NATIONAL INSTITUTE OF TECHNOLOGY ANDHRA PRADESH

SYLLABI

FOR B.TECH. PROGRAM

From 2017-18 Batch onwards

DEPARTMENT OF CHEMICAL ENGINEERING

SCHEME OF INSTRUCTION

B.Tech (Chemical Engineering) Course Structure

I - Year

Physics Cycle

S. No.	Course Code	Course Title	L	T	P	Credits
1	MA101	Mathematics - I	3	0	0	03
2	HS101	English for Technical Communication	2	0	2	03
3	PH101	Physics	3	0	0	03
4	EC101	Basic Electronic Engineering	3	0	0	03
5	CE102	Environmental Science and Engineering	2	0	0	02
6	BT101	Engineering biology	2	0	0	02
7	CS101	Problem Solving & Comp Programming	3	0	0	03
8	CS102	Problem Solving & Comp Programming Lab	0	1	2	02
9	PH102	Physics Laboratory	0	1	2	02
10	EA101	EAA: Games and Sports	0	0	3	00
		TOTAL	**18**	**2**	**9**	**23**

Chemistry Cycle

S.No.	Course Code	Course Title	L	T	P	Credits	C C
1	MA151	Mathematics – II	3	0	0	03	B
2	ME102	Engineering Graphics	1	1	4	04	E
3	CY101	Chemistry	3	0	0	03	B

4	EE101	Basic Electrical Engineering	3	0	0	03	E
5	ME101	Basic Mechanical Engineering	3	0	0	03	E
6	CE101	Engineering Mechanics	3	0	0	03	E
7	ME103	Workshop Practice	0	1	2	02	E
8	CY102	Chemistry Laboratory	0	1	2	02	B
9	EA151	EAA: Games and Sports	0	0	3	00	M
		TOTAL	**16**	**3**	**11**	**23**	

Cat. Code
BSC
HSC
BSC
ESC
ESC
ESC
ESC
ESC
BSC
MDC

:at. :ode
;SC
:SC
;SC

ESC
ESC
ESC
ESC
SSC
MDC

II - Year I - Semester

S. No.	Course Code	Course Title	L	T	P	Credits
1	MA201	Mathematics – III	3	0	0	3
2	CY201	Industrial Organic Chemistry	3	0	0	3
3	CH201	Chemical Process Calculations	3	1	0	4
4	CH202	Fluid and Particle Mechanics	3	1	0	4
5	CH203	Mechanical Operations	3	0	0	3
6	CH204	Chemical Engineering Thermodynamics – I	3	0	0	3
7	CH205	Fluid and Particle Mechanics Lab	0	1	2	2
8	CH206	Chemical Processing Lab	0	1	2	2
		TOTAL	**18**	**4**	**4**	**24**

II - Year II - Semester

S. No.	Course Code	Course Title	L	T	P	Credits
1	MA251	Mathematics – IV	3	0	0	3
2	CH251	Chemical Engineering Thermodynamics – II	3	1	0	4
3	CH252	Heat Transfer	3	1	0	4
4	CH253	Mass Transfer-I	3	1	0	4
5	CH254	Chemical Reaction Engineering – I	3	1	0	4
6	CH255	Process Instrumentation	3	0	0	3
7	CH256	Chemical Reaction Engineering Laboratory	0	1	2	2
8	CH257	Heat Transfer Laboratory	0	1	2	2
		TOTAL	**18**	**6**	**4**	**26**

Cat. Code
BSC
BSC
PCC
PCC
PCC
PCC
PCC
PCC

Cat. Code
BSC
PCC
PCC
PCC
PCC
PCC
PCC
PCC

III - Year I – Semester

S. No.	Course Code	Course Title	L	T	P	Credits
1	CH301	Chemical Reaction Engineering – II	3	0	0	3
2	CH302	Mass Transfer – II	3	1	0	4
3	CH303	Elements of Transport Phenomena	3	1	0	4
4	CH304	Chemical Technology	3	0	0	3
5	CH305	Industrial Safety and Hazard Mitigation	3	0	0	3
6		Elective – I	3	0	0	3
7	CH306	Computational Methods in Chemical Engineering Lab	0	1	2	2
8	CH307	Mass Transfer Laboratory	0	1	2	2
9	EP349	EPICS	0	0	0	2*
		TOTAL	**18**	**4**	**4**	**24**

*Credits are not considered for computation of SGPA and CGPA

III - Year II - Semester

S. No.	Course Code	Course Title	L	T	P	Credits
1	CH351	Process Dynamics and Control	3	1	0	4
2	CH352	Process Equipment Design (Open Book)	3	1	0	4
3	CH353	Petroleum Refining Processes	3	1	0	4
4	CH354	Pollution Control in Process Industries	3	0	0	3
5		Elective – II	3	0	0	3
6		Open Elective – I	3	0	0	3
7	CH355	Minor Research Project	0	1	2	2
8	EP399	EPICS	0	0	0	2*
		TOTAL	**18**	**4**	**2**	**23**

