

PROGRAMME: B.Tech
CHEMICAL ENGINEERING
CURRICULUM

SEMESTER-1										
Sl. No.	COURSE TYPE	COURSE CODE	COURSE TITLE	L	T	P	C	Marks		PAGE No.
								CAE	ESE	
1	Theory	SMTA1101	Engineering Mathematics-I	3	*	0	3	50	50	
2	Theory	SCHA1101	Principles of Chemical Engineering	3	*	0	3	50	50	
3	Theory	SCHA1102	Material Sciences	3	0	0	3	50	50	
4	Theory	SCSA1102	Fundamentals of Python Programming	3	*	0	3	50	50	
5	Theory	SCYA1101	Engineering Chemistry	3	1	0	4	50	50	
6	Practical	SCYA2101	Chemistry Laboratory	0	0	4	1	25	25	
7	Practical	SCSA2102	Fundamentals of Python Programming Lab	0	0	4	2	50	50	
8	Practical	SCHA2103	Technical Analysis and Instrumentation Lab	0	0	4	2	50	50	
9	Theory	SBTA1101	Environmental Science and Engineering	2	0	0	0	0	0	
Total Credits for 1 st semester = 21										
Total Marks for 1 st semester = 750										

SEMESTER-2										
Sl. No.	Course type	Course code	Course title	L	T	P	C	Marks		Page No.
								CAE	ESE	
1	Theory	SMTA1201	Engineering Mathematics II	3	0	0	3	50	50	
2	Theory	SPHA1101	Physics for Engineers	3	1	0	4	50	50	
3	Theory	SCHA1201	Mechanical Operations	3	0	0	3	50	50	
4	Theory	SEEA1101	Basic Electrical and Electronics Engineering	3	0	0	3	50	50	
5	Theory	SMEA1102	Engineering Drawing	3	*	0	3	50	50	
6	Theory	SHSA1101	Technical English	3	0	0	3	50	50	
7	Practical	SMEA2201	Workshop Practice	0	0	4	2	50	50	
8	Practical	SPHY2101	Physics Laboratory	0	0	2	1	25	25	
Total Credits for 2 nd semester = 22										
Total Marks for 2 nd semester = 750										

L - LECTURE HOURS, T – TUTORIAL HOURS, P – PRACTICAL HOURS, C – CREDITS

CAE – CONTINUOUS ASSESSMENT EXAMINATION,

ESE – END SEMESTER EXAMINATION,

SEMESTER-3										
Sl. No.	Course type	Course code	Course title	L	T	P	C	Marks		Page No.
								CAE	ESE	
1	Theory	SMTA1301	Engineering Mathematics – III	3	0	0	3	50	50	
2	Theory	SCHA1301	Heat Transfer	3	*	0	3	50	50	
3	Theory	SCHA1202	Chemical Engineering Thermodynamics - I	3	*	0	3	50	50	
4	Theory	SCHA1303	Fluid Mechanics	3	0	0	3	50	50	
5	Theory	SCHA1304	Chemical Process Calculations	3	*	0	3	50	50	
6	Theory	SCHA1305	Chemical Process Technology	3	0	0	3	50	50	
7	Practical	SCHA2306	Organic Chemical Process and Thermodynamics Lab	0	0	4	2	50	50	
8	Practical	SCHA2307	Unit Operations Lab	0	0	4	2	50	50	
Total Credits for 3 rd semester = 22										
Total Marks for 3 rd semester = 800										

SEMESTER- 4										
Sl. No.	Course type	Course code	Course title	L	T	P	C	Marks		Page No.
								CAE	ESE	
1	Theory	SMTA1401	Engineering Mathematics – IV	3	0	0	3	50	50	
2	Theory	SCHA1401	Mass Transfer – I	3	0	0	3	50	50	
3	Theory	SCHA1402	Chemical Reaction Engineering – I	3	*	0	3	50	50	
4	Theory	SAIC4001	Industry 4.0 (Open Elective- 1)	3	0	0	2	50	50	
5	Theory	SAIC4003	Universal Human Values	3	*	0	3	50	50	
6	Theory	SCHA1302	Chemical Engineering Thermodynamics – II	3	*	0	3	50	50	
7	Practical	SCHA2404	Heat Transfer Lab	0	0	4	2	50	50	
8	Practical	SCHA2405	Mass Transfer Lab	0	0	4	2	50	50	
Total Credits for 4 th semester = 21										
Total Marks for 4 th semester = 800										

L - LECTURE HOURS, T – TUTORIAL HOURS, P – PRACTICAL HOURS, C – CREDITS
 CAE – CONTINUOUS ASSESSMENT EXAMINATION, ESE – END SEMESTER EXAMINATION,
 VIVA – VIVAVOCE

SEMESTER- 5										
Sl. No.	Course type	Course code	Course title	L	T	P	C	Marks		Page No.
								CAE	ESE	
1	Theory	SCHA1501	Mass Transfer – II	3	*	0	3	50	50	
2	Theory	SCHA1502	Process Engineering Economics	3	0	0	3	50	50	
3	Theory	SCHA1503	Instrumentation and Process Control	3	*	0	3	50	50	
4	Theory	SCHA1504	Chemical Reaction Engineering - II	3	*	0	3	50	50	
5	Theory		Professional Elective – 1	3	0	0	3	50	50	
6	Theory		Open Elective -2	3	0	0	3	50	50	
7	Practical	SCHA2505	Chemical Reaction Engineering Lab	0	0	4	2	50	50	
8	Practical	SCHA2506	MAT Lab	0	0	4	2	50	50	
9	Practical	S19APT1	Professional Training	0	0	4	2		100	
Total Credits for 5 th semester = 24										
Total Marks for 5 th semester = 900										

SEMESTER- 6										
Sl. No.	Course type	Course code	Course title	L	T	P	C	Marks		Page No.
								CAE	ESE	
1	Theory	SCHA1601	Biochemical Engineering	3	0	0	3	50	50	
2	Theory	SCHA1602	Transport Phenomena	3	*	0	3	50	50	
3	Theory		Professional Elective – 2	3	0	0	3	50	50	
4	Theory		Open Elective – 3	3	0	0	3	50	50	
5	Theory	SCHA1403	Computational Fluid Dynamics	3	0	0	3	50	50	
6	Practical	SCHA2603	Process Dynamics and Control Lab	0	0	4	2	50	50	
7	Practical	SCHA2604	Process Equipment Design and Drawing Lab	0	0	4	2	50	50	
8	Practical	S19APT2	Interdisciplinary project	0	0	6	3		100	
Total Credits for 6 th semester = 22										
Total Marks for 6 th semester = 800										

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 CAE – CONTINUOUS ASSESSMENT EXAMINATION, ESE – END SEMESTER EXAMINATION,
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SEMESTER-7										
Sl. No.	Course type	Course code	Course title	L	T	P	C	Marks		Page No.
								CAE	ESE	
1	Theory	SCHA1701	Process modeling and Simulation	3	0	0	3	50	50	
2	Theory	SCHA1702	Process Engineering	3	0	0	3	50	50	
3	Theory		Professional Elective – 3	3	0	0	3	50	50	
4	Theory		Open Elective – 4	3	0	0	3	50	50	
5	Practical	SCHA2703	Process Simulation Lab	0	0	4	2	50	50	
6	Practical	S19APROJ1	Project Phase I	0	0	6	3		100	
Total Credits for 7 th semester = 17										
Total Marks for 7 th semester = 600										

SEMESTER-8										
Sl. No.	Course type	Course code	Course title	L	T	P	C	Marks		Page No.
								CAE	ESE	
1	Theory	SBAA4001	Principles of Management	3	0	0	3	50	50	
2	Theory		Professional Elective – 4	3	0	0	3	50	50	
3	Practical	S19APROJ2	Project Phase II	0	0	14	7		100	
Total Credits for 8 th semester = 13										
Total Marks for 8 th semester = 300										

L - LECTURE HOURS, T – TUTORIAL HOURS, P – PRACTICAL HOURS, C – CREDITS
 CAE – CONTINUOUS ASSESSMENT EXAMINATION, ESE – END SEMESTER EXAMINATION,
 VIVA – VIVAVOCE

Semester	Theory courses (including elective courses)			Practical Courses (including PT and project)		
	Total no.	Total Credits	Total Marks	Total no.	Total Credits	Total Marks
1	6	16	500	3	5	250
2	6	19	600	2	3	150
3	6	18	600	2	4	200
4	6	17	600	2	4	200
5	6	18	600	3	6	300
6	5	15	500	3	7	300
7	4	12	400	2	5	200
8	2	6	200	1	7	100
Overall Total	41	121	4000	18	41	1700

Overall total credits for B.Tech Chemical	162
Overall total marks for B.Tech Chemical	5700

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 CAE – CONTINUOUS ASSESSMENT EXAMINATION, ESE – END SEMESTER EXAMINATION,
 VIVA – VIVAVOCE

LIST OF ELECTIVES

PROFESSIONAL ELECTIVES									
Sl. No.	Course code	Course title	L	T	P	C	Marks		Page No.
							CAE	ESE	
1	SCHA3001	Optimization of chemical processes	3	0	0	3	50	50	
2	SCHA3002	Petroleum and petro chemical technology	3	0	0	3	50	50	
3	SCHA3003	Instrumental methods of analysis	3	0	0	3	50	50	
4	SCHA3004	Fertilizer technology	3	0	0	3	50	50	
5	SCHA3005	Advanced separation processes	3	0	0	3	50	50	
6	SCHA3006	Industrial catalysis	3	0	0	3	50	50	
7	SCHA3007	Fluidization engineering	3	0	0	3	50	50	
8	SCHA3008	Food technology	3	0	0	3	50	50	
9	SCHA3009	Drugs and pharmaceutical technology	3	0	0	3	50	50	
10	SCHA3010	Industrial Safety and Hazard analysis	3	0	0	3	50	50	
11	SCHA3011	Green Technology	3	0	0	3	50	50	
12	SCHA3012	Smart materials for Industries	3	0	0	3	50	50	
13	SCHA3013	Computational methods in Chemical Engineering	3	0	0	3	50	50	
14	SCHA4005	Industry 4.0 for Bio and Chemical Engineering (PBLA)				2			

SCHA1101	PRINCIPLES OF CHEMICAL ENGINEERING	L	T	P	C	Max. Marks
		3	0	0	3	100

COURSE OBJECTIVE:

- To introduce and provide an overview of chemical engineering.
- To enable the students to learn about the fluid flow, heat transfer and mass transfer in engineering applications.

UNIT 1: CHEMISTRY, CHEMICAL ENGINEERING AND CHEMICAL TECHNOLOGY**9 Hours**

Chemical process industries: History and their role in Society; Role of Chemical Engineer; History and Personalities of Chemical Engineering; Greatest achievements of Chemical Engineering, **Challenges in Petroleum sector.**

UNIT 2: COMPONENTS OF CHEMICAL ENGINEERING**9 Hours**

Role of importance of Basic sciences in chemical engineering. Batch Processing, **Safety issues in Scale up to Commercial scale.** Dimensionless Analysis: Dimensionless numbers. Application of Dimensional Analysis to a Reactor.

UNIT 3: CONCEPT OF UNIT PROCESSES AND UNIT OPERATIONS**9 Hours**

Description of different Unit Processes and Unit Operations; **Designing of equipment; Flowsheet representation of process plants,** Evolution of an Industry – Sulphuric acid and Soda ash manufacture. Demonstration of simple chemical engineering experiments; Plant visit to a chemical industry

UNIT 4: ROLE OF COMPUTER IN CHEMICAL ENGINEERING**9 Hours**

Chemical Engineering Software; Visit to Process Simulation Lab; Relation between Chemical Engineering and other engineering disciplines; Traditional vs. modern Chemical Engineering; Versatility of Chemical Engineering; Role of Chemical Engineers in the area of Food, Medical, Energy, Environmental, Biochemical, Electronics etc.

UNIT 5: SAFETY ENVIRONMENT AND ETHICS FOR CHEMICAL ENGINEERS**9 Hours**

Paradigm shifts in Chemical Engineering; Range of scales in Chemical Engineering; Opportunities for Chemical Engineers; Future of Chemical Engineering. **Safety in Chemical Process Industries,** Hazards – Case studies.

Max.45 Hours**COURSE OUTCOMES:**

- CO1. Understand the history and development of chemical industry since origin
- CO2. Examine the role and functions of chemical engineers in the engineering industry and to know the basics of interdisciplinary engineering fields.
- CO3. Analyze the relation between various unit operations and unit processes and to develop the process flow diagram.
- CO4. Justify the role of computers in the application of chemical engineering fields
- CO5. Identify the hazards and safety ethics in process industries
- CO6. Evaluate the challenges for the chemical engineers in future

TEXT / REFERENCE BOOKS

- Anantharaman N., MeeraSheriffa Begum K. M., Mass Transfer Theory and Practice, 1st Edition, PHI, 2011.
- Dryden, C.E., "Outlines of Chemicals Technology", Edited and Revised by Gopala Rao, M. and M.Sittig, 3rd Edition, Affiliated East-West press, 2000.
- McCabe, W.L., Smith, J. C. and Harriot, P. "Unit operations in Chemical Engineering", McGraw Hill, 7th Edition, 2001
- Finlayson, B. A., Introduction to Chemical Engineering Computing, John Wiley & Sons, New Jersey, 2006.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max Marks: 100

Part A: 10 questions of 2 marks each - No choice

Part B: 2 questions from each unit of internal choice; each carrying 16 marks

Examination duration: 3 Hours

20 Marks

80 Marks

SCSA1102	FUNDAMENTALS OF PYTHON PROGRAMMING	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

1. To understand why Python is a useful scripting language for developers.
2. To learn how to use lists, tuples, and dictionaries in Python programs.
3. To learn how to build and package Python modules for reusability.
4. To learn how to read and write files in Python.
5. To learn how to use exception handling in Python applications for error handling.
6. To learn how to design and program Python applications.

UNIT 1 INTRODUCTION**9Hrs**

History of Python- Introduction to the IDL Interpreter(shell)-Expressions–DataTypes-Built-infunction- Conditional statements- Iterative statements-Input/output-CompoundDataTypes-Nested compound statements–Introduction to Object Oriented Concepts.

UNIT 2 FILES AND EXCEPTIONS HANDLING , MODULES, PACKAGES**9Hrs**

File Operations–Iterators-Exception handling-Regular Expressions- Creating Modules-Import Statement-Introduction to PIP- Installing Packages via PIP-Using Python Packages

UNIT 3 GUI PROGRAMMING**9Hrs**

GUI Programming in Python-Introduction to GUI library-Layout management-Events and bindings-Fonts–Colours-Canvas- Widgets(frame,label,button,checkbox,entry, listbox, message ,radiobutton ,text, spinbox).

UNIT 4 DATABASE AND NETWORK**9Hrs**

Database(using NoSQL):ConnectorModule–Cursor–Statements-Exceptions in database.
Network connectivity:Socket module-Client–Server–Email–URL Access

UNIT 5 CASE STUDY**9Hrs**

Web Programming using Python. Image Processing–Facebook Analysis–Twitter Analysis.

COURSE OUTCOMES On completion of the course the student will be able to

- CO1- Describe primary goals of basic python using data, expression, statements and Apply the best features of mathematics, engineering and natural science to program real life problems using math functions, Regular expression.
- CO2- Design GUI Application in Python and to apply different database operations.
- CO3 -Evaluate information and choose appropriate action using Decision making or Control Structures in python
- CO4 -Understand and Develop Client Server Network Application using Python
- CO5 - Illustrate string and compound data using the List, Tuples and Dictionaries in Python
- CO6 -Create real world problems with creative thinking and solution of the with cost effectiveness.

Text Books/Reference Books

1. Y.Daniel Liang, Introduction to Programming Using Python, Pearson, 2013.
2. Paul Gries, Jennifer Campbell, Jason Montojo, Practical Programming:
3. An Introduction to Computer Science Using Python 3, Pragmatic Bookshelf, 2/E 2014
4. Magnus Lie Hetland, Beginning Python: From Novice to Professional, Apress

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max Marks: 100

Examination duration: 3 Hours

Part A: 10 questions of 2 marks each - No choice

20 Marks

Part B: 2 questions from each unit of internal choice; each carrying 16 marks

80 Marks

SBTA1101	ENVIRONMENTAL SCIENCE AND ENGINEERING	L	T	P	C	Max. Marks
		0	0	0	0	100

COURSE OBJECTIVE:

- To impart knowledge on the issues related to environment and to emphasize the importance of a clean environment.

UNIT 1: INTRODUCTION TO ENVIRONMENTAL STUDIES AND NATURAL RESOURCES**9 Hours**

Definition, scope and importance, need for public awareness, forest resources: use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams, floods, drought, conflicts over water, dams-benefits and problems, mineral resources: use effects on forests and tribal people. water resources: use and over-utilization of surface and ground water, exploitation, environmental effects of extracting and using mineral resources, case studies – food resources: world food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. Energy resources: growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources: Case studies. Land resources: land as a resource, land degradation, man induced landslides, soil erosion and desertification, role of an individual in conservation of natural resources, equitable use of resources for sustainable lifestyles.

UNIT 2: ECOSYSTEMS AND BIODIVERSITY**9 Hours**

Concept of an ecosystem, structure and function of an ecosystem - producers, consumers and decomposers - energy flow in the ecosystem, ecological succession, food chains, food webs and ecological pyramids. Introduction, types, characteristic features, structure and function of the (a) forest ecosystem (b) grassland ecosystem (c) desert ecosystem (d) aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries). Introduction to biodiversity, definition: genetic, species and ecosystem diversity - biogeographical classification of India - value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values, biodiversity at global, national and local levels. India as a mega-diversity nation, hot-spots of biodiversity, threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts, endangered and endemic species of India, conservation of biodiversity, in-situ and ex-situ conservation of biodiversity.

UNIT 3: ENVIRONMENTAL POLLUTION**9 Hours**

Definition - causes, effects and control measures of: (a) air pollution (b) water pollution (c) soil pollution (d) marine pollution (e) noise pollution (f) thermal pollution (g) nuclear hazards. Solid waste management: causes, effects and control measures of urban and industrial wastes, role of an individual in prevention of pollution, pollution case studies, disaster management: floods, earthquake, cyclone and landslides.

UNIT 4: SOCIAL ISSUES AND THE ENVIRONMENT**9 Hours**

From unsustainable to sustainable development, urban problems related to energy, water conservation, rain water harvesting, watershed management, resettlement and rehabilitation of people, its problems and concerns, case studies, environmental ethics: issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, case studies. Wasteland reclamation, consumerism and waste products – environment protection act: air (prevention and control of pollution) act - water (prevention and control of pollution) act, wildlife protection act; forest conservation act. Issues involved in enforcement of environmental legislation, Key initiatives of Rio declaration, Vienna convention, Kyoto protocol, Johannesburg summit and public awareness.

UNIT 5: HUMAN POPULATION AND THE ENVIRONMENT**9 Hours**

Population growth, variation among nations, population explosion, family welfare programme, environment and human health, human rights, value education, HIV / AIDS, women and child welfare, role of information technology in environment and human health, case studies. Visit to a local area to document environmental assets-river/forest/grassland/hill/mountain. Visit to a local polluted site-urban/rural/ industrial/agricultural-study of common plants, insects, birds-study of simple ecosystems, pond, river, hill slopes etc.

Max.45 Hours**COURSE OUTCOMES:**

- CO1. To identify, formulate, and solve environmental engineering problems using the techniques, skills, and modern engineering tools necessary for environmental engineering practice
- CO2. To design systems, processes and equipment for control and remediation of water, air, and soil quality environment within realistic constraints of economic affordability and social acceptability
- CO3. To assess the potential environmental impacts of development projects and design mitigation measures
- CO4. To have basic knowledge about environment protection and operation of pollution control devices
- CO5. To design and conduct experiments, as well as interpret data and communicate effectively
- CO6. To function in multi-disciplinary teams and understand the ethical and professional responsibility

TEXT / REFERENCE BOOKS

- Meenakshi. P, Elements of Environmental Science and Engineering, 1st Edition, Prentice Hall of India, New Delhi, 2009.
- Ravikrishnan. A, Environmental Science & Engineering, 3rd Edition, Sri Krishna Publications, Chennai, 2008.
- Wright. R. T & Nebel B.J, Environmental science-towards a sustainable future by Richard 9th edition, Prentice Hall of India, New Delhi, 2011.
- ErachBharucha, Text Book of Environmental Studies, 3rd Edition, University Press, Chennai, 2010.
- Gilbert M.Masters, "Introduction to Environmental Engineering and Science," 4th Edition, Pearson education, 2012.

SCHA1301	HEAT TRANSFER	L	T	P	C	Max. Marks
		3	0	0	3	100

COURSE OBJECTIVE:

- To provide an adequate knowledge on different modes of heat transfer and their applications in process industries.

UNIT 1: INTRODUCTION TO MODES OF HEAT TRANSFER**9 Hours**

Basic Considerations: Importance of heat transfer in Chemical Engineering operations. Modes of heat transfer. Mean temperature difference. Conduction: Concept of heat conduction. Fourier's law of heat conduction. One-dimensional steady state heat conduction equation for flat plate, hollow cylinder and hollow sphere. Heat conduction through a series of resistances. Critical thickness of insulation, Analogy between flow of heat and flow of electricity. Thermal conductivity, Conduction through liquids. Conduction through extended surfaces.

UNIT 2: CONVECTIVE HEAT TRANSFER PROCESSES**9 Hours**

Film Coefficients and their applications: Individual and overall heat transfer coefficients and relationship between them. Transient heat conduction. Convection: Concept of heat transfer by convection. Natural and forced convection. Applications of dimensional analysis for convection. Derivation of equations for forced convection under laminar, transition and turbulent conditions. Equations for natural convections. Heat transfer from condensing vapors. Heat transfer to boiling liquids. Influence of boundary layer on heat transfer.

UNIT 3: HEAT EXCHANGERS**9 Hours**

Parallel and counter flow heat exchangers. Log mean temperature difference. Single pass and multi pass heat exchangers. Plate heat exchangers. Use of correction factor charts. Heat exchanger effectiveness and its use. Number of transfer units charts for different configurations. Fouling factor and Wilson's plot. Various types of heat exchangers. Heat exchanger design. Design of condensers. Effect of non-condensable. Heat transfer equipment auxiliaries: Steam trap.

UNIT 4: RADIATION**9 Hours**

Concept of thermal radiation. Concept of black and gray bodies. Stefan-Boltzmann law. Kirchoff's law. Radiation between surfaces. Radiation from gases. Clouds of particles and luminous flames. Radiation error in temperature measurement. Radiation from shields. Radiation shape factor and relations between shape factor. Combined heat transfers by conduction and convection in radiation.

UNIT 5: EVAPORATION**9 Hours**

Introduction. Types of evaporators. Single and multiple effect evaporation. Capacity and economy of multi effect evaporators. Thermo re-compression evaporators Vapour re-compression and thermal re-compression evaporators, Effect of liquid head and boiling point elevation. Duhring's rule. Liquid characteristics. Material and energy balance in evaporators. Illustrated examples.

Max.45 Hours**COURSE OUTCOMES:**

- CO1. Understand the real time applications of solid medium heat transfer
- CO2. Develop the real time application of fluid medium heat transfer
- CO3. Calculate the overall heat transfer coefficients in designing heat exchangers
- CO4. Solve radiative problems and apply knowledge to thermal engineering problems
- CO5. Design of Evaporators
- CO6. Apply the heat transfer principles with phase change (boiling and condensation) and evaporation

TEXT / REFERENCE BOOKS

- McCabe M.L. and Smith J.C., Unit Operations in Chemical Engineering, 7th Edition, McGraw Hill, 2009.
- Donald Q. Kern, Processes Heat Transfer, 5th Edition, Tata McGraw Hill, 2001.
- McAdams W.H., Heat Transmission, 5th Edition, McGraw Hill, 2011.
- Necati Ozisik M., Basic Heat Transfer, 4th Edition, McGraw Hill and Kogakusha, 2002.
- Holman, J.P., Heat Transfer, 9th ed., Tata McGraw-Hill, 2004.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max Marks: 100

Part A: 10 questions of 2 marks each - No choice

Part B: 2 questions from each unit of internal choice; each carrying 16 marks

Examination duration: 3 Hours

20 Marks

80 Marks

SCHA1303	FLUID MECHANICS	L	T	P	C	Max. Marks
		3	0	0	3	100

COURSE OBJECTIVE:

- To impart to the student knowledge on fluid properties, fluid statics, dynamic characteristics for through pipes and porous medium, flow measurement and fluid machineries.

UNIT 1: FLUID FLOW PHENOMENA**9 Hours**

Nature of fluids-properties of fluids, incompressible and compressible, hydrostatic equilibrium. Manometers U-Tube and inclined. Potential flow, boundary layer, the velocity field, laminar flow, Newtonian and Non Newtonian fluids, Newton's law of viscosity, turbulence. Reynolds number and transition from laminar to turbulent flow, Eddy viscosity, flow in boundary layers, laminar and turbulent flow in boundary layers, boundary layer formation in straight tubes.

UNIT 2: KINEMATICS OF FLUID FLOW**9 Hours**

Streamlines and stream tubes, equation of continuity, Bernoulli equation. Flow of incompressible fluids in conduits and thin layers: friction factor, relationships between skin friction parameters, average velocity for laminar flow of Newtonian fluids, Hagen-Poiseuille equation, hydraulically smooth pipe, von Karman equation, roughness parameter, friction-factor chart, equivalent diameter. Form frictional losses in Bernoulli's equation, couette flow.

UNIT 3: FLOW PAST IMMERSED BODIES AND FLUIDIZATION**9 Hours**

Drag and drag coefficients. Drag coefficients of typical shapes, Ergun equation, terminal settling velocity, free and hindered settlings, Stokes' law, Newton's law, criterion for settling regime. Fluidization, conditions for fluidization, minimum fluidization velocity.

UNIT 4: TRANSPORTATION OF FLUIDS**9 Hours**

Introduction to pipe and tubing, joint and fittings, stuffing boxes, mechanical seals, gate valves and globe valves, plug cocks and ball valves, check valves. Classification and selection of pumps, blowers and compressors. Pumps, developed head, power requirement, suction lift and cavitation, NPSH, constructional and working principle of single-suction volute centrifugal pump, Characteristics curves of centrifugal and reciprocating pump.

UNIT 5: METERING OF FLUIDS**9 Hours**

Constructional features and working principles of Venturi meter, Orifice meter, Area meters-Rota meter, Point velocity-Pitot tube, V-element meter, Target meter-ultrasonic meters, vortex shredding meter, magnetic meters, turbine meter. Application of Bernoulli's equation to venturi and orifice meter, flow rate measurements.

Max.45 Hours**COURSE OUTCOMES:**

- CO1. Understand the fundamental aspects of fluid –flow phenomena
 CO2. Analyze the fluid kinetics
 CO3. Compute the ΔP for the flow past immersed bodies
 CO4. Determine the principle and operation of various aspects of transportation of fluids.
 CO5. Apply the concepts of metering of fluids in the selection of flow meters
 CO6. Analyze the criteria for settling regime

TEXT / REFERENCE BOOKS

- McCabe, W.L, Smith J.C and Harriot. P., Unit Operations in Chemical Engineering, 7th Edition, Mc-Graw-Hill, 2009.
- Bansal R K, Text book of Fluid Mechanics, Lakshmi Publication, 2008.
- Coulson J.M. and Richardson J.E., Chemical Engineering, Volume 1, 3rd Edition, Pergamon Press, 2000.
- White, F.M., Fluid Mechanics, 4th Edition, McGraw-Hill Inc., 2000.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max Marks: 100

Part A: 10 questions of 2 marks each - No choice

Part B: 2 questions from each unit of internal choice; each carrying 16 marks

Examination duration: 3 Hours

20 Marks

80 Marks

SCHA1304	CHEMICAL PROCESS CALCULATIONS	L	T	P	C	Max. Marks
		3	0	0	3	100

COURSE OBJECTIVE:

- To perform stoichiometric calculations for chemical and non-chemical systems and to understand quantitative relationships between matter and energy involved in physiochemical processes.

UNIT 1: INTRODUCTION**12Hours**

Units and Dimensions, Basic and derived units, use of model units in calculations, Methods of expressing, compositions of mixture and solutions. Gas Calculations: Ideal and real gas laws, Gas constant, Calculations of pressure, volume and temperature using ideal gas law. Use of partial pressure and pure component volume in gas calculations, applications of real gas relationship in gas calculation.

UNIT 2: : MATERIAL BALANCE WITHOUT CHEMICAL REACTION**12Hours**

Application of material balance to unit operations like distillation, evaporation, crystallization, extraction, absorption and stripping, drying, mixing.

UNIT 3: MATERIAL BALANCE WITH CHEMICAL REACTION**12Hours**

Stoichiometric principles, Limiting and excess reactant, conversion, selectivity and yield. Application of material balance to systems with recycle, bypass and purging.

UNIT 4: FUELS AND COMBUSTION**12Hours**

Determination of Composition by Orsat analysis of products of combustion of solid, liquid and gaseous fuels - Calculation of excess air from orsat technique, problems on sulphur and sulphur containing compounds.

UNIT 5: ENERGY BALANCE**12Hours**

Heat capacity of solids, liquids and gases, mean heat capacity, sensible heat and latent heat, evaluation of enthalpy, Standard heat of reaction, heat of formation, combustion, solution, mixing. Calculation of standard heat of reaction, Effect of pressure and temperature on heat of reaction - Energy balance for systems with and without chemical reaction

Max.60Hours**COURSE OUTCOMES:**

- CO1. Make the conversions for temperature, pressure, energy, concentration etc.
 CO2. Carry out material balance for various unit operations without reaction
 CO3. Perform the material balance with chemical reaction
 CO4. Calculate conversion, recycle ratio for the system involving recycling/purge/bypass streams
 CO5. Carry out energy balance for various systems with and without chemical reaction
 CO6. Analyze the fuel composition and flue gas analysis

TEXT / REFERENCE BOOKS

- Himmelblau, D.M., Basic Principles and Calculations in Chemical Engineering, 8th Edition, Prentice Hall Inc., 2012.
- K. V. Narayanan, B. Lakshmikutty, Stoichiometry and Process Calculations, 2nd Edition, Prentice Hall of India Pvt. Ltd., 2016.
- Venkataramani, V and Anantharaman.N., Process Calculations, 2nd Edition, Prentice Hall of India Pvt. Ltd., 2011.
- Bhatt, B.L., Vora, S.M., Stoichiometry, 5th Edition, Tata McGraw-Hill, 2011.
- Richard M. Felder, Ronald W. Rousseau, Elementary Principles of Chemical Processes, 3rd Edition, John Wiley & Sons, Inc. Singapore, 2017.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max Marks: 100

Part A: 10 questions of 2 marks each - No choice

Part B: 2 questions from each unit of internal choice; each carrying 16 marks

Examination duration: 3 Hours

20 Marks

80 Marks

SCHA1305	CHEMICAL PROCESS TECHNOLOGY	L	T	P	C	Max. Marks
		3	0	0	3	100

COURSE OBJECTIVE: This course helps the students to understand the various processes involved in chemical industries for the production of organic and inorganic chemicals

UNIT 1 INTRODUCTION - CHLORO ALKALI INDUSTRIES

9 hours.

Introduction - Basic principles of unit operations and unit process to common devices used in manufacturing processes like Reactors, Steam jet ejectors, Pumps, Thickeners, Dryers, Electrostatic precipitators, Condenser, Vacuum evaporator in block diagram - Standard symbols used for such devices, Process flow sheet. Manufacturing of soda ash, caustic soda and chlorine - manufacture of bleaching powder.

UNIT 2 SULPHUR, SULPHURIC ACID AND SILICATE INDUSTRIES

9 hours.

Mining and manufacture of sulphur, recovery of sulphur from polluting gases, sulphur trioxide and sulphuric acid, hydrochloric acid, sodium sulphate, sodium thiosulphate. Manufacture of Portland cement, Manufacture of Glasses and Special glasses.

UNIT 3 INDUSTRIAL GASES AND PAINTS

9 hours.

Manufacture of Carbon dioxide, Hydrogen, Oxygen, Nitrogen, Acetylene, Water Gas, Producer Gas, Production of Natural Gas. Introduction of Paints, Pigments, Emulsions and Varnishes, Manufacture of Paints, Manufacture of White and Coloured Pigments.

UNIT 4 NATURAL PRODUCTS

9 hours.

Edible and essential oils, soaps and detergents, glycerin, pulp and paper, starch and its derivatives, Manufacturing of sugar.

UNIT 5 SYNTHETIC ORGANIC CHEMICALS

9 hours.

Methane and synthesis gas, ethylene, acetylene and propylene. Aromatic chemicals - Benzene, toluene, and xylene. Production of thermo-plastic and thermo-setting resins: polyethylene, polypropylene, and Polyvinyl chloride, Polymers and their engineering applications. Polyamides and polyesters and processes for the production of natural and synthetic rubber.

Course Outcomes:

- CO1 - Demonstrate the schematic representation of various unit process and operation
- CO2 - Analyze the various methods of manufacturing process pertain to chloro -alkali industry
- CO3 - Explain the various techniques for sulfuric acid manufacturing
- CO4 - Apply the basic fundamentals in manufacturing of industrial gases and paints
- CO5 - Develop the flow sheet for the manufacturing of natural products
- CO6 - Develop the flow sheet for the production of synthetic organic chemicals

REFERENCE BOOKS:

- Gopala Rao. M. and Marshall Sittig, "Dryden's Outlines of Chemical Technology", 3rd Edn., EastWest Press, New Delhi, 2008
- George .T Austin, "Shreve's Chemical Process Industries", 8th Edn., McGraw-Hill International Editions, Singapore, 2002.
- Srikumar Koyikkal, "Chemical Process Technology and Simulation", 3rd Edn PHI Learning Ltd, 2013.
- Shukla and G.N. Pandey "Text book on Chemical Technology", 2nd Edn, Vikas publishing company, 2001

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max Marks: 100

Part A: 10 questions of 2 marks each - No choice

Part B: 2 questions from each unit of internal choice; each carrying 16 marks

Examination duration: 3 Hours

20 Marks

80 Marks

SCHA1402	CHEMICAL REACTION ENGINEERING - I	L	T	P	C	Max. Marks
		3	0	0	3	100

COURSE OBJECTIVE:

- To impart knowledge on the kinetics of isothermal and non-isothermal reactions for simple and multiple reactors.

UNIT 1: INTREPRETATION OF REACTOR DATA**9 Hours**

Classification of reactions, reaction rate, rate constant, order, molecularity, concentration dependent term of rate equation, temperature dependent term of rate equation, arrhenius theory, collision theory, transition state theory, kinetics of non-elementary reactions, integral and differential methods for finding order of reaction, half-life period, constant volume and variable volume reaction.

UNIT 2: DESIGN OF SINGLE IDEAL REACTORS**9 Hours**

Material balance, Energy balance, batch operation, continuous operation, semi-batch operation, ideal conditions, design of ideal batch reactor, ideal plug flow reactor, ideal mixed flow reactor, semi-batch reactor, recycle reactor.

