SHIVAJI UNIVERISTY, KOLHAPUR-416 004. MAHARASHTRA
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शिवाजी विद्यापीठ, कोल्हापूर – 416004.
दुरध्वनी (ईपीएबीएक्स) २६०९००० (अभ्यास मंडळे विभाग— २६०९०९४)
फॅक्स : ००९१-०२३१-२६९१५३३ व २६९२३३३.e-mail:bos@unishivaji.ac.in

Estd. 1962
NAAC 'A' Grade
MHRD-NIRF- 28th Rank

SU/BOS/Sci. & Tech/10399 **Date: 24/09/2018**

To,

The Principal/ Director,
All affiliated Engineering Colleges/ Institute,
Shivaji University, Kolhapur.

Subject : Regarding Guidelines, structure, of CBCS M. Tech. Program and syllabus of Part - I&II M. Tech. Program under Faculty of Science and Technology.

Sir/Madam,

With reference to the subject mentioned above, I am directed to inform you that the University Authorities have accepted and granted approval to Guidelines, structure of CBCS M. Tech. Program and syllabus of Part - I&II M. Tech. Program to following branches under Faculty of Science and Technology:

M.Tech Part I & II (CBCS) (Branch)

1.	Civil Engineering	**2.**	Chemcial Engineering
3.	Mechanical (Heat power Engineering)	**4.**	Electronics Engineering
5.	Mechanical (Design Engineering)	**6.**	Computer Science and Engineering
7.	Mechnical (CAD/CAM/CAE)	**8.**	Electronics and Telecommunication
9.	Mechanical (Machine Design)		

The revised syllabi shall be implemented from the academic year 2018-19 (i.e. from July 2018) onwards. A soft copy containing CBCS Guidelines, structure, and syllabus of Part - I&II M. Tech. is enclosed herewith. The syllabus is also made available on university website www.unishivaji.ac.in.

Further, it is hereby informed that the question papers on the pre-revised syllabi shall be set for the examination to be held in October/November 2018 and April/May 2019. These chances are available for repeater students, if any.

You are therefore, requested to bring this to the notice of all students and teachers concerned.

Thanking you,

Yours faithfully,

Dy. Registrar

Encl-: as above.
Copy to-

1) I/c Dean, Faculty of Science & Technology
2) Director, Examination and Evaluation
3) The Chairman, respective BOS / Co-ordinating Committee

} For information

4) O.E. 4 Section
5) Appointment Section
6) Eligibility Section
7) Meeting Section

} For information & necessary action

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COURSE SCHEME

EXAMINATION SCHEME

ABSORPTION SCHEME

&

SYLLABUS

Of

First, Second, Third & Fourth Semester

Choice Base Credit System (CBCS)

Of

Master of Technology (M.Tech)

In

CHEMICAL ENGINEEERING

CHEMICAL ENGINEERING – CBCS PATTERN

Sr. No	Course (Subject Title)	TEACHING SCHEME: THEORY Credits	THEORY No. of Lecture	THEORY Hours	TUTORIAL Credits	TUTORIAL No. of Lecture	TUTORIAL Hours	PRACTICAL Credits	PRACTICAL No. of Lecture	PRACTICAL Hours	EXAMINATION SCHEME: THEORY Hours	THEORY Mode	THEORY Marks	THEORY Total Marks	THEORY Min	PRACTICAL Hours	PRACTICAL Max	PRACTICAL Min	TERM WORK Hours	TERM WORK Max	TERM WORK Min
SEMESTER - I																					
1	PCC-CH101	3	3	3	1	1	1	-	-	-		CIE ESE	30 70	100	40	As per BOS Guidelines	-	-	2	25	10
2	PCC-CH102	3	3	3	1	1	1	-	-	-		CIE ESE	30 70	100	40		-	-	2	25	10
3	PCC-CH103	3	3	3	1	1	1	-	-	-		CIE ESE	30 70	100	40		-	-	2	25	10
4	PCE-CH	3	3	3	-	1	1	-	-	-		CIE ESE	30 70	100	40		-	-	-	-	-
5	PCE-CH	3	3	3	-	1	1	-	-	-		CIE ESE	30 70	100	40		-	-	-	-	-
6	MC-CH101	-	-	-	-	-	-	1	2	2		-	-	-	-		-	-	2	25	10
7	MC-CH102	-	-	-	-	-	-	1	2	2		-	-	-	-		-	-	2	50	20
	TOTAL	**15**	**15**	**15**	**3**	**5**	**5**	**2**	**4**	**4**				**500**			**-**			**150**	
SEMESTER –II																					
1	PCC-CH201	3	3	3	1	1	1	-	-	-		CIE ESE	30 70	100	40	As per BOS Guidelines	-	-	2	25	10
2	PCC-CH202	3	3	3	1	1	1	-	-	-		CIE ESE	30 70	100	40		-	-	2	25	10
3	PCC-CH203	3	3	3	1	1	1	-	-	-		CIE ESE	30 70	100	40		-	-	2	25	10
4	PCE-CH	3	3	3	-	1	1	-	-	-		CIE ESE	30 70	100	40		-	-	-	-	-
5	PCE-CH	3	3	3	-	1	1	-	-	-		CIE ESE	30 70	100	40		-	-	-	-	-
6	MC-CH201	-	-	-	-	-	-	1	2	2		-	-	-	-		25	10	2	25	10
7	MC-CH202	-	-	-	-	-	-	1	2	2		-	-	-	-		25	10	-	-	-
	TOTAL	**15**	**15**	**15**	**3**	**5**	**5**	**2**	**4**	**4**				**500**			**50**			**100**	
	TOTAL	**30**	**30**	**30**	**06**	**10**	**10**	**04**	**08**	**08**				**1000**			**50**			**250**	

CIE- Continuous Internal Evaluation

ESE – End Semester Examination

• Candidate contact hours per week : 24 Hours (Minimum)	• Total Marks for M.Tech. Sem I & II : **1300**
• Theory and Practical Lectures : 60 Minutes Each	• Total Credits for M.Tech. Sem I & II : **40**
• In theory examination there will be a passing based on separate head of passing for examination of CIE and ESE.	
• There shall be separate passing for theory and practical (term work) courses.	

CHEMICAL ENGINEERING – CBCS PATTERN

SEMESTER - III																						
		TEACHING SCHEME									EXAMINATION SCHEME											
		THEORY			TUTORIAL			PRACTICAL			THEORY					PRACTICAL			TERM WORK			
Sr. No	**Course (Subject Title)**	**Credits**	**No. of Lecture**	**Hours**	**Credits**	**No. of Lecture**	**Hours**	**Credits**	**No. of Lecture**	**Hours**	**Hours**	**Mode**	**Marks**	**Total Marks**	**Min**	**Hours**	**Max**	**Min**	**Hours**	**Max**	**Min**
1	SI-CH301	-	-	-	-	-	-	2	4	4	-	-	-	-	-	-	-	-	2	50	20
2	MC-CH301	-	-	-	-	-	-	2	4	4		-	-	-	-		-	-	2	50	20
2	PW-CH302	-	-	-	-	-	-	8	16	16	-	-	-	-	-	2	50	20	2	50	20
	TOTAL	**-**	**-**	**-**	**-**	**-**	**-**	**12**	**24**	**24**				**-**			**50**			**150**	
SEMESTER –IV																					
1	PW-CH401	-	-	-	-	-	-	16	32	32		-	-	-	-	2	100	40	2	100	40
	TOTAL	**-**	**-**	**-**	**-**	**-**	**-**	**16**	**56**	**56**				**-**			**100**			**100**	
	TOTAL	**-**	**-**	**-**	**-**	**-**	**-**	**28**	**60**	**60**							**150**			**250**	

CIE- Continuous Internal Evaluation
ESE – End Semester Examination

• Candidate contact hours per week : 24 Hours (Minimum)	• Total Marks for M.Tech. Sem III & IV : **400**
• Theory and Practical Lectures : 60 Minutes Each	• Total Credits for M.Tech. Sem III & IV : **28**
• In theory examination there will be a passing based on separate head of passing for examination of CIE and ESE.	
• There shall be separate passing for theory and practical (term work) courses.	

COURSE CODE AND DEFINITION

Sr. No.	Course code	Definitions
1	PCC	PROFESSIONAL CORE COURSES
2	PCE	PROFESSIONAL CORE ELECTIVES
3	MC	MANDATORY COURSE
4	SI	SUMMER INTERNSHIP
5	PW	PROJECT Work

Semester I

Sl. No	Code No.	Subject	Semester	Credits
1.	PCC-CH101	Advanced Momentum and Heat Transfer	1	4
2.	PCC-CH102	Advanced Chemical Engineering Thermodynamics	1	4
3.	PCC-CH103	Process Modeling in Chemical Engineering	1	4
4.	PCE-CH	Elective I *(Available & Selected MOOCs Courses #)*	1	3
5.	PCE-CH	Elective-II *(Available & Selected MOOCs Courses #)*	1	3
6.	MC-CH101	Advanced Separation Laboratory	1	1
7.	MC-CH102	Seminar-I	1	1
			Total	**20**

Semester II

Sl. No	Code No.	Subject	Semester	Credits
1.	PCC-CH201	Advanced Mass Transfer	2	4
2.	PCC-CH202	Modern Reaction Engineering	2	4
3.	PCC-CH203	Chemical Process Control	2	4
4.	PCC-CH	Elective-III *(Available & Selected MOOCs Courses #)*	2	3
5.	PCC-CH	Elective-IV (Open Elective)*	2	3
6.	MC-CH201	Analytical Laboratory	2	1
7.	MC-CH202	Comprehensive Viva	2	1
			Total	**20**

Semester III

Sr. No	Code No.	Subject	Semester	Credits
1.	SI-CH301	In-Plant Training	3	2
2.	MC-CH102	Seminar-*II (Should be on Dissertation topic)*	2	2
3.	PW-CH302	Dissertation Phase-I	3	8
			Total	**12**

Semester IV

Sr. No	Code No.	Subject	Semester	Credits
1.	PW-CH401	Dissertation Phase II	4	16
			Total	**16**