*Credits are not considered for computation of SGPA and CGPA

Cat. Code
PCC
PCC
PCC
PCC
PCC
DEC
PCC
PCC

Cat. Code
PCC
PCC
PCC
PCC
DEC
OPC
PCC

IV - Year I - Semester

S. No.	Course Code	Course Title	L	T	P	Credits
1	CH401	Plant Design and Process Economics	3	1	0	4
2		Elective-III	3	0	0	3
3		Elective-IV	3	0	0	3
4		Open Elective-II	3	0	0	3
5	CH402	Design and Simulation Laboratory	0	1	4	3
6	CH403	Process Instrumentation and Control Laboratory	0	1	2	2
7	CH449	Project Work Part-A	0	0	3	2
		TOTAL	**12**	**3**	**9**	**20**

IV - Year II - Semester

S. No.	Course Code	Course Title	L	T	P	Credits
1	SM451	Industrial Engineering and Management	3	0	0	3
2		Elective – V	3	0	0	3
3		Elective – VI	3	0	0	3
4		Elective – VII	3	0	0	3
5	CH451	Mandatory Audit Course*	0	0	0	0
6	CH499	Project Work Part-B	0	0	6	4
		TOTAL	**12**	**0**	**6**	**16**

*The result of the Mandatory Audit Course (Self Study) completed by the student either i
be reported in this semester

List of Electives

III Year I Semester

CH311 Pharmaceuticals and Fine Chemicals CH312 Renewable Energy Sources
CH313 Fuel Cells and Flow Batteries CH314 Energy Management
CH315 Corrosion Engineering CH316 Nanotechnology CH317 Polymer Technology
CH318 Material Science for Chemical Engineers

III Year II Semester

CH361 Wastewater Treatment CH362 Fertilizer Technology CH363 Food Technology CH364 Gr
CH365 Pulp and Paper Technology CH366 Catalysis
CH367 Experimental & Analytical Techniques CH368 Complex Fluids
CH369 Natural Gas Engineering

IV Year I Semester

CH411 Biochemical Engineering CH412 Interfacial Science
CH413 Statistical Thermodynamics CH414 Petrochemical Technologies CH415 Scale up Metho
CH416 CO_2 Capture & Utilization
CH417 Natural Gas Processes, Modeling and Simulation CH418 Introduction to Tribology
CH5111 Process Modelling and Analysis
CH5114 Statistical Design of Experiments CH5115 Chemical Process Synthesis

CH5117 Nuclear Power Technology CH5119 Piping Engineering
CH5212 Data Analytics

IV Year II Semester
CH461 Micro scale Unit Operations CH462 Process and Product Design
CH463 Mathematical Methods in Chemical Engineering CH464 Introduction to macromolecules
CH5161 Optimization Techniques
CH5162 Process Scheduling and Utility Integration CH5164 Advanced Mass Transfer
CH5165 Computational Fluid Dynamics CH5166 Process Intensification
CH5262 Soft Computing Techniques

List of Open Electives
(Not offered to Chemical Engineering Students)
CH390 Nanotechnology and Applications CH391 Industrial Safety Management CH392 Industria
CH393 Soft Computing Methods for Control CH440 Data driven modeling
CH441 Fuel Cell Technology CH442 Design of Experiments
CH443 Carbon capture, sequestration and utilization

Mandatory Audit Course (Self Study)
Every student is required to complete at least one course offered by the following agencies. The take prior approval from the Department, before registering for any course. The student can regi either in 6th Semester or 7th semester. Unless the student submits a pass certificate, he/she shall not be eligible for the award of degree.