UNIT 3: DESIGN OF MULTIPLE REACTOR SYSTEMS**9 Hours**

Mixed flow reactors in series and parallel connection, Plug flow reactors in series and parallel connection, reactors of different types in series, size comparison of reactors using performance charts.

UNIT 4: MULTIPLE REACTIONS**9 Hours**

Series reactions, parallel reactions, series-parallel reactions, qualitative discussion about product distribution in mixed flow reactor and plug flow reactor, quantitative treatment of product distribution in mixed flow reactor and plug flow reactor, overall fractional yield, instantaneous fractional yield, selectivity.

UNIT 5: NON-ISOTHERMAL REACTIONS**9 Hours**

Heat of reaction, equilibrium constants from thermodynamics, equilibrium conversion, temperature effects on chemical reaction rates, optimum temperature progression, size of reactor. design procedures for adiabatic and non-isothermal operation of batch and flow reactors, reactor stability, exothermic reactions in mixed flow reactors.

Max.45 Hours**COURSE OUTCOMES:**

The student will be able to

- CO1. Apply basic concepts of reaction kinetics
- CO2. Design performance equations for ideal reactors
- CO3. Analyze design aspects for multiple reactors
- CO4. Evaluate product distribution of multiple reactions
- CO5. Demonstrate the effect of temperature and pressure on conversion
- CO6. Develop skills to design reactors for non-isothermal operations

TEXT / REFERENCE BOOKS

- Levenspiel, O., Chemical Reaction Engineering, 3rd Edition, John Wiley & Sons, New York, 2007.
- Fogler, H.S., Elements of Chemical Reaction Engineering, 5th Edition, Prentice-Hall of India Pvt. Ltd, 2016.
- Smith, J.M. Chemical Engineering Kinetics, 3rd Edition, McGraw-Hill Book Company, New York, 2013..

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max Marks: 100

Part A: 10 questions of 2 marks each - No choice

Part B: 2 questions from each unit of internal choice; each carrying 16 marks

Examination duration: 3 Hours

20 Marks

80 Marks

SCHA1403	COMPUTATIONAL FLUID DYNAMICS	L	T	P	C	Max. Marks
		3	0	0	3	100

COURSE OBJECTIVE: To understand the flow, temperature field in engineering problems and diffusion in mass transfer operations. Students can develop a Computational Fluid Dynamics code to solve chemical engineering problems

UNIT 1: OVERVIEW OF CFD AND CONSERVATION LAWS

9 hours

Role of CFD, Problem solving in CFD, Components of CFD Software, Governing Equations of Fluid flow and Heat Transfer, Mass conservation, Momentum and Energy equation, Differential and Integral forms, Conservation and non-conservation form.

UNIT 2: TURBULENCE AND ITS MODELLING

9 hours Transition

from Laminar to Turbulent flow, Effect of turbulence on time-averaged Navier-Stokes equations, Characteristics of simple turbulent flows, Free turbulent flows, Flat plate boundary layer and pipe flow, Turbulence models, Mixing length model, Reynolds stress equation models.

UNIT 3: FINITE VOLUME METHOD

9 hours

Introduction, One dimensional steady state diffusion, Two-dimensional diffusion problems, Discretised equations for diffusion problems, One-dimensional unsteady state heat conduction, Discretisation of transient convection-diffusion equation, Solution procedures for unsteady flow calculations, Implementation of Inlet, outlet and wall boundary conditions, Constant pressure boundary condition.

UNIT 4: CFD METHODS

9 hours

CFD Methods for the Euler Equation- Linearization and Jacobian Matrix, Eigen values and Eigenvectors, Flux Splitting Methods. CFD Methods For Navier-Stokes Equations-Beam Warming Algorithm, Mac Cormack's scheme, Upwind Techniques.

UNIT 5: GRID GENERATION

9 hours Structured

Grid generation, Unstructured Grid generation, Adaptive Grid generation, Physical aspects, simple and multiple connected regions, grid generation by PDE solution.

Max.45 hours

Course Outcomes:

- CO1 Understand the basic concept of CFD and conservation laws in chemical engineering.
- CO2 Ability to develop model for a given fluid flow system.
- CO3 Experiment with finite volume techniques for fluid flow and heat transfer models.
- CO4 Analyze finite difference method for mass transfer problems.
- CO5 Evaluate computational fluid flow problems using finite volume techniques.
- CO6 Solve and Get familiarized to develop grid generation and analysis of complex fluid-flow systems.

TEXT / REFERENCE BOOKS:

1. Anderson, J. D., Computational Fluid Dynamics: The Basics with Applications, 2nd Edition, McGrawHill International Editions, 2012..
2. Fletcher, C. A. J., Computational Techniques for Fluid Dynamics, 3rd Edition Springer Verlag, 2001.
3. Versteeg, H.K. and Malalasekera, W., An Introduction to Computational Fluid Dynamics: The Finite Volume Method, 2nd Edition, Pearson Education Ltd., 2007.
4. Chung T. J., Computational Fluid Dynamics, 2nd Edition, 2nd Edition Cambridge University Press, 2002.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max Marks: 100

Part A: 10 questions of 2 marks each - No choice

Part B: 2 questions from each unit of internal choice; each carrying 16 marks

Examination duration: 3 Hours

20 Marks

80 Marks

SCHA1501	MASS TRANSFER – II	L	T	P	C	Max. Marks
		3	0	0	3	100

COURSE OBJECTIVE:

- To study LLE, principles of adsorption and concept of separation.

UNIT 1: DISTILLATION**9 Hours**

Vapor liquid equilibria, Raoult's law and deviations from ideality, Methods of distillation - Batch, Continuous, Flash, Vacuum, Azeotropic, Extractive and Molecular distillation. Design method - McCabe Thiele method, PonchonSavarit method, Fenske equation, Introduction to multi-component distillation.

UNIT 2: ABSORPTION**9 Hours**

Equilibrium and operating line concept in absorption calculations, Calculation of NTU, HTU, Number of stages, Packed and plate type absorbers. Absorption with chemical reaction, HETP Operating characteristics of stage wise and differential contactors. Absorption equipment – Packed and Plate towers, Centrifugal Absorbers and spray towers.

UNIT 3: ADSORPTION**9 Hours**

Introduction to adsorption, adsorbents and adsorption processes, Types of adsorption, Nature of adsorbents, Theories of adsorption- Freundlich, Langmuir, BET theories, Adsorption isotherms, Operation of adsorption columns, Break through curve, Batch and continuous operations, Multistage cross and counter current operations, Equipments- fixed-bed adsorbents, moving bed adsorbents, pressure swing adsorber and thermal swing adsorbents.

UNIT 4: EXTRACTION**9 Hours**

Equilibrium in ternary systems, Stage wise contact equipments, Calculations for batch and continuous extractors, Multistage Cross current extraction, Multistage counter current extraction, Calculation of number of stages, Equipments – Mixer settlers, Plate column, Packed column, Pulse column & RDC.

UNIT 5: LEACHING**9 Hours**

Introduction. Types of evaporators. Single and multiple effect evaporation. Capacity and economy of multi effect evaporators. Thermo re-compression evaporators Vapour re-compression and thermal re-compression evaporators, Effect of liquid head and boiling point elevation. Duhring's rule. Liquid characteristics. Material and energy balance in evaporators. Illustrated examples.

Max.45 Hours**COURSE OUTCOMES:**

- CO1 Design calculation of distillation column
 CO2 Determine the number of stages and height of continuous absorber
 CO3 Design of adsorber and calculate the adsorbent requirement
 CO4 Describe the principles of Extraction and estimate the number of ideal stages.
 CO5 Describe the principles of leaching and estimate the number of ideal stages.
 CO6 Formulate and solve mass balances for extraction, absorption, adsorption and distillation.

TEXT / REFERENCE BOOKS

- Treybal, R.E, Mass Transfer Operations, 3rd Edition, McGraw Hill, 2004.
- McCabe and Smith, Unit Operations of Chemical Engineering, 7th Edition, McGraw Hill, 2009.
- Coulson J.M. and Richardson J.F., Chemical Engineering, Vol. II, Pergamon Press. 2002.
- Gavhane K. V., Mass Transfer II, 11th Edition, NiraliPrakashan, 2011.
- Anantharaman N., MeeraSheriffa Begum K. M., Mass Transfer Theory and Practice, 1st Edition, PHI, 2011.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max Marks: 100

Part A: 10 questions of 2 marks each - No choice

Part B: 2 questions from each unit of internal choice; each carrying 16 marks

Examination duration: 3 Hours

20 Marks

80 Marks

SCHA1502	PROCESS ENGINEERING ECONOMICS	L	T	P	C	Max. Marks
		3	0	0	3	100

COURSE OBJECTIVE:

- The course deals with the thought processes, concepts, methods, and knowledge bases used by engineers to cost engineering projects and to evaluate the merit of making a particular investment, and to choose the best of a series of alternative investments to achieve a desired objective.

UNIT 1: PROCESS DESIGN DEVELOPMENT**9 Hours**

Types of Designs, Material and Energy Balance, Equipment Sizing and Selection, Process Flow Sheet and P&I Diagrams, Selection of Plant Location and Layout, Factors affecting Plant Design.

UNIT 2: ENGINEERING ECONOMICS FOR PROCESS ENGINEERS, INTEREST & INVESTMENT COSTS**9 Hours**

Time Value of Money, Equations for Economic Studies, Equivalence, Amortization, Capital Recovery, Depreciation- Nature of Depreciation, Methods of determining depreciation, Depletion.

UNIT 3: COST ESTIMATION AND ANNUAL REPORTS**9 Hours**

Capital Requirements for Process Plants, Cost Indices. Equipment Costs, The William six-tenth's Factor, Service Facilities, Capital requirements for Complete Plant, The Balance Sheet, Sources of Capital, Variable Costs, Fixed Costs, Income Statement, Income Statement Ratios.

UNIT 4: ECONOMICS OF INVESTMENT ALTERNATIVE**9 Hours**

Economics of Selecting alternates, Annual Cost methods, Present worth method, Equivalent Alternate, Rate of Return and payout-time, Economic Production Charts, Capacity Factors, Break Even Analysis – basic assumptions – break even chart – managerial use of breakeven analysis.

UNIT 5: ECONOMIC BALANCE**9 Hours**

Essentials of economic balance, economic balance in batch operations, cyclic operations, economic balance for insulation, evaporation, heat transfer equipments.

Max.45 Hours**COURSE OUTCOMES:**

- CO1. Apply the material and energy balance in process plant
 CO2. Understand the concept of economics in a process plant, time value of money and cost indices
 CO3. Compute the financial statements, Depreciation and Accounting in Cost estimation.
 CO4. Evaluate the economics of a process through cost estimation
 CO5. Determine the optimum cost for operation
 CO6. Develop economic balance for chemical engineering equipment's

TEXT / REFERENCE BOOKS

- Max. S,Peters and Klaus. D Timmerhaus., Plant Design and Economics for Chemical Engineers, 5th Edition, Mc Graw Hill International Editions, New York, 2004.
- Herbert E Schweyer, Process Engineering Economics, McGraw Hill, 2017.
- Jelen F.C and Black J.H.,Cost and Optimization Engineering,4thEdition, McGraw Hill, 2000.
- James.R.Couper.,Process Engineering Economics, 1st Edition ,Marcel Dekker Inc, New York,2003.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max Marks: 100

Part A: 10 questions of 2 marks each - No choice

Part B: 2 questions from each unit of internal choice; each carrying 16 marks

Examination duration: 3 Hours

20 Marks

80 Marks

SCHA1503	INSTRUMENTATION AND PROCESS CONTROL	L	T	P	C	Max. Marks
		3	0	0	3	100

COURSE OBJECTIVE:

- This course enables the students to know about control methods and make the students knowledgeable in various types of measuring instruments used in chemical process industries.

UNIT 1: INSTRUMENTATION**9 Hours**

Temperature measurement: Thermocouples, Resistance thermometers, Optical and Radiation pyrometers. Pressure measurement: Use of manometers, Bourdon gauge, Bellows type gauge. Flow measurement: Variable area meters. Positive displacement type meters. Liquid level measurement: Direct and differential method, measurement in open and pressure vessels. Measurement of Viscosity, Conductivity, pH and Humidity of gases.

UNIT 2: BASIC CONCEPTS OF PROCESS CONTROL**9 Hours**

Laplace transformation and its application in process control. Response of first order systems Examples of first order systems Process Dynamics of linear open systems. Second order and first order systems in series higher order systems Transfer Function Step, Ramp, Pulse and Sinusoidal inputs and Linearization.

UNIT 3: LINEAR CLOSED LOOP SYSTEMS**9 Hours**

Development of a block diagram, Controllers and Final control element Closed loop control systems. Block Diagram for feedback control systems, Servo and Regulator problems. Principles of Pneumatic and Electronic controllers. Transportation Lag Transient response of closed loop control systems, Control valve PI, P, PID control.

UNIT 4: STABILITY ANALYSIS**9 Hours**

Stability, Stability criterion, Routh test for stability; Routh-Hurwitz criterion, Root-Locus analysis. Introduction to frequency response of closed-loop systems, Frequency response - Substitution Rule, Bode diagrams Bode stability criterion. Gain and Phase margins Ziegler Nichols control settings and Transient response, Nyquist diagram.

UNIT 5: CONTROL VALVES & INDUSTRIAL CONTROL SYSTEMS**9 Hours**

Control valves, Valve sizing Characteristics Control valve construction, Valve positioning. Introduction to industrial control systems - Programmable Logic Controllers (PLCs), Distributed Control Systems (DCS), Supervisory control and Data Acquisition (SCADA). Cascade control, Feed forward control and Feedback control.

Max.45 Hours**COURSE OUTCOMES:**

- CO1. Develop mathematical modeling of different process using differential equation.
- CO2. Ability to analyze, formulate and select suitable sensor for the given industrial applications
- CO3. Design and tune process (PID) controllers.
- CO4. Evaluate stability, frequency response, and other characteristics
- CO5. Apply control schemes to various processes
- CO6. Select control valves for different systems.

TEXT / REFERENCE BOOKS

- Coughanowr D.R and Koppel L.M., Process Systems Analysis and Control, 3rd Edition, McGraw Hill, New York, 2009.
- Harriot P., Process Control, 3rd Edition, Tata McGraw Hill, New Delhi, 2008.
- George Stephanopoulos., Chemical Process Control, 2nd Edition, Prentice Hall of India Pvt. Ltd., 2015.
- Vyas.R.P., Process control and instrumentation, 8th Edition, Central Techno Publications, Nagpur 2015.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max Marks: 100

Part A: 10 questions of 2 marks each - No choice

Part B: 2 questions from each unit of internal choice; each carrying 16 marks

Examination duration: 3 Hours

20 Marks

80 Marks

SCHA1504	CHEMICAL REACTION ENGINEERING - II	L	T	P	C	Max. Marks
		3	0	0	3	100

COURSE OBJECTIVE:

- To familiarize the methods of accounting non-ideal behavior of ideal reactors, design of heterogeneous reactors for solid catalyzed reactions and non-catalytic fluid-particle reactions.

UNIT 1: NON - IDEAL REACTOR**9 Hours**

Non-ideal reactors, Reasons for non-ideal flow behaviors, Concept of mixing: micro and macro mixing, Residence Time Distribution (RTD) functions, C, E and F curves, calculation of mean residence time from E and F curves, Tanks in series models, Axial dispersion model, segregated flow model.

UNIT 2: NON-CATALYTIC REACTIONS**9 Hours**

Material balance, Energy balance, batch operation, continuous operation, semi-batch operation, ideal conditions, design of ideal batch reactor, ideal plug flow reactor, ideal mixed flow reactor, semi-batch reactor, recycle reactor.

UNIT 3: CATALYST AND CATALYTIC REACTIONS**9 Hours**

Introduction to catalysis, Physical properties of catalyst: Surface area (BET isotherm), Void volume and solid density, Pore volume distribution; Catalyst preparation, Promoters, Inhibitors and Poisons, Steps in a catalytic reaction, rate of catalytic reaction (adsorption, surface reaction and desorption as rate limiting step).

UNIT 4: CATALYTIC REACTORS**9 Hours**

The rate equation for Surface Kinetics, Pore diffusion resistance combined with Surface Kinetics, Effectiveness factor, Thiele modulus, Heat effects during reaction, Performance equations for Reactors containing porous catalyst particles, Experimental methods for finding rates.

UNIT 5: NON-ISOTHERMAL REACTIONS**9 Hours**

Heterogeneous catalytic reactors: Fixed bed reactors, Fluidized bed reactors, Slurry reactors, Trickle bed reactors: Design aspects with some simple examples.

Deactivation of catalyst, Mechanism of deactivation of catalyst, Rate and performance study of deactivation.

Max.45 Hours**COURSE OUTCOMES:**

The student will be able to

- CO1. Understand non-ideal behavior of reactors and their causes
- CO2. Understand non-ideal behavior of reactors and their causes
- CO3. Analyze various preparation and characterization methods of catalysts
- CO4. Design performance equations for reactors containing porous catalyst particles
- CO5. Apply kinetic concepts to heterogeneous reactors
- CO6. Interpret the mechanism of deactivation of catalyst

TEXT / REFERENCE BOOKS

- Octave Levenspiel, Chemical Reaction Engineering, 3rd Edition, Wiley Publications Ltd., 2007.
- Smith, J.M. Chemical Engineering Kinetics, 3rd Edition, McGraw-Hill Book Company, New York, 2013.
- Fogler, H.S., Elements of Chemical Reaction Engineering, 5th Edition, Prentice-Hall of India Pvt. Ltd., 2016.
- Froment, G.F and Bischoff, K.B., Chemical Reactor Analysis and Design, 3rd Edition, John Wiley and Sons, 2010.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max Marks: 100

Part A: 10 questions of 2 marks each - No choice

Part B: 2 questions from each unit of internal choice; each carrying 16 marks

Examination duration: 3 Hours

20 Marks

80 Marks

SCHA1701	PROCESS MODELING AND SIMULATION	L	T	P	C	Max. Marks
		3	0	0	3	100

COURSE OBJECTIVE:

- The objective of this course is to give a broad coverage of the field of mathematical modeling and simulation in chemical engineering. Both steady-state and dynamic models will be examined and discussed.

UNIT 1: BASICS OF MODELLING**9 Hours**

Introduction to Modeling, need of models and their classification, Uses of Mathematical Models, Scope of Coverage, Principles of Formulation. Fundamental Laws-Continuity Equation, Energy Equation, Equations of Motion. Regression and Correlation Analysis.

UNIT 2: MODELING OF HEAT TRANSFER AND OTHER EQUIPMENTS**9 Hours**

Two Heated Tanks, Double Pipe Heat Exchanger, Shell and Tube Heat Exchanger, Evaporators, Mixing process, interacting and non-interacting system and Gravity flow tank.

UNIT 3: MODELING OF REACTORS**9 Hours**

Batch Reactor, Series of Isothermal Constant-Holdup CSTR, CSTR with Variable Holdup, Non Isothermal CSTR, Semi batch Reactor, Plug Flow Reactor, Packed Bed Reactor and bioreactor models.

UNIT 4: MODELING OF MASS TRANSFER OPERATIONS**9 Hours**

Absorption Columns, Ideal Binary Distillation column, Multi component Non-Ideal Distillation Column, Batch Distillation with Holdup, Single Component vaporizer multi component flash drum and extraction models.

UNIT 5: DYNAMIC SIMULATION**9 Hours**

Dynamic Simulation of Batch Reactor, Non Isothermal CSTR, Three CSTR in Series, PFR, Binary Distillation Column, Evaporator, Absorption column and Gravity Flow Tank.

Max.45 Hours**COURSE OUTCOMES:**

- CO1. Organize the important physical phenomena from the problem statement
- CO2. Demonstrate the stages involved in the development of a process model.
- CO3. Develop model equations for heat transfer and other equipment
- CO4. Analyze model equations for the given reactors
- CO5. Explain model equations for the given mass transfer operations
- CO6. Solving the chemical engineering models developed

TEXT / REFERENCE BOOKS

1. Amiya K. Jana, "Chemical Process Modelling and Computer Simulation" 2nd Edn, PHI Learning Ltd, 2012.
2. Amiya K. Jana, "Process Simulation and Control Using ASPEN", 2nd Edn, PHI Learning Ltd, 2012.
3. Ramirez W., Computational Methods in Process Simulation, 2nd Edition, Butterworth's Publishers, New York, 2000.
4. Felder, R. M. and Rousseau, R. W., "Elementary Principles of Chemical Processes", John Wiley, 2000.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max Marks: 100

Part A: 10 questions of 2 marks each - No choice

Part B: 2 questions from each unit of internal choice; each carrying 16 marks

Examination duration: 3 Hours

20 Marks

80 Marks

SCH3002	PETROLEUM AND PETRO CHEMICAL TECHNOLOGY	L	T	P	C	Max. Marks
		3	0	0	3	100

COURSE OBJECTIVE:

- The subject deals with the characterization, distillation, refining of petroleum crude and the petrochemicals obtained by processing petroleum products.

UNIT 1: CLASSIFICATION OF CRUDE AND REFINING**9 Hours**

Theories on origin of petroleum, composition of crude oil, classification and evaluation of crude oil, laboratory testing techniques of crude quality like flash point, fire point etc., Characterization of crude oils : TBP and ASTM distillation, Correlation Index, Density, API gravity, Viscosity, UOP characterization factor, etc. Physical & Thermal properties of petroleum, ASTM, TBP, EFV distillation curves. Properties of crude oil: Distillation: Properties of crude oil octaneno. etc Pre-treatment, Electric desalting, Refining of petroleum – atmospheric and vacuum distillation.

UNIT 2: THERMAL AND CATALYTIC PROCESSES**9 Hours**

Thermal cracking, catalytic cracking, catalytic reforming, Naphtha cracking, coking, Hydrogenation processes, Alkylation processes, Polymerization and Isomerization process.

UNIT 3: TREATMENT TECHNIQUES**9 Hours**

Treatment techniques for removal of objectionable gases and to improve performance, treatment of gasoline, treatment of kerosene, treatment of lubes. Extraction of aromatics and olefins, Recovery operations from petroleum products.

UNIT 4: INTRODUCTION AND CHEMICALS FROM METHANE AND ETHANE**9 Hours**

History and importance of Petrochemical industry, growth in India, Classification of Petrochemicals, Feedstock of the Petrochemicals. Production of Methanol, Formaldehyde, Ethylene glycol, PTFE, ammonia, Ethylene, Manufacture of Vinyl Chloride monomer, vinyl Acetate manufacture, Ethanol from Ethylene, Acetylene manufacture.

UNIT 5: CHEMICALS FROM HIGHER ALKANES**9 Hours**

Cracking of naphtha and gas for the production of ethylene, propylene, isobutylene and butadiene., synthetic fibers.

Max.45 Hours**COURSE OUTCOMES:**

At the end of the course, student will be able familiarized in the

- CO1. Understand fundamental concepts of Petroleum Refining about processing, quality control and general overview of the industry
- CO2. insights of primary treatment processes to produce the precursors.
- CO3. Analyse the techniques for the removal of sulphur and other impurities from petroleum products
- CO4. Applications of second and third generation petrochemicals.
- CO5. Synthesis of petrochemical products from refinery
- CO6. Acquainted with technologies used for the production of desired petro products

TEXT / REFERENCE BOOKS

- Prasad, R., "Petroleum Refining Technology", Khanna Publishers, New Delhi, 2000
- Lewis F. Hatch & S Matar, From Hydrocarbon to Petrochemicals, 2nd Edition, 2000, Gulf Publishing Co. Houston, Texas, USA.
- Uttam Ray Chaudhuri "Fundamentals of Petroleum and Petrochemical Engineering", CRC Press, 2011.
- Jones D.S.J.S. Process equipment in petroleum refining. In: Jones D.S.J.S., Pujadó P.R. (eds) Handbook of Petroleum Processing. Springer, Dordrecht, 2008

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max Marks: 100

Part A: 10 questions of 2 marks each - No choice

Part B: 2 questions from each unit of internal choice; each carrying 16 marks

Examination duration: 3 Hours

20 Marks

80 Marks

SCHA3004	FERTILIZER TECHNOLOGY	L	T	P	C	Max. Marks
		3	0	0	3	100

COURSE OBJECTIVE:

- This course helps the students to understand the various processes involved in chemical industries for the production of nitrogenous fertilizers and also to know the technological advancements in agriculture and fertilizer industry.

UNIT 1: INTRODUCTION TO FERTILIZERS & NITROGENOUS FERTILIZERS**9 Hours**

Plant nutrients and its types, Fertilizer and its types, Production of Ammonia and Nitric acid, Methods of production, Specification, storage and handling of nitrogenous fertilizers, Ammonium sulphate, Ammonium nitrate, Urea, Calcium ammonium nitrate, Ammonium chloride.

UNIT 2: POTASSIUM FERTILIZERS**9 Hours**

Sources of potassium, Location, Methods of production, Specification, storage and handling of potassic fertilizers, potassium chloride, Potassium choenites. Function of potassium in plants.

UNIT 3: PHOSPHATIC FERTILIZERS**9 Hours**

Raw materials, Phosphate rock, Sulfur, pyrites etc., processes for the production of sulphuric and phosphoric acids; Phosphatic fertilizers, ground rock phosphate, Bone meal, Single super phosphate, Triple super phosphate, Thermal phosphate and their methods of production, storage and handling and specifications.

UNIT 4: COMPLEX AND NPK FERTILIZERS**9 Hours**

Types of complex fertilizers, composition, Production of ammonium phosphate fertilizers, Ammonium sulfate, Diammonium phosphate, Nitro phosphate, Mono Ammonium Phosphate and various grade of NPK fertilizers.

UNIT 5: MISCELLANEOUS FERTILIZERS**9 Hours**

Mixed fertilizers and granulated mixtures, Biofertilizers and nutrients. Secondary and micronutrients; fluid fertilizers, controlled release fertilizers.

Max.45 Hours**COURSE OUTCOMES:**

- CO1. Elaborate the production of nitrogenous fertilizers
- CO2. Explain the production of potassium fertilizers
- CO3. Analyze the application of phosphate fertilizer & their production
- CO4. Develop the production process for NPK Fertilizers/Biofertilizers
- CO5. Analyze the application of mixed fertilizers
- CO6. Evaluate the environmental impacts and their mitigation measures pertain to fertilizer industry

TEXT / REFERENCE BOOKS

- Handbook of Fertilizer Technology, Fertilizer Association of India, New Delhi, 2000.
- Gopala Rao M. and Marshall Sittig, Dryden's Outlines of Chemical Technology, 3rd Edition., East-West Press, New Delhi, 2010.
- Fertilizer technology and management, Brahma Mishra, I.K International Publishing House PVT Its, 2011
- Fertilizer Manual, Kluwer Academic Publishers, Netherlands, 2000.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max Marks: 100

Part A: 10 questions of 2 marks each - No choice

Part B: 2 questions from each unit of internal choice; each carrying 16 marks

Examination duration: 3 Hours

20 Marks

80 Marks

SCHA3005	ADVANCED SEPARATION PROCESSES	L	T	P	C	Max. Marks
		3	0	0	3	100

COURSE OBJECTIVE:

- To identify about the kind of separation processes in general and novel separations are integral part of any process chemical industries.

UNIT 1: THERMAL SEPARATION**9 Hours**

Thermal Diffusion: Basic Rate Law, Theory of Thermal Diffusion Phenomena for gas and liquid mixtures, Equipment's design and Applications. Zone Melting: Equilibrium diagrams, Controlling factors, Apparatus and Applications, Zone Refining and Zone leveling.

UNIT 2: SORPTION TECHNIQUES**9 Hours**

Types and choice of adsorbents, Normal Adsorption techniques, Chromatographic techniques, Equipment and Commercial processes, Recent advances and Economics, Molecular Sieves. Latest developments in separation techniques: Cryogenic, Supercritical fluid extraction, Bio-separation, and Azeotropic separation.

UNIT 3: MEMBRANE SEPARATION PROCESSES**9 Hours**

Principle of membrane separations process; Classification: Reverse osmosis, Ultrafiltration, Micro-filtration, Nano-filtration and Dialysis; Analysis and modeling of membrane separation processes; Membrane modules and application; Ion selective membranes and their application in electro-dialysis; Pervaporation and gas separation using membranes; Electrophoresis; Liquid membranes and its industrial applications.

UNIT 4: IONIC SEPARATION**9 Hours**

Controlling factors, Applications, Equipments for Electrophoresis, Dielectrophoresis, Electro Dialysis and Ion – Exchange. Adductive Crystallization Applications, Economics and Commercial processes.

UNIT 5: MULTICOMPONENT DISTILLATION AND FOAM SEPARATION**9 Hours**

Introduction to multi component separation system. Introduction to Multi component distillation-Key components, Estimation of minimum theoretical stages using Fenske's equation. Foam and bubble separation: Principle; Classification; Separation techniques; Column operations. Surface Adsorption, Nature of foams, Apparatus, Applications, and controlling factor.

Max.45 Hours**COURSE OUTCOMES:**

- CO1 Understand the basic theory and equipment's to thermal diffusion
 CO2 Ability to distinguish different sorption techniques and its mechanism
 CO3 Analyze the various membrane separation processes
 CO4 Estimate the mechanism and applications of ionic separation technique
 CO5 Apply separation principles and theory to multi-component distillation
 CO6 Predict the minimum theoretical stages using Fenske's equation

TEXT / REFERENCE BOOKS

- Seader, J.D, and Henley E.J., Separation Process Principles, 3rd Edition, John Wiley & Sons, Inc., 2011.
- Perry R.H. and. Green D.W., Perry's Chemical Engineers Hand book, 8th Edition. McGraw Hill, New York, 2006.
- Sinaiski E.G. and Lapiga E.J., Separation of Multiphase, Multicomponent Systems, 1st Edition, Wiley-VCH Verlag GmbH & Co, 2003.
- Suresh S and Amit Keshav, Text book of Separation processes, Studium Press India LTD, 2012
- Coulson J. M. and Richardson J. F., Chemical Engineering, Vol. II, 4th Edition, Butterworth, Heinemann, London, 2005

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max Marks: 100

Part A: 10 questions of 2 marks each - No choice

Part B: 2 questions from each unit of internal choice; each carrying 16 marks

Examination duration: 3 Hours

20 Marks

80 Marks

SCHA3008	FOOD TECHNOLOGY	L	T	P	C	Max. Marks
		3	0	0	3	100

COURSE OBJECTIVE:

- To impart knowledge to the students about advanced technology in food science and recent trends adapted in food industry.

UNIT 1: FOOD PROCESSING ENGINEERING–FUNDAMENTALS**9 Hours**

Fundamentals of Food Process Engineering, Application of Quantitative methods of Material & Energy Balances in Food Engineering Practices. Constituents of Food, Quality and Nutritive aspects, Food Adulterations, Deteriorative factors and Control.

UNIT 2: UNIT OPERATIONS IN FOOD INDUSTRIES**9 Hours**

Fluid Flow, Thermal Process Calculations, Refrigeration, Evaporation and Dehydration operations in Food Processing.

UNIT 3: FOOD CANNING TECHNOLOGY**9 Hours**

Fundamentals of Food Canning Technology, Heat Sterilization of Canned food, Containers – metal, Glass and Flexible packaging. Canning Procedures for Fruits, Vegetables, Meat, Poultry and Marine Products.

UNIT 4: FOOD PRESERVATION METHODS**9 Hours**

Preservation by Heat and Cold, Dehydration, Concentration, Drying, Irradiation, Microwave heating, Sterilization and Pasteurization, Fermentation and Pickling, Packaging Methods.

UNIT 5: PRODUCTION AND UTILIZATION OF FOOD PRODUCTS**9 Hours**

Cereal, Grains, Pulses, Vegetables, Fruits, Spices, Fats and Oils, Bakery, Confectionary and Chocolate Products. Soft and Alcoholic Beverages, Dairy Products, Meat, Poultry and Fish Products.

Max.45 Hours**COURSE OUTCOMES:**

The student will be able to

- CO1. Understand the constituents, quality and nutritive aspects of food
- CO2. Analyze Unit Operations in food processing industries
- CO3. Evaluate various food canning technologies
- CO4. Demonstrate the various methods of food preservation
- CO5. Analyze the various methods of food processing
- CO6. Develop the flow diagram to interpret manufacturing process of various food products

TEXT / REFERENCE BOOKS

- Heid J.L. Joslyn M.A., Fundamentals of Food Processing Operation, 6th Edition, The AVI publishing Co., West port 2018.
- Potter N.N., Food Science, 6th Edition, The AVI publishing Co., Westport, 2007
- Heldman D.R., Food Process Engineering, 4th Edition, The AVI publishing.2005
- Owen. R.Fennema., Food Chemistry, 4th Edition, Marcel Dekker Inc New York, 2007.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max Marks: 100

Part A: 10 questions of 2 marks each - No choice

Part B: 2 questions from each unit of internal choice; each carrying 16 marks

Examination duration: 3 Hours

20 Marks

80 Marks

SCHA3010	INDUSTRIAL SAFETY & HAZARD ANALYSIS	L	T	P	C	Max. Marks
		3	0	0	3	100

COURSE OBJECTIVE:

- To emphasize the importance of safety and to gain knowledge on the hazards and their analysis in industries.

UNIT 1: INDUSTRIAL SAFETY**9 Hours**

Industrial safety principles, accidents, site selection and plant layout, design for ventilation, , basic rules and requirements which govern the chemical industries. Emergency response systems for hazardous goods, Emergency planning and preparedness, Major Industrial accidents, causes, methods of prevention, Case Study.

UNIT 2: HAZARDS**9 Hours**

Chemical hazards classification, hazards due to fire, explosion and radiation, various explosions: VCE, UVCE and BLEVE. Potential hazards, Chemical and Physical job-safety analysis, Safety in High-pressure and high temperature operations, toxic effects, highly radioactive materials, Safe handling and operation of materials and machineries.

UNIT 3: HAZARD ANALYSIS**9 Hours**

Types of hazard analysis, hazard identification, Material safety data sheet, specifications, Safety Audit, Hazard and Operability Studies Steps involved and significance, Fault tree analysis, Event tree analysis., Failure Mode Effect Analysis procedure and Illustrated examples.

UNIT 4: SAFETY APPRAISAL**9 Hours**

Safety audit, Effective steps to implement safety procedures, periodic training and regular maintenance, personal protective equipment, types, Safety Program, Elements of safety Program, Fire Formation, Fire Triangle, Fire prevention and firefighting equipment.

UNIT 5: HEALTH HAZARDS AND LEGAL ASPECTS**9 Hours**

OSHA Regulations and Significance, Health hazards -occupational, Industrial health hazards. Health standards and rules, Safe working environment, Factories act, Labor welfare act, ESI act, Workmen compensation act, Provisions and features.