List of Electives

ELECTIVE -I	
PCE-CH101	Nano-Technology
PCE-CH102	Green Technology
PCE-CH103	Pharmaceutical Biotechnology
	Available & Selected MOOCs Courses #
ELECTIVE -II	
PCE-CH104	Catalysis and Surface Phenomena
PCE-CH105	Bioprocess Engineering
PCE-CH106	Materials Engineering
PCE-CH107	Process and Equipment Design
	Available & Selected MOOCs Courses #

ELECTIVE -III	
PCE-CH201	Computational Fluid Dynamics
PCE-CH202	Energy Engineering
PCE-CH203	Research Methodology
	Available & Selected MOOCs Courses #
ELECTIVE –IV (Open Elective)	
PCE-CH204	Project Management
PCE-CH205	Advance Separation Techniques
PCE-CH206	Downstream Process Technology
PCE-CH207	Operational research

 # MOOCs: - Meeting with the global requirements, to inculcate the habit of self-learning and in compliance with UGC guidelines, MOOC (Massive Open Online Course) have been introduced as electives

- The proposed MOOCs would be additional choices in all the elective groups subject to the availability during the respective semesters and respective departments will declare the list of the courses at the beginning of the semester, which are having a minimum of 45 hours in a given semester
- Course content for the selected MOOCs shall be drawn from respective MOOCs links or shall be supplied by the department. Course will be mentored by faculty members and Assessment & evaluation of the courses shall be done by the department
- Three credits will be awarded upon successful completion of each MOOCs

Shivaji University, Kolhapur

M. Tech. (CHEMICAL ENGINEERING) PART-I

Advanced Momentum and Heat Transfer

Teaching Scheme:		**Examination Scheme:**
Lectures	**: 3Hours per week**	**Theory Paper :** **CIE - 30 Marks** **ESE – 70 Marks**
Tutorial	**: 1Hour per week**	**Term Work : 25 Marks**
Credits	**: 04**	

Course Outcome:-

CO1: Ability to understand the chemical and physical transport processes and their mechanism
CO2: Ability to do heat, mass and momentum transfer analysis
CO3: Ability to analyze industrial problems along with appropriate approximations and boundary conditions
CO4: Ability to develop steady and time dependent solutions along with their limitations
CO5: Understand the concepts of boundary layer and its estimation in different flows
CO6: Understanding of various types of heat transfer process and devices

Unit- I

Basic Concepts: Forces and tresses, stress tensor properties constitutive equation.

Boundary Layer Flow: Boundary layer equations, separation of BL, Blasius solution for flat state, properties of BL equation, Similarity solutions, Momentum integral equations.

Unit- II

Turbulent Flow: Reynolds equation for turbulent flow, velocity distribution for flow in pipe. Statistical theory of turbulence. Effect of wall roughness, drag reduction etc.

Non-Newtonian Fluids: Rheological behavior of non-Newtonian fluids, laminar flow in cylindrical tubes, laminar flow between parallel plates, laminar flow in annuli. Generalized relationship for power law model.

Unit-III

Agitation And Mixing: Agitation of liquids, Mixing mechanisms (Laminar mixing, Turbulent mixing), Circulation, Velocities in stirred tanks. Flow patterns in stirred tanks, Power consumptions in stirred vessels, mixing equipments.

Multiphase Flow: Two phase gas vapor liquid flow, horizontal and vertical flow of gas-liquids, liquids, gas-solid mixtures, slip and hold up effect, phase separation and settling behavior, analysis of stratified and bubble flow, formation of bubbles and drops and their size distribution and hold up in different flow system, momentum and energy relations.

Motion In The Fluidized Bed: Conditions for fluidization, behavior of the fluidized, minimum fluidization velocity, different types of fluidization, particulate fluidization, bubbling fluidization, semi-fluidization, mixing and segregation in fluidized bed, application of fluidization.

REFERENCES:

1. "The Flow of Complex Mixture in Pipes" by Govier and Aziz.
2. "Chemical Engineering" by Coulson and Richardson, Volume I.

Section-II

Unit-IV

Introduction: Brief Introduction to different modes of heat transfer; Conduction: General heat conduction Equation-Initial and Boundary conditions, Steady State Heat Transfer, Transient heat conduction; Lumped system analysis, heat transfer analogies, heat transfer to liquid metals.

Turbulent Forced Convective Heat Transfer: Momentum and energy equations - turbulent boundary layer heat transfer – mixing length concept - turbulence model, Heat pipe.

Unit-V

Heat Transfer In Two Phase Systems: Mechanism of nucleation pool boiling and flow boiling, heat transfer regimes and low maps. Condensation: Basic process, on planner surface, inside and over pipe of pure and multicomponent vapors. Heat transfer in paced bed and fluidized beds. Overall pressure drop and void calculation methods. Flow regims in two phase flow. Drift flux model, annular flow, critical flow, flow instabilities, homogeneous flow, and separated flow.

Non-Newtonian Flow Heat Transfer: Comparative study of Newtonian and non-Newtonian fluid in context with heat transfer, Newtonian and non-Newtonian heat transfer in circular tube, coils and other configuration, Non-Newtonian heat transfer in PFR, CSTR. Generalised relationship of power law fluid, forced convection heat transfer to Bingham plastic and power law fluid in circular conduits.

Unit-VI

Mechanisms of heat transfer in packed, fluidized and moving bed rector, heat transfer in dilute phase transport, application of basic heat equation in a design use of heat transfer in furnaces, pipe still, thermo siphoning and other industries.

Heat Transfer Augmentation: Active and passive techniques, rough surface, swirl flow generation and compound augmentation. Compact heat exchangers.

References:

1. D.G. Knudsan and D. L. Katz. Fluid Dynamics and Heat transfer. Mc-Graw Hill, 1958
2. H. P. Skelland "Non Newtonian flow and Heat transfer" John Wiley 1867
3. Hewitt G F, Shires G L, Bott T R, Process heat transfer CRC process (NY) 1994
4. HArison & Davidson, Fluidization Engg, Mc-Graw Hill, 1968

Advanced Chemical Engineering Thermodynamics

Teaching Scheme:		**Examination Scheme:**
Lectures	**: 3Hours per week**	**Theory Paper :** **CIE - 30 Marks** **ESE – 70 Marks**
Tutorial	**: 1Hour per week**	**Term Work : 25 Marks**
Credits	**: 04**	

Course Outcome:-

CO1: Define & describe the basic laws of thermodynamic
CO2: Explain the criteria for equilibrium with stability of thermodynamic system.
CO3: Ability to predict intermolecular potential and excess property behavior of multi- component systems.
CO4: Estimate of the Gibbs free energy and fugacity of a component in mixture
CO5: Judge the Chemical equilibrium and the balance equations for chemically reacting system
CO6: Discuss statistical thermodynamic terms.

Unit-I

Detailed review of thermodynamics laws and basic concepts : Concepts of entropy, Specifications of the equilibrium state, Intensive and extensive variables, Equations of state, Enthalpy, Gibbs free energy and other important thermodynamic properties.

Unit-II

Equilibrium and Stability in one component systems : The criteria for equilibrium , Stability of thermodynamic system, Phase equilibria: Applications of equilibrium and stability criteria to the equations of state. The molar Gibbs free energy and fugacity of a pure component. Specifications of the equilibrium thermodynamics state of system of several phases. The gibbs phase rule for one component system. Thermodynamic properties of phase transitions Problems.

Unit-III

The Thermodynamic of Multi Component Mixtures : The thermodynamic description of mixtures. The partial molar gibbs free energy and the generalized Gibbs – Duhem equation.

Anotation for chemical reactions. The equations on change for a multicomponent system. The heat of reaction and convection for the thermodynamic properties of reacting mixtures. The specification of the equilibrium. Thermodynamic state for a multicomponent multi phase system. The Gibbs phase rule Problems.

Unit-IV

The estimation of the Gibbs free energy and fugasity of a component in mixture : The ideal gas mixture , The partial molar mixture properties. The fugasity of a species in gaseous, liquid and solid mixtures. Several correlative liquid mixture (activity coefficient) models Problems. Vapor liquid equilibrium using activitycoefficient models, problems.

Unit-V

Chemical equilibrium and the balance equations for chemically reacting systems : Chemical equilibrium in a single phase system, Heterogeneous chemical reactions, Chemical equilibrium when several reactions occur in single phase, the balance equation for a tank type chemical reactors, a balance equation for a tubular reactor, overall reactor balance equations, problems.

Unit-VI

Introduction to Statistical thermodynamics : Classical and quantum mechanics , the canonical ensemble, other ensembles and fluctuations, microstates, macrostates and thermodynamic probability , Physical models, Boltzmann statistics, Fremi-Dirac stastics and Bose – Einstein stastics,Ideal monoatomic gas and diatomic gas, Partition function, Phase space, Equipartition of energy.

Text Books :

1) Chemical Engineering Thermodynamics – Stanlay Sandler IInd edition Wiley graham in chemical engineering.

References :

1) Introduction to Chemical Engineering Thermodynamics : J.M. Smith, H.C.Vanness McGraw Hill International book company.
2) The Principles of Chemical Equillibrium , Kenneth Denbiegh , Cambridge University Press.
3) Chemical Process Principles – Part II (IInd Edition) O.A.Hougen,K.M.Watson R.A.Rogatz.
4) Chemical Engineering Thermodynamics – B.F.Dodge McGraw Hill

5) Statistical Thermodynamics
6) Thermodynamics – by J.P.Holman IVth edition McGraw Hill Inter.
7) Statistical thermodynamics- M.C.Gupta Wiley Eastern Ltd.