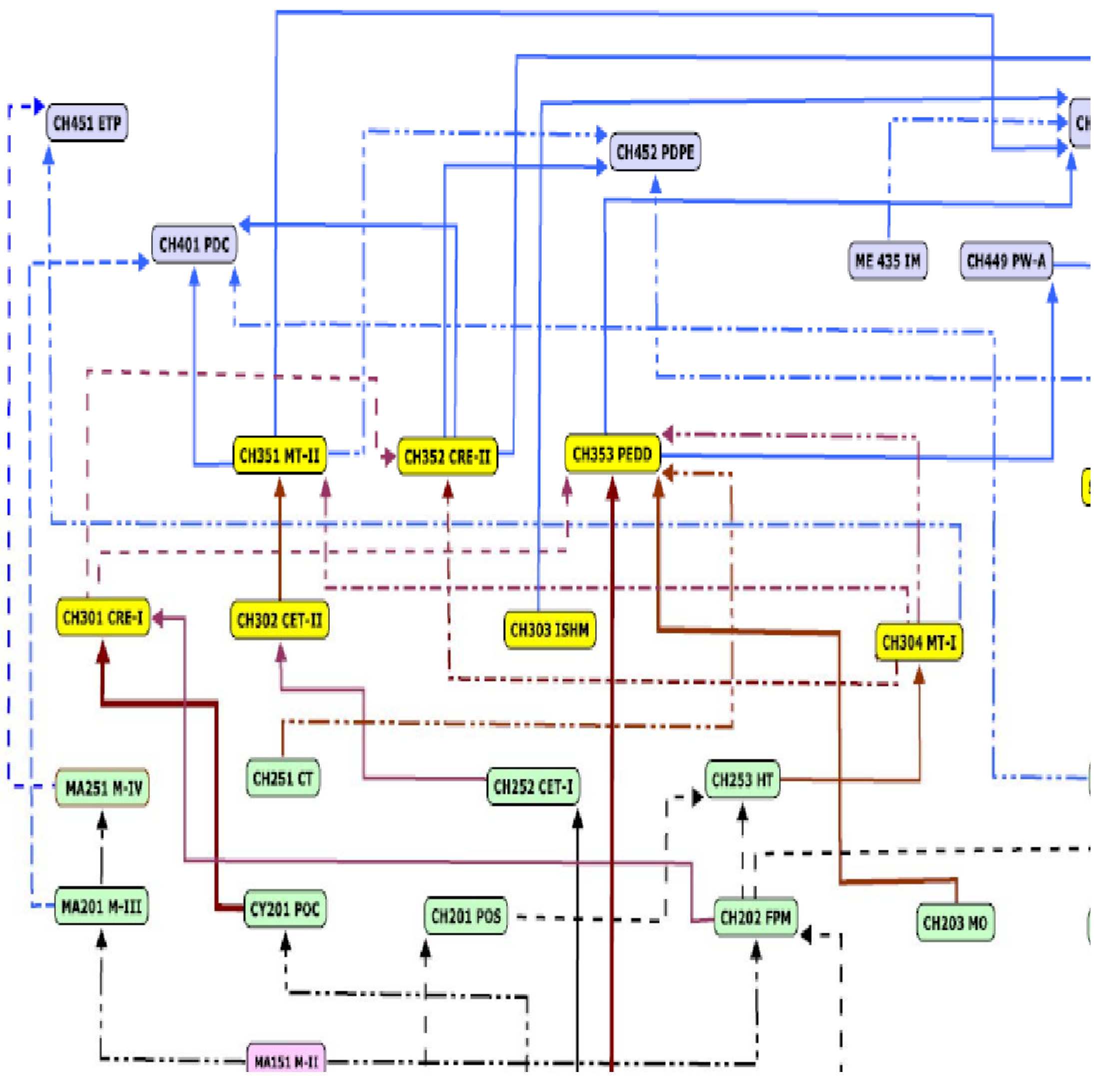
SAChE: Safety and Chemical Engineering Education Certification Program – www.aiche.org
SWAYAM:
www.swayam.gov.in *NPTEL:*
www.onlinecourse.nptel.ac.in

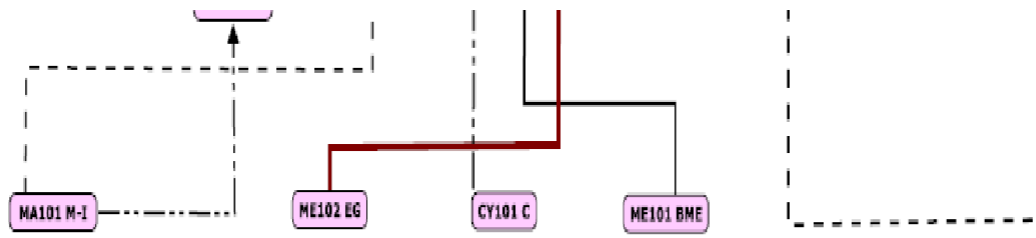
Course Era:
www.coursera.org
Free Online Courses: www.edx.org
MIT Open Course ware: www.ocw.mit.edu

1. Definition of Pre-requisite: The student should have studied that subject which
requisite.
2. Course with same name but with different code number indicates that the subject pe
departments and also the syllabus is different.
3. EPICS Project is offered in two parts as Part-A in III Year II Semester and Part- B in I
Two credits each. The credits earned are not counted for Computation of SGPA and CG
mandatory. It is Optional. Interested students can take it.
4. In first year syllabus, Engineering Biology is included in Physics cycle and Ba
Engineering is included in Chemistry cycle. This is with effect from
2018-2019 onward

B.TECH IN CHEMICAL ENGINEERING

PRE-REQUISITE CHART




MA101 M-I
ME102 EG
CY101 C
ME101 BME

Cat. Code
PCC
DEC
DEC
OPC
PCC
PCC
PRC

Cat. Code
HSC
DEC
DEC
DEC
MDC
PRC

n 6th or 7th semester will

reen Technology

ds

ıl Pollution Control

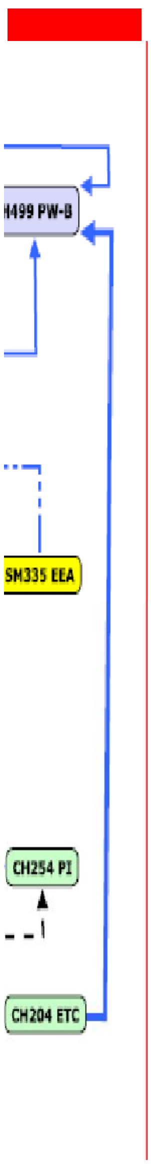
student is required to
ster for such a course

is mentioned as Pre-

rtains to different

IV Year I semester, with
PA. The course is not

sic Mechanical



CE101 EM

DETAILED SYLLABUS

MA 101	MATHEMATICS – I	BSC	3-0-0	3 C

Pre-requisites: None

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

CO1	solve the consistent system of linear equations
CO2	apply orthogonal and congruent transformations to a quadratic form
CO3	determine the power series expansion of a given function
CO4	find the maxima and minima of multivariable functions
CO5	solve arbitrary order linear differential equations with constant coefficients
CO6	apply the concepts in solving physical problems arising in engineering