Max.45 Hours**COURSE OUTCOMES:**

The student will be able to

- CO1. Apply basic rules and requirements which govern chemical industries
- CO2. Outline the various hazards and their implications
- CO3. Analyze the different hazards, their impact and prevention
- CO4. List the importance of safety audit and periodic appraisal for prevention of accidents
- CO5. Explain various fire extinguishing solutions and to ensure fire prevention
- CO6. Discuss the various acts available for employee safety and maintain periodic OSHA regulations

TEXT / REFERENCE BOOKS

- Blake R.P., Industrial Safety, 3rd Edition, Prentice Hall Inc., New Jersey, 2006.
- Deshmukh. L.M., Industrial Safety Management, 3rd Edition, Tata McGraw Hill, New Delhi, 2008.
- Jain.R.K and Sunil Rao., Industrial Safety, Health and Environmental Management Systems, 1st Edition, Khanna Delhi 2006.
- ShrikantDawande., Chemical Hazards and Safety, 2nd Edition, Khanna publishers,2012.
- Daniel A.Crowl, Joseph F. Louvar., Chemical Process Safety : Fundamentals with applications, 3rd Edition, Prentice Hall Inc., New Jersey, 2011..

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max Marks: 100

Part A: 10 questions of 2 marks each - No choice

Part B: 2 questions from each unit of internal choice; each carrying 16 marks

Examination duration: 3 Hours

20 Marks

80 Marks

SCHA3011	GREEN TECHNOLOGY	L	T	P	C	Max. Marks
		3	0	0	3	100

COURSE OBJECTIVE:

- To demonstrate the achievement of efficient and economically viable chemical production without being hazardous to human health and environment

UNIT 1: INTRODUCTION**9 Hours**

Fundamentals of Green Technology, need, goal and limitations of Green technology, sustainable development, twelve principles of Green technology.

UNIT 2: GREEN CHEMISTRY**9 Hours**

Green chemistry metrics (atom economy, atom efficiency, E-factor), Green synthesis like photochemical, microwave, sonochemistry and electrochemistry, green reagents, green catalysts, solvent free reactions, toxicity reactions.

UNIT 3 GREEN PROCESSES**9Hours** Renewable

energy technologies like solar, wind, hydropower, geothermal and biomass energy, phytoremediation, eco-restoration, issues and challenges.

UNIT4 GREENER NANOSYNTHESIS AND GREEN NANOMATERIALS**9 Hours**

Greener Synthetic methods for metal and semiconductor and inorganic oxide, functionalized metal nanoparticles. Green materials, - biomaterials, biopolymers, bioplastics, composites, Sensors, Biomimetic Sensors, Smart nanomaterials.

UNIT 5 GREEN NANOMATERIALS FOR ALTERNATIVE ENERGY/REMEDIATION**9 Hours**

Nanomaterials for fuel cells and hydrogen generation and storage. Nanostructures for efficient solar hydrogen production, solar thermal Energy and Photovoltaic. Nanomaterials -Remediation: Nano membranes, Nanofibers, Nano Adsorbents, Nano Catalysts, Nano-sensors.

Max.45 Hours**COURSE OUTCOMES:**

- CO1. Understand the principles of green chemistry and technology
 CO2. Outline to Concepts of Greener Nano synthesis and
 CO3. Apply the Green Nanomaterials to show relevance to green chemistry and technology
 CO4. To familiarize with the synthesis of nanomaterials
 CO5. To understand the application of green nanomaterials for alternative energy
 CO6. Identification, design and evaluation of remediation issues using green nanomaterials

TEXT / REFERENCE BOOKS

1. Mike Lancaster, Green Chemistry: An introductory Text, RSC Publishing V. K. Ahluwalia, Green Chemistry: Environmentally Benign Reactions, Ane Books India, New Delhi, 2006.
2. Jay Warmke, Annie Warmke, Green Technology, Educational Technologies Group, 2009.
3. David. T. Allen and David R. Shonnard, "Green engineering" Prentice Hall NJ, 2002
4. James clark, "Green chemistry" Blackwell publishing, 2008.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max Marks: 100

Part A: 10 questions of 2 marks each - No choice

Part B: 2 questions from each unit of internal choice; each carrying 16 marks

Examination duration: 3 Hours

20 Marks

80 Marks

SCHA3012	SMART MATERIALS FOR INDUSTRIES	L	T	P	C	Max. Marks
		3	0	0	3	100

COURSE OBJECTIVE:

- To acquire basic understanding of advanced materials, their functions and properties for technological applications and emphasize the significance of materials selection in the design process

Unit I INTRODUCTION TO SMART MATERIALS**9 HOURS**

Smart materials and structures- System intelligence- components and classification of smart structures, common smart materials and associated stimulus-response, Application areas of smart systems Ferroelectric materials: Piezoelectric materials- piezoelectric effect, Direct and converse, parameter definitions, Piezoceramics, Piezopolymers, Piezoelectric materials as sensors, Actuators and bimorphs

Unit II SHAPE MEMORY ALLOYS**9 HOURS**

Shape memory alloys (SMAs), Shape memory effect, Martensitic transformation, One way and two-way SME, training of SMAs, binary and ternary alloy systems, Functional properties of SMAs. Characterization tests for smart materials: Principles, instrumentation and applications of: Ion beam techniques- Surface mass spectrometry, LEIS, ISS; Mass spectrometry.

Unit III CHROMIC MATERIALS**9 HOURS**

Thermochromism, Photochromism, Electrochromism, Halochromism, Solvatochromism- principle and design strategies and applications in industries. Introduction to synchrotron radiation and its applications in materials science; Vibrational spectroscopy of surfaces based on colour change.

Unit IV POLYMERIC MATERIALS**9 HOURS**

Thermally responsive polymers, Electroactive polymers microgels, Synthesis, Properties and Applications, Protein-based smart polymers, pH-responsive and photo-responsive polymers, Self-assembly, Molecular imprinting using smart polymers, Approaches to molecular imprinting, Drug delivery using smart polymers

Unit V SENSORS AND SMART HYDROGELS**9 HOURS**

Elastic memory composites, Smart corrosion protection coatings, Self-healing materials, Sensors, Actuators, Transducers, MEMS, Deployment devices, Molecular machines, Smart hydrogels- synthesis, properties and application in industries.

COURSE OUTCOMES:

- CO1. Describe the basic features of smart materials.
 CO2. Illustrate the characteristics of shape memory alloys
 CO3. Obtain a knowledge on chromic materials
 CO4. An understanding of knowledge about Polymeric materials
 CO5. Demonstrate the usage of sensors and smart hydrogels
 CO6. Students will familiarize with various materials in industries.

TEXT / REFERENCE BOOKS

- D.J. Leo, Engineering Analysis of Smart Material Systems, Wiley 2007.
- M. Addington, D.L. Schodek, Smart Materials and New Technologies in Architecture, Elsevier 2005.
- M. Schwartz, New Materials, Processes, and Methods Technology, CRC Press, 2006.
- Galaev, B. Mattiasson (Eds.), Smart Polymers: Applications in Biotechnology and Biomedicine, 2nd ed., CRC Press, 2008.
- N. Yui, R. J. Mersny, K. Park (Eds.), Reflexive Polymers and Hydrogels: Understanding and Designing Fast Responsive Polymeric Systems, CRC Press, 2004.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max Marks: 100

Part A: 10 questions of 2 marks each - No choice

Part B: 2 questions from each unit of internal choice; each carrying 16 marks

Examination duration: 3 Hours

20 Marks

80 Marks

SCHA3013	COMPUTATIONAL METHODS IN CHEMICAL ENGINEERING	L	T	P	C	Max. Marks
		3	0	0	3	100

COURSE OBJECTIVE:

- To impart computational techniques for chemical engineering calculations

UNIT 1: BASICS OF MATLAB**9 Hours**

Starting MATLAB, Help, Simple, Functions, Output, Algebra Vectors, Graphs, Interrupting, Syntax, Suppressing Output, Defining Matrices, Size of Matrix, The Identity Matrix, Specialized Matrices, Diagonal Matrices, The Manipulating Matrices, Matrices, matrix Multiplication, String Arrays, Printing Output, MATLAB Scripting Language: M-File MATLAB Search Path, Path Management, and Startup, File, Function, Errors.

UNIT 2: FORMULATION OF PHYSICAL PROBLEMS**9 Hours**

Mathematical statement of the problem, Representation of problems, Formulation on extraction in single & multiple stages, Radial heat transfer through a cylindrical conductor, salt accumulation in stirred tank.

UNIT 3: INITIAL VALUE PROBLEMS**9 Hours**

Initial value problems for ordinary differential equations-Euler's method, Trapezoidal method, Runge Kutta methods for second and fourth order, interpolation, Newton-cotes integration, Gaussian quadrature.

UNIT 4: NUMERICAL OPTIMIZATION AND PARAMETER ESTIMATION TECHNIQUES**9 Hours**

Methods for constrained and unconstrained optimization- Lagrangian methods, Simplex, Newton line search method, Trust region Newton method, Single response linear regression, least square regression, Applications- Fitting a kinetic rate law to time dependent data.

UNIT 5: BOUNDARY VALUE PROBLEMS**9 Hours**

Introduction to boundary value problems, shooting method, finite difference method, finite volume method, finite element method. Applications of BVP-Chemical reaction and diffusion in a spherical catalyst, finite differences for a convection, diffusion equation.

Max.45 Hours**Course Outcomes:****CO1:** Understand the basic concepts of Matlab**CO2:** Outline to Formulate physical problems**CO3:** Solve Initial value problems**CO4:** Examine numerical optimization**CO5:** Evaluate parameter estimation techniques**CO6:** Estimate boundary value problems**TEXT / REFERENCE BOOKS:**

- 1 Beers K.J., Numerical Methods for Chemical Engineering: Applications in MATLAB, 1st Edition, Cambridge University Press, 2007.
2. Jain M.K., Iyengar S.R.K., Jain R.K., Numerical methods: Problems and solutions, 4th Edition, New age international publishers, 2003.
- 3 Davis. M.E., Numerical Methods and Modeling for Chemical Engineers, 1st Edition, John Wiley & Sons, 1984.
4. Loney N.W., Applied mathematical models for chemical Engineers, 2nd Edition, CRC press, 2006.
5. Mickley, Reid and Sherwood, Applied Mathematics in Chemical Engineering, 2nd Edition, Tata-McGraw-Hill, New Delhi, 1978

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max Marks: 100

Examination duration: 3 Hours

Part A: 10 questions of 2 marks each - No choice

20 Marks

Part B: 2 questions from each unit of internal choice; each carrying 16 marks

80 Marks

SCHA4002	ENERGY ENGINEERING	L	T	P	C	Max. Marks
		3	0	0	3	100

COURSE OBJECTIVE:

- To impart in depth understanding of the issues related with renewable energy and their development.

UNIT 1: INTRODUCTION TO CONVENTIONAL & NON-CONVENTIONAL ENERGY SOURCES**9 Hours**

Conventional energy sources; non-conventional energy sources; Energy sources, Coal, Oil, Natural gas, nuclear fuels, Hydro power advantages. Classification of fuels. Introduction to solar energy, Solar radiation and its measurement, solar constant, solar radiation at earth's surface, solar radiation geometry, solar radiation measurement. Applications, solar water heating, space heating, space cooling, solar thermal electric conversion. Agriculture and industrial process heating, solar distillation, solar pumping, solar cooking.

UNIT 2: ENERGY FROM BIOMASS (BIO – ENERGY): INTRODUCTION**9 Hours**

Biomass conversion Technologies. Wet processes, Dry processes. Biogas generation. Factors affecting biodigestion or generation of gas. Classification of biogas plants. Advantages and disadvantages of floating drum plant. Advantages and disadvantages of fixed dome type plant. Types of biogas plants (KVIC model & Janata model). Selection of site for biogas plant.

UNIT 3: BIO – ENERGY (THERMAL CONVERSION) AND ELECTRICAL CONDUCTION (MHD)**9 Hours**

Methods of obtaining energy from biomass, Thermal gasification of biomass, Classification of biomass gasifiers, Chemistry of gasification process, Applications of the gasifiers. Magneto hydrodynamic generator, electrical conductivity and formation of MHD, performance comparison of open and closed cycle.

UNIT 4: WIND ENERGY AND OTEC**9 Hours**

Basic components of WECS (wind energy conversion system): Classification of WECS, Types of wind machines, horizontal axis machines, vertical axis machines. Applications of wind energy. Energy from the oceans: Introduction, Ocean thermal electric conversion (OTEC), Methods of ocean thermal electric power generation, Open cycle OTEC system, Closed or Anderson OTEC cycle, hybrid cycle. Application of energy from oceans.

UNIT 5: FUEL CELLS BASICS AND WASTE HEAT RECOVERY**9 Hours**

Fuel Cells, Difference between batteries and fuel cells, Components of fuel cells, Principle of working of fuel cells, Fuel cell types: Alkaline fuel cells. Polymer electrolyte fuel cells, Phosphoric acid fuel cells, Molten carbonate fuel cells, Solid oxide fuel cells, Applications. Co-generation- waste heat recovery and heat pump.

Max.45 Hours**COURSE OUTCOMES:**

The student will be able to

- CO1. Explain various conventional and non- conventional energy resources and application of solar energy
- CO2. Evaluate the performance of various types of bio gas plants
- CO3. Demonstrate the working principle of biomass gasifiers
- CO4. Interpret the various types of wind energy conversion and ocean thermal electric conversion
- CO5. Demonstrate the working principle of various kinds of fuel cells.
- CO6. Evaluate the performance of waste heat recovery systems and heat pump.

TEXT / REFERENCE BOOKS

- Rai G.D., Non Conventional Energy Sources, 4th Edition, Khanna Publishers, New Delhi, 2004.
- Rao S.S., Energy Technology, 3rd Edition, Khanna Publishers, New Delhi, 2009
- R.K.Singal, Efficient utilization of energy, 2nd Edition, New Age International Publishers, New Delhi, 2017
- Christopher H. and Armsted H., Geothermal Energy, 3rd Edition, John Wiley, New York, 2000..

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max Marks: 100

Part A: 10 questions of 2 marks each - No choice

Part B: 2 questions from each unit of internal choice; each carrying 16 marks

Examination duration: 3 Hours

20 Marks

80 Marks

SCHA4003	ENVIRONMENTAL IMPACT ASSESSMENT	L	T	P	C	Max. Marks
		3	0	0	3	100

COURSE OBJECTIVE:

- To provide a basic understanding of the EIA process as it is used for research, planning, project or program evaluation, monitoring, and regulatory enforcement and to introduce students to the legal, economic, administrative and technical process of preparing and/or evaluating environmental impact documents.

UNIT 1: INTRODUCTION**9 Hours**

Historical development of Environmental Impact Assessment (EIA). EIA in Project Cycle. Legal and Regulatory aspects in India. Types and Limitations of EIA. Cross sectoral issues and terms of reference in EIA – Public Participation in EIA. EIA process.

UNIT 2: METHODS FOR EIA**9 Hours**

Methods of EIA – Check lists – Matrices – Networks – Cost-benefit analysis – Analysis of alternatives.

UNIT 3: PREDICTION AND ASSESSMENT**9 Hours**

Assessment of Impact on land, water, air, social & cultural activities and on flora & fauna- Mathematical models- Public participation – Rapid EIA.

UNIT 4: ENVIRONMENTAL MANAGEMENT PLAN**9 Hours**

Environmental Management Plan – preparation, implementation and review – Mitigation and Rehabilitation Plans– Policy and guidelines for planning and monitoring programmes – Post project audit – Ethical and Quality aspects of Environmental Impact Assessment. ISO 14001.

UNIT 5: CASE STUDIES**9 Hours**

EIA related to the following sectors – Infrastructure – construction and housing Mining – Industrial – Power plants – River valley and Hydroelectric – coastal projects.

Max.45 Hours**COURSE OUTCOMES:**

The student will be able to

- CO1. Understand the major principles of Environmental impact assessment (EIA)
- CO2. Analyze the different steps in Environmental impact assessment
- CO3. Categorize the prediction and assessment of impacts
- CO4. Apply ethical and quality aspect in EIA process
- CO5. Illustrate different case studies of EIA in practice
- CO6. Conclude the implications of current jurisdictional and institutional arrangements in relation to Environmental impact assessment.

TEXT / REFERENCE BOOKS

- Lawrence, D.P., Environmental Impact Assessment – Practical solutions to recurrent problems, Wiley-Interscience, New Jersey, 2003.
- Petts, J., Handbook of Environmental Impact Assessment, Vol., I and II, Blackwell Science, London, 2000.
- Y.Anjaneyulu: Environmental Impact Assessment Methodologies, BS Pub. 2002.
- Judith Petts, Handbook of Environmental Impact Assessment Vol. I & II, Blackwell Science, 2001.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max Marks: 100

Part A: 10 questions of 2 marks each - No choice

Part B: 2 questions from each unit of internal choice; each carrying 16 marks

Examination duration: 3 Hours

20 Marks

80 Marks

SCHA4004	ENVIRONMENTAL POLLUTION AND CONTROL	L	T	P	C	Max. Marks
		3	0	0	3	100

COURSE OBJECTIVE:

- To impart knowledge on the principles of various processes involved in the treatment of Industrial Pollutants such as Air, Water and Solid.

UNIT 1: INTRODUCTION**9 Hours**

Environment definition -The biosphere - Hydrologic cycle –Nutrient cycles, pollution of air, water and soil. Air pollution laws and air quality standard. Water pollution quality standards and law. MINAS. Air pollution effect on human, plant and animal. Acid rain.

UNIT 2: AIR POLLUTION AND ITS CONTROL**9 Hours**

Introduction-Sources of air pollution, Air pollution control methods-Source correction method, Cleaning of gaseous effluent, Particulate Emission control and equipment used in particulate emission control.

UNIT 3: WATER POLLUTION AND ANALYSIS**9 Hours**

Origin of waste water, Types of waste pollutants and their effects, Waste water sampling and analysis, Determination of organic and inorganic matters, Physical characteristics, Bacteriological measurements.

UNIT 4: NOISE POLLUTION**9 Hours**

Introduction, sources of noise pollution, Characteristics of sound, noise units, types of noise, effects and control of noise pollution. Radioactive pollution (RAP), Sources of RAP-Classification of its radiation effects on humans, plants and animals.

UNIT 5: SOLID WASTE AND ITS MANAGEMENT**9 Hours**

Sources and Classification of solid waste, Public health aspects, Methods of collection, Disposal Methods, Potential methods of disposal of solid waste.

Max.45 Hours**COURSE OUTCOMES:**

- CO1. Understanding of air/water pollution regulations and their scientific basis
 CO2. Evaluate the various air pollution control equipments
 CO3. Analyze waste water sampling methods and determine the impact of pollution
 CO4. Explain the control measures for noise and radioactive pollution
 CO5. Evaluate the sources and effects of solid waste
 CO6. Develop the potential methods of disposal of solid waste.

TEXT / REFERENCE BOOKS

- Kapoor B.S., Environmental Engineering, 4th Edition, Khanna Publishers, 2000.
- Rao C.S., Environmental Pollution Control Engineering, 2nd Edition, New Age International Publications, 2001.
- Jain P.C. & Monica Jain., Engineering Chemistry. 5th Edition, Dhanpat Rai Publications, 2002.
- Dara S.S., A Text Book of Engineering Chemistry, 3rd Edition, S.Chan & Co Ltd, 2006.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max Marks: 100

Part A: 10 questions of 2 marks each - No choice

Part B: 2 questions from each unit of internal choice; each carrying 16 marks

Examination duration: 3 Hours

20 Marks

80 Marks

SAIC4001	INDUSTRY 4.0	L	T	P	C	Max. Marks
		2	0	2	2	100

UNIT 1 ADVANCED TECHNOLOGY AND ADVANCED MATERIALS**7 Hrs.**

Advanced electro-optical sensing technology-active, passive multi-spectral and hyper spectral imaging; electronic beam steering; vacuum technology, surface and coating technology, health care technology, Nanotechnology- Nano mechanics, Nano optoelectronics; energy storage technology-next generation Li-based Batteries, Hydrogen storage, solar photovoltaics', Flexible electronics. Intellectual Property Rights - case studies governing/pertaining to Materials/Technology.

UNIT 2 TRANSFORMING TECHNOLOGIES IN BIOENGINEERING**7 Hrs.**

Establishment of smart biotechnology factory, Artificial intelligence in Bioprocess technology, Omics – Big data analysis through automation, 3D bio printing for tissue engineering. Simulation tools, RSM and Box model. Cyber physical system based telemedicine, diagnosis and therapeutics through real time biosensors. Bio nanotechnology. Intellectual Property rights (IPR): Case Studies.

UNIT 3 ADVANCEMENTS IN SUSTAINABLE BUILT ENVIRONMENT**7 Hrs.**

Introduction – Technological developments in Architectural, Engineering and Construction (AEC) - Building Information Modelling (BIM) using Cloud computing technology and Internet of things (IoT) – Unmanned Aerial Vehicles, sensors – Additive manufacturing in construction – Concrete 3D printing - Materials used - Lightweight and functionally graded structures - Net Zero Energy buildings, Bioswales, Biofiltration pond. Ecosan systems- Recent developments in Waste water Management, Air pollution control, waste disposal - Integration of energy, water and environmental systems for a sustainable development- Emerging Technologies: Robot Highway- Vertical farming - Intellectual Property rights: Case studies

UNIT 4 SMART MANUFACTURING**8 Hrs.**

Smart factories and interconnection, Smart Manufacturing – automation systems, Additive Manufacturing, Smart grids, Micro Electro Mechanical Systems (MEMS), Stealth technology, Metal Finishing, Self-propelled vehicles, e mobility, green fuels, drones – unmanned aerial vehicles (UAVs), aerodynamics. Robotic Automation and Collaborative Robots – Augmented reality and haptics, engineering cybernetics and artificial intelligence (AI), Disruptive Technologies – Frugal Innovations – Emerging Technologies - Autonomous Robots, Swam Robot, Modular Robotics, Space craft, Intellectual Property Rights (IPR): Case Studies.

UNIT 5 SMART WORLD**8 Hrs.**

Smart Sensors and IIOT, Smart grid, Hybrid renewable energy systems, Electronics in Smart city, Integration of Sensors in Robots and Artificial Intelligence, 5G Technology, Communication protocols, Human-Machine Interaction, Virtual Reality, Quantum Computing: Changing trends in transistor technology: Processor, Emerging Trends: Deep Space, Swarm Robots, Cyborg, Geofencing, Pervasive Computing, Intellectual Property Rights- Case Studies.

UNIT 6 CYBER PHYSICAL SYSTEMS**8 Hrs.**

Introduction to Cyber Physical Systems (CPS), Architecture of CPS, Data science and technology for CPS, Prototypes of CPS, Emerging applications in CPS including social space, crowd sourcing, healthcare and human computer interactions, Industrial Artificial Intelligence, Deep Learning, Gamification, Networking systems for CPS applications, Wearable cyber physical systems and applications, Domain applications of CPS: Agriculture, Infrastructure, Disaster management, Energy, Transportation, Intellectual Property Rights (IPR) :Case Studies.

COURSE OUTCOMES:

- CO1. Apply the basic concepts for electro optical sensing technology and selection of materials.
- CO2. Analyze the technology on AI and Big Data for biomedical applications.
- CO3. Elaborate the various technologies for sustainable built environment.
- CO4. Evaluate different smart manufacturing technologies for industrial robotics-based automation.
- CO5. Compare various advanced technologies for development of smart city.
- CO6. Build Cyber physical systems using AI for Industry, Agriculture and disaster management applications.

Max. 45 Hrs.**TEXT / REFERENCE BOOKS**

- William D. Callister, Materials Science and Engineering: An Introduction, John Wiley and Sons Inc. Singapore, 2001.
- Raghavan V., Physical Metallurgy: Principle and Practice, Prentice Hall India Pvt. Ltd., 2006.

3. Flavio Craveiro, Jose Pinto Duarte, Helena Bartolo and Paulo Jorge Bartolo, "Additive manufacturing as an enabling technology for digital construction: A perspective on Construction 4.0", Automation in Construction, Vol. 103, 2019.
3. Klaus Schwab, Fourth Industrial Revolution, Random House USA Inc., New York, USA, 2017.
4. Oliver Grunow, "SMART FACTORY AND INDUSTRY 4.0. The current state of Application Technologies", Studylab Publications, 2016.
5. Alasdair Gilchrist, "INDUSTRY 4.0: Industrial Internet of Things", Apress, 2016.
6. Sang C.Suh, U.JohnTanik, John N Carbone, Abdullah Eroglu, "Applied Cyber-Physical Systems", Springer Publications, New York, 2013

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100

Exam Duration: 3 Hrs.

PART A: 11 Questions of 2 marks each-No choice

22 Marks

PART B: 2 Questions from each unit with internal choice, each carrying 13 marks

78 Mark

SAIC4004	INDUSTRY 4.0 FOR BIO-CHEMICAL ENGINEERS PROJECT BASED LEARNING APPROACH	L	T	P	C	Max. Marks
		1	0	2	2	100

COURSE OBJECTIVE:

- To demonstrate the achievement of efficient and economically viable production without being hazardous to human health and environment. Learners will gain deep insights into how smartness is being harnessed from data and appreciate what needs to be done in order to overcome some of the challenges.

UNIT 6: MODELLING AND SIMULATION**6 Hours**

Introduction to Industry 4.0 - The Various Industrial Revolutions - Modeling Principles: Introduction, definition of modeling and simulation, different types of models, application of mathematical modeling.

Simulation: Introduction, Simulation Tools, Process Simulation Software Platforms and Applications, Trends in Process Simulation Engineering

UNIT 2: SMART INDUSTRY**6 Hours**

Road to Industry 4.0 - Green manufacturing, Robotic Automation, Industrial Applications- Manufacturing, Control, Maintenance and Assembly, RFID- Type, RFID system, applications, RFID in health care, Embedded Systems - Embedded firmware, Platform software design, Wireless design, Embedded testing, modeling & automation, Hardware platform design, Device Management, Monitoring - Industrial monitoring, condition monitoring, Health monitoring.

UNIT 3 BIG DATA ANALYTICS AS SERVICE PROVIDER**7 Hours**

Technologies for enabling Industry 4.0 - Role of data, information, knowledge and collaboration in future organizations. Big Data - Background - Programming- Python and R - Git - Docker - Pipelines - DNA and RNA Sequencing - Massively parallel sequencing - Applications - Next Generation Sequencing and its future and big data analytics in healthcare - Big Data Repositories - Cloud platforms and computing for automation - Embedded systems in healthcare - Digitization the future of healthcare - medical cyber physical systems - Case study - Integration of Multi-Omics Big Data in Cardiovascular Risks and Diseases.

UNIT4 PLANT/PROCESS MANAGEMENT**6 Hours**

Business issues in Industry 4.0 - Nanobiotechnology: Synthesis of different Nanostructures, Characterization of Nanostructures, Nanostructures in Diagnosis and Therapy. Tissue Engineering: Scaffolds: Natural and Artificial polymers, Scaffold fabrication, 3D Bioprinting; Bioreactors for Tissue Engineering; Effect of different Parameters, Conditions; Tissue engineering for Skin, Bone, Vasculature and Cornea; Regulatory framework in development and marketing tissue-based products.

UNIT 5 PROTOTYPING – TESTING AND COMMUNICATION**20 Hours**

Applications and Case Studies - New ideas – centered design process – functional prototype - testing methods/ideas – prototyping and test beds – proof of concept – assembly – prototyping apps – addressing the complex problems.

Max.45 Hours**COURSE OUTCOMES:**

- CO7. Articulate on the new age technologies in the modeling of biochemical engineering.
- CO8. Integrate different emerging technologies to evolve Smart Factories
- CO9. Deduce the components that lead to industrial digital revolution
- CO10. Ability to assess the developments in bioengineering.
- CO11. Criticize the professional and ethical issues in novel industrial technologies.
- CO6. Develop a prototype/ innovative ideas in the various fields of biochemical engineering.

TEXT / REFERENCE BOOKS

1. Diego Galar Pascual, Pasquale Daponte, Uday Kumar, Handbook of Industry 4.0 and SMART Systems, 1st Editio, CRC Press, 2020
2. Sider W.D., Seader J. D., and Lewin D.R., Product and Process Design principles, Synthesis, Analysis and Evaluation, 2nd Edition, John Wiley and Sons, 2010.
3. Thomas Varghese & K.M. Balakrishna, Nanotechnology: An Introduction to Synthesis, Properties and Applications of Nanomaterials, Atlantic, 2012
4. Uthayan Elangovan, Smart Automation to Smart Manufacturing: Industrial Internet of Things, Momentum Pr, 1st Edition, 2019.

END SEMESTER EXAMINATION PATTERN

Max Marks: 100

PROJECT PRESENTATION

SCSA2102	Fundamentals of Python Programming Lab	L	T	P	Credits	Total Marks
		0	0	4	2	100

1. Program to handle Input and Output statements
2. Program using Lists, Tuples, Dictionary and Sets
3. Program using conditional statements
4. Program using looping constructs
5. Program using functions and modules
6. Program using File handling
7. Program using Exception handling
8. GUI Programming using Python - Canvas Widget
9. GUI Programming using Python -Frame,label,button,checkbox,entry, listbox,message,radio button,text,spinbox
10. Database Programming using Python
11. Socket Programming using Python

COURSE OUTCOMES:

- CO1. Describe primary goals of basic python program using data, expression and statements.
- CO2. Evaluate information around the world and choose appropriate action using control structure, loops.
- CO3. Develop programs for code reusability using functions.
- CO4. Create a python program to implement Exception Handling and File concept for various applications.
- CO5. Design GUI based applications.
- CO6. Create database for a specified application.

SCHA2306	ORGANIC CHEMICAL PROCESSES & THERMODYNAMICS LAB	L	T	P	C	Max. Marks
		0	0	4	2	100

1. Organic Preparations -Synthesis of compounds involving the following reactions

- a. Reduction
- b. Bromination
- c. Acetylation
- d. Hydrolysis
- e. Nitration

2. Qualitative Analysis -Analysis of following classes of compounds

- a. Aldehydes
- b. Ketones
- c. Acids
- d. Alcohols
- e. Amines
- f. Esters

3. Quantitative Analysis -Analysis of following classes of compounds

- a. Fertilizer
- b. Cement
- c. Sugar
- d. Drugs
- e. Proximate analysis of coal

4. Thermodynamics Experiments

- a. Heat of solution
- b. Heat of Neutralization
- c. Heat of Ionization

COURSE OUTCOMES:

- CO1. Identify the physical and chemical properties of common organic functional groups.
- CO2. Quantitative reasoning to determine quantities of energy involved in chemical changes
- CO3. Predict the reactivity of an organic compound from its structure.
- CO4. Develop basic skills for the multi-step synthesis of organic compounds.
- CO5. Predict the major and minor products of a variety of organic reactions with appropriate stereochemistry.
- CO6. Identify the physical and chemical properties of common organic functional groups.

SCHA2307	UNIT OPERATIONS LAB	L	T	P	C	Max. Marks
		0	0	4	2	100

1. Flow through Venturimeter
2. Flow through Orifice meter
3. Flow through Pitot tube
4. Characteristics of a Reciprocating pump
5. Characteristics of a Centrifugal pump
6. Characteristics of a Gear pump
7. Flow through packed bed
8. Flow through helical coil
9. Flow through V- Notches
10. Flow through annular pipe/ non circular conduits
11. Particle size distribution - differential and cumulative analysis by manual method using standard screens
12. Determination of Screen Effectiveness by Mechanical Method using Standard screens
13. Energy requirement and crushing constants determination using Ball mill
14. Energy requirement and crushing constants determination using Drop weight crusher
15. Determination of filtration constants at constant pressure conditions using Vacuum Leaf Filter
16. Minimum thickener area calculations performing Batch Sedimentation test

COURSE OUTCOMES:

- CO1 Estimate the critical parameters for various unit operations
 CO2 Design and drawing of mass transfer equipment's
 CO3 Design of pressure vessels and heat transfer equipment's
 CO4 Design of thickeners and cyclone separators
 CO5 Applying the principles of selection & design of supports and enclosures for vessels and columns
 CO6 Acquire the knowledge of CAD in design of equipment's

SCHA2404	HEAT TRANSFER LAB	L	T	P	C	Max. Marks
		0	0	4	2	100

1. Measure the emissivity of the test plate and plot a graph between emissivity and temperature.
2. Determine the thermal conductivity of metal rod. (Brass rod)
3. Determine the thermal conductivity of hylem, wood, and asbestos.
4. Find the thermal conductivity of the given insulated material by using lagged pipe.
5. Determine the temperature distribution for a cylinder due to heat transfer by natural convection.
6. Study and compare temperature distribution heat transfer rate, overall heat transfer co-efficient in parallel flow heat exchanger.
7. Study and compare temperature distribution, heat transfer rate, overall heat transfer co-efficient in counter flow heat exchanger

COURSE OUTCOMES:

- CO1. Apply the concepts of heat transfer to the operation of heat transfer equipments.
- CO2. Estimate the heat transfer rate and heat transfer co-efficient
- CO3. Estimate the thermal conductivity of solid material
- CO4. Evaluate the performance of heat exchangers
- CO5. Calculate the emissivity of the test plate
- CO6. Collect and analyze the heat transfer data practically.

SCHA2506	MATLAB	L	T	P	C	Max. Marks
		0	0	4	2	100

1. Practicing MATLAB environment with simple exercises to familiarize Command Window, History, Workspace, Current Directory, Figure window, Edit window, Shortcuts, Help files.
2. Data types, Constants and Variables, Character constants, operators, Assignment statements.
3. Control Structures: For loops, While, If control structures, Switch, Break, Continue statements.
4. Program to calculate the vapor pressure of water by using Antoine equation
5. Program to find the Bottoms and distillate composition in distillation column
6. Program to find out the feed and product composition in mixer
7. Estimation of average boiling point of a water /ethanol system at different water composition
8. Estimation of composition in sequence of distillation column
9. Calculation of vapor pressure vapour using pressure vs. temperature data in fourth order polynomial equation
10. Calculation of average density, conductivity and specific heat for water in various range of temperature

COURSE OUTCOMES:

- CO1. Use MATLAB effectively to analyze and visualize data
- CO2. Implement simple mathematical functions/equations in numerical computing environment
- CO3. Interpret and visualize simple mathematical functions and operations there on using plots/display
- CO4. Analyze the program and estimate the output for chemical environment
- CO5. Apply numeric techniques and computer simulations to solve engineering-related problems
- CO6. Create and control simple programs in MATLAB

SCHA2603	PROCESS DYNAMICS AND CONTROL LAB	L	T	P	C	Max. Marks
		0	0	4	2	100

1. Simulation of proportional controller using Matlab
2. Step Response of first order system with and without delay using Matlab
3. Step Response of second order system with and without Delay using Matlab
4. Simulation of Ziegler Nicholas Method of controller tuning using Matlab.
5. Simulation of Cascade control loop Using Matlab
6. Step response of interacting level system
7. Step response of Non-interacting level system
8. Characteristics of ON-OFF Controller in Thermal Process
9. Characteristics of control valve (Actuated and Flow Lift characteristics)
10. Characteristics of I/P Converter
11. Characteristics of P/I Converter
12. Study and control of a Level process using ON-Off, P, PI, PD and PID controllers
13. Study and control of a Pressure process using ON-Off, P, PI, PD and PID controllers
14. Study and control of a Flow process using ON-Off, P, PI, PD and PID controllers

COURSE OUTCOMES:

- CO1. Apply the concepts of first order and second order system with feedback using MATLAB
- CO2. Develop the mathematical model for interacting and non-interacting system
- CO3. Analyze the characteristics of control valve.
- CO4. Design controller parameter using Tuning methods
- CO5. Implementation of P,PI and PID for different processes
- CO6. Evaluate the performance of cascade and ratio control

SCHA2604	PROCESS EQUIPMENT DESIGN AND DRAWING LAB	L	T	P	C	Max. Marks
		0	0	4	2	100

1. Detailed design and drawing of enclosures and supports.
2. Detailed design and drawing of agitated vessel.
3. Detailed design and drawing of basket centrifuge.
4. Detailed design and drawing of gravity thickener.
5. Detailed design and drawing of cyclone separator.
6. Detailed design and drawing of crystallizer.
7. Detailed design and drawing of cooling tower.
8. Introduction to computer aided design of equipments.
9. Detailed design and drawing of various types of heat exchangers.
10. Detailed design and drawing of various types of evaporators.
11. Detailed design and drawing of distillation column.
12. Detailed design and drawing of absorber.
13. Detailed design and drawing of rotary dryer.