Process Modeling in Chemical Engineering

Teaching Scheme:		**Examination Scheme:**
Lectures	**: 3Hours per week**	**Theory Paper :** **CIE - 30 Marks** **ESE – 70 Marks**
Tutorial	**: 1Hour per week**	**Term Work : 25 Marks**
Credits	**: 04**	

Course Outcome:-

CO1: Define physical problems in terms of mathematical modeling and how it is related
CO2: Apply the need for modeling, estimate necessary model complexity through modeling process
CO3: Recognize how models are develop from rate laws , balances and constitutive equations
CO4: Solve the basis of chemical engineering process and adjustable parameters in them
CO5: Analyze the mathematical tool to predict the chemical engineering process
CO6: Create the small modeling with simulation for any physical chemical engineering problem

Unit-I

Introduction to dynamic models: Mass balance equation - Balancing procedure, Case studies: CSTR, Tubular reactor, Coffee percolator, Total mass balance – Case Studies: Tank drainage, Component balances - Case Studies: Waste holding tank, Energy balance- Heating in a filling tank, Parallel reaction in a semi continuous reactor with large temperature difference, Momentum balances – Dimensionless model equations, CSTR, Gas liquid mass transfer in a continuous reactor**.**

Modeling of stage wise processes: Reactor Configurations, Generalized model description, Heat transfer to and from reactors, Steam heating in jacket, Dynamics of the metal jacket walls, Batch reactor – Constant volume, Semi - batch reactor, CSTR - Constant volume CSTR, CSTR cascade, bubble column reactor, Reactor stability.

Unit-II

Mass transfer models: such as liquid-liquid extraction, distillation, Multicomponent separation, multi component steam distillation, absorber- stage wise absorption, steady state gas absorption with heat effects, evaporator**.**

Model Discrimination And Parameter Estimation: Rate equations, Linear and non-linear regression analysis, Design of experiments, Factorial, Central, fractional design, Evolutionary operation techniques, Case studies.

Unit-III

Lumped and distributed system: Distributed system- Counter current heat exchanger, Flasher design, Condensation, Definition of lumped parameter model**.** Mathematical models of heat-transfer equipments: Shell & tube heat exchangers, Evaporators, Fired heaters, Partial condensers. Plug flow reactor, Plug flow reactor contactors, Liquid –liquid extraction column dynamics .

Unit-IV

Flow sheet simulation : Process flow sheet simulation; Process and information matrix, Recycle calculation sequence; Materials and Energy balance computation using modular approach; Process analysis, Process variables, selection, Equipment selection.

Unit-V

Dynamic simulation: Dynamic simulation of Reactors, distillation column, Absorbers, evaporators and crystallizes, introduction to simulation packages like GPSS, CSMP.

Unit-VI

Process Simulators: Introduction to professional simulator like Aspen.Hysys and Mathematical tools like MATLAB, Introduction to SIMULINK and Poly Math etc.

Application Of Optimization: Heat transfer and energy conservation, Separation techniques, Fluid flow systems, Chemical Reactor design.

Reference Books:

1. C. L. Smith, R. L. Pike and P. W. Murill, "Formulation Optimization of Mathematical odels", International Text, Pennsylvania, 1970.
2.. John Ingham, Irving, J. Dunn, Elmar, Heinzle Jiri, E. Prenosil, "Chemical Engineering Dynamics", VCH Publishers Inc., New York, 1974.
3. Roger G. E. Franks, "Modeling and Simulation in Chemical Engineer", Wiley Inter Science, New York, 1972.
4. R. W. Gaikwad, Dr. Dhirendra, "Process Modeling and Simulation", Central Techno Publications, Nagpur, 2003.
5. Edgar, T.F. and D.M. Himmelblau - " Optimization of Chemical Processes ", McGraw Hill BookCo., New York, 1989.
6. Lubeyn W.L. "Process Modeling, Simulation and Control Engineering ", McGraw Hill Book Co., New York, 1990.
7. Chemical Engineering Tutorial Numerical methods, Chemical Engineering, August 17, October 26, 1987 Feb. 15, April 25, July 18, Nov. 21, 1988, July14, 1989.
8. Chemical Engineering Tutorial Statistics for Chemical Engineers, Chemical Engineering., July 23, 1985, Feb. 3, April 14, June 23, Sept. 1, 1986.

Elective-I
Nanotechnology

Teaching Scheme:		**Examination Scheme:**
Lectures	**: 3Hours per week**	**Theory Paper :** **CIE - 30 Marks** **ESE – 70 Marks**
Tutorial	**: 1Hour per week**	**Term Work : ---**
Credits	**: 03**	

Course Outcome:-

CO1: To understand the application of nano science in catalysis and green chemistry
CO2: Demonstrate the understanding of length scale concepts, nanostructures and nanotechnology
CO3: Characterization of nano materials
CO4: Physico chemical aspects of different types of nano structures
CO5: Systematically solve scientific problems related specifically to nano-technological materials using conventional scientific and mathematical notation
CO6: Identify the principles of processing, and synthesis of nonmaterial's and nanostructures.

Unit-I

Introduction to Nanotechnology: History, Importance of Nanoscales, Fundamental concepts(Bottom-up and Top-down processes).

Unit-II

Application of Nanotechnology.

Unit-III

Nanomaterials: Fundamental concept of nanomaterial, Materials used in nanotechnology, carbon nanotubes-properties

Unit-IV

Synthesis, Purification, Application of Nanomaterials.

Unit-V

Recent Advances in Nanotechnology

Unit-VI

Intellectual property rights on Nanotechnology: Importance of IP Protection, copy rights and trade secrets

Reference Books:

1.“Principles of Nanotechnology” , Phani umar
2.”Nanomaterials”,Vishwanathan
3.”The Nanoscope” Encyclopedia of Nanoscience and NanotechnologyVol I to Vol 6, Edited by Dr.Parag Diwan and Ashish Bharadwaj

Green Technology

Teaching Scheme:		**Examination Scheme:**
Lectures	**: 3Hours per week**	**Theory Paper :** **CIE - 30 Marks** **ESE – 70 Marks**
Tutorial	**: 1Hour per week**	**Term Work : --**
Credits	**: 03**	

Course Outcome:-

CO1: To understand the principles of green chemistry and engineering
CO2: To design processes those are benign and environmentally viable
CO3: To design processes and products those are safe and hazard free
CO4: To learn to modify processes and products to make them green safe and economically acceptable
CO5: Ability to implement theoretical concepts for industrial problems to arrive at suitable solutions.
CO6: Application of green principles to specific industrial processes

Unit I

Introduction to Organic Chemistry /Analytical Chemistry /Basic Chemical Engineering

Unit II

Introduction to Green Chemistry: Principles of Green Chemistry, Reasons for Green Chemistry (resource minimisation, waste minimisation, concepts), Green reactions solvent free reactions, Catalyzed (heterogeneous/homogeneous) reactions, MW/ Ultrasound mediated reactions, Bio catalysts etc

Unit III

Introduction to Pharmaceutical Process Chemistry: Introduction to process chemistry, the difference between synthesis and process,

Unit-IV

Rote design, Route optimization, DOE

Unit-V

Role of Analytical Chemistry in Process Chemistry Role of Process Safety in Process Chemistry: TH classification, MSDS, Thermal Hazards, Waste segregation and disposal.

Unit-VI

Scale-up aspects including PE in Process Chemistry: Case Studies; New Initiatives : Micro reactors.

References:

[1] James H.Clarke & Duncan Maacquarrie, Handbook of Green Chemistry and Technology, Wiley-Blackwell; 1 edition (2002)

[2] Paul T.Anastas and John C. Warner, Green Chemistry: Theory and Practice, Oxford University Press, USA (2000)

[3] M.Lancaster, Green Chemistry (Paperback), Royal Society of Chemistry; 1 edition (2002)

[4] Stanley E.Manahan, Green Chemistry and the Ten Commandments of Sustainability, 2nd ed (Paperback), ChemChar Research Inc (2005)

[5] Albert Matlack, Introduction to Green Chemistry (Hardcover), CRC Press; 1 edition (2001)

[6] Kenneth M.Doxsee and James Hutchison Green Organic Chemistry: Strategies, Tools, and Laboratory Experiments (Paperback), Brooks Cole; 1 edition (May 7, 2003)

[7] Green Chemistry in the Pharmaceutical Industry, Peter Dunn (Editor), Andrew Wells (Editor), Michael T. Williams (Editor), Wiley-VCH (2010)

[8] Handbook of Green Chemistry – Green Solvents (Hardcover), Walter Leitner (Editor), Philip G. Jessop (Editor), Chao-Jun Li (Editor), Peter Wasserscheid (Editor), Annegret Stark (Editor), Paul T. Anastas, Wiley-VCH (2010)

Pharmaceutical Biotechnology

Teaching Scheme:		**Examination Scheme:**
Lectures	**: 3Hours per week**	**Theory Paper :** **CIE - 30 Marks** **ESE – 70 Marks**
Tutorial	**: 1Hour per week**	**Term Work : --**
Credits	**: 03**	

Course Outcome:-

CO1: Understand the various techniques used in modern biotechnology.
CO2: Design research strategy with step by step instructions to address a research problem
CO3: Provide examples of current applications of biotechnology and advances in the different areas like medical, microbial, environmental, bioremediation, agricultural, plant, animal, and forensic
CO4: Explain the concept and application of monoclonal antibody technology.
CO5: Demonstrate and Provide examples on how to use microbes and mammalian cells for the production of pharmaceutical products
CO6: Explain the general principles of generating transgenic plants, animals and microbes

Unit-I

Drug Development in Pharmaceutical Process- Production of pharmaceuticals by genetically engineered cells (hormones, interferrons) - Microbial transformation for production of important pharmaceuticals (steroids and semi-synthetic antibiotics)

Unit-II

Techniques for development of new generation antibioticsl,Protein engineering, drug design, drug targeting.

Unit-III

Disease Diagnosis and Therapy,ELISA and hybridoma technology,DNA vaccine,Gene Therapy, Toxicogenomics.

Unit-IV

Proteomics in Drug Development,Role of Proteomics in Drug Developmen.

Unit-V

Diagnosis of disease by Proteomics,Separation and identification techniques for protein analysis,Development of antibody based protein assay for diagnosis.

Unit-VI

Diagnosis and Kit Development,Use of enzymes in clinical diagnosis, Use of biosensors for rapid clinical analysis,Diagnostic kit development for microanalysis.