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	3	1	2	1	-	-	-	-	-	-	-	-
CO2	3	3	1	2	1	-	-	-	-	-	-	-	-
CO3	3	3	1	2	1	-	-	-	-	-	-	-	-
CO4	3	3	1	2	1	-	-	-	-	-	-	-	-
CO5	3	3	1	2	1	-	-	-	-	-	-	-	-
CO6	3	3	1	3	1	-	-	-	-	-	-	-	-

Detailed Syllabus:

Matrix Theory: Linear dependence and independence of vectors; Rank of a matrix; Consistenc equations; Eigenvalues and eigenvectors of a matrix; Caley-Hamilton theorem and its applicat form; Reduction of a quadratic form to canonical form - orthogonal transformation and conç Properties of complex matrices - Hermitian, skew-Hermitian and Unitary matrices.

Differential Calculus: Taylor's theorem with remainders; Taylor's and Maclaurin's expansi Curve tracing; Functions of several variables - partial differentiation; total differentiation; Euler' Change of variables - Jacobians; maxima and
minima of functions of several variables (2 and 3 variables) - Lagrange's method of multipliers

Ordinary Differential Equations: Geometric interpretation of solutions of first order ODE

differential equations; integrating factors; orthogonal trajectories; Higher
order
linear differential equations with constant coefficients - homogeneous and non-homogeneous

Reading:

1. R. K. Jain and S. R. K. Iyengar, Advanced Engineering Mathematics, Narosa Publish
2. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley and Sons, 8th Edition, 2
3. B. S. Grewal, Higher Engineering Mathematics, Khanna Publications, 2015.

redits

PSO2	PSO3
1	2
1	2
1	2
1	2
1	2
1	2

cy of the system of linear
ions; Reduction to diagonal
gruent transformation;

ions; Asymptotes; Curvature;
s theorem and generalization;

.

�

E ′ = (,); Exact

s; Euler and Cauchy's

ing House, 5^{th} Edition, 2016.
2015.

HS101	ENGLISH FOR TECHNICAL COMMUNICATION	HSC	2-0-2	3

Pre-requisites: None

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

CO1	Understand basic principles of grammar and vocabulary
CO2	Write clear and coherent paragraphs
CO3	Write effective résumé, cover letter and letters for a variety of purposes
CO4	Prepare technical reports and interpret graphs
CO5	Develop reading comprehension skills
CO6	Comprehend English speech sounds, stress and intonation

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	-	-	-	-	-	1	-	-	-	3	-	1	-
CO2	-	-	-	-	-	1	-	-	-	3	-	1	-
CO3	-	-	-	-	-	1	-	-	-	3	-	1	-
CO4	-	-	-	-	-	1	-	-	-	3	-	1	-
CO5	-	-	-	-	-	1	-	-	-	3	-	1	-
CO6	-	-	-	-	-	1	-	-	-	3	-	1	-

Detailed Syllabus:

1. Grammar Principles (Correction of sentences, Concord) and Vocabulary Building (synony and Phrasal verbs--patterns of use and suggestions for effective employment in varied
2. Effective Sentence Construction - strategies for bringing variety and clarity in sentences- long sentences for brevity and clarity
3. Reported speech - contexts for use of reported speech - its impact on audience passive voice- reasons for preference for passive voice in scientific English
4. Paragraph-writing: Definition of paragraph and types- features of a good paragraph - un linking devices- direction- patterns of development.
5. Note-making - definition- the need for note-making - its benefits - various note formats- li tree diagram, block or list notes, tables, etc.

6. Letter-Writing: Its importance in the context of other channels of communication- qualit personal, official, letters for various purposes- emphasis on letter of application for jobs - cov examples and exercises
7. Reading techniques: Definition- Skills and sub-skills of reading- Skimming and Scanning examples and exercises.
8. Reading Comprehension - reading silently and with understanding- proces of comprehension questions.
9. Features of Technical English - description of technical objects and process- Report-Writ types- structure- formal and informal reports- stages in developing report- proposal, pro examples and exercises
10. Book Reviews- Oral and written review of a chosen novel/play/movie- focus on appropria language items like special vocabulary and idioms used

Language laboratory

1. English Sound System -vowels, consonants, Diphthongs, phonetic symbols- using dictic transcription-- Received Pronunciation, its value and relevance- transcription of exerc
2. Stress and Intonation –word and sentence stress - their role and importance in s spoken English -definition, patterns of intonation- –falling, rising, etc.- use of intonation in da
3. Introducing oneself in formal and social contexts- Role plays- their uses in developing flu general.
4. Oral presentation - definition- occasions- structure- qualities of a good presentatio language and use of visual aids.
5. Listening Comprehension -Challenges in listening, good listening traits, some stan and exercises.
6. Debate/ Group Discussions-concepts, types, Do’s and don’ts- intensive practice.

