stability, Stability criterion, Routh test for stability, Concept of root locus, Locus diagram

Frequency response analysis**:** First order systems, Bode diagram, and Complex numbers to get frequency response.

UNIT IV

Controller selection and tuning, Control valve characteristics and sizing, cascade control, Feed forward control. Introduction of digital control principles. Use of MATLAB for control designing

Text and References

1. D. R. Coughanowr, Process system analysis and control, 2nd ed, McGraw Hill, 1991.
2. P. Harriott, Process Control, Reprint of text, ed. Tata McGraw Hill, 1983.
3. G. Stephanopoulos, Chemical Process Control: An introduction to theory and practice, Prentice Hall, New Jersey, 1984.
4. B. Wayne Bequette, Process Control: Modeling, Design, and Simulation, Prentice Hall Professional (Technology & Engineering), 2003

CH 311P Process Dynamics and Control										
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total marks
					MS	ES	IA	LW	LE/Viva	
--	--	4	2	4				25	25	50

List of Experiments

1. To study the dynamics of given thermometer and compare the theoretical value of the time constant with experimental value.
2. To study the dynamics of liquid level in a tank and compare the experimental value of time constant with the experimental value. (for step input)
3. To study the dynamics of liquid level in a tank and compare the experimental value of time constant with the experimental value. (for Impulse)
4. To study the response of two first order system (tank) in series of the non – interacting system (For step input)
5. To study the response of two first order system (tank) in series of the non – interacting system (For Impulse)
6. To study the response of first order system in series of the interacting system (For step input)
7. To Study the response of first order system in series of the two interacting system. (for Impulse disturbance)
8. To develop approximation for nonlinear model to be linear & study the dynamics of liquid tank.
9. To develop approximation for nonlinear model to be linear & study the dynamics of liquid tank.(For Impulse distribution)
10. To determine the time constant of the given thermowell from its response to the change in the surrounding temperature.
11. To find out the response of first order mixing index.

CH 304 Modelling and optimization										
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total marks
					MS	ES	IA	LW	LE/Viva	
3	1	--	7	4	30	60	10	--	--	100

UNIT I

Single-variable optimization algorithms: Optimal problem formulation, Optimization algorithms,

Optimality criteria, Bracketing methods, Region-elimination methods, Point-estimation method, Gradient based methods, Root finding using optimization techniques. Multi-variable optimization algorithms: Unidirectional search, Direct search methods, Gradient based methods.

UNIT II

Constrained optimization algorithms: Kuhn-Tucker conditions, Transformation methods,

Sensitivity analysis, Direct search for constrained minimization, Linearized search techniques, Feasible direction method, Generalized reduced gradient method, Gradient projection method

Specialized algorithms: Integer programming, Geometric programming.

Nontraditional optimization algorithms: Genetic algorithms, Simulated annealing, Global optimization.

UNIT III

Introduction to mathematical modeling: Uses of Mathematical Models, Scope of Coverage, Principles of Formulation

Fundamental Laws: continuity equations, energy equations, equations of motion, transport equations, equations of state, equilibrium, chemical kinetics.

UNIT IV

Examples of Mathematical Models of Chemical Engineering Systems: Introduction, Series of Isothermal, Constant-Holdup CSTRs, CSTRs With Variable Holdups, Two Heated Tanks, Gas-Phase, Pressurized CSTR, Nonisothermal CSTR, Single-Component Vaporizer, Multicomponent Flash Drum, Batch Reactor, Reactor With Mass Transfer

Text and References:

1. Deb K., Optimization for Engineering Design, Algorithms and Examples, Prentice Hall of India, New Delhi 1996
2. T. F. Edgar and D. M. Himmelblau, Optimization of Chemical Processes**, 2ND** EDITION**,** McGraw-Hill, 2001
3. Luyben, Process Modeling, Simulation & Control for Chemical Engineers, Optimization of Chemical Processes**, 2**nd EDITION**,** McGraw- Hill, 2001

HS 311 SOCIAL SCIENCE APPROACHES TO DEVELOPMENT										
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total marks
					MS	ES	IA	LW	LE/Viva	
3	--	--	6	3	30	60	10	--	--	100

Unit I **06**

Development and Underdevelopment – Historical genesis, theories, social indicators and measures. Issues of Human Development, MDGs, Poverty and Inequality,

Unit II: **06**

Indian Experiences with Development – India's path of planning and mixed economy, Post Independence development experiences, Measures of Achievement of Indian Development, Phase of Economic reforms and liberalization.