References:

1. Balasubramanian, Bryce, Dharmalingam, Green and Jayaraman (ed), Concepts in Biotechnology, University Press, 1996
2. Epenetos A.A.(ed), Monoclonal antibodies: applications in clinical oncology, Chapman and Hall Medical, London

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Elective-II

Catalysis and Surface Phenomena

Teaching Scheme:		Examination Scheme:
Lectures	**: 3Hours per week**	**Theory Paper :** **CIE - 30 Marks** **ESE – 70 Marks**
Tutorial	**: 1Hour per week**	**Term Work : --**
Credits	**: 03**	

Course Outcome:-

CO1: To understand the concepts of homogenous and heterogeneous catalysis, catalytic activity and selectivity and the relevance to green chemistry and technology
CO2: To understand the kinetics of homogenous and heterogeneous catalytic reactions and catalytic cycles
CO3: To familiarise with the synthesis and characterization of catalysts
CO4: To understand the application and mechanisms of several types of catalysts
CO5: Knowledge of heat and mass transfer effects on catalytic reactions.
CO6: Ability to design different types of reactors for conducting catalytic reactions.

Unit-I

Introduction of Catalysis : Classification of Catalysis - Homogeneous, Heterogeneous, Biocatalysts, Preparation of catalysis - Laboratory Techniques, Industrial methods, Transition models, Dual functional catalysts, Zeolites, Enzymes, Solid Catalysts, Powder Catalysts, Pellets, Composition, Active ingredients, Supportive materials, Catalysts activation.

Unit-II

Catalysts Characterization: Surface area measurements, BET Theory, Pore size distribution, Porosimetry Chemisorption techniques, Static and dynamic methods, Crystallography and surface analysis techniques, XRD, XPS, ESCA, ESR, NMR, Raman and Masbauar spectroscopies, Surface acidity and toxicity, Activity, Life time, Bulk density, Thermal stability etc.

Unit-III

Theories of Catalysts: Crystal structure and its defects, Geometric and electronic factors, Analysis of transition model catalysis, Chemistry and thermodynamics of adsorption, Adsorption isotherms - Langmuir model, Tempkin model, Freundich model, Elovich equation, Langmiur Hinshel - wood model, Rideal - Eely mechanism, Reversible - irreversible mono and bimolecular reactions with and without inerts, Determination of rate controlling steps, Inhibition, parameter estimation.

Unit-IV

Mass and Heat Transport in Porous Catalysts : Internal and external transport, fixed bed, Fluidized bed reactors, Effect of internal transport on selectivity. Effectiveness factor and Thiele modulus.

Unit-V

Catalyst Deactivation : Poisons, sintering of catalysts, Pore mouth plugging and uniform poisoning models, Kinetics of deactivation, Catalyst regeneration.

Unit-VI

Industrial Catalysis : Industrial catalysts preparation methods, Typical industrial catalytic processes, Case studies, Catalytic deactivation prevention methods, New techniques for catalyst characterization, Overall study.

References:

1. Emmett, P.H. - “Catalysis Vol. I and II, Reinhold Corp.", New York, 1954.
2. Smith, J.M. - “Chemical Engineering Kinetics ", McGraw Hill, 1971.
3. Thomas and Thomas - “Introduction to Heterogeneous Catalysts ", Academic Press, London 1967.

BIOPROCESS ENGINEERING

Teaching Scheme:		**Examination Scheme:**
Lectures	**: 3Hours per week**	**Theory Paper :** **CIE - 30 Marks** **ESE – 70 Marks**
Tutorial	**: 1Hour per week**	**Term Work :**

Credits	: 03	

Course Outcome:-
CO1: Understanding of biological basics and bioprocessing
CO2: Understanding the difference between bioprocesses and chemical processes
CO3: Bioprocess design and operation
CO4: Choice of bioreactor
CO5: Heat & mass transfer considerations and scale up of bioprocesses
CO6: Introduction to bioprocess monitoring/control

Unit-I

Review of fundamentals of microbiology and biochemistry. Bioprocess principles: Kinetics of biomass production. Substrate utilization and product formation.

Unit-II

Batch and continuous cultures. Fed batch culture introduction. Fermentation processes. General requirements of fermentation processes.

Unit-III

An overview of aerobic and anaerobic fermentation processes. Examples of simple and complex media. Design and usage of commercial media for industrial fermentation. Thermal death kinetics of microorganisms. Heat sterilizations of liquid media. Filter stabilizations of liquid media and air.

Unit-IV

Enzyme technology- Microbial metabolism enzymes classification and properties. Applied enzyme catalysis-kinetics of enzyme catalytic reaction. Metabolic pathways. Protein synthesis in cells. Bioreactor design and operations. Selection scale up operations of bioreactors.

Unit-V

Mass transfer in heterogeneous biochemical reaction systems. Oxygen transfer rates and coefficients. Role of aeration and agitation in oxygen transfer. Heat transfer processes in biological systems. Recovery and purification of products.

Unit-VI

Introduction to instrumentation and process control in bioprocesses. Measurement of physical and chemical parameters in bioreactors. Monitoring and control of dissolved oxygen, pH, Impeller speed and temperature in a stirred fermenter.

Text books:

1. M. L. Shuler, F. Kargi. Bioprocess engineering. 2nd edition. PHI. New Delhi. 2002.
2. J. E. Bailey, D. F. Ollis. Biochemical engineering. 2nd edition. Mc Graw Hill Publication co. NY. 1985.
3. Pauline M. Doran, Bioprocess Engineering Principles, Academic Press, 2001

Teaching Scheme:		**Examination Scheme:**
Lectures	**: 3Hours per week**	**Theory Paper :** **CIE - 30 Marks** **ESE – 70 Marks**
Tutorial	**: 1Hour per week**	**Term Work : ---**
Credits	**: 03**	

Course Outcome:-

CO1: To review physics and chemistry in the context of materials science & engineering
CO2: To describe the different types of bonding in solids, and the physical ramifications of these differences
CO3: To describe and demonstrate diffraction, including interpretation of basic x-ray data.
CO4: To promote an understanding of the relationship between material structure, processing and properties.
CO5: Gain important conceptual and operational understanding of a wide range of methods for characterizing Materials
CO6: Gained a broad perspective on materials chemistry and physics

Unit-I

Engg. requirement of materials, atomic bonding, atomic arrangements, structural imperfections and atom movements, electronic structures & process binary alloys and equilibrium diagrams.

Unit-II

metallic phases and their properties, phase transformations in iron carbon system.

Unit-III

heat treatment, surface hardening, case hardening metals and their alloys, organic materials & their properties, ceramic phases and their properties, multiphase materials, reactions within solid materials.

Unit-IV

modification of properties through change in microstructure, corrosion, oxidation, thermal stability, radiation damage, composite materials .

Unit-V

Crystallography, X-Ray Diffraction Methods, Reitveld Refinement, Neutron Diffraction, XRay absorption, XRay Fluorescence spectroscopy, Electron Diffraction- diffraction pattern in specific modes.

Unit-VI

LEED and RHEED, Electron Optics, Electron Microscopy-Transmission and Scanning Electron Microscopy, STM and AFM, Compositional analysis employing AES, ESCA and Electron Probe Microanalysis.

Reference Books

1. James F. Shackelford, Introduction to Materials Science for Engineers, 7th Edition, Pearson Prentice Hall (2009)
2. W. D. Callister, Fundamentls of Materials Science and Engineering, Wiley (2007)
3. C. Kittle, Introductin to Solid State Physics, Wiley (2007)
4. R. W. Cahn and P. Haasen, Physical Metallurgy, North Holland (1996)
5. Bradley D. Fahlman Materials Chemistry, Kindle Edition 2008).

6. B.D.Cullity ElementS of X-ray Diffraction Addision Wesely Reading Mass 1978.
7. David D. Brandon and Wayne D. Kaplan Microstructural Characterization of Materials wiley
8. Dawn Bonnel Scanning Probe Microscopy and Spectroscopy: Theory, Techniques, and Applications 2000.
9. C. Julian Chen Introduction to Scanning Tunneling Microscopy Monographs on the Physics and Chemistry of Materials.

Process and Equipment design

Teaching Scheme:		**Examination Scheme:**
Lectures	**: 3Hours per week**	**Theory Paper :** **CIE - 30 Marks** **ESE – 70 Marks**
Tutorial	**: 1Hour per week**	**Term Work : ---**
Credits	**: 03**	

Course Outcome:-
CO1: Recall their concepts in designing the chemical equipments
CO2: Interpret causes of failure of chemical equipment
CO3: Have awareness on advances in process engineering design of many process equipments
CO4: Take part in remedial or preventive measurements to avoid failure of vessel with safe design Guide lines
CO5: Evaluate and apply their ideas on dimensional analysis to explore the optimum design variables
CO6: Test the process equipment with prior safety.

Unit-I
Shell and Tube Heat exchanger: Classification, Shell and Tube side Heat Transfer Coefficients, Pressure drop, Fouling, Baffles, Passes Tubes Tube Sheet, Effectiveness, of Heat exchanger, Heat Exchangers sizing For Heating or Cooling in agitated vessel, Heat exchangers and their Suitability, Jacketed Batch Reactor Heating, Air Cooled Heat exchanger, optimum Cooling water Temp, Mechanical Design Of Shell and Tube Heat exchanger, Differential Expansions and Thermal Stress in Heat exchanger.

Unit-II
Heat Exchange equipment: Plate Heat Exchanger, Fired Heater Design Consideration, Heater Efficiency, Heat Regenerator, Thermic Fluid Heating System Design Consideration, Cooling Tower Design Consideration, Cooling Water Blow Down, Cooling Water Corrosion, Crossed flow indused Draft Cooling Tower , Evaporation, Single and Multiple Effect forward and Backward Feed Evaporators.

Unit-III
Reactor: Reactor Classification, Design Equation for Batch PFR and CSTR, Fluidized Bed Reactor, Scale Up.

Unit-IV
Separation Equipment and Distillation column: Classifications of Separator, Design Procedure

For Gas Liquid Separator Oil Water Separator, Decanter, Gravity Separators, Centrifugal Separators Gas Cleaning Equipment: Cyclone Separator, Electrostatic Precipitator, Granular Bed Filter, Hydro-cyclone,Method For Calculating No Of Trays, No of plates at Total Reflux, Plate column or Packed Column, Types of Plate, Entrainment, Minimum No of Plates, Pressure Drop Calculation, Packed Column.