Reading:

1. English for Engineers and Technologists (Combined Edition, Vol. 1 and 2), Orient Blac
2. Ashraf, M Rizvi. Effective Technical Communication. Tata McGraw-Hill, 2006.
3. Meenakshi Raman and Sangeetha Sharma, Technical Communication: Principles a Oxford University Press, 2011.

Software:

1. Clear Pronunciation – Part-1 *Learn to Speak English.*
2. Clear Pronunciation – Part-2 *Speak Clearly with Confidence*
3. Study Skills
4. English Pronunciation

3 Credits

PSO2	PSO3
-	-
-	-
-	-
-	-
-	-
-	-

yms and antonyms): Idioms
contexts
- removing ambiguity - editing

es and readers- active and

ity of theme- coherence-

ke

ies of effective letters-types -
ver letter and resume types -

- their uses and purposes-

ss of comprehension- types

ting- definition- purpose -
gress and final reports-

ate vocabulary and structure -

onary to decode phonetic
cises
spoken English-Intonation in
ily life–exercises
uency and communication in

n with emphasis on body

dard listening tests- practice

k Swan, 2006.

and Practice 2nd Edition,

PH101	PHYSICS	BSC	3-0-0	3

Pre-requisites: None

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

CO 1	Solve engineering problems using the concepts of wave and particle nature of radiant energy.
CO 2	Understand the use of lasers as light sources for low and high energy applications
CO 3	Understand the nature and characteristics of new Materials for engineering applications.
CO 4	Apply the concepts of light propagation in optical fibers, light wave communication systems, holography and for sensing physical parameters.
CO 5	Apply the knowledge of Solar PV cells for choice of materials in efficient alternate energy generation.

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	3	1	1	-	-	-	-	-	-	-	-	-
CO2	3	3	1	1	-	-	-	-	-	-	-	-	-
CO3	3	3	1	1	-	-	-	-	-	-	-	-	-
CO4	3	3	1	`1	-	-	-	-	-	-	-	-	-
CO5	3	3	1	1	-	-	-	-	-	-	-	-	-

Detailed Syllabus:

Quantum Mechanics: Concepts and Experiments that led to the discovery of Quantum Natu principle; Schrodinger time independent and time dependent wave equations, The free an infinite and finite potential well, Quantum mechanical tunneling. MB, BE and FD distributi

Wave and Quantum Optics:

Interference and Diffraction: Concept of interference and working of Fabry-perot Interferome wavelength filter. Multiple beam diffraction and Working of diffraction Gratings, Applic wavelength splitter.

Polarization Devices: Principles, Working and applications of Wave Plates, Half Polarimeter, Polariscope, Isolators and Liquid Crystal Displays.

Lasers: Basic theory of Laser, Concept of population inversion and Construction and workin
White light LED, Semiconductor Laser, Holography and NDT. Optical Fibers: Structure, Types, Features, Ligh
applications in Communications and Sensing.
Solar Cells: Solar spectrum, photovoltaic effect, materials, structure and working principle, conversion efficiency, quantum efficiency, emerging PV technologies, applications.
Magnetic and Dielectric Materials:
Magnetic Materials and Superconductors: Introduction - Weiss Theory of Ferromagnet
– Curie Transition - Hard and soft magnetic materials – Spinel Ferrites – Structure – Classifi
Meissner effect - Type-I and Type-II Superconductors
– Applications.
Dielectric Materials: Introduction to Dielectrics, Dielectric constant – Polarizability - Propertie
materials - Polarization mechanisms in dielectrics(Qualitative) – Frequency and tempe
polarization – Dielectric loss Clausius-Mossotti Equation(Qualitative)– dielectric Bre
Functional and Nano Materials:
Functional Materials: Fiber reinforced plastics, fiber reinforced metals, surface acousti
materials, high temperature materials and smart materials - Properties and application
Nanomaterials: Introduction, classification, properties, different methods of preparation
applications.

Reading:

1. Halliday, Resnic and Walker, Fundamentals of Physics, John Wiley, 9th Edition, 2011.
2. Beiser A, Concepts of Modern Physics, McGraw Hill International, 5th Edition, 2003.
3. Ajoy Ghatak, Optics, Tata McGraw Hill, 5th Edition, 2012.
4. S.O. Pillai,Solid State Physics, New Age Publishers, 2015.

3 Credits

t
g

PSO2	PSO3
1	1
1	1
1	1
1	1
1	1

re. Heisenberg uncertainty particle problem - Particle in ons.

eter and its application as ation of Grating as

Shade

g of He-Ne, Nd-YAG, CO_2 Lasers, LED,
t guiding mechanism and

I-V characteristics, power

ism – Properties – Domains
cation – Applications -

s and types of insulating
rature dependence of
akdown – Applications.

c wave materials, Bio-
s.
and

EC101	BASIC ELECTRONIC ENGINEERING	ESC	3-0-0	3

Pre-requisites: None

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

CO1	Comprehend the characteristics of semiconductor devices, and operational amplifiers
CO2	Understand the principles of working of amplifiers
CO3	Understand and design of simple combinational and basics of sequential logic circuits
CO4	Understand the principles of electronic measuring instruments and Transducers
CO5	Understand the basic principles of electronic communication

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	3	1	-	-	1	-	-	-	-	-	-	-
CO2	3	3	1	-	-	1	-	-	-	-	-	-	-
CO3	3	3	1	-	-	1	-	-	-	-	-	-	-
CO4	3	3	1	-	-	1	-	-	-	-	-	-	-
CO5	3	3	1	-	-	1	-	-	-	-	-	-	-

Detailed Syllabus:

Electronics Systems: Introduction to electronics, review of p-n junction operation, diode as regulator.