Unit III: **07**

Structures and Frameworks of Development in India – Social Structures and Indian Development Processes of Decentralization, Institutions of Local Governance and impact on Development; Government-Market-Civil Society Interface.

Unit IV: **07**

Interrogation of the accepted paradigm of development – Gender, Religion, Caste, Environment; Appropriate Technology and Development

Approximate Total : 26 Hrs

References & Text Books:

1. Chakravarty.Sukhomoy: Development Planning : The Indian Experience, Clarendon press, Oxford
2. Kumar, D. And Bhattacharya, S.,Cambridge Economic History of India: Vol. 2, 1757-2003.Hyderabad: Orient Longman.
3. Mathur, B. L., (2002): Economic Planning and Development, Sublime Publications, New Delhi
4. Mkandawire, Thandika: Social Policy in a Development Context, UNRISD and Palgrave, New York,
5. Prabhu, K. Seetha: Economic Reforms and Social Sector Development: A study of Two Indian States, Sage, New Delhi
6. Rajneesh, S., S L Goel,: Panchayati Raj in India: Theory and Practice, Deep and Deep, New Delhi
7. Sachs, J.D., Varshney, A., and Bajpai, N, India in the era of economic reforms. New Delhi: Oxford University Press
8. Second Administrative Reforms Commission, Local Governance: An Inspiring Journey into Future, Sixth Report, GoI, New Delhi
9. Sen, Amartya, Reprinted, Inequality Reexamined, Oxford, New Delhi
10. Sen, Amartya, Development as Freedom, OUP, New Delhi
11. Singh, Katar, Rural Development: Principles, Policies and Management, Sage, New Delhi.

HS 312 SCIENCE AND HUMANISAM: TOWARDS A UNIFIED WORLD										
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total marks
					MS	ES	IA	LW	LE/Viva	
3	--	--	6	3	30	60	10	--	--	100

UNIT I

UNIT II

UNIT III

UNIT IV

Text and References

1.

HS 314 Organizational Psychology										
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total marks
					MS	ES	IA	LW	LE/Viva	
3	--	--	6	3	30	60	10	--	--	100

Course Content:-

Definition and explanation of the term, 'industrial psychology' or 'occupational psychology.'
Objectives for studying industrial psychology
Work place problems
Ideal workplace environment and its effects.
Motivation and leadership.
Organizational behaviour.
Relation between a personal and professional life.
Character, common sense and intellect.
Working in a team.
Crisis management.
Decision making in an organization.

Evaluation Parameters:-

Group Projects - 30
Mid- semester Exam – 20
Attendance in lecture – 05
Assignments - 05
End – Semester Exam – 40

Recommended Reading:

Leadership: Theory and Practice, Peter G. Northouse
Working with Emotional Intelligence, Daniel Goleman
Industrial Psychology, Bulm and Nailen
Occupational Stress in Bureaucracy, S. Kumar
The Seven Habits of Highly Effective People, Stephen Covey
First Break all the Rules, Marcus Buckingham and Curt Coffman.
Organization and Management, R D. Agarwal

Industrial Training										

Guidelines while performing the Industrial Training

You may carry on with your Industrial training in a given company as per the direction of the company management.

Following additional points to be observed and should be reported for a given industry/plant etc.

1. Study of DCS and Scada systems
2. Identification of pipe fittings
3. In-depth knowledge of instrument type
4. Types of pumps, blowers, compressors, heat exchanges
5. Reaction controllers in a reactor
6. Control mechanism of each equipment
7. P&I diagram in field of safety
8. Equipment design and codes, guidelines and codes
9. Industrial safety aspects
10. Industrial standards
11. Mini project can be taken up in consultation with the department and/or the division/section/plant where candidate is taking up the industrial training based on the current and/or existing live problems. Subsequently the report should contain the detail write-up and discussion on the same for evaluation.