Unit-V

Drying equipment: Common Terms In drying, Drying Rate, Performance of Continuous Dryer, Drying Equipments: Rotary Dryers, Turbo Dryers, Drum Dryers, Spray Dryer, Solvent Dryer, Fluidized Bed Dryer, Insipient Fluidization Velocity.

Unit-VI

Pipe line: Pipe Thickness, Pipe diameter, Condensate Piping, Pipe Support, Design of Pipeline for Natural Gas, Transportation of Crude oil, Pipe Line in Sea Water, Pipeline Design on Fluid Dynamics Parameters.

References:

1. Process Design Of Equipments Vol.-1, 4th Edn by Dr.S.D.Dwande, Denett & Company Publication 2011
2. Process Design Of Equipments Vol.-2, 4th Edn by Dr.S.D.Dwande, Denett & Company Publication 2012
3. Introduction to Process Engineering and Design 4th Reprint 2011, S.B.Thakore, B.I.Bhatt, Tata Mc. Graw Hill, Eduction Pvt. Ltd,Delhi

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M.E. (Chemical Engineering), Part:-I Practical

Advance Separation Laboratory

Practical – 2hrs.
Credits- 01
Term Work – 25 Marks

Course Outcome:

CO1: Knowledge of various chemical engineering separation processes
CO2: Ability to Select appropriate separation technique for intended problem
CO3: Ability to analyze the separation system for multi-component mixtures
CO4: Ability to design separation system for the effective solution of intended problem
CO5: Understanding of modern separation technique in various applications
CO6: Ability to analyze and design pervaporation, chromatography and dialysis based separation processes

Unit 1: Introduction: Reveiw of conventional processes, Recent advances in separation techniques based on size, surface properties, ionic properties and other special characteristics of substances, Process concept, Theory and equipment used in cross flow filtration, cross flow electro filtration, dual functional filter, Surface based solid - liquid separations involving a second liquid, Sirofloc filter.

Unit 2: Membrane Separation: Types and choice of membranes, Plate and frame, tubular, spiral wound and hollow fiber membrane reactors and their relative merits, Commercial, pilot plant and laboratory membranes permeators involving dialysis, reverse osmosis, Nanofiltration, ultrafiltration, Microfiltration and Donnan dialysis, Economics of membrane operations, Ceramic membranes.

Unit 3: Separation By Adsorption Techniques: Mechanism, Types and choice of adsorbents, Normal adsorption techniques, Affinity chromatography and immuno chromatography. Types of equipment and commercial processes, Recent advances and process economics.

Unit 4: Ionic Separations: Controlling factors, Applications, Types of equipment employed for electrophoresis, Di-electrophoresis, Ion exchange chromatography and electro dialysis, Commercial Processes.

Unit 5: Other Techniques: Separations involving Iyophilisation, Prevaporation and permeation techniques for solids, liquids and gases. Industrial viability and examples, Zone melting, Addluctive crystallization, Other separation process, Supercritical fluid extraction, Oil spill Management, Industrial effluent treatment by modern techniques.

References:

1. Lacey, R.E. and S.Loaeb - " Industrial Processing with Membranes ", Wiley -Inter Science, New York, 1972.
2. King, C.J. " Separation Processes ", Tata McGraw - Hill Publishing Co., Ltd., 1982.
3. Schoew, H.M. - " New Chemical Engineering Separation Techniques ", Interscience Publishers, 1972.
4. Ronald W.Roussel - " Handbook of Separation Process Technology ", John Wiley, New York, 1987.
5. Kestory, R.E. - " Synthetic polymeric membrances ", Wiley, New York, 1987

M.E. (Chemical Engineering), Part:-I
Seminar

Teaching Scheme: **Examination Scheme:**

Practical: 2 Hours per week **Term Work: 50 Marks**

Credits: 01

Course Outcome:-

CO1: Know the bridge between the chemical engineering and other disciplines
CO2: Learn the solutions from world class researchers for chemical engineering problems
CO3: Prepare an oral presentations related to the technical assignments
CO4: Identify and communicate the concepts of chemical engineering for building confidence
CO5: Through understanding of technical resources towards successful preparation for a talk/lecture
CO6: Demonstration of the presentation on most recent concepts in technology and impact skill in real- time environment

Seminar-I should be based on the literature survey on any topic relevant to Chemical Engineering (should be helpful for selecting a probable title of dissertation). Each student has to prepare a write up of about 25 pages of “A4” size sheets and submit it in duplicate as the termwork.

The student has to deliver a seminar talk in front of the faculty members of the department and his classmates. The faculty members, based on the quality of the work and preparation and understanding of the candidate, shall do an assessment of the seminar internally – jointly.

M.E. (Chemical Engineering), Sem.-II

Advanced Mass transfer

Teaching Scheme:		Examination Scheme:
Lectures	: 3Hours per week	Theory Paper : CIE - 30 Marks ESE – 70 Marks
Tutorial	: 1Hour per week	Term Work : 25 Marks
Credits	: 04	

Course Outcome:-

CO1: Define various operations like distillation, extraction, leaching
CO2: Compare and classify various mass transfer operations with or without chemical reaction
CO3: Design calculation of distillation column for the multi-component system
CO4: Analyze the problem of Separation by adsorption and design of absorber, chromatographic separation
CO5: Evaluate the separation by liquid extraction, leaching used and justify the extract operation to choose for specific problem
CO6: Estimate final data for designing number of stages, Height of column in the operations

Unit-I

Physical-Chemical Phenomena: Diffusivity and mechanism, Diffusion dispersion, Diffusivity measurements and prediction in non- electrolytes and electrolytes, solubility of gases in liquids, Interphase mass transfer in two phase and multi component system.

Unit-II

Mass transfer with Chemical reaction: Fluid-fluid reactions involving diffusion transfer, application of mass transfer to reacting systems Residence time distribution analysis, mass transfer coefficients, determination and prediction in dispersed multiphase contractors under the conditions of free forced convection, prediction of mean drop or bubble size of dispersion.

Unit-III

Capacity and efficiency of contacting devices, energy requirements of separation process.

Unit-IV

Multicomponent distillation: Mass transfer models, Binary distillation in tray columns, Multicomponent distillation tray column, Distillation in packed column –Non-equilibrium models, solving the model equations, Design studies of Depropanizer, Extractive distillation, Reactive distillation , cryogenic distillation and molecular distillation.

Unit-V

Adsorption, Ion exchange and chromatography: Adsorption, equilibrium considerations, pure gas adsorption, liquid adsorption, Ion exchange equilibrium, equilibrium in chromatography, Kinetic and transport considerations, external and internal transport, mass transfer in ion exchange and chromatography.

Unit-VI

Extraction: Supercritical fluid extraction, Supercritical fluid, phase equilibria, industrial applications, residuum oil Supercritical process – decaffeination of coffee, extraction of oil from seeds, residual oil Supercritical application (ROSE), Supercritical fluid chromatography.

References:-

1. “Separation process” by J. Sieder and Henley, Wiley publishers, 1998
2. “Chemical Engineering Handbook” by Perry, Mc Graw Hill
3. “Unit operation in Chemical Engineering” 6TH edition, McCabe Smith, Mc Graw Hill
4. “Mass Transfer Operations” by Trebyal, , Mc Graw Hill
5. “Transport Separations and Unit Operations” 3rd edition ,G.J.Geankoplis,Prentice Hall,NJ,1993
6. “Seperation process” by C.Judson King,Mc Graw Hill,1982
7. “Distillation” ,Matther Van Winkle, Mc Graw Hill, Book Company, NY

Modern Reaction Engineering

Teaching Scheme:		**Examination Scheme:**
Lectures	**: 3Hours per week**	**Theory Paper :** **CIE - 30 Marks** **ESE – 70 Marks**
Tutorial	**: 1Hour per week**	**Term Work : 25 Marks**
Credits	**: 04**	

Course Outcome:-

CO1: To understand the principles of designing reactors
CO2: To evaluate reaction rates in different types of reactors
CO3: To understand the design and operation of catalytic reactors
CO4: To design and modify rectors to make processes safe and efficient
CO5: Analyze multiple reactions carried out both isothermally and non-isothermally in flow, batch and semi batch reactors to determine selectivity and yield.
CO6: Describe the steps in a catalytic mechanism and how one goes about deriving a rate law, mechanism, and rate-limiting step that are consistent with experimental data.

Unit I:

A brief review of Chemical kinetics and Ideal reactor.

Unit- II:

Non Ideal flow and mixing: Mixing concept, RTD, Response measurement, segregated flow model, Dispersion model, Tank in Series model, recycle rector model, analysis non ideal reactor.

Unit- III:

Heterogeneous reaction: Classification, Rate Controlling step, globale rate of reaction.

Unit- IV:

Fluid-solid Non Catalytic reaction: Sinking core model, untreated core model, kinetics of non catalytic reaction for spherical and cylindrical solid particles, Contacting patterns, Reactor design.

Unit- V:

Fluid-Fluid Reaction: Gas-liquid reaction, practical ability of film theory, kinetic regime identification, kinetics of fluid-fluid reaction, Contacting patterns, Reactor design.

Unit- VI:

Catalysis and Catalytic reaction: Classification of catalysis, surface area measurement, BET theory, pore size distribution, adsorption, adsorption isotherm, Internal and External transport in pore catalyst, effectiveness factor and their modules, Effect of internal transport on selectivity, Catalyst deactivation, poison,Sintering of catalyst, and uniform posing model, Mechanism and kinetics of deactivation, catalyst regeneration.

Design of heterogeneous catalyst: Isothermal and adiabatic fixed bed reactors, non-isothermal, non-adiabatic fixed bed reactor, Introduction to multiphase reactor design, two phase fluidized bed model, slurry reactor model, trickle bed reactor model.