Transistor and applications: Introduction to transistors, BJT Characteristics, biasing RC coupled amplifier and frequency response. FET and MOSFET characteristics a Feedback in Electronic Systems: open loop and closed loop systems, Negative and p demerits, Principles of LC and RC oscillators.

Integrated Circuits: Operational amplifiers – characteristics and linear applications

Digital Circuits: Number systems and logic gates, Combinational Logic circuits, Flip-Flo registers, data converters, Analog to Digital and Digital to Analog converters (ADC/DAC's), Introduction to microprocessors and microcontrollers.

Laboratory measuring instruments: principles of digital multi-meters, Cathode ray oscilloscop
Electronics Instrumentation: Measurement, Sensors, principles of LVDT, strain gauge a
Introduction to data acquisition system.
Principles of Communication: Need for Modulation, Definitions of various Modulation a
techniques, AM radio transmitter and receiver, brief understanding of FM and
mobile communications.

Reading:

1. Bhargava N. N., D C Kulshreshtha and S C Gupta, Basic Electronics & Linear Circuits, T
2013.
2. Malvino and Brown,Digital Computer electronics, McGraw Hill, 3rd Edition,1993.
3. Keneddy and Davis, Electronic Communication Systems, McGraw Hill, 4th Edition, 1999.
4. Helfrick and Cooper, Modern Electronic Instrumentation and Measurement Techniq
5. Salivahanan, N Suresh Kumar, Electronic Devices and circuits, McGraw Hill publications,
6. Neil Storey, Electronics A Systems Approach, Pearson Education Publishing Company P
Ltd, 4th Edition, 2009.

3 Credits

PSO2	PSO3
-	-
-	-
-	-
-	-
-	-

diode applications, Zener

and applications, simple
nd applications.
ositive Feedback, merits and

ps, counters and shift

es (CRO's).
ınd thermocouples.

nd Demodulation

ata McGraw Hill, 2^{nd} Edition,

ues, Prentice Hall India, 2011.
3^{rd}Edition, 2012.
'vt.

CE102	ENVIRONMENTAL SCIENCE AND ENGINEERING	ESC	2-0-0	

Pre-requisites: None

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

CO1	Identify environmental problems arising due to engineering and technological activities and the science behind those problems.
CO2	Estimate the population - economic growth, energy requirement and demand.
CO3	Analyse material balance for different environmental systems.
CO4	Realize the importance of ecosystem and biodiversity for maintaining ecological balance.
CO5	Identify the major pollutants and abatement devices for environmental management and sustainable development

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	3	3	-	-	2	3	1	-	-	-	-	1
CO2	3	3	3	-	-	2	3	1	-	-	-	-	1
CO3	3	3	3	-	-	2	3	1	-	-	-	-	1
CO4	3	3	3	-	-	2	3	1	-	-	-	-	1
CO5	3	3	3	-	-	2	3	1	-	-	-	-	1

Detailed Syllabus:

Introduction to Environmental Science: Environment and society, major environmental iss Acid rains, global climate change etc., sustainable development, Environmental impact management

Natural Resources Utilization and its Impacts: Energy, minerals, water and land resou consumption, population dynamics, urbanization.

Ecology and Biodiversity: Energy flow in ecosystem, food chain, nutrient cycles, eutroficati value of biodiversity, biodiversity at global, national and local levels, threats for biodi biodiversity

Water Pollution: Sources, types of pollutants and their effects, water quality issues, contami purification capacity of streams and water bodies, water quality standards, principles c treatment.
Air Pollution: Sources, classification and their effects, Air quality standards, dispersior pollution, automobile pollution and its control.
Solid Waste Management: Sources and characteristics of solid waste, effects, Collectic transfer system, disposal methods

Reading:

1. G.B. Masters, Introduction to Environmental Engineering and Science, Pearson Educati
2. Gerard Kiely, Environmental Engineering, McGraw Hill Education Pvt. Ltd., Special
3. W P Cunningham, M A Cunningham, Principles of Environmental Science, Inquiry McGraw Hill, 8th Edition, 2016.
4. M. Chandrasekhar, Environmental science, Hi Tech Publishers, 2009.