COURSE OUTCOMES:

- CO1 Estimate the critical parameters for various unit operations
CO2 Design and drawing of mass transfer equipment's
CO3 Design of pressure vessels and heat transfer equipment's
CO4 Design of thickeners and cyclone separators
CO5 Applying the principles of selection & design of supports and enclosures for vessels and columns
CO6 Acquire the knowledge of CAD in design of equipment's

SCHA2703	PROCESS SIMULATION LAB	L	T	P	C	Max. Marks
		0	0	4	2	100

1. Introduction to software (flow sheeting)
2. Simulation of flash drum
3. Simulation of distillation columns
4. Simulation of absorption columns
5. Simulation of Reactors
6. Simulation of Heat Exchangers.
7. Simulation of pumps and compressors.
8. Simulation of mixing
9. Simulation of compressors.

COURSE OUTCOMES:

- CO1. Demonstrate process simulation software
- CO2. Solve chemical engineering problems
- CO3. Analyze mixing problems
- CO4. Develop simulation for heat exchangers
- CO5. Develop simulation for separation process
- CO6. Examine chemical process plant

PROGRAMME: B.TECH**CHEMICAL ENGINEERING****SEMESTER I**

Sl. No.	COURSE.CODE	TITLE	L	T	P	C	Page . No
1	SCH1101	Environmental Science And Engineering	3	0	0	3	19,20
2	SMT1101	Engineering Mathematics –I	3	1	0	4	3,4
3	SPH 1101	Physics of Engineering Materials	3	0	0	3	11,12
4	SCY1101	Engineering Chemistry	3	0	0	3	15,16
5	SEE1103	Basic Electrical and Electronics Engineering	3	0	0	3	25,26
6	SCS1102	Fundamentals of Programming	3	0	0	3	21,22

PRACTICALS

1	SPH 4051	Engineering Physics Lab	0	0	2	1	66
2	SCY4051	Engineering Chemistry Lab	0	0	2	1	67
3	SCS4101	Programming In C Lab	0	0	4	2	68

TOTAL CREDITS: 23**SEMESTER II**

Sl. No.	COURSE.CODE	TITLE	L	T	P	C	Page. No
1	SHS1101	English For Science And Technology	3	0	0	3	1,2
2	SMT1105	Engineering Mathematics – II	3	1	0	4	5,6
3	SPH 1103	Engineering Physics	3	0	0	3	13,14
4	SCY1104	Physical Chemistry	3	0	0	3	17,18
5	SCS1202	Object Oriented Programming	3	0	0	3	23,24
6	SCH1102	Material Science And Engineering	3	0	0	3	28,29

PRACTICALS

1	SME 4053	Engineering Graphics	0	0	4	2	71,72
2	SCS4201	Object Oriented Programming Lab	0	0	4	2	69

TOTAL CREDITS: 23

SEMESTER III

Sl. No.	COURSE.CODE	TITLE	L	T	P	C	Page.No
1	SMT1201	Engineering Mathematics – III	3	1	0	4	7,8
2	SCH1201	Mechanical Operations	3	0	0	3	30,31
3	SCH1202	Chemical Engineering Thermodynamics-I	3	0	0	3	32,33
4	SCH1203	Fluid Mechanics	3	0	0	3	34
5	SCH1204	Chemical Process Calculations	3	1	0	4	35
6	SCH1205	Energy Engineering	3	0	0	3	36,37

PRACTICALS

1	SCH4051	Technical Analysis And Instrumentation Lab	0	0	4	2	72
2	SCH4052	Organic Chemical Process And Thermodynamics Lab	0	0	4	2	73

TOTAL CREDITS: 24**SEMESTER IV**

Sl. No.	COURSE.CODE	TITLE	L	T	P	C	Page.No
1	SMT1204	Engineering Mathematics – IV	3	1	0	4	9,10
2	SCH1206	Mass Transfer -I	3	1	0	4	38
3	SCH1207	Chemical Engineering Thermodynamics-II	3	1	0	4	39,40
4	SCH1208	Chemical Reaction Engineering - I	3	1	0	4	41
5	SCH1209	Bio Chemical Engineering	3	0	0	3	42,43
6	SCH1212	Heat Transfer	3	0	0	3	44,45

PRACTICALS

1	SCH4053	Fluid Mechanics Lab	0	0	4	2	74
2	SCH4054	Mechanical Operations Lab	0	0	4	2	75
3	S19PT1	Internship	0	0	10	5	

TOTAL CREDITS: 31

SEMESTER V

SI. No.	COURSE.CODE	TITLE	L	T	P	C	Page.No
1	SCH1301	Computational Methods In Chemical Engineering	3	1	0	4	46,47
2	SCH1302	Mass Transfer -II	3	0	0	3	48,49
3	SCH1303	Chemical Reaction Engineering - II	3	1	0	4	50
4	SCH1304	Chemical Process Technology	3	0	0	3	51,52
5	SCH1305	Instrumentation And Process Control	3	0	0	3	53
6	SCH1306	Process Engineering	3	0	0	3	54,55

PRACTICALS

1	SCH4055	PROCESS DYNAMICS & CONTROL LAB	0	0	4	2	76
2	SCH4056	HEAT TRANSFER LAB	0	0	4	2	77

TOTAL CREDITS: 24**SEMESTER VI**

SI. No.	COURSE.CODE	TITLE	L	T	P	C	Page.No
1	SCH1307	Process Equipment Design	3	1	0	4	56
2	SCH1308	Petroleum And Petro Chemical Technology	3	0	0	3	57
3	SCH1309	Transport Phenomena	3	1	0	4	58,59
4	SCH1310	Environmental Pollution And Control	3	0	0	3	60
5	SCH1311	Industrial Safety & Hazard Analysis	3	0	0	3	61,62
6		Elective – I	3	0	0	3	

PRACTICALS

1	SCH4057	Mass Transfer Lab	0	0	4	2	78
2	SCH4058	Chemical Reaction Engineering Lab	0	0	4	2	79
3	S19PT2	Internship	0	0	10	5	

TOTAL CREDITS: 29

SEMESTER VII

SI. No.	COURSE.CODE	TITLE	L	T	P	C	Page.No
1	SCH1401	Process Modeling And Simulation	3	0	0	3	63
2	SCH1402	Optimization Of Chemical Processes	3	1	0	4	64
3		Elective – III	3	0	0	3	
4		Elective – IV	3	0	0	3	

PRACTICALS

1	SCH4059	Mat Lab	0	0	4	2	80
2	S19PROJ1	Project Work-Phase-1	0	0	10	5	

TOTAL CREDITS: 20**SEMESTER VIII**

SI. No.	COURSE.CODE	TITLE	L	T	P	C	Page.No
1	SCH1403	Process Engineering Economics	3	0	0	3	65
2	SBA1101	Principles Of Management & Professional Ethics	3	0	0	3	27
3		Elective – IV	3	0	0	3	

PRACTICALS

1	SCH4060	Process Simulation Lab	0	0	4	2	81
2	S19PROJ2	Project Work-Phase-2	0	0	20	10	

TOTAL CREDITS: 21**TOTAL CREDITS FOR THE COURSE: 195**

LIST OF ELECTIVES

S. No.	COURSE.CODE	TITLE	L	T	P	C	Page.No
1.	SCH1603	Instrumental Methods of Analysis	3	0	0	3	82,83
2.	SCH1604	Fertilizer Technology	3	0	0	3	84
3.	SCH1605	Novel Separation Processes	3	0	0	3	85
4.	SCH1609	Food Technology	3	0	0	3	86
5.	SCH1612	Drugs and Pharmaceutical Technology	3	0	0	3	87
6.	SCH1613	Nano Science and Technology	3	0	0	3	88
7.	SCH1614	Corrosion Engineering	3	0	0	3	89
8.	SCH1616	Environmental Impact Assessment	3	0	0	3	90,91

*L - LECTURE HOURS, T – TUTORIAL HOURS, P – PRACTICAL HOURS, C – CREDITS

SCH1101	ENVIRONMENTAL SCIENCE AND ENGINEERING	L	T	P	C	Max. Marks
		3	0	0	3	100

OBJECTIVE: To impart knowledge on the issues related to environment and to emphasize the importance of a clean environment

UNIT 1: INTRODUCTION TO ENVIRONMENTAL STUDIES AND NATURAL RESOURCES

10 Hours

Definition, scope and importance, need for public awareness, forest resources: use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams, floods, drought, conflicts over water, dams-benefits and problems, mineral resources: use effects on forests and tribal people. water resources: use and over-utilization of surface and ground water, exploitation, environmental effects of extracting and using mineral resources, case studies – food resources: world food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. Energy resources: growing energy needs, renewable and non renewable energy sources, use of alternate energy sources: Case studies. Land resources: land as a resource, land degradation, man induced landslides, soil erosion and desertification, role of an individual in conservation of natural resources, equitable use of resources for sustainable lifestyles.

UNIT 2: ECOSYSTEMS AND BIODIVERSITY

10 Hours

Concept of an ecosystem, structure and function of an ecosystem - producers, consumers and decomposers - energy flow in the ecosystem, ecological succession, food chains, food webs and ecological pyramids. Introduction, types, characteristic features, structure and function of the (a) forest ecosystem (b) grassland ecosystem (c) desert ecosystem (d) aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries). Introduction to biodiversity, definition: genetic, species and ecosystem diversity - biogeographical classification of India - value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values, biodiversity at global, national and local levels. India as a mega-diversity nation, hot-spots of biodiversity, threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts, endangered and endemic species of India, conservation of biodiversity, in-situ and ex-situ conservation of biodiversity.

UNIT 3: ENVIRONMENTAL POLLUTION

09 Hours

Definition - causes, effects and control measures of: (a) air pollution (b) water pollution (c) soil pollution (d) marine pollution (e) noise pollution (f) thermal pollution (g) nuclear hazards. Solid waste management: causes, effects and control measures of urban and industrial wastes, role of an individual in prevention of pollution, pollution case studies, disaster management: floods, earthquake, cyclone and landslides.

UNIT 4: SOCIAL ISSUES AND THE ENVIRONMENT

08 Hours

From unsustainable to sustainable development, urban problems related to energy, water conservation, rain water harvesting, watershed management, resettlement and rehabilitation of people; its problems and concerns, case studies, environmental ethics: issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, case studies. Wasteland reclamation, consumerism and waste products – environment protection act: air (prevention and control of pollution) act - water (prevention and control of pollution) act, wildlife protection act; forest conservation act. Issues involved in enforcement of environmental legislation, Key initiatives of Rio declaration, Vienna convention, Kyoto protocol, Johannesburg summit and public awareness.

UNIT 5: HUMAN POPULATION AND THE ENVIRONMENT

08 Hours

Population growth, variation among nations, population explosion, family welfare programme, environment and human health, human rights, value education, HIV / AIDS, women and child welfare, role of information technology in environment and human health, case studies. Visit to a local area to document environmental assets-river/forest/grassland/hill/mountain. Visit to a local polluted site-urban/rural/ industrial/agricultural-study of common plants, insects, birds-study of simple ecosystems, pond, river, hill slopes etc.

Max. 45 Hours

Course Outcomes:

At the end of the course, the students will be able to:

CO1: Recognize the need of conservation of natural resources for the future generations

CO2: Differentiate the uniqueness of each and every ecosystem and biodiversity

CO3: Identify the environmental pollution and to control them in a sustainable way

CO4: Execute the possible solutions to manage the natural and manmade disasters for the sustainable living

CO5: Distinguish the reasons for over population and give awareness to people through media to control population growth

CO6: Solve the environment related problems by conserving the natural resources for the future generations

REFERENCE BOOKS:

1. Meenakshi. P, Elements of Environmental Science and Engineering, 1st Edition, Prentice Hall of India, New Delhi, 2009.
2. Ravikrishnan. A, Environmental Science & Engineering, 3rd Edition, Sri Krishna Publications, Chennai, 2008.
3. Wrih. R. T & Nebel B.J, Environmental science-towards a sustainable future by Richard 8th edition, Prentice Hall of India, NewDelhi,2006
4. Erach Bharucha, Text Book of Environmental Studies, 2nd Edition ,University Press, Chennai, 2006

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 80

Exam Duration: 3 Hours

Part A: 10 questions of 2 marks each – No Choice

20 marks

Part B: 5 questions from each of the five units of internal choice, each carrying 12 marks each

60 marks

SBA1101	PRINCIPLES OF MANAGEMENT AND PROFESSIONAL ETHICS	L	T	P	C	Max. Marks
		3	0	0	3	100

OBJECTIVE:

To familiarize engineering students with the concepts of Management useful for Managing their own enterprise or to work in a professional organization in Managerial capacity and to provide them an ethical outlook.

UNIT 1: MANAGEMENT FUNCTIONS & STRUCTURE**9 Hours**

Management – Definition – Role of managers- Levels of management-Basic Function – Contribution of Taylor & Fayol. Types of structures – Line, staff, Functional, Committee and Project & Matrix – Structures. Departmentalization – Centralization – Decentralization – Span of control. **Management by Objectives** (MBO)– **Management by Exception** (MBE).

UNIT 2: MANAGEMENT OF ORGANISATION**9 Hours**

Forms of Business / Industrial Ownership – Sole Trader, Partnership, Joint stock Company, Performance Appraisal – Basic Principles – Pitfalls – Methods to Overcome. Industrial Safety – Causes of Accidents – Cost of Accidents – Measures to avoid Accidents. Plant Layout & Maintenance – Need, Types & Managerial Aspects.

UNIT 3: ORGANISATIONAL BEHAVIOUR**9 Hours**

Organisational Behaviour – Definition – Nature & Scope – Contributing Disciplines – Importance of OB to Managers. Personality – Definition – Theories – Factors Influencing Personality. Motivation – Definition – Theories. Transactional Analysis. Morale & Job Satisfaction – Factors Influencing Job Satisfaction.

UNIT 4: GROUP DYNAMICS**9 Hours**

Group – Definition – Types – Determinants of Group Cohesiveness. Communication – Process – Barriers – Effective Communication. **Leadership-Definition- leadership styles- Theories of leadership** – Factors Contributing to Effective Leadership. Trade Unions- Role of Trade Union in Organizations – Types and Functions of Trade Unions.

UNIT 5: PROFESSIONAL ETHICS**9 Hours**

Ethics in Workplace – Formulation of Ethics – Managerial Ethics – Managing Ethical Behaviour – Codes of Ethics – Encouraging Ethical Behaviour – Ethical Leadership – Ethical Decision making. Corporate Social Responsibility (CSR) – Intellectual Property Rights (IPR)- Meaning- Laws relating to Intellectual Property Rights (IPRs)

Max. 45 Hours Course Outcomes:

At the end of the course, the students will be able to:

CO1: Recognize the need of conservation of natural resources for the future generations

CO2: Differentiate the uniqueness of each and every ecosystem and biodiversity

CO3: Identify the environmental pollution and to control them in a sustainable way

CO4: Execute the possible solutions to manage the natural and manmade disasters for the sustainable living

CO5: Distinguish the reasons for over population and give awareness to people through media to control population growth

CO6: Solve the environment related problems by conserving the natural resources for the future generation

REFERENCE BOOKS

1. Gupta C.B., Management Theory and Practice, 14th Edition, Sultan Chand & Sons, 2009.
2. Dr. Prasad L.M., Principle & Practice of Management, 7th Edition, Sultan Chand & Sons, 2008.
3. Aswathappa, Organisational Behaviour, 8th Edition, Himalaya Publishing House, 2010.
4. Dr. Prasad L.M., Organisational Behaviour, 4th Edition, Sultan Chand & Sons, 2008.
5. Harold Koontz, Principles of Management, 1st Edition, Tata McGraw Hill, 2004.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max Marks: 80

Part A: 10 questions of 2 marks each - No choice

Part B: 2 questions from each unit of internal choice; each carrying 12 marks

Examination duration: 3 Hours

20 Marks

60 Marks

SCH1201	MECHANICAL OPERATIONS	L	T	P	C	Max. Marks
		3	0	0	3	100

OBJECTIVE: This course is concerned with the properties, modification and separation of particulate solids.

UNIT 1: PARTICLE SIZE AND SHAPE

9 Hours

Introduction:-Scope & Application of Solid Fluid Operation. Particle Size Analysis:-Particle Size Measurement & Distribution, Sieve Analysis- Differential and Cumulative screen analysis, Specific surface area, Particle population, Different mean diameters for a mixture of particles. Particle size measurement, Surface area measurements, Statistical mean diameters, Screening Equipments : Size separation, Screening, Industrial screens, Grizzly, Gyratory and Vibratory screens, Revolving screens, Trommels, Capacity and Effectiveness of screens, Relevant equations and problems.

UNIT 2: INTRODUCTION TO SIZE REDUCTION EQUIPMENTS

9 Hours

Principles of Comminution - Laws of crushing & Power Requirement in Milling Operations, Crushing and Grinding efficiency, Description and working of size reduction equipment, Jaw and Roll crushers, Hammer mill, Gyratory crushers, Ball mills, Revolving mills, Attrition mills, Fluid energy mill, Cutting machines, Open and Closed circuit grinding, Wet and Dry grinding, Grindability Index.

UNIT 3: SEDIMENTATION, STORAGE AND CONVEYING OF SOLIDS

9 Hours

Batch sedimentation, Equipments for sedimentation, Kynch theory of sedimentation, Calculation of area and depth of continuous thickeners, Batch thickeners and Continuous thickeners. Phase separation: Centrifugal separation, Electrostatic precipitators and Magnetic separation. Gas-solid separation: Gravity settling, Impingement separators, Cyclone separators, Bag filters, Scrubbers, Mineral jig, Cyclone separator, Hydro cyclone types and Centrifuges, Centrifugal clarifier

Storage and Conveying of Solids: Introduction to storage and conveying of solids, Bins, Hoppers and Silos, Flow out of bins, design consideration of bins, loading and unloading of solids. Bucket elevators, Apron conveyors. Belt conveyors: Types of Belt conveyors, Selection considerations.

UNIT 4: FILTRATION

9 Hours

Filter media and filter aids, Classification of filtration, Pressure drop through filter cake, Filter medium resistance, Specific cake resistance, Continuous Filtration, Washing and Dewatering of filter cakes, Centrifugal filtration.

UNIT 5: MIXING AND AGITATIONS

9 Hours

Necessity of mixing & agitation in chemical industries, Types of Impellers & propellers, Different flow patterns in mixing, Calculation of power requirement of mixing equipment, Mixing equipment of pastes & viscous material, Solid – Solid Mixing, Agitator selection.

Max.45 Hours

Course Outcomes:

At the end of the course, the students will be able to:

CO1: Determine various properties of particulates; identify the conveyors and storage for particular application

CO2: Evaluate the power consumption for particle size reduction and ability to select size reduction equipments

CO3: Analyse solid liquid separation in industries based on settling, density and centrifugal force

CO4: Evaluate the parameters of filtration and design of filters

CO5: Understand the operation and working principle of filters

CO6: Apply the principles of agitation and mixing

REFERENCE BOOKS:

1. Warren L. McCabe, Julian C. Smith and Peter Harriott, Unit Operations of Chemical Engineering, 8th Edition, McGraw Hill International Edition., New York 2009.
2. Badger and Banchero, Introduction to Chemical Engineering, 2nd Edition, McGraw Hill, 2001.
3. Coulson J.M., Richardson J.F., Backhurst J.R. and Harker J.M., Coulson & Richardson's Chemical Engineering, Vol. II, 5th Edition, Butterworth Heinemann, Oxford, 2002.

4. Brown, G.G., Unit Operations, 2nd Edition, CBS Publishers & Distributors, New Delhi, 2005.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max Marks: 80

Part A: 10 questions of 2 marks each - No choice

Part B: 2 questions from each unit of internal choice; each carrying 12 marks

Examination duration: 3 Hours

20 Marks

60 Marks

SCH1202	CHEMICAL ENGINEERING THERMODYNAMICS - 1	L	T	P	C	Max. Marks
		3	0	0	3	100

OBJECTIVE: To acquire basic understanding of concepts and laws of thermodynamics, volumetric properties of fluids and thermodynamic properties of fluids

UNIT 1: BASIC CONCEPTS & FIRST LAW OF THERMODYNAMICS

9 Hours

The terminologies of thermodynamics - Work, energy, heat, internal energy, extensive & intensive properties, equilibrium, the variables and quantities of thermodynamics, categorization of systems and processes. Energy classifications, point and path properties, reversible and irreversible processes, Zeroth law of thermodynamics, statements of first law for the non flow and flow systems, enthalpy and heat capacity, limitations of the first law.

UNIT 2: LAWS OF THERMODYNAMICS

9 Hours

Statements of the second law of thermodynamics, Heat Engines, Heat pumps, Carnot principle, The entropy function, Calculation of entropy changes - for phase change, processes involving ideal gas, **adiabatic mixing process, isothermal mixing of ideal gases**, chemical reactions, clausius inequality, applications of the second law. Third law of thermodynamics.

UNIT III THERMODYNAMIC EQUATIONS OF STATE

9 Hours

The PVT behaviour of pure fluids, laws of corresponding states and equation of states approaches to the PVT relationships of real gases – Vander waals equation, Redlich Kwong Equation, Bertholet equation, Virial equation, compressibility factors, generalized equations of state, property estimation via generalized equation of state.

UNIT 4: THERMODYNAMIC FORMULATIONS

9 Hours

Measurable quantities, basic energy relations, Maxwell relations, thermodynamic formulations to calculate enthalpy, internal energy and entropy as function of pressure and temperature, other formulations involving Cp and Cv, complex thermodynamic formulations, thermodynamic properties of an ideal gas, entropy change in reversible and irreversible process.

UNIT 5: APPLICATIONS OF THE LAWS OF THERMODYNAMICS

9 Hours

Flow Processes – Continuity Equation, Energy Equation, **Flow through nozzles, Ejectors, compression process**, classification of compression processes, the work expression for different situations, the effect of clearance volume, multistage compression, Refrigeration- Vapor compression and Vapor absorption refrigeration, Choice of refrigerant, Liquefaction processes.

Max.45 Hours

Course Outcomes:

At the end of the course, the students will be able to:

CO1: Understand the basic principles of thermodynamics and the properties

CO2: Apply second law of thermodynamics to analyse the feasibility of system

CO3: Relate PVT behaviour of fluids and analyse the equations of state

CO4: Analyse the thermodynamic property relations

CO5: Analyse the performance of compressors and nozzles

CO6: Analyze the ideal and actual vapor-compression refrigeration cycle and Evaluate the performance

REFERENCE BOOKS:

1. Smith, J.M., and Van Ness, H.C., Introduction to Chemical Engineering Thermodynamics, 6th Edition Mc-Graw-Hill, 2004.

2. Narayanan K.V., A Text Book of Chemical Engineering Thermodynamics, 3rd Edition Prentice Hall of India Pvt. Ltd. 2001.
3. Hougen, O.A., Watson, K.M., and Ragatz, R.A., Chemical Process Principles, Part II, Thermodynamics, 3rd Edition, John Wiley 1970.
4. Gopinath Halder, Introduction to Chemical Engineering Thermodynamics, 2nd Edition, PHI Learning Private Limited, 2009.
5. Rao Y.V.C., Chemical Engineering Thermodynamics, 1st Edition, University Press (I) Ltd., Hyderabad, 1997.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max Marks: 80

Part A: 10 questions of 2 marks each - No choice

Part B: 2 questions from each unit of internal choice; each carrying 12 marks

Examination duration: 3 Hours

20 Marks

60 Marks

SCH1203	FLUID MECHANICS	L	T	P	C	Max. Marks
		3	0	0	3	100

OBJECTIVE: To understand the governing principles of momentum transport in chemical process systems.**UNIT 1: FLUID FLOW PHENOMENA****9 Hours**

Nature of fluids-properties of fluids, incompressible and compressible, hydrostatic equilibrium. Manometers U-Tube and inclined. Potential flow, boundary layer, the velocity field, laminar flow, Newtonian and Non Newtonian fluids, Newton's law of viscosity, turbulence. Reynolds number and transition from laminar to turbulent flow, Eddy viscosity, flow in boundary layers

UNIT 2: KINEMATICS OF FLUID FLOW**9 Hours**

Streamlines and stream tubes, equation of continuity, Bernoulli equation. Flow of incompressible fluids in conduits and thin layers: friction factor, relationships between skin friction parameters, average velocity for laminar flow of Newtonian fluids, Hagen-Poiseuille equation, hydraulically smooth pipe, von Karman equation, roughness parameter, friction-factor chart, equivalent diameter.

UNIT 3: FLOW PAST IMMERSED BODIES AND FLUIDIZATION**9 Hours**

Drag and drag coefficients. Ergun equation, terminal settling velocity, free and hindered settlings, Stokes' law, Newton's law. Fluidization, conditions for fluidization, minimum fluidization velocity.

UNIT 4: TRANSPORTATION OF FLUIDS**9 Hours**

Introduction to pipe and tubing, joint and fittings, stuffing boxes, mechanical seals, gate valves and globe valves, plug cocks and ball valves. Classification and selection of pumps, **Reciprocating and Centrifugal pumps, developed head, power requirement, suction lift cavitation and pump work in Bernoulli equation, characteristic curves.**

UNIT 5: METERING OF FLUIDS**9 Hours**

Constructional features and working principles **of Venturi meter, Orifice meter, Area meters-Rota meter, Point velocity-Pitot tube, V-element meter, Target meter-ultrasonic meters, vortex shredding meter, Turbine meter.**

Max.45 Hours**Course Outcomes:**

At the end of the course, the students will be able to:

CO1: Understand the fundamental aspects of fluid –flow phenomena**CO2:** Analyze the fluid kinetics**CO3:** Compute the ΔP for the flow past immersed bodies**CO4:** Determine the principle and operation of various aspects of transportation of fluids.**CO5:** Apply the concepts of metering of fluids in the selection of flow meters**CO6:** Analyse the criteria for settling regime**REFERENCE BOOKS:**

1. McCabe, W.L, Smith J.C and Harriot. P., Unit Operations in Chemical Engineering, 7th Edition, Mc-Graw-Hill, 2009.

- Noel de Nevers, Fluid Mechanics for Chemical Engineers, 2nd Edition, McGraw-Hill, 1991.
- Coulson J.M. and Richardson J.E., Chemical Engineering, Volume 1, 3rd Edition, Pergamon Press, 2000.
- Shames, I.H., Mechanics of Fluids, 3rd Edition, McGraw-Hill Inc., 1992.
- White, F.M., Fluid Mechanics, 4th Edition, McGraw-Hill Inc., 1999.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max Marks: 80

Part A: 10 questions of 2 marks each - No choice

Part B: 2 questions from each unit of internal choice; each carrying 12 marks

Examination duration: 3 Hours

20 Marks

60 Marks

SCH1204	CHEMICAL PROCESS CALCULATIONS	L	T	P	C	Max. Marks
		3	1	0	4	100

OBJECTIVE: To perform stoichiometric calculations for chemical and non-chemical systems and to understand quantitative relationships between matter and energy involved in physiochemical processes.

UNIT 1: INTRODUCTION**12 Hours**

Units and Dimensions, Basic and derived units, use of model units in calculations, Methods of expressing, compositions of mixture and solutions. Gas Calculations: Ideal and real gas laws, Gas constant, Calculations of pressure, volume and temperature using ideal gas law. Use of partial pressure and pure component volume in gas calculations, applications of real gas relationship in gas calculation.

UNIT 2: MATERIAL BALANCE WITHOUT CHEMICAL REACTION**12 Hours**

Application of material balance to unit operations like distillation, evaporation, crystallization, extraction, absorption and stripping, drying, mixing.

UNIT 3: MATERIAL BALANCE WITH CHEMICAL REACTION**12 Hours**

Stoichiometric principles, Limiting and excess reactant, conversion, selectivity and yield. Application of material balance to systems with recycle, bypass and purging.

UNIT 4: FUELS AND COMBUSTION**12 Hours**

Determination of Composition by Orsat analysis of products of combustion of solid, liquid and gaseous fuels - Calculation of excess air from orsat technique, problems on sulphur and sulphur containing compounds.

UNIT 5: ENERGY BALANCE**12 Hours**

Heat capacity of solids, liquids and gases, mean heat capacity, sensible heat and latent heat, evaluation of enthalpy, Standard heat of reaction, heat of formation, combustion, solution, mixing etc., calculation of standard heat of reaction, Effect of pressure and temperature on heat of reaction - Energy balance for systems with and without chemical reaction

Max.60 Hours**Course Outcomes:**

At the end of the course, the students will be able to:

- CO1:** Make the conversions for temperature, pressure, energy, concentration etc.
- CO2:** Carry out material balance for various units operations without reaction
- CO3:** Perform the material balance with chemical reaction
- CO4:** Calculate conversion, recycle ratio for the system involving recycling/purge/bypass streams
- CO5:** Carry out energy balance for various systems with and without chemical reaction
- CO6:** Analyse the fuel composition and flue gas analysis

REFERENCE BOOKS:

- Himmelblau, D.M., Basic Principles and Calculations in Chemical Engineering, 6th Edition, Prentice Hall Inc., 2003 (with CD containing programmes and problems).
- Houghen. O.A., Watson. K.M and Ragatz. R.A, Chemical Process Principles, Part I, 2nd Edition, John Wiley and Asia Publishing, 1970.

- Venkataramani, V and Anantharaman.N., Process Calculations, 2nd Edition, Prentice Hall of India Pvt. Ltd., 2003
- Bhatt, B.L., Vora, S.M., Stoichiometry, 4th Edition, Tata McGraw-Hill, 2004.
- Richard M. Felder, Ronald W. Rousseau, Elementary Principles of Chemical Processes, 3rd Edition, John Wiley & Sons, Inc. Singapore, 2000.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max Marks: 80

Part A: 10 questions of 2 marks each - No choice

Part B: 2 questions from each unit of internal choice; each carrying 12 marks

Examination duration: 3 Hours

20 Marks

60 Marks

SCH1205	ENERGY ENGINEERING	L	T	P	C	Max. Marks
		3	0	0	3	100

OBJECTIVE: To impart in depth understanding of the issues related with renewable energy and their development**UNIT 1: INTRODUCTION TO CONVENTIONAL & NON-CONVENTIONAL ENERGY SOURCES****9 Hours**

Conventional energy sources; non-conventional energy sources; Energy sources, Coal, Oil, Natural gas, nuclear fuels, Hydro power advantages. Classification of fuels. Solar Energy, Solar radiation and its measurement, solar constant, solar radiation at earth's surface, solar radiation geometry, solar radiation measurement. Introduction to solar energy. Applications, solar water heating, space heating, space cooling, solar thermal electric conversion. Agriculture and industrial process heating, solar distillation, solar pumping, solar cooking.

UNIT 2: ENERGY FROM BIOMASS (BIO – ENERGY): INTRODUCTION**9 Hours**

Biomass conversion Technologies. Wet processes, Dry processes, Biogas generation. Factors affecting biogas generation or generation of gas. Classification of biogas plants. Advantages and disadvantages of floating drum plant. Advantages and disadvantages of fixed dome type plant. Types of biogas plants (KVIC model & Janata model). Selection of site for biogas plant.

UNIT 3: BIO – ENERGY (THERMAL CONVERSION) AND ELECTRICAL CONDUCTION (MHD)**9 Hours**

Methods of obtaining energy from biomass, Thermal gasification of biomass, Classification of biomass gasifiers, Chemistry of gasification process, Applications of the gasifiers. Magneto hydrodynamic generator, electrical conductivity and formation of MHD, performance

UNIT 4: WIND ENERGY: INTRODUCTION**9 Hours**

Basic components of WECS (wind energy conversion system): Classification of WECS, Types of wind machines, horizontal axis machines, vertical axis machines. Applications of wind energy. Energy from the oceans: Introduction, Ocean thermal electric conversion (OTEC), Methods of ocean thermal electric power generation, Open cycle OTEC system, Closed or Anderson OTEC cycle, hybrid cycle. Application of energy from oceans.

UNIT 5: FUEL CELLS BASICS-ENERGY CONSERVATION**9 Hours**

Fuel Cells, Difference between batteries and fuel cells, Components of fuel cells, Principle of working of fuel cells, Fuel cell types: Alkaline fuel cells, Polymer electrolyte fuel cells, Phosphoric acid fuel cells, Molten carbonate fuel cells, Solid oxide fuel cells, Types of solid acid fuel acid fuel cells, Applications. Co-generation- waste heat recovery and heat pump.

Max.45 Hours**Course Outcomes:**

At the end of the course, the students will be able to:

CO1: Explain various conventional and non- conventional energy resources and application of solar energy**CO2:** Evaluate the performance of various types of bio gas plants**CO3:** Demonstrate the working principle of biomass gasifiers

CO4: Interpret the various types of wind energy conversion and ocean thermal electric conversion

CO5: Demonstrate the working principle of various kinds of fuel cells.

CO6: Evaluate the performance of waste heat recovery systems and heat pump.

REFERENCE BOOKS:

1. Rai G.D., Solar Energy Utilisation, 3rd Edition, Khanna Publishers, New Delhi, 2000.
2. Rai G.D., Non Conventional Energy Sources, 3rd Edition, Khanna Publishers, New Delhi, 2000.
3. Rao S.S., Energy Technology, 3rd Edition, Khanna Publishers, New Delhi, 2006
4. Rused C.K., Elements of Energy Conservation, 4th Edition, McGraw Hill, 1985.
5. Christopher H. and Armsteed H., Geothermal Energy, 2nd Edition, John Wiley, New York, 1978.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max Marks: 80

Part A: 10 questions of 2 marks each - No choice

Part B: 2 questions from each unit of internal choice; each carrying 12 marks

Examination duration: 3 Hours

20 Marks

60 Marks

SCH1206	MASS TRANSFER – I	L	T	P	C	Max. Marks
		3	1	0	4	100

OBJECTIVE: To impart the knowledge on fundamentals of mass transfer principles, concept of mass transfer coefficients and basic mass transfer operations.