References:

1. Octave Levanspeil, Chemicaal Reaction Engineering,Jhon Wiley, London
2. S.M.Walas, Reaction Kinetics for Chemical Engineers, Mc Graw Hill, New Yark
3. J.M.Smith, Chemical Reaction Kinetics, Mc Graw Hill,1981
4. Bischott and Fromment, Chemical Reactor Design and analysis,Wesley-1982
5. Fogler H.S, Ellement of Chemical Reaction engineering,prantice-hall19863

Chemical Process Control

Teaching Scheme:		Examination Scheme:
Lectures	: 3Hours per week	Theory Paper : CIE - 30 Marks ESE – 70 Marks
Tutorial	: 1Hour per week	Term Work : 25 Marks
Credits	: 04	

Course Outcome:-

CO1: Develop structured, logical control schemes for complex processes.
CO2: Study dynamics of process and control behaviour.
CO3: Choose control configurations for standard operations.
CO4: Estimate controller parameter setting.
CO5: Understand type of controller that can be used for specific problem in chemical industry.
CO6: Design digital control systems.

Unit-I

Introduction To Feed Back Control: Concept of feedback Control, Types of feedback Controllers, Measuring Devises, Transmission Lines, Final Control Elements.

Dynamic Behavior Of Feedback Control System: Block Diagram and closed looped response, effect of P Control, I Control, D Control, and Composite Control Action on response of a controlled process.

Unit-II

Stability Analysis Of Feedback System: Notion of Stability, the characteristics equation, Routh –Hurwitz Criterion for stability, Root locus analysis.

Design Of Feedback Controller: Outline of Design Problem, Simple Performance Criteria, Time integral performance criteria, Select the type of feedback Controller, Controller tuning.

Unit-III

Frequency Response Analysis Of Linear Process: Response of First Order System to Sinusoidal input, frequency response characteristics of a general linear system, Bode Diagram, Nyquist Plots.

Design Of Feedback Control System Using Frequency Response Technique Bode Stability Criteria, Gain and Phase Margin, Ziegler- Nicholas Tuning Techniques, Nyquist Stability Criteria.

Unit-IV

Feed Back Control Of System With Large Dead Time Or Inverse Response : Processes with Large dead time, Dead Time compensation, Control of System with Inverse response.

Control System With Multiple Loop: Cascade Control, Selective Control System, Split Range Control.

Unit-V

Feed Forward And Ratio Control: Logic of Feed Forward Control, Problem of Designing feed forward controllers, Prctical Aspect on Design of Feed forward controllers, Feed forward- Feed Back Control, Ratio Control.

Adaptive and Inferential control system: Adaptive Control, Inferential Control **Introduction To Plant Wide Control:**Plant Wide Control issues, Hypothetical plant for Plant wide control Studies, Internal Feedback of Material and Energy, Interaction of Plant Design and control system design.

Unit-VI

Plant Wide Control System Design: Procedures for Designs of Plant wide control systems, A Systematic procedure for plant wide control system design, Case studies: The Reactor Flash Unit Plant, Effect of Control Structure on Closed looped performance.

Digital Process Control System: Hard ware and Software, Distributed Digital Control System, Analog and Digital Signals and Data transfer, Microprocessors and Digital Hardware in Process Control, Software Organization.

References:

1. Chemical Process Control An Introduction To Theory And Practice- George Stephanopolous, Prentice Hall Of India , New Delhi 2003
2. Process Dynamics And Control, Dale E Seborg, Yhomas F Edgar, Duncan A, Mellichamp- Wiley India 2006
3. Process Control Modeling, Design And Simulation, B.Wayne Beqnette, Prentice Hall Of India, New Delhi 2004

M.E. (Chemical Engineering), Sem.-II

Elective-III

COMPUTATIONAL FLUID DYNAMICS

Teaching Scheme:		**Examination Scheme:**
Lectures	**: 3Hours per week**	**Theory Paper :** **CIE - 30 Marks** **ESE – 70 Marks**
Tutorial	**: 1Hour per week**	**Term Work : ---**
Credits	**: 03**	

Course Outcome:-

CO1: Provide the student with a significant level of experience in the use of modern CFD software for the analysis of complex fluid-flow systems.

CO2: Understand solution of aerodynamic flows. Appraise & compare current CFD software. Simplify flow problems and solve them exactly

CO3: Define and setup flow problem properly within CFD context, performing solid modelling and producing grids via meshing tool

CO4: Understand both flow physics and mathematical properties of governing Navier-Stokes equations and define proper boundary conditions for solution

CO5: Develop an awareness of the power and limitations of CFD.

CO6: Place CFD in the context of a useful design tool for industry and a vital research tool for thermos-fluid research across many disciplines.

Unit-I

Governing Differential Equation And Finite Difference Method :

Classification, Initial and Boundary conditions – Initial and Boundary Value problems – Finite difference method, Central, Forward, Backward difference.

Unit-II

Uniform and non uniform Grids, Numerical Errors, Grid Independence Test.

Unit-III

Conduction Heat Transfer

Steady one-dimensional conduction, two and three dimensional steady state problems, Transient one-dimensional problem, Two-dimensional Transient Problems.

Unit-IV

Incompressible Fluid Flow

Governing Equations, Stream Function – Verticity method, Determination of pressure for viscous flow, SIMPLE Procedure of Patankar and Spalding, Computation of Boundary layer flow, finite difference approach.

Unit-V

Convection Heat Transfer And Fem

Steady One-Dimensional and Two-Dimensional Convection – diffusion, Unsteady one-dimensional convection – diffusion, Unsteady two-dimensional convection –Diffusion – Introduction to finite element method – solution of steady heat conduction by FEM – Incompressible flow – simulation by FEM.

Unit-VI

Turbulence Models

Algebraic Models – One equation model, K – ϵ Models, Standard and High and Low Reynolds number models, Prediction of fluid flow and heat transfer using standard codes.

Reference Books:

1. Muralidhar, K., and Sundararajan, T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi, 1995.
2. Ghoshdasdidar, P.S., "Computer Simulation of flow and heat transfer" Tata McGraw-Hill Publishing Company Ltd., 1998.
3. Subas, V.Patankar "Numerical heat transfer fluid flow", Hemisphere Publishing Corporation, 1980.
4. Taylor, C and Hughes, J.B. "Finite Element Programming of the Navier-Stokes Equation", Pineridge Press Limited, U.K., 1981.
5. Anderson, D.A., Tannehill, J.I., and Pletcher, R.H., "Computational fluid USA,1984.
6. Fletcher, C.A.J. "Computational Techniques for Fluid Dynamics 1" Fundamental and General Techniques, Springer – Verlag, 1987.
7. Fletcher, C.A.J. "Computational Techniques for fluid Dynamics 2" Specific Techniques for Different Flow Categories, Springer – Verlag, 1987.
8. Bose, T.X., "Numerical Fluid Dynamics" Narosa Publishing House, 1997.

Energy Engineering

Teaching Scheme:		Examination Scheme:
Lectures	: 3Hours per week	Theory Paper : CIE - 30 Marks ESE – 70 Marks
Tutorial	: 1Hour per week	Term Work : ----
Credits	: 03	

Course Outcome:-

CO1: Discuss and compare various types of energy resources and the principles for converting from one form to another.
CO2: Analyse and evaluate energy use over the lifecycle of a product or project.
CO3: Collect data from thermodynamic systems and evaluate the performance of the system.
CO4: Evaluate the global considerations of energy production, management and conservation including the environmental and economic impact of common fuels.
CO5: Understanding Energy management methods. Rational energy consumption. Energy conservation. Waste heat recovery.
CO6: Understanding Energy conservation in industry.

Unit-I

Energy, units of energy, conversion factors, general classification of energy, Historical Events, Energy requirement of Society in Past and Present situation, World energy resources and energy consumption, Indian energy resources and energy consumption, energy crisis, energy alternatives, future possibilities of energy need and availability, electrical energy from conventional energy resources, internal combustion engines, steam turbines, gas turbines, hydroturbines (thermodynamic cycles not included).

Unit-II

Nuclear reactors, thermal, hydel and nuclear power plants (process outlines only), efficiency, merits and demerits of the above power plants, combined cycle power plants, fluidized bed combustion, small hydropower.

Unit-III

Solar energy, solar thermal systems, flat plate collectors, focusing collectors, solar water heating, solar cooing, solar distillation, solar refrigeration, solar dryers, solar pond, solar thermal power generation, solar photovoltaic systems, solar cells, solar photovoltaic power generation, solar energy application in India, energy plantations, wind energy, types of windmills, types of wind rotors,

Unit-IV

Darrieus rotor and Gravian rotar, wind electric power generation, wind power in India, economics of wind farm, ocean wave energy conversion, ocean thermal energy conversion, tidal energy conversion, geothermal energy.

Unit-V

Biomass energy resources, thermochemical and biochemical methods of biomass conversion, combustion, gasification, pyrolysis, biogas production, ethanol, fuel cells, alkaline fuel cell, phosphoric acid fuel cell, molten carbonate fuel cell, solid oxide fuel cell, solid polymer electrolyte fuel cell, magneto hydro dynamics, open cycle and closed cycle systems, magneto hydro dynamic power generation, energy storage routes like thermal energy storage, chemical, mechanical storage, electrical storage.

Unit-VI

Energy conservation in chemical process plants, energy audit energy saving in heat exchangers, distillation columns, dryers, ovens and furnaces and boilers, steam economy in chemical plants, energy conservation in petroleum, fertilizer and steel industry, cogeneration, pinch technology, recycling for energy saving, electrical energy conservation in chemical process plants, environmental aspects of energy use.

References:

1. Goldmberg J., Johansson, Reddy A.K.N. & Williams R.H., Energy for a Sustainable World, John Wiley
2. Bansal N.K., Kleeman M. & Meliss M., Renewable Energy Sources & Conversion Tech., Tata McGraw Hill
3. Sukhatme S.P., Solar Energy, Tata McGraw Hill
4. Mittal K.M., Non-Conventional Energy Systems, Wheeler Pub.
5. Venkataswarlu D., Chemical Technology, I, S. Chand
6. Pandey G.N., A Text Book on Energy System and Engineering, Vikas Pub.
7. Rao S. & Parulekar B.B., Energy Technology, Khanna Pub.
8. Rai G.D., Non-Conventional Energy Sources, Khanna Pub.
9. Nagpal G.R., Power Plant Engineering, Khanna Pub.