2 Credits

PSO2	PSO3
2	-
2	-
2	-
2	-
2	-

ues: Ozone layer depletion,
assessment, environmental

urces, Resource

on,
versity, conservation of

nant transport, self-
of water and wastewater

n of pollutants, control of air

on and

on, 2013.
Indian Edition, 2007.
and Applications, Tata

BT101	ENGINEERING BIOLOGY	ESC	2 – 0 – 0	2

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Realize the significance of biomolecules for sustaining life
CO2	Identify the difference between unicellular to multi-cellular organisms
CO3	Understand heredity, variation and central dogma of life
CO4	Analyse and understand the concepts of biology for engineering the cell

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	2	3	3	1	-	-	-	-	-	-	-	-	-
CO2	2	3	3	1	-	-	-	-	-	-	-	-	-
CO3	2	3	3	1	-	-	-	-	-	-	-	-	-
CO4	2	3	3	1	-	-	-	-	-	-	-	-	-

Detailed Syllabus:

Molecules of life, water and carbon - chemical basis of life, protein structure and function, nu world, carbohydrates, lipids, membranes and first cells.

Cell structure and function, inside the cell, cell–cell Interactions, cellular respiration ar photosynthesis, cell cycle, biological signal transduction.

Gene structure and expression, Mitosis, Meiosis, Mendel and the gene, DNA and the how genes work, transcription, RNA processing, and translation, control of gene expression, genes, genomics.

Engineering concepts in biology – genetic engineering, disease biology and biopharmaceuti stem cell engineering, metabolic engineering, synthetic biology, neuro transmission, bic

Reading:

1. Quillin, Allison Scott Freeman, Kim Quillin and Lizabeth Allison, Biological Science, Pear

2. Reinhard Renneberg, Viola Berkling and Vanya Loroch, Biotechnology for Beginne Academic Press, 2017.

Credits

PSO2	PSO3
2	-
2	-
2	-
2	-

ıcleic acids and the RNA

ıd fermentation,

e gene: synthesis and repair,
analysing and engineering

cals,
›safety and bioethics.

son Education India, 2016.
ers,

CS101	PROBLEM SOLVING AND COMPUTER PROGRAMMING	ESC	3 – 1 – 2

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Design algorithms for solving simple mathematical problems including computing, searching and sorting
CO2	Compare and contrast algorithms in terms of space and time complexity to solve simple mathematical problems
CO3	Explore the internals of computing systems to suitably develop efficient algorithms
CO4	Examine the suitability of data types and structures to solve specific problems
CO5	Apply control structures to develop modular programs to solve mathematical problems
CO6	Apply object oriented features in developing programs to solve real world problems

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	2	3	2	3	-	-	-	-	-	-	-	-
CO2	3	2	3	2	3	-	-	-	-	-	-	-	-
CO3	3	2	3	2	3	-	-	-	-	-	-	-	-
CO4	3	2	3	2	3	-	-	-	-	-	-	-	-
CO5	3	2	3	2	3	-	-	-	-	-	-	-	-
CO6	3	2	3	2	3	-	-	-	-	-	-	-	-

Detailed Syllabus:

Theory:

Fundamentals of Computers, Historical perspective, Early computers, Components Flowcharts, Memory, Variables, Values, Instructions, Programs.

Problem solving techniques – Algorithmic approach, characteristics of algorithm, Problem so approach, Bottom-up approach, Time and space complexities of algorithms. Number system Basics of C++, Basic data types.

Numbers, Digit separation, Reverse order, Writing in words, Development of Elementary Sch Arithmetic Testing System, Problems on Date and factorials, Solutions using flow of statements - If-else, Switch-case constructs, Loops - while, do-while, for.

Functions –Modular approach for solving real time problems, user defined functions, l passing - call by value, call by reference, return values, Recursion, Introduction to poir Sorting and searching algorithms, large integer arithmetic, Single and Multi-Dimensional Arra parameters to functions

Magic square and matrix operations using Pointers and Dynamic Arrays, Multidimensio String processing, File operations.

Structures and Classes - Declaration, member variables, member functions, access modifier Problems on Complex numbers, Date, Time, Large Numbers.

Laboratory:

1. Programs on conditional control constructs.
2. Programs on loops (while, do-while, for).
3. Programs using user defined functions and library functions.
4. Programs on arrays, matrices (single and multi-dimensional arrays).
5. Programs using pointers (int pointers, char pointers).
6. Programs on structures.
7. Programs on classes and objects.

Reading:

1. Walter Savitch, Problem Solving with C++, Pearson, 9th Edition, 2014.
2. Cay Horstmann, Timothy Budd, Big C++, Wiley, 2nd Edition, 2009.
3. R.G. Dromey, How to solve it by Computer, Pearson, 2008.