UNIT 1: DIFFUSION

12 Hours

Molecular and Eddy diffusion in gases and liquids, Measurement and calculation of diffusivity, Equimolar and Unicomponent diffusion in gases and liquids, Diffusion in Multicomponent gaseous mixtures, Wilke Lee correlation Diffusion in solids and its applications – Steady state diffusion under stagnant and laminar flow conditions.

UNIT 2: MASS TRANSFER CO-EFFICIENTS

12 Hours

Concept of mass transfer co-efficient, Mass transfer under laminar and turbulent flow past the solids, Boundary layers, Introduction to convective mass transfer, Correlation of mass transfer co-efficient, Analogies between momentum, heat and mass transfer, Reynolds, Prandtl, Von karman, Chilton and colburn analogy, Theories of mass transfer and their application, Interphase and overall mass transfer co-efficient in binary systems.

UNIT 3: DISTILLATION

12 Hours

Vapor liquid equilibria, Raoult's law and deviations from ideality, Methods of distillation - Batch, Continuous, Flash, Vacuum, Azeotropic, Extractive and Molecular distillation. Design method - McCabe Thiele method, Ponchon Savarit method, Fenske equation, Introduction to multi-component distillation.

UNITIV: ABSORPTION

12 Hours

Equilibrium and operating line concept in absorption calculations, Calculation of NTU, HTU, Number of stages, Packed and plate type absorbers. Absorption with chemical reaction, HETP Operating characteristics of stage wise and differential contactors. Absorption equipment – Packed and Plate towers, Centrifugal Absorbers and spray towers.

UNITV: MEMBRANE SEPARATION PROCESS

12 Hours

Solid and liquid membranes, Membrane fouling, Concept of Osmosis, reverse osmosis, Dialysis, Electrodialysis, Ultrafiltration, Microfiltration, Nanofiltration, Pervaporation, Thermal and Sweep diffusion process, Ion Exchange, Zone Refining, Industrial application of membrane process.

Max.60 Hours

Course Outcomes:

At the end of the course, the students will be able to:

- CO1:** Estimate the diffusivity and rate for transfer of solute in gases, liquids and solids.
- CO2:** Applying principles of diffusion, mass transfer coefficients and interphase mass transfer.
- CO3:** Design calculation of distillation column
- CO4:** Determine the number of stages and height of continuous absorber
- CO5:** Analyse the various membrane separation process
- CO6:** Apply working principles of membranes in Industrial applications

REFERENCE BOOKS:

1. Treybal, R.E, Mass Transfer Operations, 3rd Edition, McGraw Hill, 2004.
2. McCabe and Smith, Unit Operations of Chemical Engineering, 7th Edition, McGraw Hill, 2009
3. Coulson J.M. and Richardson J.F., Chemical Engineering, Vol – II, 6th Edition, Pergamon Press, 2002.
4. Sherwood T.K., Pigford R.L. and Wilke C.R., Mass Transfer, 2nd Edition, McGraw Hill, 1960.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max Marks: 80

Part A: 10 questions of 2 marks each - No choice

Part B: 2 questions from each unit of internal choice; each carrying 12 marks

Examination duration: 3 Hours

20 Marks

60 Marks

SCH1208	CHEMICAL REACTION ENGINEERING –I	L	T	P	C	Max. Marks
		3	1	0	4	100

OBJECTIVE: To impart knowledge on the kinetics of isothermal and non-isothermal reactions for simple and multiple reactors

UNIT 1: INTREPRETATION OF REACTOR DATA

12 Hours

Classification of reactions, reaction rate, rate constant, order, molecularity, concentration dependent term of rate equation, temperature dependent term of rate equation, arrhenius theory, collision theory ,transition state theory, kinetics of non-elementary reactions, integral and differential methods for finding order of reaction, half life period, constant volume and variable volume reaction. reversible reactions ,autocatalytic reaction.

UNIT 2: DESIGN OF SINGLE IDEAL REACTORS

12 Hours

Material balance , Energy balance , batch operation, continuous operation , semi-batch operation, ideal conditions, design of ideal batch reactor, ideal plug flow reactor, ideal mixed flow reactor, semi-batch reactor ,recycle reactor.

UNIT 3: DESIGN OF MULTIPLE REACTOR SYSTEMS

12 Hours

Mixed flow reactors in series and parallel connection , Plug flow reactors in series and parallel connection , reactors of different types in series ,size comparison of reactors using performance charts

UNIT 4: MULTIPLE REACTIONS

12 Hours

Series reactions , parallel reactions , series-parallel reactions , qualitative discussion about product distribution in mixed flow reactor and plug flow reactor, quantitative treatment of product distribution in mixed flow reactor and plug flow reactor, overall fractional yield ,instantaneous fractional yield, selectivity.

UNIT5: NON-ISOTHERMAL REACTIONS

12 Hours

Heat of reaction, equilibrium constants from thermodynamics, equilibrium conversion ,temperature effects on chemical reaction rates, optimum temperature progression , size of reactor. design procedures for adiabatic and non-isothermal operation of batch and flow reactors, reactor stability, exothermic reactions in mixed flow reactors.

Max.60 Hours

Course Outcomes:

At the end of the course, the students will be able to:

- CO1: Apply basic concepts of reaction kinetics
- CO2: Design performance equations for ideal reactors
- CO3: Analyze design aspects for multiple reactors
- CO4: Evaluate product distribution of multiple reactions
- CO5: Demonstrate the effect of temperature and pressure on conversion
- CO6: Develop skills to design reactors for non-isothermal operations

REFERENCE BOOKS:

- Levenspiel, O., Chemical Reaction Engineering, 3rd Edition, John Wiley & Sons, New York,1995.
- Fogler, H.S., Elements of Chemical Reaction Engineering, 4th Edition, Prentice-Hall of India Pvt. Ltd,1995.
- Smith, J.M. Chemical Engineering Kinetics, 2nd Edition, McGraw-Hill Book Company, New York,1981.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max Marks: 80

Part A: 10 questions of 2 marks each - No choice

Part B: 2 questions from each unit of internal choice; each carrying 12 marks

Examination duration: 3 Hours

20 Marks

60 Marks

SCH1209	BIOCHEMICAL ENGINEERING	L	T	P	C	Max. Marks
		3	0	0	3	100

OBJECTIVE: To introduce the key aspects of biochemical processes and to enable the implementation of these principles in related industries

UNIT 1: BATCH AND CONTINUOUS CULTURES

9 Hours

Batch and Continuous Cultures, Growth Rate: Kinetics of Cell Growth, Measurement of Cell Growth, Effects of Environment on Cell Growth, Temperature, pH, Oxygen, Oxygen Uptake Rate (OUR), Medium requirements for fermentation processes- Carbon, nitrogen, minerals, vitamins and other complex nutrients; Medium formulation for optimal growth and product formation- examples of simple and complex media; Design of commercial media for industrial fermentations, medium optimization methods.

UNIT 2: MICROBIAL GROWTH

9 Hours

Microbial Growth, Phases of cell growth in batch cultures, Microbial Growth Kinetics, The Stoichiometry of Microbial Reactions, Medium Formulation and Yield Factors, Material Balance of Cell Growth, Degree of Reduction, Fed Batch Culture, Fed-Batch Model Formulation, Comparison Between Fed-Batch and Continuous Bioreactors, Advantages of Fed-Batch System, Application of Fed-Batch System

UNIT 3: MIXING AND MASS TRANSFER

9 Hours

Mixing and Mass Transfer, Macro-mixing, Micro-mixing, Methods for Characterizing Mixing, Oxygen Transfer, Gas-Liquid Mass Transfer, Oxygen Transfer Rate, Oxygen Consumption in Cell Growth, Factors Affecting Cellular Oxygen Demand, Measurement of *k_{la}* in Continuous-Stirred-Tank Bioreactor and Airlift Bioreactor, Continuous-Stirred-Tank Bioreactor, Airlift Bioreactor, Liquid Mixing, Types of Mixing and Stirrers Types of Flows in Agitated Tanks, The Mechanism of Mixing Power Requirement for Mixing, Un-gassed Newtonian Fluids, Un-gassed non-Newtonian Fluids, Gassed Fluids.

UNIT 4: BIOCHEMICAL KINETICS

9 Hours

Kinetics of Substrate Utilisation, **Product Formation and Biomass Production in Cell Cultures,** The kinetics of substrate consumption in cellular growth and enzyme-catalysed reaction and their relationship with bioreactor modelling, Unstructured Batch Growth Models, Structured Kinetic Models, Compartmental models, Metabolic models, Product Formation Kinetics, Unstructured model, structured product formation, kinetic modelling, Microbial and enzyme kinetic models and their applications in bioreactor design, Sterilization, Introduction, Applications, Heat Sterilization.

UNIT 5: BIOREACTOR DESIGN

9 Hours

Bioreactor Design, **Downstream Processing in Biochemical Engineering,** Introduction to downstream processing, Cell disruption methods for intracellular products, removal of insolubles, **biomass separation techniques,** flocculation and sedimentation, centrifugation and filtration methods, Solid-Liquid Separation, **Filtration/Ultrafiltration, Centrifugation, Liquid-liquid Extraction,** Cell Rupture/Disruption, Product Recovery, Purification, Solvent recovery, Drying, Crystallisation.

Course Outcomes:

At the end of the course, the students will be able to:

CO1: Understand basics of microbiology to engineer them

CO2: Apply the basic concepts of mass and energy balances, reaction kinetics and for biochemical processes

CO3: Apply mass transfer correlations to bioreactor design

CO4: Estimation of the biomass growth and product formation rate, used for bioreactor design.

CO5: Design of bioreactors and develop downstream processing

CO6: Application of chemical concepts in bio-based industries

Max.45 Hours

REFERENCE BOOKS:

1. Pauline Doran, Bioprocess engineering principles, 1st Edition, Academic Press, 1995.

2. Michael Shuler and Fikret Kargi, Bioprocess Engineering: Basic Concepts, 2nd Edition, Prentice Hall, Englewood Cliffs, NJ, 2002.
3. Bailey J.E and Ollis D.F, Biochemical Engineering Fundamentals, 2nd Edition, Mc-Graw Hill, Inc., 1986.
4. Stanbury P.E., Whitaker A., Hall S.J, Principles of Fermentation Technology, 2nd Edition, Pergamon Press, 1995.
5. Harvey W. Blanch, Douglas S. Clark, Biochemical Engineering, 2nd Edition, Marcel Dekker, Inc, 1997.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max Marks: 80

Part A: 10 questions of 2 marks each - No choice

Part B: 2 questions from each unit of internal choice; each carrying 12 marks

Examination duration: 3 Hours

20 Marks

60 Marks

SCH1210	HEAT TRANSFER	L	T	P	C	Max. Marks
		3	0	0	3	100

OBJECTIVE: To provide an adequate knowledge on different modes of heat transfer and their applications in process industries

UNIT 1: INTRODUCTION TO MODES OF HEAT TRANSFER

9 Hours

Basic Considerations: Importance of heat transfer in Chemical Engineering operations. Modes of heat transfer. Mean temperature difference. Conduction: Concept of heat conduction. Fourier's law of heat conduction. One-dimensional steady state heat conduction equation for flat plate, hollow cylinder and hollow sphere. Heat conduction through a series of resistances. Critical thickness of insulation, Analogy between flow of heat and flow of electricity. Thermal conductivity, Conduction through liquids. Conduction through extended surfaces.

UNIT 2: CONVECTIVE HEAT TRANSFER PROCESSES

9 Hours

Film Coefficients and their applications: Individual and overall heat transfer coefficients and relationship between them. Transient heat conduction. Convection: Concept of heat transfer by convection. Natural and forced convection. Applications of dimensional analysis for convection. Derivation of equations for forced convection under laminar, transition and turbulent conditions. Equations for natural convections. Heat transfer from condensing vapors. Heat transfer to boiling liquids. Influence of boundary layer on heat transfer. Heat transfer to molten metals. Heat transfer in packed and fluidized beds.

UNIT 3: HEAT EXCHANGERS

9 Hours

Parallel and counter flow heat exchangers. Log mean temperature difference. Single pass and multi pass heat exchangers. Plate heat exchangers. Use of correction factor charts. Heat exchanger effectiveness and its use. Number of transfer units charts for different configurations. Fouling factor and Wilson's plot. Various types of heat exchangers. Heat exchanger design. Design of condensers. Effect of non-condensable.

UNIT 4: RADIATION

9 Hours

Concept of thermal radiation. Concept of black and gray bodies. Stefan-Boltzmann law. Kirchoff's law. Radiation between surfaces. Radiation from gases. Clouds of particles and luminous flames. Radiation error in temperature measurement. Radiation from shields. Radiation shape factor and relations between shape factor. Radiation network for absorbing and transmitting medium.

UNIT 5: EVAPORATION

9 Hours

Introduction. Types of evaporators. Single and multiple effect evaporation. Capacity and economy of multi effect evaporators. Thermo re-compression evaporators. Vapour re-compression and thermal re-compression evaporators, Effect of liquid head and boiling point elevation. Duhring's rule. Liquid characteristics. Material and energy balance in evaporators. Illustrated examples.

Max.45 Hours

Course Outcomes:

At the end of the course, the students will be able to:

CO1: Understand the real time applications of solid medium heat transfer

CO2: Develop the real time application of fluid medium heat transfer

CO3: Calculate the overall heat transfer coefficients in designing heat exchangers

CO4: Solve radiative problems and apply knowledge to thermal engineering problems

CO5: Design of Evaporators

CO6: Apply the heat transfer principles with phase change (boiling and condensation) and evaporation

REFERENCE BOOKS:

1. McCabe M.L. and Smith J.C., Unit Operations in Chemical Engineering, 7th Edition, McGraw Hill, 2009.
2. Donald Q. Kern, Processes Heat Transfer, 4th Edition, Tata McGraw Hill, 1997.
3. McAdams W.H., Heat Transmission, 2nd Edition, McGraw Hill, 1954.
4. Holman J.P., Heat Transfer, 6th Edition, McGraw Hill and Kogakusha, 1997.
5. Necati Ozisik M., Basic Heat Transfer, 2th Edition, McGraw Hill and Kogakusha, 1977.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max Marks: 80

Part A: 10 questions of 2 marks each - No choice

Part B: 2 questions from each unit of internal choice; each carrying 12 marks

Examination duration: 3 Hours

20 Marks

60 Mark

SCH1302	MASS TRANSFER – II	L	T	P	C	Max. Marks
		3	0	0	3	100

OBJECTIVE: To study LLE, principles of adsorption and concept of separation.**UNIT 1: HUMIDIFICATION****9 Hours**

Humidification Theory, Basic concepts, Dry bulb temperature, Relative saturation, Percentage saturation, Dew point, Humid volume, Humid heat, Enthalpy, Adiabatic saturation curves, wet bulb temperature, Psychometric Chart, Adiabatic Saturator, Wet Bulb Theory, Methods of Humidification and dehumidification, Cooling tower theory, Design of cooling towers, Industrial cooling towers, Cooling towers principle and operation, equipments.

UNIT 2: DRYING**9 Hours**

Drying Theory and Mechanism, Drying Characteristics, Estimation of Drying time, Equilibrium moisture content of materials. Bound and unbound moisture. Free and equilibrium moisture., Rate of Drying curves, Calculation methods for constant rate drying period and falling rate drying period, Classification of Driers, Through circulation driers design, Design of driers, Design and performance of Batch and Continuous Dryers, Application of Driers, Equipments for drying, Tray dryer, Vacuum-shelf indirect dryers, continuous tunnel dryers, rotary dryers, drum and spray dryers.

UNIT 3: CRYSTALLIZATION**9 Hours**

Crystallization Theory, Solubility curve, Types of crystals, Principles of Crystallization, Supersaturation Theory, Factors governing nucleation and crystal growth. Theory of crystallization, Classification of crystallizers and their applications. Industrial crystallizers, Crystallizer Design.

UNIT 4: ADSORPTION**9 Hours**

Introduction to adsorption, adsorbents and adsorption processes, Types of adsorption, Nature of adsorbents, Theories of adsorption- Freundlich, Langmuir, BET theories, Adsorption isotherms, Operation of adsorption columns, Break through curve, Batch and continuous operations, Multistage cross and counter current operations, Equipments - fixed-bed adsorbers, moving bed adsorbers, pressure swing adsorber and thermal swing adsorbers.

UNIT 5: EXTRACTION LEACHING**9 Hours**

Equilibrium in ternary systems, Stage wise contact equipments, Calculations for batch and continuous extractors, Multistage Cross current extraction, Multistage counter current extraction, Calculation of number of stages, Equipments – Mixer settlers, Plate column, Packed column, Pulse column & RDC.

General principles of leaching, Constant and variable underflow, Multistage crosscurrent and counter current leaching, working principle of leaching equipments: Bollman extractor, Rotocel extractor, Thickeners, Continuous counter current decantation (CCD), Industrial application of Leaching process.

Max.45 Hours**Course Outcomes:**

At the end of the course, the students will be able to:

CO1: Understand the humidification process and its application in industries

CO2: Formulate and solve material balances for unit operations such as drying and crystallization operations.

CO3: Apply the concept of drying operations in industrial applications

CO4: Design of adsorber and calculate the adsorbent requirement

CO5: Describe the principles of leaching and estimate the number of ideal stages.

CO6: Formulate and solve mass balances for extraction, crystallisation, adsorption and humidification.

REFERENCE BOOKS:

1. Treybal, R.E, Mass Transfer Operations, 3rd Edition, McGraw Hill, 2004.
2. McCabe and Smith, Unit Operations of Chemical Engineering, 7th Edition, McGraw Hill, 2009.
3. Coulson J.M. and Richardson J.F., Chemical Engineering, Vol. II, Pergamon Press. 2002.
4. Gavhane K. V., Mass Transfer II, 11th Edition, Nirali Prakashan, 2011.
5. Anantharaman N., Meera Sheriffa Begum K. M., Mass Transfer Theory and Practice, 1st Edition, PHI, 2011.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max Marks: 80

Part A: 10 questions of 2 marks each - No choice

Part B: 2 questions from each unit of internal choice; each carrying 12 marks

Examination duration: 3 Hours

20 Marks

60 Marks

SCH1303	CHEMICAL REACTION ENGINEERING – II	L	T	P	C	Max. Marks
		3	1	0	4	100

OBJECTIVE: To familiarize the methods of accounting non-ideal behavior of ideal reactors, design of heterogeneous reactors for solid catalyzed reactions and non-catalytic fluid-particle reactions.

UNIT 1: NON - IDEAL REACTOR

12 Hours

Non-ideal reactors, Reasons for non-ideal flow behaviors, Concept of mixing: micro and macro mixing, Residence Time Distribution (RTD) functions, C, E and F curves, calculation of mean residence time from E and F curves, Tanks in series models, Axial dispersion model, segregated flow model, Conversion in non-ideal reactors.

UNIT 2: NON-CATALYTIC REACTIONS

12 Hours

Fluid-solid noncatalytic reactions: Progressive Conversion Model, Unreacted or Shrinking Core Model, Determination of the rate controlling step, Conversion in reactors with constant fluid composition, Conversion in reactors with variable fluid composition.

UNIT 3: CATALYST AND CATALYTIC REACTIONS

12 Hours

Introduction to catalysis, Physical properties of catalyst: Surface area (BET isotherm), Void volume and solid density, Pore volume distribution; **Catalyst preparation, Promoters, Inhibitors and Poisons,** Steps in a catalytic reaction, rate of catalytic reaction (adsorption, surface reaction and desorption as rate limiting steps).

UNIT 4: CATALYTIC REACTORS

12 Hours

The rate equation for Surface Kinetics, Pore diffusion resistance combined with Surface Kinetics, Effectiveness factor, Thiele modulus, Heat effects during reaction, Performance equations for Reactors containing porous catalyst particles, Experimental methods for finding rates.

UNIT 5: INDUSTRIAL REACTORS & CATALYST DEACTIVATION

12 Hours

Heterogeneous catalytic reactors: Fixed bed reactors, Fluidized bed reactors, Slurry reactors, Trickle bed reactors: Design aspects with some simple examples.

Deactivation of catalyst, Mechanism of deactivation of catalyst, Rate and performance study of deactivation.

Max.60 Hours

Course Outcomes:

At the end of the course, the students will be able to:

CO1: Understand non-ideal behavior of reactors and their causes

CO2: Evaluate the mechanism of non catalytic gas-liquid reactions

CO3:Analyze various preparation and characterization methods of catalysts

CO4: Design performance equations for reactors containing porous catalyst particles

CO5: Apply kinetic concepts to heterogeneous reactors

CO6: Interpret the mechanism of deactivation of catalyst

REFERENCE BOOKS:

1. Octave Levenspiel, Chemical Reaction Engineering, 3rd Edition, Wiley Publications Ltd., 2007.
2. Smith. J.M., Chemical Engineering Kinetics, 3rd Edition, McGraw Hill, 1981.
3. Gavhane. K. A., Chemical Reaction Engineering – II, 2nd Edition, Nirali Prakashan, 2013.
4. Fogler.H.S., Elements of Chemical Reaction Engineering, 3rd Edition, Prentice Hall of India Ltd., 2001.
5. Froment. G.F and Bischoff.K.B., Chemical Reactor Analysis and Design, 2nd Edition, John Wiley and Sons, 1979.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max Marks: 80

Part A: 10 questions of 2 marks each - No choice

Part B: 2 questions from each unit of internal choice; each carrying 12 marks

Examination duration: 3 Hours

20 Marks

60 Marks

SCH1304	CHEMICAL PROCESS TECHNOLOGY	L	T	P	C	Max. Marks
		3	0	0	3	100

OBJECTIVE: To improve knowledge on the chemical processes along with emphasis on technological development

UNIT 1: INTRODUCTION - CHLORO ALKALI INDUSTRIES

9 Hours

Introduction - Basic principles of unit operations and unit process to common devices used in manufacturing processes like Reactors, Steam jet ejectors, Pumps, Thickeners, Dryers, Electrostatic precipitators, Condenser, Vacuum evaporator in block diagram - Standard symbols used for such devices, Process flow sheet. Manufacturing of soda ash, caustic soda and chlorine - manufacture of bleaching powder.

UNIT 2: SULPHUR, SULPHURIC ACID AND SILICATE INDUSTRIES

9 Hours

Mining and manufacture of sulphur, recovery of sulphur from polluting gases, sulphur trioxide and sulphuric acid, hydrochloric acid, sodium sulphate, sodium thiosulphate. **Manufacture of Portland cement, Manufacture of Glasses and Special glasses.**

UNIT III INDUSTRIAL GASES AND PAINTS

9 Hours

Manufacture of Carbon dioxide, Hydrogen, Oxygen, Nitrogen, Acetylene, Water Gas, Producer Gas, Production of Natural Gas. Introduction of Paints, Pigments, Emulsions and Varnishes, **Manufacture of Paints**, Manufacture of White and Coloured Pigments.

UNIT 4: NATURAL PRODUCTS

9 Hours

Edible and essential oils, soaps and detergents, glycerin, pulp and paper, **starch and its derivatives, Manufacturing of sugar.**

UNIT 5: SYNTHETIC ORGANIC CHEMICALS

9 Hours

Methane and synthesis gas, ethylene, acetylene and propylene. Aromatic chemicals - Benzene, toluene, and xylene. Production of thermo-plastic and thermo-setting resins: polyethylene, polypropylene, and Polyvinylchloride, **Polymers and their engineering applications**, **Polyamides and polyesters and processes for the production of natural and synthetic rubber.**

Max.45 Hours

Course Outcomes:

At the end of the course, the students will be able to:

Course Outcomes:

At the end of the course, the students will be able to:

- CO1:** Demonstrate the schematic representation of various unit process and operation
CO2: Analyse the various methods of manufacturing process pertain to chloro -alkali industry
CO3: Explain the various techniques for sulfuric acid manufacturing
CO4: Apply the basic fundamentals in manufacturing of industrial gases and paints
CO5: Develop the flow sheet for the manufacturing of natural products
CO6: Develop the flow sheet for the production of synthetic organic chemicals

REFERENCE BOOKS:

1. Gopala Rao M. and Marshall Sittig., Dryden's Outlines of Chemical Technology, 3rd Edition., East-West Press, New Delhi, 1997.
2. Shreve. N., Chemical Process Industries, 8th Edition, McGraw Hill, 2004.
3. Mark. W.V, S.C. Bhatia., Chemical Process Industries volume I and II, 2nd Edition, East-West Press, 2007.
4. Badger and Banchero., Introduction to Chemical Engineering, 2nd Edition, McGraw Hill, 2001,
5. Jacob A. Moulijn, Michiel Makkee, Annelies E. Van Diepen, Chemical process technology, 2nd Edition, Wiley India, 2013.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max Marks: 80

Part A: 10 questions of 2 marks each - No choice

Part B: 2 questions from each unit of internal choice; each carrying 12 marks

Examination duration: 3 Hours

20 Marks

60 Marks

SCH1305	INSTRUMENTATION AND PROCESS CONTROL	L	T	P	C	Max. Marks
		3	0	0	3	100

OBJECTIVE: This course enables the students to know about control methods and make the students knowledgeable in various types of measuring instruments used in chemical process industries.

UNIT 1: INSTRUMENTATION

9 Hours

Temperature measurement: Thermocouples, Resistance thermometers, Optical and Radiation pyrometers. Pressure measurement: Use of manometers, Bourdon gauge, Bellows type gauge. Flow measurement: Variable area meters. Positive displacement type meters. Liquid level measurement: Direct and differential method, measurement in open and pressure vessels. Measurement of Viscosity, Conductivity, Humidity of gases and pH.

UNIT 2: BASIC CONCEPTS OF PROCESS CONTROL

9 Hours

Laplace transformation and its application in process control. Response of first order systems Examples of first order systems Process Dynamics of linear open systems. Second order and first order systems in series higher order systems Transfer Function Step, Ramp, Pulse and Sinusoidal inputs and Linearization

UNIT 3: LINEAR CLOSED LOOP SYSTEMS

9 Hours

Development of a block diagram, Controllers and Final control element Closed loop control systems. Block Diagram for feedback control systems, Servo and Regulator problems. Principles of Pneumatic and Electronic controllers. Transportation Lag Transient response of closed loop control systems, Control valve PI, P, PID control.

UNIT 4: STABILITY ANALYSIS

9 Hours

Stability, Stability criterion Routh test for stability ; Routh-Hurwitz criterion, Root-Locus analysis. Introduction to frequency response of closed-loop systems, Frequency response Substitution rule Bode diagrams Bode stability criterion. Gain and Phase margins Ziegler Nichols control settings and Transient response Nyquist diagram.

UNIT 5: CONTROL VALVES & ADVANCED CONTROL SYSTEMS

9 Hours

Control valves, Valve sizing Characteristics Control valve construction Valve positioning Power unit Transducers Electric to Pneumatic and pneumatic to electric types Transfer function matrix Dead time compensation. Introduction to advanced control systems, Cascade control, Feed forward control and Feedback control.

Max.45 Hours

Course Outcomes:

At the end of the course, the students will be able to:

CO1: Develop mathematical modeling of different process using differential equation.

CO2: Ability to analyze, formulate and select suitable sensor for the given industrial applications

CO3: Design and tune process (PID) controllers.

CO4: Evaluate stability, frequency response, and other characteristics

CO5: Apply control schemes to various processes

CO6: Select control valves for different systems

REFERENCE BOOKS:

1. Coughanowr D.R and Koppel L.M., Process Systems Analysis and Control, 3rd Edition, McGraw Hill, New York, 1991.
2. Harriot P., Process Control, 3rd Edition, Tata McGraw Hill, New Delhi, 2008.
3. Eckman D.P., Industrial Instrumentation, 2nd Edition, Wiley Eastern Ltd, 1996.
4. George stephanopolus., Chemical Process Control, 2nd Edition, Prentice Hall of india Pvt. Ltd 1910.
5. Vyas.R.P., Process control and instrumentation, 2nd Edition, Central Techno Publications, Nagpur 2005.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max Marks: 80

Part A: 10 questions of 2 marks each - No choice

Part B: 2 questions from each unit of internal choice; each carrying 12 marks

Examination duration: 3 Hours

20 Marks

60 Mar

SCH1306	PROCESS ENGINEERING	L	T	P	C	Max. Marks
		3	0	0	3	100

OBJECTIVE: To provide an adequate knowledge on process engineering and their applications in process industries

UNIT 1: INTRODUCTION

9 Hours

Scales of Production, Selection of Plant Capacity, Plant Location. Availability of Raw Materials, Energy Gestation Period. Expansion, Diversification and Obsolescence. Scope for Standardization in Design and Production. Economics of Research and Development. Indian Chemical Industry, Current Status and Trends.

UNIT 2: PROCESS CREATION

9 Hours

Preliminary database creation, Preliminary process synthesis, Development of base case design, Generalization of the Resolution Based Synthesis procedure for development of flow sheet for a chemical plant. Principles of steady state flow sheet, simulation, Principles of batch process simulation

UNIT 3: HEURISTICS FOR PROCESS SYNTHESIS

9 Hours

Raw materials and Chemical reactions, Distribution of chemicals, Separations, Heat removal from and addition to reactors, Heat exchangers and furnaces, Pumping, Compression, Pressure reduction, Vacuum, and Conveying of solids

UNIT 4: SYNTHESIS OF SEPARATION TRAINS

9 Hours

Feed separation systems, Phase separation of reactor effluent, Industrial separation operations, Criteria for selection of separation methods, Selection of equipment, Sequencing of ordinary distillation columns for the separation of nearly ideal fluid

mixtures, Sequencing of operations for the separation of nonideal fluid mixtures, Separation systems for gas mixtures, Separation sequencing for solid-fluid systems.

UNIT 5: SCALING UP PROCESS**9 Hours**

Scaling up of process from laboratory to pilot plant and to industrial scale Process Evaluation: Batch Versus Continuous, Equilibrium Limitations, Process alternatives, Preparation of study report.

Max.45 Hours**Course Outcomes:**

At the end of the course, the students will be able to:

CO1: Selection of site and designing of plant layout

CO2: Synthesize feasible and develop optimum flow-sheet

CO3: Optimum design of equipments based on economics and process considerations.

CO4: Analyse the separation technique which suitable for the processes

CO5: Design for commercial scale

CO6: Create and design the process plant

REFERENCE BOOKS

1. Vogel.G.H .,Process Development - From the Initial Ideal to the Chemical Production Plant, 2nd Edition,Wiley- VCH Verlag GmbH, 2005.
2. Douglas. J. M., Conceptual Design of Chemical Process,3rd Edition Mc Graw Hill Book Company. 1998.
3. Jordan ,Chemical Process Development,2nd Edition, Mc-Graw Hill,1996
4. Seider W.D, Seader J.D, and Lewin D.R., Product and Process Design Principles-Synthesis, Analysis and Evaluation, 2nd Edition, John Wiley and Sons. 2004.
5. Turton. R , Bailie R.C, Whiting W. B, Shaeiwitz J.A.,Analysis, Synthesis and Design of Chemical Processes,3rd Edition,Prentice Hall, New Jersey. 1998.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max Marks: 80

Part A: 10 questions of 2 marks each - No choice

Part B: 2 questions from each unit of internal choice; each carrying 12 marks

Examination duration: 3 Hours

20 Marks

60 Marks

SCH1307	PROCESS EQUIPMENT DESIGN	L	T	P	C	Max. Marks
		3	1	0	4	100

OBJECTIVE: To Enabling the students to learn the methods and practices followed in the design of process equipments

UNIT1: DESIGN BASICS**12 Hours**

Design of Plant Layout Schematics and Presentation, Standards, Materials of Construction and Selection of process equipment. Supports for vessels-Bracket support, Leg Support, Skirt support, Saddle support.

UNIT2: DESIGN OF HEAT TRANSFER EQUIPMENTS**12 Hours**

Heat Exchangers-Shell and Tube heat exchangers, Condensers, Reboilers-Kettle type, Evaporators-Single effect evaporator-Area calculation.

UNIT3: DESIGN OF MASS TRANSFER EQUIPMENT**12 Hours**

Distillation Column- Plate type distillation column, Calculation of number of trays and diameter of column, Absorption column- Calculation of NTU and HTU for height determination.

UNIT4: DESIGN OF PRESSURE VESSELS AND STORAGE TANKS**12 Hours**

Pressure vessels-High pressure vessel-Stress in high pressure vessels Vessel closures- Design of Storage vessels-Types- Design of spherical and Rectangular tanks.

UNIT5: DESIGN OF SEPARATION EQUIPMENT AND SAFETY**12 Hours**

Filters-Rotary Vacuum filter design, Sedimentation-Thickeners, Cyclone Separators-High throughput and High efficiency -Safety measures in Equipment design.

Max.60 Hours**Course Outcomes:**

At the end of the course, the students will be able to:

CO1: Develop and draw process flow sheets and plant layouts.

CO2: Importance of codes and standards and their applications in design heat transfer equipment

CO3: Design of distillation column and determine NTU, HTU, HETP and height of packed bed Absorber

CO4: Design of distillation column and determine NTU, HTU, HETP and height of packed bed Absorber

CO5: Design of thickeners and cyclone separators

CO6: Design of thickeners and cyclone separators

REFERENCE BOOKS:

1. Sinnott, R. K., Coulson & Richardson's Chemical Engineering, Vol. 6, Butterworth Heinemann, Oxford, 1996.
2. Dawande, S. D., Process Design of Equipments, 4th Edition, Central Techno Publications, Nagpur, 2005.
3. Mahajani, V.V. Umarji S.B., Joshi's Process equipment Design, 4th Edition, Mac Millan, 1988.
4. Perry, R. H., Chemical Engineers Handbook, 6th Edition, McGraw Hill, New York, 1998.
5. Baranan, C.R., Rules of Thumb for Chemical Engineers, 4th Edition, Gulf Publishing Co, Texas, 1996.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max Marks: 80

Part A: 10 questions of 2 marks each - No choice

Part B: 2 questions from each unit of internal choice; each carrying 12 marks

Examination duration: 3 Hours

20 Marks

60 Marks

SCH1308	PETROLEUM AND PETRO CHEMICAL TECHNOLOGY	L	T	P	C	Max. Marks
		3	0	0	3	100

OBJECTIVE: The subject deals with the characterization, distillation, refining of petroleum crude and the petrochemicals obtained by processing petroleum products.

UNIT 1: CLASSIFICATION OF CRUDE AND REFINING**9 Hours**

Theories on origin of petroleum, composition of crude oil, classification and evaluation of crude oil, laboratory testing techniques of crude quality like flash point, fire point etc., Refining of petroleum – atmospheric and vacuum distillation.

UNIT 2: THERMAL AND CATALYTIC PROCESSES**9 Hours**

Thermal cracking, catalytic cracking, catalytic reforming, Naphtha cracking, coking, Hydrogenation processes, Alkylation processes, Polymerization and Isomerization process.

UNIT 3: TREATMENT TECHNIQUES**9 Hours**

Treatment techniques for removal of objectionable gases and to improve performance, treatment of gasoline, treatment of kerosene, treatment of lubes. Extraction of aromatics and olefins, Recovery operations from petroleum products.