TEXT BOOKS:

1. Power Plant Engineering, P. K. Nag Tata McGraw Hill 2nd edn 2001.
2. Power Plant Engineering, Domakundawar, Dhanpath Rai sons. 2003

Research Methodology

Teaching Scheme:		**Examination Scheme:**
Lectures	**: 3Hours per week**	**Theory Paper :** **CIE - 30 Marks** **ESE – 70 Marks**
Tutorial	**: 1Hour per week**	**Term Work : -------**
Credits	**: 03**	

Course Outcome:-

CO1: Understand some basic concepts of research and its methodologies
CO2: Identify appropriate research topics
CO3: Select and define appropriate research problem and parameters
CO4: Prepare a project proposal (to undertake a project)
CO5: Organize and conduct research (advanced project) in a more appropriate manner
CO6: Understanding how to write a research report and thesis

Unit-I - Objectives and types of research: Motivation and objectives – Research methods *vs* Methodology. Types of research– Descriptive *vs*. Analytical, Applied *vs*. Fundamental, Quantitative *vs*. Qualitative, Conceptual *vs*. Empirical.

Unit-II - Research Formulation – Defining and formulating the research problem - Selecting the problem - Necessity of defining the problem - Importance of literature review in defining a problem – Literature review – Primary and secondary sources – reviews, treatise, monographs-patents – web as a source – searching the web - Critical literature review – Identifying gap areas from literature review - Development of working hypothesis.

Unit-III - Research design and methods – Research design – Basic Principles- Need of research design — Features of good design – Important concepts relating to research design – Observation and Facts, Laws and Theories, Prediction and explanation, Induction, Deduction, Development of Models. Developing a research plan - Exploration, Description, Diagnosis,and Experimentation. Determining experimental and sample designs.

Unit-IV - Data Collection and analysis: Execution of the research - Observation and Collection of data - Methods of data collection – Sampling Methods- Data Processing and Analysis strategies - Data Analysis with Statistical Packages - Hypothesis-testing - Generalization and Interpretation.

Unit-V - Reporting and thesis writing – Structure and components of scientific reports - Types of report – Technical reports and thesis – Significance – Different steps in the preparation – Layout, structure and Language of typical reports – Illustrations and tables - Bibliography, referencing and footnotes - Oral presentation – Planning – Preparation – Practice – Making presentation – Use of visual aids - Importance of effective communication.

Unit-VI - Application of results and ethics - Environmental impacts - Ethical issues - ethical committees - Commercialization – Copy right – royalty - Intellectual property rights and patent law – Trade Related aspects of Intellectual Property Rights – Reproduction of published material – Plagiarism - Citation and acknowledgement - Reproducibility and accountability.

REFERENCES

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
2. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 418p.
3. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, Ess Ess Publications. 2 volumes.
4. Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing. 270p.
5. Wadehra, B.L. 2000. Law relating to patents, trademarks, copyright designs and geographical indications. Universal Law Publishing.

M.E. (Chemical Engineering), Sem.-II

Elective-IV

Project Management

Teaching Scheme:		**Examination Scheme:**
Lectures	**: 3Hours per week**	**Theory Paper :** **CIE - 30 Marks** **ESE – 70 Marks**
Tutorial	**: 1Hour per week**	**Term Work : ---**
Credits	**: 03**	

Course Outcome:-

CO1: To acquaint with the project management skills
CO2: Ability to use CPM and PERT methods in effective project management
CO3 Ability to do resource planning and project scheduling
CO4: Ability to do project costing and adopt latest trends in project management
CO5: To develop a project scope while considering factors such as customer requirements and internal/external goals
CO6: Conduct project closure activities and obtain formal project acceptance.

Unit I: Project Management growth

Concept and Definition , General System Management, Project management, Resistance to Change, System programmed, Project product vs project management a definition focus of success, Face of failure, Project life cycle, Project management methodologies, Corporate culture.

Unit II: Organizational structure

Introduction, organizational work flow, Traditional organization, Developing work , integration position, Project coordinator, Projected organization , Matrix structure, Strong weak balanced matrix, Project management Expertise, Studying tips for the PMF (Project Management Certificate Exam)

Unit III : Organizing and staffing the project office and team

The staffing environment, Selecting the project manager,Skill requirement for project and programme manager, Organizational staffing progress,The project office, Project organizational chart.

Unit IV : management function

Controlling, Directing ,Project Authority, Interpersonal life cycle, leadership in a project management environment, life cycle leadership, organizational impact ,employee manager problem, management pit falls, Communication, Human behavior education, Management policies and procedure.

Unit V: Special Topic

Performance measurement, Financial compensation and rewards, Critical Issues with rewarding project team, mega Project, Morality, Ethics and corporate culture, Professional responsibility, Internal Prternership , External Prternership, Training and education, Integrated project team , Virtual project team, Break through Project.

Unit VI: Project Graphics:

Customer reporting, Bar chart, Presentation technique, Logic diagram/ Net working.

Cost Control

Understanding Control, The operating Cycle, Cost amount codes, Budgets, The Earned Value Management System, Variance and Earned Value, The Lost Base done, The lost overrun dilemma, Recording material Lost, Material Accounting Criteria, Cost Controll Problem.

Text Book:

A system Approach to planning, Scheduling, Controlling, by harolad Kerzner 10th Ed Willy

References:

1. project Management Theory and Practices Crary L Richardsion, CRC press, Taylor and Franas Group, boca ration London, new yark
2. Project Management for Engineer business, technology 4th Ed, Jhon M Nicholas, herman Stegn.

Modern Separation Techniques

Teaching Scheme:		Examination Scheme:
Lectures	: 3Hours per week	Theory Paper : CIE - 30 Marks ESE – 70 Marks
Tutorial	: 1Hour per week	Term Work : ----
Credits	: 03	

Course Outcome:-

CO1: Apply modern separation techniques in various applications.
CO2: To design a process based on separation principles.
CO3: Appropriate application of separation steps in industrial processes.
CO4: To compute the kinetics of various types of separation processes.
CO5: Analyze and design pervaporation, chromatography and dialysis based separation processes.
CO6: Analyze and design novel membranes for intended application.

Unit I : General

Review of Conventional process, recent advances in separation technique based on size, surface properties ionic properties and other special characteristics of substance.

Unit II: Filtration

Process Concept, Theory and Equipment used in Cross flow filtration , Cross flow electro filtration, duel functional filtration surface based solid- liquid separation involving stead liquid , Sirofloc filter.

Unit III: Membrane filtration

Types and choice of membranes, Plates and frame, tubular, Spherial wounded and hollow fibre membrane, reactor and their relative merits , commercial, pilot plant, and labortary membranes, Permeates involving analysis, reverse osmosis, nano filtration, ultrafiltration, microfiltration and donan analysis, economics of membrane operation, cevanic membrane.

Unit IV: Separation by Adsorption technique

Mechanism, Choice and type of adsorbent, normal adsorption technique, affinity chromatography, and immune chromatography, types of equipment and commercial processes, recent advance and processes, Economics.

Unit V: Ionic Separation:

Controlling factor, application, type of equipment used in electrophoresis, dielectrophoresis, ion exchange chromatography, and electro-dialysis, commercial processes.

Unit VI: Other technique:

Separation Involving lyophilisation, pervaporation and permeation technique for solid, liquid, and gases, industrial variables and examples, zone melting, add crystallization, other separation processes, supercritical fluid extraction, oil spillage management.

References:

1. Lacey R.E and S. loaeb, industrial processing with membrane, wiely ,new yark-1972
2. King C.J, Separation processes, Tata Mc-Graw –hill publication Co. ltd-1982
3. Schoew, HM, New Chemical Engineering Separation technique, future science publisher 1972
4. Ronald W. Ronssel, Hand book of process Technology, wily new York 1987

Down Stream Processing

Teaching Scheme:		Examination Scheme:
Lectures	: 3Hours per week	Theory Paper : CIE - 30 Marks ESE – 70 Marks
Tutorial	: 1Hour per week	Term Work : ---
Credits	: 03	

Course Outcome:-

CO1: Understanding the fundamentals of downstream processing for biochemical product recovery.
CO2: Assessing the impact of change on overall process performance
CO3: Examining traditional unit operations, as well as new concepts and emerging technologies that are likely to benefit biochemical product recovery in the future.
CO4: Understanding analytical and process validation issues that are critical to successful manufacturing.
CO5: Strategies for biochemical process analysis and synthesis.
CO6: Design and operation of unit processes with centrifugation, chromatography, filtration, and membrane processes

Unit I

Requirement of Downstream Processing : Basic concepts of separation Technology, Overview of a bioprocess including upstream and downstream processing, Importance of downstream processing in biotechnology, characteristics of biological molecules, New Separation process in modern biotechnology; Separation characteristics of proteins and enzymes – size, stability & other biological properties; Selection of purification methodologies, Characteristics of fermentation broth & its pretreatment.

Unit II

Biomass Removal and Disruption: Biomass removal and disruption: Cell disruption by Mechanical and non mechanical methods, Chemical lysis, Enzymatic lysis, physical methods, Sonication, Types of Homogenizers, Centrifugation; Sedimentation; Flocculation.

Unit III

Product Isolation: Liquid - liquid extractions, Precipitation (salt, pH, organic solvent, high molecular weight polymer). Separation of particulate by filtration, Rotary Vacuum Filtration, Centrifugation & Ultracentrifugation (Batch, continuous, basket), settling, sedimentation, decanting; Electrophoresis.

Unit IV

Membrane Based Separation: Membrane based purification: Microfiltration, Ultrafiltration, Reverse osmosis (UF and RO); Dialysis; Electrodialysis; Diafiltration; Pervaporation; Perstraction, Biotechnological application, Structure and characteristics of membranes; Liquid membranes; Supported liquid membrane; Membrane reactors.

Unit- V

Separation by Adsorption and Chromatography: Types of adsorption; adsorbents types, their preparation and properties, Types of adsorption isotherms and their importance; Chromatography: general theory, partition coefficients, zone spreading, resolution and plate height concept and other chromatographic terms and parameters; chromatographic method selection; selection of matrix; separation based on size, charge, hydrophobicity and affinity: Gel filtration, Ion exchange chromatography, Affinity chromatography, IMAC chromatography; Covalent chromatography; Reverse phase chromatography (RPC) and hydrophobic interaction chromatography (HIC), HPLC, role of HPLC in protein characterization; Chromatofocussing; Polishing of Bioproducts by Crystallization of small and large molecules, drying and Formulations.

Unit- VI

Case Studies : Baker's yeast, Ethanol, Power alcohol, Citric acid, Intracellular proteins, Penicillin, Streptomycin, Insulin, Casein, interferon, Large scale separation and purification of *E.coli*, yeast, Recombinant products.

References:

1. E L V Harris and S. Angal, Protein Purification Methods, Ed. IRL Press at Oxford University Press, 1989.
2. P.A. Belter, E.L. Cussler and Wei-Shou Hu., Bioseparations-Downstream Processing for Biotechnology, Wiley- Interscience Publication, 1988.
3. J. E. Bailey and D. F. Ollis, Biochemical Engineering Fundamentals, 2nd Edition, Mc-Graw Hill, Inc., 1986.
4. Seperation, Recovery and Purification in Biotechnology, Aenjo J.A. and J.Hong
5. Priniciples of fermentation technology" by P F Stanbury and A Whitaker, Pergamon press (1984)
6. Comprehensive Biotechnology" Vol.2 Ed.: M. Moo-Young (1985)
7. Biotreatment, Downstream Processing and Modeling" (Advances in Biochemical Engineering /Biotechnology, Vol 56) by T. Schepler et al, Springer Verlag
8. Chromatographic and Membrane Processes in Biotechnology" by C.A. Costa and J.S. Cabral, Kluwer, Academic Publisher
9. Downstream Processing" by J.P. Hamel, J.B. Hunter and S.K. Sikdar, American Chemical Society
10. Protein Purification" by M.R. Ladisch, R.C. Wilson, C.C. Painton and S.E. Builder, American Chemical society ,Verlag
11. Protein purification: Principle and practice, third edition, Robert k. Scopes, Springer, editor: Charles R. Cantor

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Operation Research

Teaching Scheme:		**Examination Scheme:**
Lectures	**: 3Hours per week**	**Theory Paper :** **CIE - 30 Marks** **ESE – 70 Marks**
Tutorial	**: 1Hour per week**	**Term Work : ----**
Credits	**: 03**	

Course Outcome:-

CO1: Identify and develop operational research models from the verbal description of the real system.
CO2: Understand the mathematical tools that are needed to solve optimisation problems.
CO3: Use mathematical software to solve the proposed models
CO4: Develop a report that describes the model and the solving technique, analyse the results and propose recommendations in language understandable to the decision-making processes in Management Engineering.
CO5: Conduct and interpret post-optimal and sensitivity analysis and explain the primal-dual relationship.
CO6: Define and formulate linear programming problems and appreciate their limitations.

UNIT I

Introduction to Operations Research: Basics definition, scope, objectives, phases, models and limitations of Operations Research. Linear Programming Problem – Formulation of LPP, Graphical solution of LPP. Simplex Method, Artificial variables, big-M method, two-phase method, degeneracy and unbound solutions.

UNIT II

Transportation Problem. Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method.

UNIT III

Assignment model. Formulation. Hungarian method for optimal solution. Solving unbalanced problem. Traveling salesman problem and assignment problem.

UNIT IV

Sequencing models. Solution of Sequencing Problem – Processing n Jobs through 2 Machines – Processing n Jobs through 3 Machines – Processing 2 Jobs through m machines – Processing n Jobs through m Machines.

UNIT V

Dynamic programming. Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.

UNIT VI

Games Theory. Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.

UNIT VII

Replacement Models. Replacement of Items that Deteriorate whose maintenance costs increase with time without change in the money value. Replacement of items that fail suddenly: individual replacement policy, group replacement policy.

Inventory models. Inventory costs. Models with deterministic demand – model (a) demand rate uniform and production rate infinite, model (b) demand rate non-uniform and production rate infinite, model (c) demand rate uniform and production rate finite.

TEXT BOOKS:

1. P. Sankara Iyer, "Operations Research", Tata McGraw-Hill, 2008.
2. A.M. Natarajan, P. Balasubramani, A. Tamilarasi, "Operations Research", Pearson Education, 2005.

REFERENCE BOOKS:

1. J K Sharma., "Operations Research Theory & Applications , 3e", Macmillan India Ltd, 2007.
2. P. K. Gupta and D. S. Hira, "Operations Research", S. Chand & co., 2007.

3. J K Sharma., "Operations Research, Problems and Solutions, 3e", Macmillan India Ltd.
4. N.V.S. Raju, "Operations Research", HI-TECH, 2002.

M.E. (Chemical Engineering), Sem.-II (Practical)
Analytical Laboratory

Practical – 2hrs.
Credits- 1
Term Work – 25 Marks
Practical Orel Exam-
25 Marks

Course Outcome:-

CO1: Apply mathematical, physical and chemical concepts to routine tasks such as the analysis and synthesis of chemical compounds and samples.
CO2: Describe and understand the capabilities and limitations of instrumental methods
CO3: Demonstrate competence in collecting and interpreting data in the laboratory.
CO4: Apply principles of chemistry to the observations of substances experiencing physical or chemical changes.
CO5: Laboratory skills for the purpose of collecting, interpreting, analyzing, and reporting (in written form) chemical data.
CO6: Conduct basic manual quantitative and qualitative analyses accurately, using prescribed laboratory procedures.

1. Analysis Of Given Sample by using Gas Chromatography
2. Detail study and Analysis of High Performance Liquid Chromatography (HPLC)
3. Instrument Exploration :Scanning Electron Microscopy (SEM)
4. Measurement , analyze, and discussion of three different types of Sample via Thermogravimetric Analysis, or TGA
5. Determination of the amount of carbon monoxide in exhaust samples by FTIR spectroscopy
6. Spectrophotometry: Absorption spectra and the use of light absorption to measure concentration
7. Analysis by using Gel Electrophoresis

Comprehensive Viva

Examination scheme
Oral: 25 Marks
Credits- 1

The students have to prepare on all subjects which they have studied In IST and IInd Semesters the viva will be conducted by the External/Internal Examiner jointly and their appointments will be made by university. The in-depth knowledge, preparation and subjects understanding will be assessed by the Examiners.

ME Chemical Engineering
Part II Sem III

In-plant Training

Examination scheme:
Term work: 50 marks
Credits- 2

Course Outcome:-
CO1: To get industry exposure.
CO2: To work under factory discipline
CO3: To understand the psychology of the workers, their habits, attitudes and approach to problems along with the practices followed either at factory or at site
CO4: To get familiarised with various design, Manufacturing, Analysis, Automation and purchase, Six Sigma, TPM, Materials, Machines, processes, products and their applications along with relevant aspects of industry management.
CO5: To understand the scope, functions and job responsibilities in various departments of an organization.
CO6: Identify the industry and their locations, products/expertise/domain, and interact with the authorities there at

The student has to prepare the report of training undergone in the industry during vacation after semester II. It shall include the brief details of assignment completed by the candidate and general observation and analysis. The identified areas for undertaking the dissertation work shall form part of report. The term work marks be based on report and departmental oral exams. The training should be of minimum two weeks from reputed industries and certificate of the same should be part of report

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Seminar-II

Teaching Scheme: **Examination Scheme:**

Practical: 2 Hours per week **Term Work: 50 Marks**

Credits: 02

Course Outcome:-
CO1: Know the bridge between the chemical engineering and other disciplines
CO2: Learn the solutions from world class researchers for chemical engineering problems
CO3: Prepare an oral presentations related to the technical assignments
CO4: Identify and communicate the concepts of chemical engineering for building confidence
CO5: Through understanding of technical resources towards successful preparation for a talk/lecture
CO6: Demonstration of the presentation on most recent concepts in technology and impact skill in real- time environment

Seminar-II should be based on the dissertation Phase literature survey on any topic relevant to Chemical Engineering (should be helpful for selecting a probable title of dissertation). Each student has to prepare a write up of about 25 pages of “A4” size sheets and submit it in duplicate as the termwork.

The student has to deliver a seminar talk in front of the faculty members of the department and his classmates. The faculty members, based on the quality of the work and preparation and understanding of the candidate, shall do an assessment of the seminar internally – jointly.

ME Chemical Engineering
Part II and IV - Semester- III and IV
Dissertation

Phase- I	Phase-II
Practical-16 Hours	**Practical-32 Hours**
Term Work-50 Marks	**Term Work-100Marks**
Practical – 50Marks	**Practical – 100 Marks**
Credits- 8	**Credits- 16**

Course Outcome:-
CO1: To gets exposure to design a research investigation that incorporates appropriate theoretical approaches, conceptual models, and a review of the existing literature.
CO2: to structure a discussion in a coherent and convincing way by summarizing the key arguments and providing suitable and coherent findings.
CO3: To draw valid conclusions, relating them to the research topic.
CO4: write a comprehensive review of the literature, including a review of other dissertation research related to their study
CO5: Develop a design of their study with a discussion of the methodology to be used.
CO6: Describe how their data will be treated and analyzed of their study.

The objective of dissertation is to give the student opportunity to demonstrate his/her assimilation of knowledge in a wider spectrum of the chosen field of specialization by Appling it to solve a specific problem gaining experience and confidence. This may involve analysis, Synthesis, Design development, Construction, testing of a product or a system, generation of a new concept, idea, method technique, innovation, improvement etc.

Each student shall take up dissertation in the area of his/ her specialization and pursue the work under the guidance of faculty. One full semester is allotted for dissertation and at the end of semester he/ she shall submit a thesis.

The thesis should embody the result of scholarly work in a specialized area. It should exhibit Candidates knowledge of a recognized technique of investigation and critical evaluation and be presented in an organized and systematic way.