UNIT 4: CHEMICALS FROM METHANE AND ETHANE**9 Hours**

Production of Methanol, Formaldehyde, Ethylene glycol, PTFE, ammonia Ethylene, Manufacture of Vinyl Chloride monomer, vinyl Acetate manufacture, Ethanol from Ethylene, Acetylene manufacture

UNIT 5: CHEMICALS FROM HIGHER ALKANES**9 Hours**

Cracking of naphtha and gas for the production of ethylene, propylene, isobutylene and butadiene., synthetic fibers

Max.45 Hours**Course Outcomes:**

At the end of the course, the students will be able to:

CO1: Understand fundamental concepts of Petroleum Refining about processing, quality control and general overview of the industry**CO2:** insights of primary treatment processes to produce the precursors.**CO3**Analyse the techniques for the removal of sulphur and other impurities from petroleum products**CO4:** Applications of second and third generation petrochemicals.**CO5:** Synthesis of petrochemical products from refinery**CO6:** Acquainted with technologies used for the production of desired petro products**REFERENCE BOOKS:**

1. Nelson, W.L., Petroleum Refinery Engineering, 4th Edition., McGraw Hill, New York,1985
2. Bhaskara Rao B. K., Modern Petroleum Refining Processes, 2nd Edition., Oxford and IBH Publishing Company, New Delhi,1989.
- 3.. Hobson G. D and Pohl. W., Modern Petroleum Technology, 2nd Edition, Gulf Publishers,1986.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max Marks: 80

Part A: 10 questions of 2 marks each - No choice

Part B: 2 questions from each unit of internal choice; each carrying 12 marks

Examination duration: 3 Hours

20 Marks

60 Marks

SCH1309	TRANSPORT PHENOMENA	L	T	P	C	Max. Marks
		3	1	0	4	100

OBJECTIVE: To provide the fundamentals for the application of basic laws of mass, momentum, and energy transport in engineering analysis

UNIT 1: FUNDAMENTALS OF TRANSPORT PHENOMENA

12 Hours

Introduction to transport phenomena – scope and importance, Newton's law, Non-Newtonian fluids, models for Non Newtonian fluids, pressure and temperature dependence of viscosity, Shell Momentum balances, flow of falling film, flow through a circular tube, flow through an annulus, adjacent flow of two immiscible fluids, The equation of Continuity, The equation of Motion, use of the Equations of Change to set up steady flow problems

UNIT 2: TEMPERATURE DISTRIBUTION

12 Hours

Fourier's Law of Heat Conduction, Temperature Distribution in Solids and in Laminar Flow, Shell Energy Balances, Heat Conduction with an electrical heat source, heat conduction with a viscous heat source, heat conduction with a chemical heat source, heat conduction through composite walls, heat conduction in a cooling fin, forced and free convection.

UNIT 3: CONCENTRATION DISTRIBUTION

12 Hours

Definitions of concentrations, velocities and mass fluxes, relations among the molar fluxes, Fick's law of Diffusion, Temperature and Pressure Dependence of Mass Diffusivity, Theory of ordinary diffusion in gases, theories of ordinary diffusion in liquids, Pseudo steady state diffusion, Shell mass balances, Diffusion through a stagnant gas film, Diffusion with heterogeneous chemical reaction, Diffusion with homogeneous chemical reaction, Diffusion and Chemical reaction inside a porous catalyst.

UNIT 4: FRICTION FACTORS AND MACROSCOPIC MOMENTUM BALANCE

12 Hours

Definition of Friction factors, friction factors for flow through tubes and for flow around spheres, Determination of diameter of a falling sphere, Friction factors for packed columns, the macroscopic Mass, Momentum and Mechanical energy balances, use of Macroscopic balances to set up steady flow problems, Pressure rise and friction loss in a sudden expansion, performance of a liquid- liquid ejector, Isothermal flow of a liquid through an orifice.

UNIT 5: TRANSPORT IN TURBULENT AND ANALOGIES BETWEEN TRANSPORT PROCESSES

12 Hours

Turbulence, Reynolds equation for incompressible turbulent flow, Reynolds stresses Prandtl's mixing length theory, Eddy viscosity, the statistical theory of turbulence, Correlation coefficients, intensity and scale of turbulence. Turbulence measurement, Hot – wire anemometer. Turbulence flow in a closed conduit, Prandtl's Power law of Velocity distribution in smooth and rough pipes. Analogy between Momentum, Heat and Mass transfer. The Reynolds' Analogy for turbulent flow over a flat plate, The Prandtl's Analogy, The Von Karman Analogy, Colburn analogy

Course Outcomes:

Max.60 Hours

At the end of the course, the students will be able to:

CO1: Understand the mechanisms of momentum, heat and mass transfer each at molecular, micro and macro levels.

CO2: Develop mathematical models to solve heat flux

CO3: Analyse the interrelationship between the microscopic and macroscopic descriptions of transport processes

CO4: Apply the basics to solve of momentum, mass and heat transport problems.

CO5: Develop steady and time dependent solutions along with their limitations

CO6: Analyze the analogy between transports and understand the turbulence.

REFERENCE BOOKS:

1. Bird R.B., Stewart W.E. and Lightfoot E.N., Transport Phenomena, 2nd Edition, Wiley, New York, 2006,
2. Knudsen J.G. and Katz D.L., Fluid Dynamics and Heat Transfer, 2nd Edition, McGraw Hill, New York, 2000.
3. Roy S.C and C.Guha., Introduction to Transport Phenomena, 1st Edition, Dhanpat Rai & Co, 2008.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max Marks: 80

Part A: 10 questions of 2 marks each - No choice

Part B: 2 questions from each unit of internal choice; each carrying 12 marks

Examination duration: 3 Hours

20 Marks

60 Marks

SCH1310	ENVIRONMENTAL POLLUTION AND CONTROL	L	T	P	C	Max. Marks
		3	0	0	3	100

OBJECTIVE: To impart knowledge on the principles of various processes involved in the treatment of Industrial Pollutants such as Air, Water and Solid

UNIT 1: INTRODUCTION**9 Hours**

Environment definition -The biosphere - Hydrologic cycle –Nutrient cycles, pollution of air, water and soil. Air pollution laws and air quality standard. Water pollution quality standards and law. MINAS. Air pollution effect on human, plant and animal. Acid rain.

UNIT2: AIR POLLUTION AND ITS CONTROL**9 Hours**

Introduction-Sources of air pollution, Air pollution control methods-Source correction method, Cleaning of gaseous effluent, **Particulate Emission control and equipments** used in particulate emission control.

UNIT3: WATER POLLUTION AND ANALYSIS**9 Hours**

Origin of waste water, Types of waste pollutants and their effects, **Waste water sampling and analysis**, Determination of organic and inorganic matters, Physical characteristics, Bacteriological measurements.

UNIT4: NOISE POLLUTION**9 Hours**

Introduction, sources of noise pollution, Characteristics of sound, noise units, types of noise, effects and control of noise pollution. **Radioactive pollution (RAP)**, Sources of RAP-Classification of its radiation effects on humans, plants and animals.

UNIT5: SOLID WASTE AND ITS MANAGEMENT**9 Hours**

Sources and Classification of solid waste, Public health aspects, Methods of collection, Disposal Methods, **Potential methods of disposal of solid waste.**

Max.45 Hours**Course Outcomes:**

At the end of the course, the students will be able to:

CO1: Understanding of air/water pollution regulations and their scientific basis

CO2: Evaluate the various air pollution control equipments

CO3: Analyze waste water sampling methods and determine the impact of pollution

CO4: Explain the control measures for noise and radioactive pollution

CO5: Evaluate the sources and effects of solid waste

CO6: Develop the potential methods of disposal of solid waste

REFERENCE BOOKS:

1. Kapoor B.S., Environmental Engineering, 3rd Edition, Khanna Publishers, 1997.
2. Mahajan S.P., Pollution Control in Process Industries, 1st Edition, Tata McGraw Hill, 1995.
3. Rao C.S., Environmental Pollution Control Engineering, 2nd Edition, New Age International Publications, 2000.
4. Jain P.C. & Monica Jain., Engineering Chemistry. 5th Edition, Dhanpat Rai Publications, 2002.
5. Dara S.S., A Text Book of Engineering Chemistry, 3rd Edition, S.Chan & Co Ltd, 2006.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max Marks: 80

Part A: 10 questions of 2 marks each - No choice

Part B: 2 questions from each unit of internal choice; each carrying 12 marks

Examination duration: 3 Hours

20 Marks

60 Marks

SCH1311	INDUSTRIAL SAFETY AND HAZARD ANALYSIS	L	T	P	C	Max. Marks
		3	0	0	3	100

OBJECTIVE: To emphasize the importance of safety and to gain knowledge on the hazards and their analysis in industries

UNIT 1: INDUSTRIAL SAFETY

9 Hours

Industrial safety principles, accidents, site selection and plant layout, design for ventilation, emergency response systems for hazardous goods, basic rules and requirements which govern the chemical industries. Emergency response systems for hazardous goods, Emergency planning and preparedness, Major Industrial accidents, causes, methods of prevention, Case Study.

UNIT 2: HAZARDS

9 Hours

Chemical hazards classification, hazards due to fire, explosion and radiation, various explosions: VCE, UVCE and BLEVE. Potential hazards, Chemical and Physical job-safety analysis, Safety in High-pressure and high temperature operations, toxic effects, highly radioactive materials, Safe handling and operation of materials and machineries.

UNIT 3: HAZARD ANALYSIS

9 Hours

Types of hazard analysis ,hazard identification ,Material safety data sheet ,specifications, Safety Audit, Hazard and Operability studies Steps involved and significance, Fault tree analysis, Event tree analysis., Failure Mode Effect Analysis procedure and Illustrated examples.

UNIT 4: SAFETY APPRAISAL

9 Hours

Safety audit ,Effective steps to implement safety procedures, periodic training and regular maintenance, personal protective equipments, types, Safety Program, Elements of safety Program , Fire Formation, Fire Triangle, Fire prevention and fire fighting equipments

UNIT 5: HEALTH HAZARDS AND LEGAL ASPECTS

9 Hours

OSHA Regulations and Significance, Health hazards -occupational, Industrial health hazards. Health standards and rules, Safe working environment, Factories act, Labor welfare act, ESI act, Workmen compensation act, Provisions and features.

. Max.45 Hours

Course Outcomes:

At the end of the course, the students will be able to:

- CO1:** Apply basic rules and requirements which govern chemical industries
- CO2:** Outline the various hazards and their implications
- CO3:** Analyze the different hazards, their impact and prevention
- CO4:** Analyze the different hazards, their impact and prevention
- CO5:** Explain various fire extinguishing solutions and to ensure fire prevention
- CO6:** Explain various fire extinguishing solutions and to ensure fire prevention

REFERENCE BOOKS:

1. Fawcett H.H. and Wood W.S., Safety and Accedent Prevention in Chemical Operation, 2nd Edition, Inter Science, 1982.
2. Blake R.P., Industrial Safety, 2nd Edition, Prentice Hall Inc., New Jersey, 2006.
3. Deshmukh. L.M., Industrial Safety Management, 3rd Edition, Tata McGraw Hill, New Delhi, 2008.
4. Jain.R.K and Sunil Rao., Industrial Safety, Health and Environmental Management Systems, 1st Edition, Khanna Delhi 2006.
5. Shrikant Dawande., Chemical Hazards and Safety, 2nd Edition, Khanna publishers,2007.
6. Daniel A.Crowl, Joseph F. Louvar., Chemical Process Safety : Fundamentals with applications, 3rd Edition, Prentice Hall Inc., New Jersey, 2011.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max Marks: 80

Part A: 10 questions of 2 marks each - No choice

Part B: 2 questions from each unit of internal choice; each carrying 12 marks

Examination duration: 3 Hours

20 Marks

60 Marks

SCH1401	PROCESS MODELING AND SIMULATION	L	T	P	C	Max. Marks
		3	0	0	3	100

OBJECTIVE: The objective of this course is to give a broad coverage of the field of mathematical modeling and simulation in chemical engineering. Both steady-state and dynamic models will be examined and discussed.

UNIT 1: BASICS OF MODELLING**9 Hours**

Introduction to Modeling, need of models and their classification, Uses of Mathematical Models, Scope of Coverage, Principles of Formulation. Fundamental laws-Continuity Equation, Energy Equation, Equations of Motion. Regression and Correlation Analysis

UNIT 2: MODELING OF HEAT TRANSFER AND OTHER EQUIPMENTS**9 Hours**

Two Heated Tanks, Double Pipe Heat Exchanger, Shell and Tube Heat Exchanger, Evaporators, Mixing process, interacting and non interacting system and Gravity flow tank

UNIT 3: MODELING OF REACTORS**9 Hours**

Batch Reactor, Series of Isothermal Constant-Holdup CSTR, CSTR with Variable Holdup, Non Isothermal CSTR, Semi batch Reactor, Plug Flow Reactor, Packed Bed Reactor and bioreactor models

UNIT 4: MODELING OF HEAT AND MASS TRANSFER OPERATIONS**9 Hours**

Absorption Columns, Ideal Binary Distillation column, Multicomponent Non-Ideal Distillation Column, Batch Distillation with Holdup, Single Component vaporizer multicomponent flash drum and extraction models,

UNIT 5: DYNAMIC SIMULATION**9 Hours**

Dynamic Simulation of Batch Reactor, Non Isothermal CSTR, Three CSTR in Series, PFR, Binary Distillation Column, Evaporator, Absorption column and Gravity Flow Tank

Max.45 Hours**Course Outcomes:**

At the end of the course, the students will be able to:

CO1: Organize the important physical phenomena from the problem statement

CO2: Demonstrate the stages involved in the development of a process model.

CO3: Develop model equations for heat transfer and other equipment

CO4: Analyze model equations for the given reactors

CO5: Explain model equations for the given mass transfer operations

CO6: Solving the chemical engineering models developed

REFERENCE BOOKS:

1. William L. Luyben, Process Modelling, Simulation and Control For Chemical Engineers, 2nd Edition, McGraw Hill International Editions, New York, 1980.

2. Davis M.E., Numerical methods and Modelling for Chemical Engineers, 1st Edition, Wiley, New York, 1984.

3. Denn M.M., Process Modelling, 2nd Edition, Wiley, New York, 1986.

4. Ramirez W., Computational Methods in Process Simulation, 1st Edition, Butterworth's Publishers, New York, 1989.

5. Mickley. H.S. Sherwood. T.S. and Reed C.E., Applied Mathematics for Chemical Engineers, 1st Edition, Tata McGraw Hill Publishing Co. Ltd, New Delhi, 1989.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max Marks: 80

Part A: 10 questions of 2 marks each - No choice

Examination duration: 3 Hours

20 Marks

SCH1402	OPTIMIZATION OF CHEMICAL PROCESSES	L	T	P	C	Max. Marks
		3	1	0	4	100

OBJECTIVE : To exhibit and develop the decision making skills for achieving conceptual knowledge in the curriculum of operations research.

UNIT 1: OBJECTIVE AND FORMULATION OF OPTIMIZATION

12 Hours

Objective and Introduction, Objective Function and Decision variables, Inequality and Equality Constraints in Models Formulation of the Objective Function, Lower and Upper Bounds, Selecting Functions to Fit Empirical Data, Factorial Experimental Designs, Degrees of Freedom, Economic Objective Functions, Measures of Profitability.

UNIT 2: BASIC CONCEPTS OF OPTIMIZATION

12 Hours

Continuity of Function, NLP Problem Statement, Convexity and Its Applications, Convex and concave functions, Interpretation of the Objective Function in terms of its Quadratic Approximation, Necessary and Sufficient Conditions for an Extremum of an Unconstrained Function.

UNIT 3: OPTIMIZATION OF UNCONSTRAINED FUNCTIONS

12 Hours

One-Dimensional Search Numerical Methods for Optimizing a Function of One Variable, Scanning and Bracketing Procedures, Newton's, Divided difference and Quasi-Newton Methods of Unidimensional Search.

UNIT 4: CONSTRAINED MULTIVARIABLE OPTIMIZATION

12 Hours

Linear Programming (LP) and Applications Geometry of Linear Programs, Basic Linear Programming Definitions and Results, Simplex Algorithm, Barrier Methods, Sensitivity Analysis, Linear Mixed Integer Programs, Application of the EXCEL Solver Spreadsheet for Optimization, Formulation. Introduction to Non linear Programming with Constraints and Mixed-Integer Programming.

UNIT 5: APPLICATION OF OPTIMIZATION IN CHEMICAL ENGINEERING

12 Hours

Examples of Optimization in Chemical Processes like optimizing recovery of waste heat, Optimal Shell and Tube Heat Exchanger Design, Optimal Design and Operation of binary Distillation Column, Optimal pipe diameter etc. Flow sheet Optimization - Case studies.

Course Outcomes:

At the end of the course, the students will be able to:

CO1: Identify different types of optimization problems

CO2: Apply the different optimization technique to obtain the solutions

CO3: solve the various multivariable optimization problems

CO4: Solve the optimization problems by using least square analysis and Quasi method

CO5: Solve the optimization problems by using least square analysis and Quasi method.

CO6: Solve optimization using software tools.

Max. 60 Hours

REFERENCE BOOKS:

1. Edger T.F., Himmelblau D.M. and Lasdon L.S., Optimization of Chemical Processes, 2nd Edition, McGraw- Hill, 2001.
2. Seider W.D., Seader J.D. and Lewin D.R., Product and Process Design Principles-Synthesis, Analysis, and Evaluation", 2nd Edition, John Wiley and Sons Inc., 2008.
3. Kalyan Moy Deb., Optimization for Engineering Design, 2nd Edition, Prentice Hall of India, 2009.
4. Singiresu S. Rao., Engineering Optimization Theory and Practice ,3rd Edition, John Wiley and Sons Inc., 1995.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max Marks: 80

Part A: 10 questions of 2 marks each - No choice

Part B: 2 questions from each unit of internal choice; each carrying 12 marks

Examination duration: 3 Hours

20 Marks

60 Marks

SCH1403	PROCESS ENGINEERING ECONOMICS	L	T	P	C	Max. Marks
		3	0	0	3	100

OBJECTIVE: The course deals with the thought processes, concepts, methods, and knowledge bases used by engineers to cost engineering projects and to evaluate the merit of making a particular investment, and to choose the best of a series of alternative investments to achieve a desired objective.

UNIT 1: PROCESS DESIGN DEVELOPMENT**9 Hours**

Types of Designs, Material and Energy Balance, Equipment Sizing and Selection, **Process Flow Sheet and P&I Diagrams, Plant Location and Layout, Factors affecting Plant Design.**

UNIT 2: ENGINEERING ECONOMICS FOR PROCESS ENGINEERS, INTEREST & INVESTMENT COSTS**9 Hours**

Time Value of Money, Equations for Economic Studies, Equivalence, Amortization, Capital Recovery, Depreciation- Nature of Depreciation, Methods of determining depreciation, Depletion.

UNIT 3: COST ESTIMATION AND ANNUAL REPORTS**9 Hours**

Capital Requirements for Process Plants, Cost Indices. Equipment Costs, The William six-tenth's Factor, Service Facilities, Capital requirements for Complete Plant, The Balance Sheet, Sources of Capital, Variable Costs, Fixed Costs, Income Statement, Income Statement Ratios.

UNIT 4: ECONOMICS OF INVESTMENT ALTERNATIVE**9 Hours**

Economics of Selecting alternates, Annual Cost methods, Present worth method, Equivalent Alternate, Rate of Return and payout-time, Economic Production Charts, Capacity Factors, Break Even Chart for Production Schedule and its Significance for Optimum Analysis.

UNIT 5: ECONOMIC BALANCE**9 Hours**

General Procedure, Practical Considerations, General Procedure for finding optimum Conditions, Procedure for Solving Single-Variable Balances, Procedure With More than One Controllable Variable, Interactive Systems.

Max.45 Hours**Course Outcomes:**

At the end of the course, the students will be able to:

CO1: Apply the material and energy balance in process plant

CO2: Understand the concept of economics in a process plant, time value of money and cost indices

CO3: Understand the concept of economics in a process plant, time value of money and cost indices

CO4: Evaluate the economics of a process through cost estimation

CO5: determine the optimum cost for operation

CO6: Develop economic balance for chemical engineering equipment's

REFERENCE BOOKS

1. Max. S, Peters and Klaus. D Timmerhaus., Plant Design and Economics for Chemical Engineers, 5th Edition, Mc Graw Hill International Editions, New York, 2004.
2. Schweyer. H.E., Process Engineering Economics, 1st Edition, Mc Graw Hill, 1955.
3. Jelen F.C and Black J.H., Cost and Optimization Engineering, 3rd Edition, McGraw Hill, 1992.
4. James.R.Couper., Process Engineering Economics, 1st Edition, Marcel Dekker Inc, New York, 2003.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max Marks: 80

Part A: 10 questions of 2 marks each - No choice

Part B: 2 questions from each unit of internal choice; each carrying 12 marks

Examination duration: 3 Hours

20 Marks

60 Marks

Max. Marks: 50

Exam Duration: 2 hours

SCH4052	ORGANIC CHEMICAL PROCESSES & THERMODYNAMICS LAB	L	T	P	C	Max. Marks
		0	0	4	2	100

1. Organic Preparations -Synthesis of compounds involving the following reactions

- Reduction
- Bromination
- Acetylation
- Hydrolysis
- Nitration

2. Qualitative Analysis -Analysis of following classes of compounds

- Aldehydes
- Ketones
- Acids
- Alcohols
- Amines
- Esters

3. Quantitative Analysis -Analysis of following classes of compounds

- Fertilizer
- Cement
- Sugar
- Drugs
- Proximate analysis of coal

4. Thermodynamics Experiments

- Heat of solution
- Heat of Neutralization
- Heat of Ionization

Course Outcomes:

At the end of the course, the students will be able to:

CO1:Demonstrate the method of identification of functional groups of an organic compound**CO2:** Identify the physical and chemical properties of common organic functional groups.**CO3:**Quantitative reasoning to determine quantities of energy involved in chemical changes**CO4:** Predict the reactivity of an organic compound from its structure.**CO5:**Develop basic skills for the multi-step synthesis of organic compounds.**CO6:**Predict the major and minor products of a variety of organic reactions with appropriate stereochemistry and regiochemistry.

SCH4055	PROCESS DYNAMICS AND CONTROL LAB	L	T	P	C	Max. Marks
		0	0	4	2	100

1. Simulation of proportional controller using Matlab
2. Step Response of first order system with and without delay using Matlab
3. Step Response of second order system with and without Delay using Matlab
4. Simulation of Ziegler Nicholas Method of controller tuning using Matlab.
5. Simulation of Cascade control loop Using Matlab
6. Step response of interacting level system
7. Step response of Non-interacting level system
8. Characteristics of ON-OFF Controller in Thermal Process
9. Characteristics of control valve (Actuated and Flow Lift characteristics)
10. Characteristics of I/P Converter
11. Characteristics of P/I Converter
12. Study and control of a Level process using ON-Off, P, PI, PD and PID controllers
13. Study and control of a Pressure process using ON-Off, P, PI, PD and PID controllers
14. Study and control of a Flow process using ON-Off, P, PI, PD and PID controllers

Course Outcomes:

At the end of the course, the students will be able to:

CO1: Apply the concepts of first order and second order system with feedback using MATLAB

CO2: Develop the mathematical model for interacting and noninteracting system

CO3: Analyse the characteristics of control valve.

CO4: Design controller parameter using Tuning methods

CO5: Implementation of P, PI and PID for different processes

CO6: Evaluate the performance of cascade and ratio control

SCH4056	HEAT TRANSFER LAB	L	T	P	C	Max. Marks
		0	0	4	2	100

1. Measure the emissivity of the test plate and plot a graph between emissivity and temperature.
2. Determine the thermal conductivity of metal rod. (Brass rod)
3. Determine the thermal conductivity of hylem, wood, and asbestos.
4. Find the thermal conductivity of the given insulated material by using lagged pipe.

5. Determine the temperature distribution for a cylinder due to heat transfer by natural convection.

6. Study and compare temperature distribution heat transfer rate, overall heat transfer co-efficient in parallel flow heat exchanger.

7. Study and compare temperature distribution, heat transfer rate, overall heat transfer co-efficient in counter flow heat exchanger

Course Outcomes:

At the end of the course, the students will be able to:

CO1: Apply the concepts of heat transfer to the operation of heat transfer equipments.

CO2: Estimate the heat transfer rate and heat transfer co-efficient

CO3: Estimate the thermal conductivity of solid material

CO4: Evaluate the performance of heat exchangers

CO5: Calculate the emissivity of the test plate

CO6: Collect and analyse the heat transfer data practically.

SCH4059	MATLAB	L	T	P	C	Max. Marks
		0	0	4	2	100

1. Practicing MATLAB environment with simple exercises to familiarize Command Window, History, Workspace, Current Directory, Figure window, Edit window, Shortcuts, Help files.

2. Data types, Constants and Variables, Character constants, operators, Assignment statements.

3. Control Structures: For loops, While, If control structures, Switch, Break, Continue statements.

4. Program to calculate the vapor pressure of water by using Antoine equation

5. Program to find the Bottoms and distillate composition in distillation column

6. Program to find out the feed and product composition in mixer

7. Estimation of average boiling point of a water /ethanol system at different water composition

8. Estimation of composition in sequence of distillation column

9. Calculation of vapor pressure vapour using pressure vs. temperature data in fourth order polynomial equation

10. Calculation of average density, conductivity and specific heat for water in various range of temperature

Course Outcomes:

At the end of the course, the students will be able to:

CO1: Use MATLAB effectively to analyze and visualize data

CO2: Implement simple mathematical functions/equations in numerical computing environment

CO3: Interpret and visualize simple mathematical functions and operations there on using plots/display

CO4: Analyze the program and estimate the output for chemical environment

CO5: Apply numeric techniques and computer simulations to solve engineering-related problems

CO6: Create and control simple programs in MATLAB

SCH4060	PROCESS SIMULATION LAB	L	T	P	C	Max. Marks
		0	0	4	2	100

1. Introduction to software (flow sheeting)
2. Simulation of flash drum
3. Simulation of distillation columns
4. Simulation of absorption columns
5. Simulation of Reactors
6. Simulation of Heat Exchangers.
7. Simulation of pumps and compressors.
8. Simulation of mixing
9. Simulation of compressors.

Course Outcomes:

At the end of the course, the students will be able to:

CO1: Demonstrate process simulation software

CO2: Solve chemical engineering problems

CO3: Analyze mixing problems

CO4: Develop simulation for heat exchangers

CO5: Develop simulation for separation process

CO6: Examine chemical process plant

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max Marks: 80

Part A: 10 questions of 2 marks each - No choice

Part B: 2 questions from each unit of internal choice; each carrying 12 marks

Examination duration: 3 Hours

20 Marks

60 Marks

SCH1604	FERTILIZER TECHNOLOGY	L	T	P	C	Max. Marks
		3	0	0	3	100

OBJECTIVE: To make the student's understand and improve the Technological advancements in agriculture and fertilizer industry

UNIT1: INTRODUCTION TO FERTILIZERS & NITROGENOUS FERTILIZERS

9 Hours

Plant nutrients and its types, Fertilizer and its types, Production of Ammonia and Nitric acid, Methods of production, Specification, storage and handling of nitrogenous fertilizers, Ammonium sulphate, Ammonium nitrate, Urea, Calcium ammonium nitrate, Ammonium chloride.

UNIT 2: POTASSIUM FERTILIZERS

9 Hours

Sources of potassium, Location, Methods of production, Specification, storage and handling of potassic fertilizers, potassium chloride, Potassium choenites. Function of potassium in plants.

UNIT 3: PHOSPHATIC FERTILIZERS

9 Hours

Raw materials, Phosphoric acid, Sulphuric acid, Phosphate rock, Sulfur, pyrite. Methods of production, Specification, storage and handling of Phosphatic fertilizers, ground rock phosphate, Bone meal, Single super phosphate, Triple super phosphate, Thermal phosphate.

UNIT 4: COMPLEX AND MISCELLANEOUS FERTILIZERS**9 Hours**

Types of complex fertilizers, composition, Production of ammonium phosphate fertilizers, Ammonium sulfate, Diammonium phosphate, Nitro phosphate, Mono Ammonium Phosphate and various grade of NPK fertilizers Produced in industries. Mixed fertilizers and granulated mixtures, Biofertilizers and nutrients. Secondary nutrients and Micronutrients, Fluid fertilizers

UNIT 5: ENVIRONMENTAL PROTECTION & POLLUTION PREVENTION**9 Hours**

Environmental issues related to the use of fertilizers, Environmental impact of the fertilizer industry, Phosphogypsum, Environmental Impact Assessment, and Role of international organizations.

Max.45 Hours**Course Outcomes:**

At the end of the course, the students will be able to:

CO1: Elaborate the production of nitrogenous fertilizers

CO2: Explain the production of potassium fertilizers

CO3: Analyse the application of phosphate fertilizer and their production

CO4: Develop the production process for NPK Fertilizers/Biofertilizers

CO5: Analyse the application of mixed fertilizers

CO6: Evaluate the environmental impacts and their mitigation measures pertain to fertilizer industry

REFERENCE BOOKS:

1. Handbook of Fertilizer Technology, Fertilizer Association of India, New Delhi, 1998.
2. George T. Austin, Shreve's Chemical Process Industries, 5th Edition, McGraw-Hill International Editions, Singapore, 1984.
3. Gopala Rao M. and Marshall Sittig, Dryden's Outlines of Chemical Technology, 3rd Edition., East-West Press, New Delhi, 1997.
4. Slack. A.V., Chemistry and Technology of Fertilizers, 2nd Edition, Interscience, New York, 1967.
5. Fertilizer Manual, Kluwer Academic Publishers, Netherlands, 1998.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max Marks: 80

Part A: 10 questions of 2 marks each - No choice

Part B: 2 questions from each unit of internal choice; each carrying 12 marks

Examination duration: 3 Hours

20 Marks

60 Marks

SCH1605	NOVEL SEPARATION PROCESSES	L	T	P	C	Max. Marks
		3	0	0	3	100

OBJECTIVE: To identify about the kind of separation processes in general and novel separations are integral part of any process chemical industries.

UNIT 1:THERMAL SEPARATION**9 Hours**

Thermal Diffusion: Basic Rate Law, Theory of Thermal Diffusion Phenomena for gas and liquid mixtures, Equipments design and Applications. Zone Melting: Equilibrium diagrams, Controlling factors, Apparatus and Applications, Zone Refining and Zone leveling.

UNIT 2: SORPTION TECHNIQUES**9 Hours**

Types and choice of adsorbents, Normal Adsorption techniques, Chromatographic techniques, Equipment and Commercial processes, Recent advances and Economics, Molecular Sieves. Latest developments in separation techniques: Cryogenic, Supercritical fluid extraction, Bio-separation, and Azeotropic separation.

UNIT 3: MEMBRANE SEPARATION PROCESSES**9 Hours**

Principle of membrane separations process; Classification: Reverse osmosis, Ultrafiltration, Micro-filtration, Nano-filtration and Dialysis; Analysis and modeling of membrane separation processes; Membrane modules and application; Ion selective membranes and their application in electro-dialysis; Pervaporation and gas separation using membranes; Electrophoresis Liquid membranes and its industrial applications.

UNIT 4: IONIC SEPARATION**9 Hours**

Controlling factors, Applications, Equipments for Electrophoresis, Dielectrophoresis, Electro Dialysis and Ion - Exchange, Commercial processes. Other Techniques: Adductive Crystallization: Molecular addition compounds, Clathrate compounds and Adducts, Equipments, Applications, Economics and Commercial processes.

UNIT 5: FOAM SEPARATION**9 Hours**

Foam and bubble separation: Principle; Classification; Separation techniques; Column operations. Surface Adsorption, Nature of foams, Apparatus, Applications, and controlling factor.

Max.45 Hours**Course Outcomes:**

At the end of the course, the students will be able to:

CO1: Understand the various separation technique

CO2: Analyze and design sorption, chromatography and azeotropic separation

CO3: Analyze and design novel membranes for industrial applications

CO4: Design the separation system for ionic separation

CO5: Design of separation system for the effective solution of intended problem

CO6: Apply the various novel separation methods for industrial processes

REFERENCE BOOKS:

1. Schoen H. M., New Chemical Engineering Separation Techniques, 2nd Edition, Inter Science Publications, New York, 1972.
2. Seader, J.D. and Henley E.J., Separation Process Principles, John Wiley & Sons, Inc., 1984.
3. Perry R.H. and Green D.W., Perry's Chemical Engineers Hand book, 6th Edition. McGraw Hill, New York, 1990.
4. Coulson J. M. and Richardson J. F., Chemical Engineering, Vol. II, 4th Edition, Butterworth, Heinemann, London, 1991.
5. King C.J., separation Processes, 4th Edition, Tata McGraw Hill, New Delhi, 1978

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max Marks: 80

Part A: 10 questions of 2 marks each - No choice

Part B: 2 questions from each unit of internal choice; each carrying 12 marks

Examination duration: 3 Hours

20 Marks

60 Marks

SCH1609	FOOD TECHNOLOGY	L	T	P	C	Max. Marks
		3	0	0	3	100

OBJECTIVE: To impart knowledge to the students about advanced technology in food science and recent trends adapted in food industry.

UNIT I: FOOD PROCESSING ENGINEERING–FUNDAMENTALS**9 Hours**

Fundamentals of Food Process Engineering, Application of Quantitative methods of Material & Energy Balances in Food Engineering Practices. Constituents of Food, Quality and Nutritive aspects, Food Adulterations, Deteriorative factors and Control

UNIT 2: UNIT OPERATIONS IN FOOD INDUSTRIES**9 Hours**

Fluid Flow, Thermal Process Calculations, Refrigeration, Evaporation and Dehydration operations in Food Processing

UNIT 3: FOOD CANNING TECHNOLOGY**9 Hours**

Fundamentals of Food Canning Technology, Heat Sterilization of Canned food, Containers – metal, Glass and Flexible packaging. Canning Procedures for Fruits, Vegetables, Meat, Poultry and Marine Products

UNIT 4: FOOD PRESERVATION METHODS**9 Hours**

Preservation by Heat and Cold, Dehydration, Concentration, Drying, Irradiation, Microwave heating, Sterilization and Pasteurization, Fermentation and Pickling, Packaging Methods

UNIT 5: PRODUCTION AND UTILIZATION OF FOOD PRODUCTS**9 Hours**

Cereal, Grains, Pulses, Vegetables, Fruits, Spices, Fats and Oils, Bakery, Confectionary and Chocolate Products. Soft and Alcoholic Beverages, Dairy Products, Meat, Poultry and Fish Products

Max.45 Hours**Course Outcomes:**

At the end of the course, the students will be able to:

CO1: Understand the constituents, quality and nutritive aspects of food

CO2: Analyze Unit Operations in food processing industries

CO3: Evaluate various food canning technologies

CO4: Demonstrate the various methods of food preservation

CO5: Analyze the various methods of food processing

CO6: Develop the flow diagram to interpret manufacturing process of various food products

REFERENCE BOOKS:

1. Heid J.L. Joslyn M.A., Fundamentals of Food Processing Operation, 5th Edition, The AVI publishing Co., West port 1967
2. Potter N.N., Food Science, 6th Edition, The AVI publishing Co., Westport, 2003
3. Heldman D.R., Food Process Engineering, 4th Edition, The AVI publishing.2005
4. Owen .R.Fennema., Principles of Food Science Part I & II, 4th Edition, Marcel Dekker Inc New York, 1976.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max Marks: 80

Part A: 10 questions of 2 marks each - No choice

Part B: 2 questions from each unit of internal choice; each carrying 12 marks

Examination duration: 3 Hours

20 Marks

60 Marks

SCH1612	DRUGS AND PHARMACEUTICALS TECHNOLOGY	L	T	P	C	Max. Marks
		3	0	0	3	100

OBJECTIVE: To impart knowledge on the various processes involved in a Pharmaceutical industry along with formulation and quality control

UNIT 1: INTRODUCTION**9 Hours**

Pharmaceutical Industry, Drug discovery and Development of Drugs, Organic Therapeutic agents uses and Economics, Physio chemical principles, Drug Metabolism and pharmacokinetics, Kinetic Studies and Action of drugs on Human Bodies

UNIT 2: UNIT PROCESSES AND THEIR APPLICATIONS**9 Hours**

Chemical Conversion Processes - Alkylation, Carboxylation, Condensation, Cyclisation, Dehydration, Esterification, Halogenation Oxidation, Sulfonation, Complex Chemical Conversions and Fermentation

UNIT 3: MANUFACTURING PRINCIPLES**9 Hours**

Compressed Tablets, Wet Granulation, Dry Granulation or Slugging, Direct Compression, Tablet Presses, Formulation, Coating Pills, Parental Solutions, Oral Liquid, Injections, Ointments, Role of Regulatory Authorities (FDA), Standard of Hygiene and Manufacturing Practice (GMP)

UNIT 4: PRODUCT FORMULATION**9 Hours**

Vitamins and other nutrients, Cold Remedies, Laxatives, Analgesics, External Antiseptics, CNS Stimulants, sedatives, Antacids, Antibiotics, Biologicals, Hormones

UNIT 5: ANALYSIS & QUALITY CONTROL**9 Hours**

Pharmaceutical Analysis Packaging and Control, Analytical Methods and Tests for various Drugs & Pharmaceuticals- principle, instrumentation and applications of UV/VIS and IR spectroscopy, chromatography principle and its types, Packaging Techniques and Quality Control

Max.45 Hours**Course Outcomes:**

At the end of the course, the students will be able to:

CO1: Understanding the drug metabolism, pharmaco-dynamic and pharmaco-kinetic principles

CO2: Understanding knowledge of various drugs on different disease

CO3: Demonstrate statistical quality control procedure

CO4: Analyse the quality assurance programmes in various stages of pharmaceutical process

CO5: Apply the principles on choosing active ingredients for finished product

CO6: Develop new process and product formulations.

REFERENCE BOOKS:

- 1 Rawlins, E.A., Bentley's Text Book of Pharmaceuticals, 7th Edition, Bailliere Tindalls, London, 2009.
2. Remington, Pharmaceutical Sciences, 18th Edition, Mach Publishing Co., 1990.
3. Nita pandit K, Introduction to pharmaceutical sciences, 1st Edition, lipincott Williams & wilkins, 2007.
4. James swarbrick, Encyclopedia of pharmaceutical technology, 3rd Edition, informa healthcare distribution, 2006.
- 5.Mark Saltzman.W., Drug delivery, engineering principles for drug therapy, 1st Edition, oxford university press, 2001.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max Marks: 80

Part A: 10 questions of 2 marks each - No choice

Part B: 2 questions from each unit of internal choice; each carrying 12 marks

Examination duration: 3 Hours

20 Marks

60 Marks

SCH1616	ENVIRONMENTAL IMPACT ASSESSMENT	L	T	P	C	Max. Marks
		3	0	0	3	100

OBJECTIVE: To provide a basic understanding of the EIA process as it is used for research, planning, project or program evaluation, monitoring, and regulatory enforcement and to introduce students to the legal, economic, administrative and technical process of preparing and/or evaluating environmental impact documents.

UNIT 1: INTRODUCTION**09 hrs**

Historical development of Environmental Impact Assessment (EIA). EIA in Project Cycle. Legal and Regulatory aspects in India. Types and Limitations of EIA, Cross sectoral issues and terms of reference in EIA – Public Participation in EIA. EIA process.

UNIT 2: METHODS FOR EIA**09 hrs**

Methods of EIA – Check lists – Matrices – Networks – Cost-benefit analysis – Analysis of alternatives.

UNIT 3: PREDICTION AND ASSESSMENT**09 hrs**

Assessment of Impact on land, water, air, social & cultural activities and on flora & fauna- Mathematical models- Public participation – Rapid EIA.

UNIT 4: ENVIRONMENTAL MANAGEMENT PLAN**09 hrs**

Environmental Management Plan – preparation, implementation and review – **Mitigation and Rehabilitation Plans**– Policy and guidelines for planning and monitoring programmes – Post project audit – Ethical and Quality aspects of Environmental Impact Assessment. ISO 14001

UNIT 5: CASE STUDIES**09 hrs**

EIA related to the following sectors – Infrastructure – construction and housing Mining – Industrial – Power plants – River valley and Hydroelectric – coastal projects.

Course Outcomes:

At the end of the course, the students will be able to:

CO1: Understand the major principles of Environmental impact assesment (EIA)

CO2: Analyse the different steps in Environmental impact assesment

CO3: Categorize the prediction and assesment of impacts

CO4: Apply ethical and quality aspect in EIA process

CO5: Illustrate different case studies of EIA in practice

CO6: Conclude the implications of current jurisdictional and institutional arrangements in relation to Environmental impact assesment.

REFERENCE BOOKS:

1. Lawrence, D.P., Environmental Impact Assessment – Practical solutions to recurrent problems, Wiley-Interscience, New Jersey, 2003.
2. World Bank –Source book on EIA
3. Petts, J., Handbook of Environmental Impact Assessment, Vol., I and II, Blackwell Science, London, 1999.
4. Canter, L.W., Environmental Impact Assessment, McGraw Hill, New York. 1996
5. Y.Anjaneyulu: Environmental Impact Assessment Methodologies, BS Pub. 2002.
6. S.K.Shukla and Srivastava P.R., Concepts in Environmental Impact Analysis, Common Wealth Publishers, New Delhi, 1992.
7. John G. Rau and David C Hooten (Ed)., “Environmental Impact Analysis Handbook”, McGraw-Hill Book Company, 1990.
8. Environmental Assessment Source book, Vol. I, II & III. The World Bank, Washington, D.C., 1991.
9. Judith Petts, Handbook of Environmental Impact Assessment Vol. I & II, Blackwell Science, 1999.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max Marks: 80

Part A: 10 questions of 2 marks each - No choice

Part B: 2 questions from each unit of internal choice; each carrying 12 marks

Examination duration: 3 Hours

20 Marks

60 Marks

SCHX1025	MASS TRANSFER – I	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT I DIFFUSION**10 hrs.**

Molecular and Eddy diffusion in gases and liquids – Measurement and calculation of diffusivity – Diffusion in Multicomponent gaseous mixtures – Diffusion in solids and its applications – Steady state diffusion under stagnant and laminar flow conditions.

UNIT II MASS TRANSFER CO-EFFICIENT AND OPERATIONS**10 hrs.**

Concept of mass transfer co-efficient – Mass transfer under laminar and turbulent flow past the solids – Boundary layers- Correlation of mass transfer co-efficient – Analogies between momentum, heat and mass transfer – Theories of mass transfer and their application – Interphase and overall mass transfer co-efficient in binary systems j_d factor. Material balances on batch, co-current and counter-current staged operations, Equipment's for gas liquid operations.

UNIT III HUMIDIFICATION**10 hrs.**

Basic concepts – construction of psychometric charts – Methods of humidification and dehumidification operations: Design calculation – Cooling towers principle and operation, equipment's.

UNIT IV DRYING**10 hrs.**

Theory and mechanism of drying - Drying characteristics – Design and performance of Batch and Continuous Dryers - Estimation of Drying rates – Drying equipment's.

UNIT V CRYSTALLIZATION**10 hrs.**

Theory of Crystallization - Factors governing nucleation and crystal growth - Growth coefficient, Classification of Crystallization and Applications – Batch and Continuous Industrial Crystallizer- equipment's.

TEXT/REFERENCE BOOKS:

1. Treybal, R.E, Mass Transfer Operations, 3rd Edition, McGraw Hill, 2004.
2. McCabe and Smith, Unit Operations of Chemical Engineering, 7th Edition, McGraw Hill, 2009
3. Coulson J.M. and Richardson J.F., Chemical Engineering, Vol – II, 6th Edition, Pergamon Press, 2002.
4. Sherwood T.K., Pigford R.L. and Wilke C.R., Mass Transfer, 2nd Edition, McGraw Hill, 1960.

UNIVERISTY EXAM QUESTION PAPER PATTERN**Max. Marks:** 80**Exam Duration:** 3 hrs.**Part A:** 2 Questions from each unit, each carrying 2 marks

20 marks

Part B: 60% Problems- 2 Questions from each unit with internal choice, each carrying 12 marks

60 marks

SCHX1026	CHEMICAL REACTION ENGINEERING - I	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT I BASICS OF REACTOR DESIGN**10 hrs.**

Definition of reaction rate, different ways of expressing reaction rate, Molecularity and order of reaction, elementary and non-elementary reactions, single and multiple reactions. Temperature dependency of reaction rate, Arrhenius theory, Collision theory, Transition state theory. Mechanism of chemical reactions. Concentration dependent term of rate equation. Interpretation of batch reactor data. Constant and variable volume reactions. Conversion from total pressure data. Methods of determining the order of a reaction, Integral and Differential methods, methods of isolation, initial rates, excess. Autocatalytic reactions, Runaway reactions.

UNIT II REACTOR DESIGN FOR SINGLE REACTIONS**10 hrs.**

Design equation for batch reactor. Flow reactors – Concept of Space time, Space velocity. Material balance and design equation for PFR and CSTR. Semi-batch reactors. Size comparison of reactors for single reactions. Recycle reactors.

UNIT III DESIGN OF MULTIPLE REACTORS FOR SINGLE REACTIONS**10 hrs.**

Charts comparing the sizes of single PFR and CSTR's for various orders of reaction - calculating conversion from these charts. Multiple reactor systems for single reaction – PFR's in series and parallel; CSTR's in series and parallel. Material balance and design equations for multiple reactions. Graphical method for finding number of CSTR's. Charts for comparison of sizes of multiple CSTR's and PFR and calculating conversions.

UNIT IV DESIGN OF SINGLE AND MULTIPLE REACTORS FOR MULTIPLE REACTIONS**10 hrs.**

Multiple reactions – Series, Parallel and Series-Parallel. Qualitative and Quantitative treatment of series and parallel reactions. Definitions of Instantaneous and Overall fractional yields and selectivity. Design of single multiple reactors for multiple reactions.

UNIT V NON-ISOTHERMAL REACTOR DESIGN**10 hrs.**

Isothermal and non-isothermal reactor systems. Single reactions – Irreversible and reversible reaction, Temperature and Pressure effects – Information from thermodynamics. Equilibrium flow reactor design, adiabatic temperature and equilibrium conversion, optimum temperature progression.

TEXT/REFERENCE BOOKS:

1. Octave Levenspiel, Chemical Reaction Engineering, 3rd Edition, McGraw Hill, 1998
2. Scott Fogler, Chemical Reaction Engineering, 4th Edition, McGraw Hill, 2005
3. Smith J.M., Chemical Kinetics and Reactor Design, 2nd Edition, McGraw Hill, 2004

UNIVERSITY EXAM QUESTION PAPER PATTERN**Max. Marks:** 80**Exam Duration:** 3 hrs.**Part A:** 2 Questions from each unit, each carrying 2 marks

20 marks

Part B: 60% Problems- 2 Questions from each unit with internal choice, each carrying 12 marks

60 marks

SCHX1028	HEAT TRANSFER	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT I INTRODUCTION TO BASIC HEAT TRANSFER**10 hrs.**

Basic Considerations: Importance of heat transfer in Chemical Engineering operations. Modes of heat transfer. Mean temperature difference. Conduction: Concept of heat conduction. Fourier's law of heat conduction. 1D steady state heat conduction equation for flat plate, hollow cylinder and hollow sphere. Heat conduction through a series of resistances. Analogy between flow of heat and flow of electricity. Thermal conductivity. Conduction through liquids.

UNIT II CONDUCTION AND CONVECTION**10 hrs.**

Film Coefficients and their applications: Individual and overall heat transfer coefficients and relationship between them. Conduction through extended surfaces. Two-dimensional steady state conduction. Analytical and graphical methods. Transient heat conduction. Convection concept of heat transfer by convection. Natural and forced convection. Applications of dimensional analysis for convection. Derivation of equations for forced convection under laminar, transition and turbulent conditions. Equations for natural convections. Heat transfer from condensing vapours. Heat transfer to boiling liquids. Influence of boundary layer on heat transfer. Heat transfer to molten metals. Heat transfer in packed and fluidized beds.

UNIT III HEAT EXCHANGERS**10 hrs.**

Parallel and counter flow heat exchangers. Log mean temperature difference. Single pass and multi pass heat exchangers. Plate heat exchangers. Use of correction factor charts. Heat exchanger effectiveness and its use. Number of transfer units' charts for different configurations. Fouling factor and Wilson's plot. Various types of heat exchangers. Heat exchanger design. Design of condensers. Effect of non-condensable.

UNIT IV RADIATION**10 hrs.**

Concept of thermal radiation. Concept of black and Gray bodies. Stefan-Boltzmann law. Kirchhoff's law. Radiation between surfaces. Radiation from gases. Clouds of particles and luminous flames. Radiation error in temperature measurement.

UNIT V EVAPORATION**10 hrs.**

Introduction. Types of evaporators. Single and multiple effect evaporation. Capacity and economy of multi effect evaporators. Thermo compression evaporators. Effect of liquid head and boiling point elevation. Duhring's rule. Liquid characteristics. Material and energy balance in evaporators. Illustrated examples.

TEXT/REFERENCE BOOKS:

1. M.L. McCabe and J.C. Smith, Unit Operations in Chemical Engineering, 7th Edition, McGraw Hill, 2009
2. Donald Q. Kern, Processes Heat Transfer, 4th Edition, Tata McGraw Hill, 1997.
3. McAdams W.H., Heat Transmission, 2nd Edition, McGraw Hill, 1954.

UNIVERISTY EXAM QUESTION PAPER PATTERN**Max. Marks:** 80**Exam Duration:** 3 hrs.**Part A:** 2 Questions from each unit, each carrying 2 marks

20 marks

Part B: 60% Problems- 2 Questions from each unit with internal choice, each carrying 12 marks
60 marks

SCHX1029	PROCESS EQUIPMENT DESIGN AND DRAWING - I	L	T	P	Credits	Total Marks
		3	0	0	3	100

All Tables/Chemical Engineers' Handbook/Data Books/Graph Sheets are permitted during the Examination.

UNIT I FASTENERS

10 hrs.

Design and drawing considerations of bolt, nut and screws, welded and riveted joints, flanged joints, nozzles and reinforcements. Pipe fittings.

UNIT II FLOW METERS AND SUPPORTS

10 hrs.

Fundamental principles, equations, general design and drawing considerations of flow meters, and vessel supports such as bracket, saddle, skirt, etc.

UNIT III PRESSURE VESSELS

10 hrs.

Fundamental principles, equations, general design and drawing considerations of vessels subjected to internal pressure, vessel subjected to external pressure. High pressure vessels. Storage tanks.

UNIT IV UNIT OPERATION EQUIPMENTS

10 hrs.

Fundamental principles, equations, general design and drawing considerations of cyclones, centrifuges, thickeners and filtration equipment's.

UNIT V MIXING EQUIPMENTS

10 hrs.

Fundamental principles, equations, general design and drawing considerations of agitated vessel, jacketed and coil-heated vessels.

TEXT/REFERENCE BOOKS:

1. Perry R.H., "Chemical Engineers' Handbook", 8th Edition, McGraw Hill, 2008.
2. McCabe W.L., Smith J.C. and Harriet, "Unit Operation of Chemical Engineering", 7th Edition, McGraw Hill. 2009
3. Robert Treybal, "Mass Transfer Operations", 3rd Edition, McGraw Hill, 2004.
4. Coulson J.M. and Richardson J., "Chemical Engineering", Vol. 6, Asian Books Printers Ltd. R.S. Khurmi, "Machine design".2200
5. Joshi M.V. and Mahajan V.V., "Process Equipment Design", 5th Edition, MacMillan India Ltd, 2005.
6. Dawande S.D., "Process Design of Equipment's", 2nd Edition, Central Techno Publications, Nagpur, 2000.
7. Indian Standard Specifications IS-803, 1962; IS-4072, 1967; IS-2825, 1969. Indian Standards Institution, New Delhi.

UNIVERISTY EXAM QUESTION PAPER PATTERN

Max. Marks: 80

Exam Duration: 3 hrs.

Part A: 2 Questions from each unit, each carrying 2 marks

20 marks

Part B: 60% Problems- 2 Questions from each unit with internal choice, each carrying 12 marks
60 marks

SCHX1030	INSTRUMENTATION AND PROCESS CONTROL	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT I INSTRUMENTATION**10 hrs.**

Temperature measurement: Thermocouples, resistance thermometers, optical and radiation pyrometers. Pressure measurement: Use of manometers, Bourdon gauge, bellows type gauge. Flow measurement: Variable area meters. Positive displacement type meters. Liquid level measurement: direct and differential method, measurement in open and pressure vessels. Measurement of viscosity, conductivity, humidity and pH.

UNIT II BASIC CONCEPTS OF PROCESS CONTROL**10 hrs.**

Response of first order systems Examples of first order systems Process Dynamics of linear open systems Second order and first order systems in series Higher order systems Transfer Function Step, Ramp, Pulse and Sinusoidal inputs, Linearization

UNIT III LINEAR CLOSED LOOP SYSTEMS**10 hrs.**

Development of a block diagram, Controllers and Final control element Closed loop control systems. Block Diagram for feedback control systems, Servo and Regulator problems. Principles of Pneumatic and Electronic controllers Transportation Lag Transient response of closed loop control systems Control valve PI, P, PID control.

UNIT IV STABILITY ANALYSIS**10 hrs.**

Stability, Stability criterion Routh test for stability. Theorems of Routh test root locus Root locus diagram Frequency response Substitution rule Bode diagrams Bode stability criterion Gain and Phase margins Ziegler Nichols control settings Transient response Nyquist diagram.

UNIT V CONTROL VALVES, DYNAMICS AND MICROPROCESSOR**10 hrs.**

Control valves, Valve sizing Characteristics Control valve construction Valve positioning Power unit Transducers Electric to Pneumatic and pneumatic to electric types Transfer function matrix Dead time compensation Step testing Frequency testing Pulse testing. Dynamics and control of chemical reactors Heat exchangers and Distillation columns Analog and digital computer applications Microprocessors and computer control of chemical processes. Introduction to advanced control systems

TEXT/REFERENCE BOOKS:

1. Coughanowr D.R. and Koppel L.M., Process Systems Analysis and Control, 2nd Edition, McGraw Hill, New York, 1991.
2. Harriot P., Process Control, 3rd Edition, Tata McGraw Hill, New Delhi, 2008.
3. Eckman D.P., Industrial Instrumentation, 2nd Edition, Wiley Eastern Ltd, 1996.
4. George Stephanopolus, Chemical Process Control, 2nd Edition, Prentice Hall of India Pvt. Ltd., 1990

UNIVERISTY EXAM QUESTION PAPER PATTERN**Max. Marks:** 80**Exam Duration:** 3 hrs.**Part A:** 2 Questions from each unit, each carrying 2 marks

20 marks

Part B: 60% Problems- 2 Questions from each unit with internal choice, each carrying 12 marks

60 marks

SCHX4005	PROCESS DYNAMICS AND CONTROL LAB	L	T	P	Credits	Total Marks
		0	0	4	2	100

1. ON-OFF control of thermal process
2. Simulation of Proportional Controller
3. Flow control loop and Flow Transmitter
4. Level Control loop and Level Transmitter
5. Pressure control loop and Pressure Transmitter
6. Control valve characteristics
7. Verifying the inherent characteristics of control valve
8. Flow co-efficient of control valve
9. Range ability of control valve
10. Verifying the response of non-Interacting level system
11. Verifying the response of Interacting level system
12. Effect of PI controller on flow control system
13. The effect of a P controller on level process for set point and load changes
14. Effect of P, PI, PID Controller on Pressure Control Loop
15. Optimum Controller Setting using Ziegler Nichols Method
16. Optimum Controller Tuning on Level Process Station

SCHX1030	MASS TRANSFER – II	L	T	P	Credits	Total Marks
		3	1	0	4	100

UNIT I DISTILLATION**10 hrs.**

Vapor liquid equilibria, Raoult's law and deviations from ideality, Methods of distillation Batch, Continuous, Flash, steam, vacuum. McCabe Thiele method Ponchon - Savarit method, Azeotropic, Extractive and Molecular distillation.

UNIT II ABSORPTION**10 hrs.**

Equilibrium and operating line concept in absorption calculations, Calculation of NTU, HTU, Number of stages, Packed and plate type absorbers. Absorption with chemical reaction, HETP Operating characteristics of stage wise and differential contactors.

UNIT III LIQUID – LIQUID EXTRACTION AND LEACHING**10 hrs.**

Equilibrium in ternary systems, Stage wise contact equipment's, Calculations for batch and continuous extractors Calculation of number of stages, Equipment's. Solid Liquid equilibrium Equipment's - Batch and Continuous types, Calculation of number of stages.

UNIT IV ADSORPTION**10 hrs.**

Types of adsorption Nature of adsorption, Theories of adsorption, Adsorption isotherms, Operation of adsorption columns, Batch and continuous operations, Equipment's.

UNIT V MISCELLANEOUS SEPARATION PROCESSES**10 hrs.**

Solid and liquid membranes, Concept of Osmosis, reverse osmosis, Dialysis, Foam Separation, Thermal and Sweep diffusion process, Ion Exchange, Zone Refining.

TEXT/REFERENCE BOOKS:

1. Treybal, R.E, Mass Transfer Operations, 3rd Edition, McGraw Hill, 2004
2. McCabe and Smith, Unit Operations of Chemical Engineering, 7th Edition, McGraw Hill, 2009
3. Coulson J.M. and Richardson J.F., Chemical Engineering, Vol. II, Pergamon Press. 2002

UNIVERISTY EXAM QUESTION PAPER PATTERN**Max. Marks:** 80**Exam Duration:** 3 hrs.**Part A:** 2 Questions from each unit, each carrying 2 marks

20 marks

Part B: 60% Problems- 2 Questions from each unit with internal choice, each carrying 12 marks

60 marks

SCHX1032	CHEMICAL REACTION ENGINEERING – II	L	T	P	Credits	Total Marks
		3	1	0	4	100

UNIT I NON - IDEAL REACTOR DESIGN**10 hrs.**

Non ideal reactors, residence time distribution studies, stimulus response techniques, Pulse and step input, other types of inputs, definition of C, E and F curves and relationship between the curves. **Developing RTD equation for CSTR, PFR, CSTR**. Macromixing and Micro mixing data. Zero parameter model – complete segregation model. One parameter model. Tanks in series and dispersion modes. Equations for no. of tanks in series and conversion using these two models (for 1st order reactions). Definition of vessel dispersion number and Peclet number.

UNIT II NON-CATALYTIC REACTIONS**10 hrs.**

Heterogeneous non-catalytic fluid particle reactions. External diffusion effects on heterogeneous reactions, definitions of reactions rates for heterogeneous reactions. Incorporating the mass transfer term – steps in series. Overall resistance – combining resistances for steps in series and linear reaction. Steady state assumption for steps in series. **Models for heterogeneous non catalytic fluid (GAS) – solid reactions** – Progressive conversion model, unreacted or shrinking core model. Steps in the unreacted core model. Diffusion and reaction steps. Diffusion through gas film and ash layer: Chemical reaction as the controlling steps – Development of equations for rate controlling steps.

UNIT III CATALYSIS AND CATALYTIC REACTIONS**10 hrs.**

Introduction to catalysis, general properties of homogeneous, steps in a catalytic reaction, adsorption, surface reaction and description as rate limiting steps, physisorption and chemisorption, adsorption isotherm, unimolecular and bimolecular surface reactions, applications of adsorption, **B.E.T. theory of multilayer adsorption**, synthesizing a rate law mechanism and rate limiting step, preparation and evaluation of industrial catalysts.

UNIT IV DESIGN OF HETEROGENEOUS CATALYTIC REACTORS**10 hrs.**

Rate equation for heterogeneous catalytic system, film resistance, surface reaction and pore diffusion as the controlling steps, internal effectiveness factor of a porous catalyst pellet, overall effectiveness factor, mass transfer and reaction in a packed bed, experimental methods for finding rates – **design and comparison of experimental heterogeneous reactors.**

UNIT V CATALYST DEACTIVATION**10 hrs.**

Catalytic poisoning, mechanism of catalyst deactivation, the rate equation, regeneration of catalyst. **Multiphase reactors** – slurry, fluidized and packed bed and some important examples of industrial reactors.

TEXT/REFERENCE BOOKS:

1. Octave Levenspiel, Chemical Reaction Engineering, 3rd Edition, McGraw Hill, 1998
2. Fogler, Chemical Reaction Engineering, 4th Edition, McGraw Hill, 2005
3. Smith J.M., Chemical Kinetics and Reactor Design, 2nd Edition, McGraw Hill, 2004

UNIVERSITY EXAM QUESTION PAPER PATTERN**Max. Marks:** 80**Exam Duration:** 3 hrs.**Part A:** 2 Questions from each unit, each carrying 2 marks

20 marks

Part B: 60% Problems- 2 Questions from each unit with internal choice, each carrying 12 marks
60 marks

SCHX1033	PROCESS EQUIPMENT DESIGN AND DRAWING – II	L	T	P	Credits	Total Marks
		3	0	0	3	100

(All Tables/Handbook/Data Books/Graph Sheets are permitted during the Examination)

UNIT I REACTORS

10 hrs.

Fundamental principles, equations, general design and drawing considerations of Reactors.

UNIT II DRIERS AND CRYSTALLIZERS

10 hrs.

Fundamental principles, equations, general design and drawing considerations of cooling towers, driers and crystallizers.

UNIT III HEAT EXCHANGERS AND EVAPORATORS

10 hrs.

Fundamental principles, equations, general design and drawing considerations of heat exchangers, condensers, reboilers and evaporators.

UNIT IV DISTILLATION COLUMNS

10 hrs.

Fundamental principles, equations, general design and drawing considerations of distillation columns - plate and packed.

UNIT V ABSORPTION AND ADSORPTION

10 hrs.

Fundamental principles, equations, general design and drawing considerations of equipment's for adsorption and absorption.

TEXT/REFERENCE BOOKS:

1. Perry R.H., "Chemical Engineers' Handbook", 8th Edition, McGraw Hill, 2008
2. McCabe W.L., Smith J.C. and Harriet, "Unit Operation of Chemical Engineering", 7th Edition, McGraw Hill, 2009
3. Robert Treybal, "Mass Transfer Operations", 3rd Edition, McGraw Hill, 2004
4. Coulson J.M. and Richardson J., "Chemical Engineering", Vol. 6, Asian Books Printers Ltd.
5. Joshi M.V. and Mahajan V.V., "Process Equipment Design", 5th Edition, MacMillan India Ltd, 2005.
6. Dawande S.D., "Process Design of Equipment's", 2nd Edition, Central Techno Publications, Nagpur, 2000.
7. Indian Standard Specifications IS-803, 1962; IS-4072, 1967; IS-2825, 1969. Indian Standards Institution, New Delhi, 1969.

UNIVERSITY EXAM QUESTION PAPER PATTERN

Max. Marks: 80

Exam Duration: 3 hrs.

Part A: 2 Questions from each unit, each carrying 2 marks

20 marks

Part B: 60% Problems- 2 Questions from each unit with internal choice, each carrying 12 marks
60 marks

SCHX4006	HEAT TRANSFER LAB	L	T	P	Credits	Total Marks
		0	0	4	2	100

1. To measure the emissivity of the test plate and plot a graph between emissivity and temperature.
2. To determine the thermal conductivity of metal rod. (Brass rod)
3. To determine the thermal conductivity of hylem, wood, and asbestos.
4. To find the thermal conductivity of the given insulated material by using lagged pipe.
5. To determine the temperature distribution for a cylinder due to heat transfer by natural convection.
6. To study and compare temperature distribution heat transfer rate, overall heat transfer co-efficient in parallel flow heat exchanger.
7. To study and compare temperature distribution, heat transfer rate, overall heat transfer co-efficient in counter flow heat exchanger

SCHX4007	MASS TRANSFER LAB	L	T	P	Credits	Total Marks
		0	0	4	2	100

1. Study the drying characteristics of calcium carbonate and find the critical moisture content and equilibrium moisture content of the sample.
2. Determine the diffusivity coefficient for the acetone - air system.
3. Verify Rayleigh's equation for the given acetone - water system by simple distillation.
4. Conduct a batch leaching test to leach out sodium carbonate from the mixture given and hence find out the percentage of sodium carbonate leached out.
5. Verify Freundlich equation for the adsorption of oxalic acid onto activated carbon.
6. Determine the liquid - liquid equilibrium of the system (Benzene - acetic acid - Water) and hence draw the ternary graph for the system.
7. Determine the HETP of the packed column by Fenske's method.

SBAX1001	PRINCIPLES OF MANAGEMENT AND PROFESSIONAL ETHICS	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT I MANAGEMENT FUNCTIONS & STRUCTURE**10 hrs.**

Management – Definition – Basic Function – Contribution of Taylor & Fayol. Types of structure – Line, staff, Functional, Committee, **Project & Matrix** – Structures.

Departmentalization – Centralization – Decentralization – span of control. **Management By Objectives – Management by Exception.**

UNIT II MANAGEMENT OF ORGINASATION**10 hrs.**

Forms of Business / Industrial Ownership – Sole Trader, Partnership, Company, Performance Appraisal – Basic Principles – Pitfalls – Methods to Overcome. Industrial Safety – Causes of Accidents – Cost of Accident – How to minimize Accidents. **Plant Layout & Maintenance – Need, Types & Managerial Aspects.**

UNIT III ORGANISATIONAL BEHAVIOUR**10 hrs.**

OB – Definition – Nature & Scope – Contributing Disciplines – Importance of OB to Managers. Personality – Definition – Theories – Factors Influencing Personality. Motivation – Definition – Theories. **Theory X & Y** – Transactional Analysis. Morale & Job Satisfaction – Factors Influencing Job Satisfaction.

UNIT IV GROUP DYNAMICS**10 hrs.**

Group – Definition – Types – **Determinants of Group Cohesiveness** – Communication – Process – Barriers – **Effective Communication. Leadership Theories** – Factors Contributing to Effective Leadership – **Role of Trade Union in Organizations** – Functions of Trade Union – Why Trade Union is required? – **Types of Trade Union.**

UNIT V PROFESSIONAL ETHICS**10 hrs.**

Ethics in Workplace – Formulation of Ethics – **Managerial Ethics** – Managing Ethical Behaviour – Codes of Ethics – Encouraging Ethical Behaviour – Social Responsibility – Spirituality.

TEXT / REFERENCE BOOKS

1. Gupta C.B., Management Theory and Practice, 14th Edition, Sultan Chand & Sons, 2009.
2. Dr. Prasad L.M., Principle & Practice of Management, 7th Edition, Sultan Chand & Sons, 2008.
3. Aswathappa, Organisational Behaviour, 8th Edition, Himalaya Publishing House, 2010.
4. Dr. Prasad L.M., Organisational Behaviour, 4th Edition, Sultan Chand & Sons, 2008.
5. Harold Koontz, Principles of Management, 1st Edition, Tata McGraw Hill, 2004.

UNIVERISTY EXAM QUESTION PAPER PATTERN**Max. Marks:** 80**Exam Duration:** 3 hrs.**Part A:** 2 Questions from each unit, each carrying 2 marks

20 marks

Part B: 60% Problems- 2 Questions from each unit with internal choice, each carrying 12 marks

60 marks

SCHX1034	BIOCHEMICAL ENGINEERING	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT I MICROBIOLOGY**10 hrs.**

Types of Microorganism: Structure and function of microbial cells. Fundamentals of microbial growth, batch and continuous culture.

UNIT II ENZYME AND ENZYME KINETICS**10 hrs.**

Introduction to Biochemistry, Function and applications. Nature and function of enzyme. Coenzyme / Cofactor. Classification of enzymes. Isolation and purification of enzymes from cells. Assay methods and units. Examples of applications of enzymes in pharmaceutical industry.

UNIT III FERMENTATION AND KINETICS**10 hrs.**

Fermentation – Types of mechanisms, Continuous fermentation aeration and agitation, kinetics of fermentation Processes Immobilization: Cell and enzyme immobilization

UNIT IV DESIGN OF BIOREACTOR**10 hrs.**

Introduction of Bioreactor design: Continuously stirred aerated tank bioreactors. Mixing power correlation. Determination of volumetric mass transfer rate of oxygen from air bubbles and effect of mechanical mixing and aeration on oxygen transfer rate, heat transfer and power

UNIT V INDUSTRIAL BIOREACTORS**10 hrs.**

Industrial Bioreactors Utilizing Isolated enzymes and biosensors development and applications. Design of reactor, Batch and continuous type; analysis for immobilized enzyme reactors. Sterile and non-sterile operations; reactors in series with and without recycle.

TEXT/REFERENCE BOOKS:

1. Bailey J.E. and Ollis D.F., "Bio Chemical Engg. Fundamentals", 2nd Edition., Mc Graw Hill Publishing Company New York, 1986.
2. Wiseman A., "Hand Book of Enzyme Biotechnology", Ellis Horwood, 1983.
3. Pye E.K. and Wingard L.B., "Enzyme Engg II", 2nd Edition, Plenum Press, Newyork, 1974.
4. Aaiba S; Humphrey A E; Millis N.F., Bio Chemical Engg., 2nd Edition., Academic Press, 1973.

UNIVERISTY EXAM QUESTION PAPER PATTERN**Max. Marks:** 80**Exam Duration:** 3 hrs.**Part A:** 2 Questions from each unit, each carrying 2 marks

20 marks

Part B: 60% Problems- 2 Questions from each unit with internal choice, each carrying 12 marks

60 marks

SCHX1035	TRANSPORT PHENOMENA	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT I FUNDAMENTALS OF TRANSPORT PHENOMENA**10 hrs.**

Newton's law, non-Newtonian fluids, pressure and temperature dependence of viscosity theory of viscosity of liquids, Shell Momentum balances, flow of falling film, flow through a circular tube, flow through an annulus, adjacent flow of two immiscible fluids the equation of Continuity, the equation of Motion, use of the Equations of Change to set up steady flow problems

UNIT II TEMPERATURE DISTRIBUTION**10 hrs.**

Fourier's Law of Heat Conduction, Temperature Distribution in Solids and in Laminar Flow, Shell Energy Balances, Heat Conduction with an electrical heat source, heat conduction with a viscous heat source, heat conduction with a chemical heat source, heat conduction through composite walls, **heat conduction in a cooling fin, forced and free convection.**

UNIT III CONCENTRATION DISTRIBUTION**10 hrs.**

Definitions of concentrations, velocities and mass fluxes, relations among the molar fluxes, Fick's law of Diffusion, Temperature and Pressure Dependence of Mass Diffusivity, Theory of ordinary diffusion in gases at a low density, theories of ordinary diffusion in liquids, Shell mass balances, Diffusion through a stagnant gas film, Diffusion with heterogeneous chemical reaction, Diffusion with homogeneous chemical reaction, Diffusion and Chemical reaction inside a porous catalyst and the **"Effectiveness Factor"**.

UNIT IV FRICTION FACTORS AND MACROSCOPIC MOMENTUM BALANCE 10 hrs.

Definition of Friction factors, friction factors for flow in tubes and for flow around spheres, Determination of diameter of a falling sphere, Friction factors for packed columns, the macroscopic mass, Momentum and Mechanical energy balances, use of Macroscopic balances to set up steady flow problems, Pressure rise and friction loss in a sudden expansion, performance of a liquid- liquid ejector, thrust on a pipe bend, Isothermal flow of a liquid through an orifice

UNIT V TRANSPORT IN TURBULENT AND ANALOGIES BETWEEN TRANSPORT PROCESSES**10 hrs.**

Turbulence, Reynold's equation for incompressible turbulent flow, Reynolds stresses Prandtl's mixing length theory, Eddy viscosity, the statistical theory of turbulence, Correlation coefficients, intensity and scale of turbulence. Turbulence measurement, Hot wire anemometer. Turbulence flow in a closed conduit, Prandtl's Power law of Velocity distribution in smooth and rough pipes. Analogy between Momentum, Heat and Mass transfer. The Reynolds 'Analogy for turbulent flow over a flat plate, The Prandtl's Analogy, The Von karmon Analogy, Colburn analogy

TEXT/REFERENCE BOOKS:

1. Bird R.B., Stewart W.E. and Lightfoot E.N., Transport Phenomena, 2nd Edition, Wiley, New York, 2006,
2. Knudson J.G. and Katz D.L., Fluid Dynamics and Heat Transfer, 2nd Edition, McGraw Hill, New York, 2000.

UNIVERSITY EXAM QUESTION PAPER PATTERN**Max. Marks:** 80**Exam Duration:** 3 hrs.**Part A:** 2 Questions from each unit, each carrying 2 marks

20 marks

Part B: 60% Problems- 2 Questions from each unit with internal choice, each carrying 12 marks

60 marks

SCHX1036	ENERGY ENGINEERING	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT I CONVENTIONAL ENERGY SOURCES**10 hrs.**

Energy sources. Coal, Oil, Natural gas, nuclear fuels, Hydro power, The Formation of Natural Resources, energy situation, exploration.

UNIT II NEW AND RENEWABLE ENERGY SOURCES**10 hrs.**

Study and design aspect of power plants using new and renewable energy sources. Viz., solar, wind, geothermal, ocean thermal, tidal wave. **Design of bio gas plant.** Bio mass energy, alternate fuels from biomass for automotive engines.

UNIT III DIRECT ENERGY CONVERSION**10 hrs.**

Solar cells, photovoltaic cells, theory of junction type cells and construction details. Fuel cells, types, practical considerations. Magneto hydrodynamic generator, electrical conductivity and formation of MHD, performance. **Prospects of large, medium and small-scale generations.**

UNIT IV NEW ENERGY CONVERSION SYSTEMS**10 hrs.**

Other energy transformations, coal gasification and liquefaction, role of coal in energy crisis, fluidized bed combustion. **Synfuels.** Hydrogen- methods of application, co- generation.

UNIT V ENERGY CONVERSION AND MANAGEMENT**10 hrs.**

Waste heat recovery, heat pump. Demand forecasting, global developments, principles of energy accounting and auditing, economics. **Principles of energy management. Technology assessment.**

TEXT/REFERENCE BOOKS:

1. Rai G.D., Solar Energy Utilisation, 3rd Edition, Khanna Publishers, New Delhi, 2000.
2. Rai G.D., Non-Conventional Energy, 3rd Edition, Khanna Publishers, New Delhi, 2000
3. Rao S.S., Energy Technology, 3rd Edition, Khanna Publishers, New Delhi, 2006
4. Rused C.K., Elements of Energy Conservation, 4th Edition, McGraw Hill, 1985
5. Christopher H., Armsteed H., Geothermal Energy, 2nd Edition, John Wiley, New York, 1978.
6. Pandyan S.B., Conventional Energy Technology, Fuels and Chemical Engineering, 2nd Edition, Tata McGraw Hill, New Delhi, 1988.

UNIVERSITY EXAM QUESTION PAPER PATTERN**Max. Marks:** 80**Exam Duration:** 3 hrs.**Part A:** 2 Questions from each unit, each carrying 2 marks

20 marks

Part B: 60% Problems- 2 Questions from each unit with internal choice, each carrying 12 marks

60 marks

SCHX1037	PROCESS MODELING SIMULATION AND OPTIMIZATION	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT I BASICS OF MODELING**10 hrs.**

Introduction to Modelling, Mathematical model, Types of Mathematical model, Classification of models. Application and scope of coverage, Principles of formulation. Fundamental laws- Continuity equation, Energy equation, Equations of motion. **Regression and Correlation analysis**

UNIT II NUMERICAL METHODS**10 hrs.**

Review of generation and solution of linear equations, algebraic equations, ordinary and partial differential equations. Solution of linear simultaneous equations, Gauss elimination, Gauss seidel method, successive over relaxation method. Matrix computation, linear transformation, eigenvalue and singular value decomposition.

UNIT III MODELING OF REACTORS**10 hrs.**

Batch reactor, CSTR, series of isothermal, Constant Holdup CSTR, CSTR with variable holdup, non-isothermal CSTR, Plug flow Reactor, Packed bed reactor.

UNIT IV MODELING OF HEAT AND MASS TRANSFER OPERATIONS**10 hrs.**

Modelling of heat exchangers, evaporators, absorption columns, ideal binary distillation column, multicomponent non-ideal distillation column, batch distillation with holdup, Single component vaporizer

UNIT V SIMULATION AND OPTIMIZATION**12 hrs.**

Dynamic simulation of batch reactor, CSTR, PFR, Distillation column, **Evaporator and Absorption column.** Introduction, applications, types of optimization scope and hierarchy of optimization. General procedure for solving optimization problems.

TEXT/REFERENCE BOOKS:

1. William L. Luyben, Process Modelling, Simulation and Control for Chemical Engineers, 2nd Edition. McGraw Hill International Editions, New York, 1990.
2. Davis M.E., Numerical methods and Modelling for Chemical Engineers, 1st Edition, Wiley, New York, 1984.
3. Denn M.M., Process Modelling, 2nd Edition, Wiley, New York, 1986.
4. Ramirez W., Computational Methods in Process Simulation, 1st Edition, Butterworth's Publishers, New York, 1989.
5. Mickley. H.S. Sherwood. T.S. and Reed C.E., Applied Mathematics for Chemical Engineers, 1st Edition, Tata McGraw Hill Publishing Co. Ltd, New Delhi, 1989.

UNIVERISTY EXAM QUESTION PAPER PATTERN**Max. Marks:** 80**Exam Duration:** 3 hrs.**Part A:** 2 Questions from each unit, each carrying 2 marks

20 marks

Part B: 60% Problems- 2 Questions from each unit with internal choice, each carrying 12 marks

60 marks

SCHX1038	INDUSTRIAL SAFETY AND HAZARD ANALYSIS	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT I INDUSTRIAL SAFETY**10 hrs.**

Industrial safety principles, accidents, site selection and plant layout, design for ventilation, emergency response systems for hazardous goods, basic rules and requirements which govern the chemical industries. Major Industrial accidents – Case Study

UNIT II HAZARDS**10 hrs.**

Chemical hazards classification, hazards due to fire, explosion and radiation. Potential hazards. Chemical and Physical job-safety analysis, High-pressure and high temperature operations, toxic effects, highly radioactive materials. Safe handling and operation of materials and machineries.

UNIT III HAZARD ANALYSIS**10 hrs.**

Types of hazard analysis -hazard identification –MSDS, Safety Audit- Hazard and Operability studies. Fault tree analysis. Event tree analysis.

UNIT IV APPRAISAL**10 hrs.**

Effective steps to implement safety procedures, periodic training and regular maintenance, personal protective equipment's-types, firefighting equipment's.

UNIT V HEALTH HAZARDS AND LEGAL ASPECTS**10 hrs.**

OSHA Health hazards -occupational - Industrial health hazards. Health standards and rules. Safe working environment. Factories act, Labour welfare act, ESI act, Workmen compensation act.

TEXT/REFERENCE BOOKS:

1. Fawcett H.H. and Wood W.S., Safety and Accident Prevention in Chemical Operation, 2nd Edition, Inter Science, 1982
2. Blake R.P., Industrial Safety, 2nd Edition, Prentice Hall Inc., New Jersey, 2006.
3. Deshmukh. L.M. Industrial Safety Management, 3rd Edition, Tata McGraw Hill, New Delhi, 2008
4. Jain.R.K and Sunil Rao, Industrial Safety, Health and Environmental Management Systems, 1st Edition, Khanna Publishers Delhi 2006.
5. Shrikant Dawande, Chemical Hazards and Safety, 2nd Edition, Denmet & Co 2007

UNIVERISTY EXAM QUESTION PAPER PATTERN**Max. Marks:** 80**Exam Duration:** 3 hrs.**Part A:** 2 Questions from each unit, each carrying 2 marks

20 marks

Part B: 60% Problems- 2 Questions from each unit with internal choice, each carrying 12 marks

60 marks

SCHX4008	CHEMICAL ENGINEERING LAB	REACTION	L	T	P	Credits	Total Marks
			0	0	4	2	100

1. Determine the rate constant for the saponification of Ethyl acetate with sodium hydroxide in a Plug Flow Reactor
2. Determine the rate constant for the reaction of ethyl acetate with sodium hydroxide of equimolar concentration in a batch reactor
3. Determine the rate constant for the reaction of ethyl acetate with sodium hydroxide of non-equimolar concentration in a batch reactor
4. Study the residence time distribution in a Plug Flow Reactor using Step Input
5. Study the residence time distribution in a Mixed Flow Reactor using Step Input
6. Determine the performance of three Mixed Flow reactors in series
7. Study of residence time distribution in a Mixed Flow Reactor using Pulse Input
8. Determine the rate and enhancement factor using non-catalytic solid liquid reactor
9. Determine the enhancement factor for the dissociation factor of Cinnamic acid in a Photochemical reactor
10. Determine the rate constant for the saponification of Ethyl acetate with sodium hydroxide in a Mixed Flow Reactor
11. Determine the heat of reaction using adiabatic reactor

SCHX4009	PROCESS SIMULATION LAB	L	T	P	Credits	Total Marks
		0	0	4	2	100

1. Introduction to software (flow sheeting)
2. Simulation of flash drum
3. Simulation of distillation columns
4. Simulation of absorption columns
5. Simulation of Reactors
6. Simulation of Heat Exchangers.
7. Simulation of pumps and compressors.
8. Simulation of mixing
9. Process simulation study involving mixing, reactor, distillation, heat exchanger for any of the following:
 - (a) Ethylene Glycol from Ethylene oxide
 - (b) Atmospheric distillation of crude oil
 - (c) Propylene Glycol from Propylene oxide
 - (d) Styrene from Ethyl Benzene

SCHX1040	OPTIMIZATION OF CHEMICAL PROCESSES	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT I OBJECTIVE AND FORMULATION OF OPTIMIZATION**10 hrs.**

Objective and Introduction, Objective Function and Decision variables, Inequality and Equality Constrains in Models Formulation of the Objective Function, Lower and Upper Bounds, Selecting Functions to Fit Empirical Data, Factorial Experimental Designs, Degrees of Freedom, Economic Objective Functions, Measures of Profitability

UNIT II BASIC CONCEPTS OF OPTIMIZATION**10 hrs.**

Continuity of Function, NLP Problem Statement, Convexity and Its Applications, Interpretation of the Objective Function in Terms of its Quadratic Approximation, Necessary and Sufficient Conditions for an Extremum of an Unconstrained Function

Unit III OPTIMIZATION OF UNCONSTRAINED FUNCTIONS**10 hrs.**

One-Dimensional Search Numerical Methods for Optimizing a Function of One Variable, Scanning and Bracketing Procedures, Newton and Quasi-Newton Methods of Unidimensional Search

UNIT IV UNCONSTRAINED MULTIVARIABLE OPTIMIZATION**10 hrs.**

Linear Programming (LP) and Applications Geometry of Linear Programs, Basic Linear Programming Definitions and Results, Simplex Algorithm, Barrier Methods, Sensitivity Analysis, Linear Mixed Integer Programs, Application of the EXCEL Solver Spreadsheet for Optimization, Formulation. Introduction to Nonlinear Programming with Constraints and Mixed-Integer Programming

Unit V APPLICATION OF OPTIMIZATION IN CHEMICAL ENGINEERING**10 hrs.**

Examples of Optimization in Chemical Processes like optimizing recovery of waste heat, Optimal Shell and Tube Heat Exchanger Design, Optimal Design and Operation of binary Distillation Column, Optimal pipe diameter etc. Flow sheet Optimization - Case studies.

TEXT / REFERENCE BOOK:

1. Edger T.F., Himmelblau D.M. and Lasdon L.S., "Optimization of Chemical Processes", 2nd Edition, McGraw- Hill, 2001
2. Seider W.D., Seader J.D. and Lewin D.R., "Product and Process Design Principles- Synthesis, Analysis, and Evaluation", 2nd Edition, John Wiley and Sons Inc., 2008.
3. Kalyan Moy Deb "Optimization for Engineering Design", 2nd Edition, Prentice Hall of India, 2009

UNIVERISTY EXAM QUESTION PAPER PATTERN**Max. Marks:** 80**Exam Duration:** 3 hrs.**Part A:** 2 Questions from each unit, each carrying 2 marks

20 marks

Part B: 60% Problems- 2 Questions from each unit with internal choice, each carrying 12 marks

60 marks

SCHX1041	FOOD TECHNOLOGY	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT I FOOD PROCESSING ENGINEERING–FUNDAMENTALS 10 hrs.

Fundamentals of Food Process Engineering, Application of Quantitative methods of Material & Energy Balances in Food Engineering Practices. Constituents of Food, Quality and Nutritive aspects, Food Adulterations, Deteriorative factors and Control

UNIT II UNIT OPERATIONS IN FOOD INDUSTRIES 10 hrs.

Fluid Flow, Thermal Process Calculations, Refrigeration, Evaporation and Dehydration operations in Food Processing

UNIT III FOOD CANNING TECHNOLOGY 12 hrs.

Fundamentals of Food Canning Technology, Heat Sterilization of Canned food, Containers – metal, Glass and Flexible packaging. Canning Procedures for Fruits, Vegetables, Meat, Poultry, marine Products

UNIT IV FOOD PRESERVATION METHODS 10 hrs.

Preservation by Heat and Cold, Dehydration, Concentration, Drying, Irradiation, Microwave heating, Sterilization and Pasteurization, Fermentation and Pickling, Packaging Methods

UNIT V PRODUCTION AND UTILIZATION OF FOOD PRODUCTS 10 hrs.

Cereal Grains, Pulses, Vegetables, Fruits, Spices, Fats and Oils, Bakery, Confectionary and Chocolate Products. Soft and Alcoholic Beverages, Dairy Products, Meat, Poultry and Fish Products

TEXT/REFERENCE BOOKS:

1. Norman N. Potler Joseph. H. Hutch's, 5th Edition. CBS Publishers & Distributors India, 1987.
2. Owen. R. Fennema. Principles of Food Science Part I & II, Marcel Dekker Inc New York, 1976.
3. Heid, J.L., Joslyn M.A, Fundamentals of Food Processing Operation, 3rd Edition, The AVI Publishing Co., Westport, 1967.
4. Heldman, D.R., Food Process Engineering, 2nd Edition, The AVI Publishing Co., 1965.

UNIVERSITY EXAM QUESTION PAPER PATTERN**Max. Marks:** 80**Exam Duration:** 3 hrs.**Part A:** 2 Questions from each unit, each carrying 2 marks

20 marks

Part B: 60% Problems- 2 Questions from each unit with internal choice, each carrying 12 marks

60 marks

SCHX1042	FERTILIZER TECHNOLOGY	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT I INTRODUCTION TO CHEMICAL FERTILIZERS**10 hrs.**

Chemical inorganic Fertilizer and organic manure. Types of fertilizers plant nutrients, location and function of fertilizer components. **Manufacture of Ammonia, Nitric acid, Phosphoric acid.**

UNIT II NITROGENOUS FERTILIZERS**10 hrs.**

Feed stock for production of Ammonia- Natural gas, Associated gases, Naphtha, Fuel oil, Coke oven gas. Production of nitrogenous fertilizers-Ammonium sulphate, Ammonium nitrate, Urea, Calcium ammonium nitrate, Diammonium phosphate, Ammonium chloride and their methods of production, Specification, storage and handling.

UNIT III POTASSIUM FERTILIZERS**10 hrs.**

Sources of potassium- Location, Methods of production of potassium chloride, Potassium cohenites. Function of potassium in plants. Their methods of production, Characteristic and Specifications

UNIT IV PHOSPHATIC FERTILIZERS**10 hrs.**

Raw materials, Phosphate rock, Sulphur pyrite, etc., Phosphate fertilizer- ground rock phosphate, **Bone meal**- Single super phosphate, Triple super phosphate, Thermal phosphate, their methods of production, characteristics and specifications.

UNIT V COMPLEX FERTILIZER AND MISCELLANEOUS FERTILIZERS**10 hrs.**

Types of complex fertilizers, composition, Production of ammonium phosphate fertilizers, Ammonium sulphate, Di ammonium phosphate, Nitro phosphate, Mono Ammonium Phosphate and various grade of NPK fertilizers Produced in industries. Mixed fertilizers and granulated mixtures- **Bio fertilizers and nutrients**. Secondary nutrients and Micronutrients, Fluid fertilizers.

TEXT/REFERENCE BOOKS:

1. Handbook of Fertilizer Technology, Fertilizer Association of India, New Delhi, 1998
2. George T. Austin, Shreve's Chemical Process Industries, 5th Edition., McGraw-Hill International Editions, Singapore, 1984.
3. Gopala Rao M. and Marshall Sittig, Dryden's Outlines of Chemical Technology, 3rd Edition., East-West Press, New Delhi, 1997.
4. Slack. A.V., Chemistry and Technology of Fertilizers, 2nd Edition, Interscience, New York, 1967

UNIVERISTY EXAM QUESTION PAPER PATTERN**Max. Marks:** 80**Exam Duration:** 3 hrs.**Part A:** 2 Questions from each unit, each carrying 2 marks

20 marks

Part B: 60% Problems- 2 Questions from each unit with internal choice, each carrying 12 marks

60 marks

SCHX1049	DRUGS AND PHARMACEUTICALS TECHNOLOGY	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT I INTRODUCTION**10 hrs.**

Pharmaceutical Industry, Drug discovery and Development of Drugs, Organic Therapeutic agents uses and Economics. Drug Metabolism, Physico - Chemical Principles in Drug Metabolism Kinetic Studies and Action of drugs on Human Bodies

UNIT II UNIT PROCESSES AND APPLICATIONS**10 hrs.**

Chemical Conversion Processes - Alkylation, Carboxylation, Condensation, Cyclisation, Dehydration, Esterification, Halogenation, Oxidation, Sulfonation, Complex Chemical Conversions and Fermentation.

UNIT III MANUFACTURING PRINCIPLES**10 hrs.**

Compressed Tablets, Wet Granulation, Dry Granulation or Slugging, Direct Compression, Tablet Presses, Formulation, Coating Pills, Parental Solutions, Oral Liquid, Injections Ointments, Role of Regulatory Authorities (FDA), Standard of Hygiene and Manufacturing Practice (GMP)

UNIT IV PHARMACEUTICAL / MICROBIOLOGICAL AND ANIMAL PRODUCTS 10 hrs.

Vitamins, Cold Remedies, Laxatives, Analgesics, Non-Steroidal Contraceptives, External Antiseptics, Antacids, Antibiotics, Biologicals, Hormone – Preservation

UNIT V ANALYSIS & QUALITY CONTROL**10 hrs.**

Pharmaceutical Analysis Packaging and Control, Analytical Methods and Tests for various Drugs & Pharmaceuticals. Packaging Techniques & Quality Control of Pharmaceutical Products.

TEXT/REFERENCE BOOKS:

1. Rawlins, E.A., Bentley's Text Book of Pharmaceuticals, 7th Edition, Bailliere Tindalls, London, 2009.
2. Remington, Pharmaceutical Sciences, 18th Edition, Mac Publishing Co., 1990.

UNIVERSITY EXAM QUESTION PAPER PATTERN**Max. Marks:** 80**Exam Duration:** 3 hrs.**Part A:** 2 Questions from each unit, each carrying 2 marks

20 marks

Part B: 60% Problems- 2 Questions from each unit with internal choice, each carrying 12 marks

60 marks

SCHX1052	PETROLEUM TECHNOLOGY	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT I INTRODUCTION**10 hrs.**

Classification of crude oil, Atmospheric distillation, Vacuum distillation of residue – Products and distillation practice

UNIT II CRACKING AND REFORMING**10 hrs.**

Light end products of Distillation, Hydro cracking, Thermal cracking, FCCU, Vis breaking, Catalytic reforming of Naphtha and its products.

UNIT III PRIMARY FINISHING TREATMENTS**10 hrs.**

Processes for Kerosene, Diesel and Hydrodesulphurisation. Treatment techniques for removal of objectionable odours, Storage stability. Extraction of aromatics, olefins and recovery operations.

UNIT IV SECONDARY FINISHING PROCESSES**10 hrs.**

Treatment of Gasoline production, Alkylation - Sulphuric acid process and Hydrofluoric acid process, Isomerisation process, Polymer gasoline.

UNIT V HEAVY ENDS TREATMENT**10 hrs.**

Production of Lube Oil stock, Wax and Asphalt

TEXT/REFERENCE BOOKS:

1. Nelson W.L., Petroleum Refinery Engineering, 4th Edition, McGraw Hill, 1958.
2. Bhaskara Rao B K, "Modern Petroleum Refining Processes", 2nd Edition, Oxford and IBH Publishing Company, New Delhi, 1990.
3. Ramprasad, Petroleum Refining Technology, 1st Edition, Khanna Publishers, New Delhi, 2000.

UNIVERSITY EXAM QUESTION PAPER PATTERN**Max. Marks:** 80**Exam Duration:** 3 hrs.**Part A:** 2 Questions from each unit, each carrying 2 marks

20 marks

Part B: 60% Problems- 2 Questions from each unit with internal choice, each carrying 12 marks

60 marks

SCHX1055	NANO TECHNOLOGY	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT I SUPRAMOLECULAR CHEMISTRY**10 hrs.**

Supramolecular Chemistry. Definition and examples of the main intermolecular forces used in supramolecular chemistry. Self-assembly processes in organic systems. Main supramolecular structures.

UNIT II NANOMATERIALS**10 hrs.**

Physical Chemistry of Nanomaterials. Students will be exposed to the very basics of nanomaterials; A series of nanomaterials that exhibit unique properties will be introduced.

UNIT III FABRICATION**10 hrs.**

Methods of Synthesis of Nanomaterials. Equipment and processes needed to fabricate nanodevices and structures such as bio-chips, power devices, and opto-electronic structures. Bottom-up (building from molecular level) and top-down (breakdown of microcrystalline materials) approaches.

UNIT IV NANO-BIOTECHNOLOGY**10 hrs.**

Biologically-**Inspired Nanotechnology** Basic biological concepts and principles that may lead to the development of technologies for nanoengineering systems. molecular nanoscale engineered devices, nanoscale biotechnologies, nano products.

UNIT V CHARACTERIZATION OF NANOMATERIALS**10 hrs.**

Instrumentation for **Nanoscale Characterization**- Instrumentation SEM, TEM, XRD, FTIR for characterization of properties. Limits of each technique.

TEXT/REFERENCE BOOKS:

1. Jean-Marie Lehn. Supramolecular Chemistry, 1st Edition, Wiley Publications, 1995.
2. Novailhat, Alain, Introduction to Nano technology, 2nd Edition, Wiley Publications, 2007.
3. Hovnyax G., Moore J., Tibbals J., Fundamental of Nanotechnology, 1st Edition, CRC Press, 1997

UNIVERISTY EXAM QUESTION PAPER PATTERN**Max. Marks:** 80**Exam Duration:** 3 hrs.**Part A:** 2 Questions from each unit, each carrying 2 marks

20 marks

Part B: 60% Problems- 2 Questions from each unit with internal choice, each carrying 12 marks

60 marks

SCHX1046	ENVIRONMENTAL POLLUTION AND CONTROL	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT I INTRODUCTION**10 hrs.**

Environment definition -The biosphere -the hydrologic cycle –the nutrient cycles, pollution of air, water and soil. **Air pollution laws and air quality standard.** Water pollution quality standards and law. MIMAS. Air pollution effect on human, plant and animal, acid rain.

UNIT II WATER POLLUTION AND ANALYSIS**10 hrs.**

Origin of waste water, types of waste pollutants and their effects, waste water sampling and analysis, determination of organic and inorganic matters, physical characteristics, bacteriological measurements.

UNIT III WATER TREATMENT**10 hrs.**

Characteristics of natural water, water conditioning, softening of water, demineralization of water. Treatment of water for municipal water supplies. Industrial water treatment, the aerobic process, the anaerobic process. **Water pollution effect on man, plant and animal.**

UNIT IV NOISE POLLUTION**10 hrs.**

Introduction, sources of noise pollution, Characteristics of sound, noise units, types of noise, effects and control of noise pollution. **Radioactive pollution (RAP),** sources of RAP- classification of its radiation effects on humans, plants and animals.

UNIT V POLLUTION CONTROL AND DISPOSAL METHODS**10 hrs.**

Control of air pollution-UV spectrophotometry -IR spectrometry. Emission spectrometry-chromatography -prevention of water pollution and its control -waste treatment, wastewater reclamation. **Various approaches to prevent and control water pollution,** effectiveness of prevention and control of water pollution, industrial waste disposal method. Noise prevention and control of the types of noise pollution.

TEXT/REFERENCE BOOKS:

1. Kapoor B.S., Environmental Engineering, 3rd Edition, Khanna Publishers, 1997
2. Mahajan S.P., Pollution Control in Process Industries, 1st Edition, Tata McGraw Hill, New Delhi, 1995.
3. Jain P.C, & Monica Jain, "Engineering Chemistry". 5th Edition, Dhanpat Rai Publications, New Delhi, 2002
4. Dara S.S, A Text Book of Engineering Chemistry, 3rd Edition, S. Chan & Co Ltd, New Delhi, 2006.

UNIVERSITY EXAM QUESTION PAPER PATTERN**Max. Marks:** 80**Exam Duration:** 3 hrs.**Part A:** 2 Questions from each unit, each carrying 2 marks

20 marks

Part B: 60% Problems- 2 Questions from each unit with internal choice, each carrying 12 marks

60 marks

SCHX1047	NOVEL SEPARATION PROCESSES	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT I THERMAL SEPARATION**10 hrs.**

Thermal Diffusion: Basic Rate Law, Theory of Thermal Diffusion Phenomena for gas and liquid mixtures, Equipment's design and Applications. Zone Melting: Equilibrium diagrams, Controlling factors, Apparatus and Applications.

UNIT II SORPTION TECHNIQUES**10 hrs.**

Types and choice of adsorbents, Normal Adsorption techniques, chromatographic techniques, Equipment and commercial processes, Recent advances and economics, Molecular Sieves.

UNIT III MEMBRANE SEPARATION PROCESSES**10 hrs.**

Types and choice of membranes, their merits, commercial, pilot plant and laboratory membrane permeators, Dialysis, Reverse Osmosis, Ultrafiltration, and Economics of Membrane operations.

UNIT IV IONIC SEPARATION**10 hrs.**

Controlling factors, Applications, Equipment's for Electrophoresis, Di electrophoresis, Electro Dialysis and Ion - Exchange, Commercial processes. Other Techniques: Adductive Crystallization: Molecular addition compounds, Clathrate compounds and Adducts, Equipment's, Applications, Economics and Commercial processes.

UNIT V FOAM SEPARATION**10 hrs.**

Surface Adsorption, Nature of foams, Apparatus, Applications, and Controlling factors.

TEXT/REFERENCE BOOKS:

1. Schoen H. M., "New Chemical Engineering Separation Techniques", 2nd Edition, Inter Science Publications, New York, 1972.
2. Loeb .C and Lacey R. E., "Industrial Processing with Membranes", 2nd Edition, Wiley Inter Science, 1972
3. Perry R.H. and. Green D.W, "Perry's Chemical Engineers Hand book", 6th Edition., McGraw Hill, New York, 1990.
4. Coulson J. M. and Richardson J. F., "Chemical Engineering", Vol. II, 4th Edition, Butterworth, Heinemann, London, 1991.

UNIVERISTY EXAM QUESTION PAPER PATTERN**Max. Marks:** 80**Exam Duration:** 3 hrs.**Part A:** 2 Questions from each unit, each carrying 2 marks

20 marks

Part B: 60% Problems- 2 Questions from each unit with internal choice, each carrying 12 marks

60 marks

SCHX1039	CORROSION ENGINEERING	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT I INTRODUCTION**10 hrs.**

Definition of Corrosion, corrosion damage, effect of material safety and reliability, classification of corrosion, expression of corrosion rate, electrochemical corrosion reaction, redox reaction, effect of oxygen, oxidizers. Effect of temperatures and concentration of chemicals on corrosion rate, Corrosion direct & two stage attack, electrochemical attack, environment conditioning.

UNIT II TYPES OF CORROSION**10 hrs.**

Effect of galvanic coupling, metallurgical aspects, metallic properties, ringworm corrosion, Principle of modern corrosion theory, Forms of corrosion – Uniform attack, galvanic corrosion, crevice corrosion, pitting intergranular corrosion and hydrogen damage, higher corrosion resistance through proper selection of material, isolation of corrosion prone materials from destructive environment.

UNIT III CORROSION PRODUCTIVE MEASURES**10 hrs.**

Technologies of anodization, enamelling, rubber lining, glass lining, refractory lining, painting and other surface protective measures.

UNIT IV APPLICATION OF CORROSION ENGINEERING**10 hrs.**

Corrosion engineering in special applications such as material transport, pumping, filtration, condensation, boiling, riveting, welding, and high temperature environments.

UNIT V CORROSION TESTING AND MEASUREMENTS**10 hrs.**

Corrosion testing, monitoring and inspection, laboratory corrosion test, accelerated chemical tests for studying different forms of corrosion, electrochemical methods of corrosion rate measurements by DC and AC methods, corrosion monitoring methods, chemical and electrochemical removal of corrosion products, cost factor in competitive corrosion prevention / inhibition techniques.

TEXT/REFERENCE BOOKS:

1. Unling, H.H., Corrosion Control, 2nd Edition, John Wiley & Sons, 1971
2. Butler, G. & Ison, H.C.K., Corrosion & its Prevention in Waters, 2nd Edition, Leonard Hill, London, 1966.
3. Maslow, P., Chemical Materials for Construction, 1st Edition, Structures Publishing Co., 1974.
4. Fontance, M.G. & Gtetrnee, N.D., Corrosion Engineering, 2nd Edition, McGraw Hill, 1967.
5. Rajagopalan, K.S. Corrosion and its Prevention, Chemical Engineering Education Development Centre, IIT Madras, 1975.

UNIVERISTY EXAM QUESTION PAPER PATTERN**Max. Marks:** 80**Exam Duration:** 3 hrs.**Part A:** 2 Questions from each unit, each carrying 2 marks

20 marks

Part B: 60% Problems- 2 Questions from each unit with internal choice, each carrying 12 marks

60 marks

SCHX1048	ELECTROCHEMICAL ENGINEERING	L	T	P	Credits	Total Marks
		3	0	0	3	100

UNIT I INTRODUCTION**10 hrs.**

Faraday's law, Nernst Potential, Galvanic Cells, Polarography. The Electrical Double Layer- It's role in Electrochemical processes, Electrocapillary curve, Helmholtz layer fields at the interface.

UNIT II BATTERIES**10 hrs.**

Batteries - Primary Batteries and Secondary Batteries, Leclanche dry cell, Alkaline Manganese cell, Mercury cell Reverse electrolytic cells like Mg-Cu₂C, IMg-PbO, Zn-PbO, Secondary cells like lead acid, Ni-Cd, Ni-Fe, AgO-Zn, AgO-Cd, Sodium-Sulfur, Li-S, Fuel Cells.

UNIT III ELECTRODES**10 hrs.**

Electrodes-Metals Graphite, Lead Oxide, Titanium Substrate insoluble electrodes, Iron Oxide, Semiconductor type electrodes. Metal finishing, Electro Deposition, Electro refining, Electro reforming, Electro polishing, Anodizing, Selective Solar Coatings.

UNIT IV ION-ION INTERACTIONS**10 hrs.**

True and Potential Electrolytes The nature of the Electrolyte and the Relevance of Ion-Ion Interactions. The Debye-Huckel Theory of Ion-Ion Interactions, Activity Coefficients and Ion-Ion Interactions-Ion Solvent Interactions and the Activity Coefficient, Ion Transport in Solutions, Ionic drift under an Electric field. Conduction Electro neutrality Coupling between the drifts of different Ionic Species.

UNIT V ELECTROCHEMICAL SYSTEMS**10 hrs.**

Technological Aspects of Electrochemistry, Thermodynamics and the Stability of Metals, The Corrosion Current and the Corrosion Potential, The Passivation Surface Instability and Internal Decay of Metals; Hydrogen Embrittlement-Charge Transfer and the Stability of metals, Electrochemical Energy Conversion, Electricity Storage the Lead-Acid Storage battery, Dry cell, Two Relatively New Electricity Storers.

TEXT/REFERENCE BOOKS:

1. Pickett, "Electrochemical Engineering", 1st Edition, Prentice Hall Inc., 1965.
2. Mantell C., "Electrochemical Engineering", 2nd Edition, McGraw Hill, 1972.
3. Newman J.S., "Electrochemical Systems", 2nd Edition, Prentice Hall Inc., 1973.

UNIVERSITY EXAM QUESTION PAPER PATTERN**Max. Marks:** 80**Exam Duration:** 3 hrs.**Part A:** 2 Questions from each unit, each carrying 2 marks

20 marks

Part B: 60% Problems- 2 Questions from each unit with internal choice, each carrying 12 marks

60 marks