5 Credits

PSO2	PSO3
-	2
-	2
-	2
-	2
-	2
-	2

of a computers, Problems,

lving strategies: Top-down
s and data representation,

ıool
:ontrol constructs, Conditional

ibrary functions, parameter
nters.
ıys, passing arrays as

onal Dynamic Arrays

s, function overloading,

PH102	PHYSICS LABORATORY	BSC	0 – 1 – 2	2 (

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Use CRO, signal generator, spectrometer, polarimeter and GM counter for making mea
CO2	Test optical components using principles of interference and diffraction of light
CO3	Determine the selectivity parameters in electrical circuits
CO4	Determine the width of narrow slits, spacing between close rulings using lasers and appr accuracy in measurements

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	2	-	3	-	-	-	-	3	2	-	-	-
CO2	3	2	-	3	-	-	-	-	3	2	-	-	-
CO3	3	2	-	3	-	-	-	-	3	2	-	-	-
CO4	3	2	-	3	-	-	-	-	3	2	-	-	-

Detailed Syllabus:

1. Determination of Wavelength of Sodium light using Newton's Rings.
2. Determination of Wavelength of He-Ne laser – Metal Scale.
3. Measurement of Width of a narrow slit using He- Ne Laser.
4. Determination of Specific rotation of Cane sugar by Laurent Half-shade Polarimeter.
5. Determination of capacitance by using R-C circuit.
6. Determination of resonating frequency and bandwidth by LCR circuit.
7. Measurement of half-life of radioactive source using GM Counter.
8. Diffraction grating by normal incidence method.

Reading:

1. Physics Laboratory Manual.

·redits

surements
eciate the

PSO2	PSO3
1	-
1	-
1	-
1	-

MA 151	MATHEMATICS - II	BSC	3-0-0	3 C

Pre-requisites: MA101-Mathematics-I

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

CO 1	analyze improper integrals
CO 2	evaluate multiple integrals in various coordinate systems
CO 3	apply the concepts of gradient, divergence and curl to formulate engineering problems
CO 4	convert line integrals into surface integrals and surface integrals into volume integrals
CO 5	apply Laplace transforms to solve physical problems arising in engineering

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	3	1	2	1	-	-	-	-	-	-	-	-
CO2	3	3	1	2	1	-	-	-	-	-	-	-	-
CO3	3	3	1	2	1	-	-	-	-	-	-	-	-
CO4	3	3	1	2	1	-	-	-	-	-	-	-	-
CO5	3	3	1	2	1	-	-	-	-	-	-	-	-

Detailed Syllabus

Integral Calculus: Convergence of improper integrals; Beta and Gamma integrals; Differentia Double and Triple integrals - computation of surface areas and volumes; change of va integrals.

Vector Calculus: Scalar and vector fields; vector differentiation; level surfaces; directio scalar field; divergence and curl of a vector field; Laplacian; Line and Surface integrals; Gre Stoke's theorem; Gauss Divergence theorem.

Laplace Transforms: Laplace transforms; inverse Laplace transforms; Properties of La transforms of unit step function, impulse function, periodic function; Convolution theore transforms - solving certain initial value problems, solving system of linear differential equati systems to various inputs viz.

sinusoidal inputs acting over a time interval, rectangular waves, impulses etc.

Reading:

1. R. K. Jain and S. R. K. Iyengar, *Advanced Engineering Mathematics*, Narosa Pub 2016.
2. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley and Sons, 8^{th} Edition, 2
3. B. S. Grewal, Higher Engineering Mathematics, Khanna Publications, 2015.

;redits

PSO2	PSO3
1	2
1	2
1	2
1	2
1	2

ation under integral sign;
riables in double and triple

nal derivative; gradient of a
en's theorem in a plane;

place transforms; Laplace
m; Applications of Laplace
ons, finding responses of

lishing House, 5th Edition,

2015.

ME102	ENGINEERING GRAPHICS	ESC	1 - 1 - 4

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Recall BIS standards and conventions while drawing Lines, printing Letters and showing Dimensions.
CO2	Classify the systems of projection with respect to the observer, object and the reference planes.
CO3	Construct orthographic views of an object when its position with respect to the reference planes is defined.
CO4	Analyse the internal details of an object through sectional views.
CO5	Relate 2D orthographic views to develop 3D Isometric View.
CO6	Construct 2D (orthographic) and 3D (isometric) views in CAD environment.

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO
CO1	2	2	2	-	1	-	-	-	1	2	-	-	-	-
CO2	2	2	2	-	1	-	-	-	1	2	-	-	-	-
CO3	2	2	2	-	1	-	-	-	1	2	-	-	-	-
CO4	2	2	2	-	1	-	-	-	1	2	-	-	-	-
CO5	2	2	2	-	1	-	-	-	1	2	-	-	-	-
CO6	2	2	2	-	1	-	-	-	1	2	-	-	-	-

Detailed Syllabus:

Introduction: Overview of the course, Lines Lettering and Dimensioning: Types of lines, Lettering, Geometrical Constructions, Polygons, Scales

Orthographic Projection: Principles of Orthographic projection, Four Systems of Orthographi Projection of Points: Projections of points when they are situated in different quadrants. Projectior of a line parallel to one of the reference planes and inclined to the other, line inclined to both the r Traces.

Projections of Planes: Projections of a plane perpendicular to one of the reference planes and inclined to the other, Oblique planes.

Projections of Solids: Projections of solids whose axis is parallel to one of the reference planes ar
axis inclined to both the planes.
Section of Solids: Sectional planes, Sectional views - Prism, pyramid, cylinder and cone, true sha
Isometric Views: Isometric axis, Isometric Planes, Isometric View, Isometric projection, Isometric vi
Auto-CAD Practice: Introduction to Auto-CAD, DRAW tools, MODIFY tools, TEXT, DIMENSION,
PROPERTIES

Reading:

1. N.D. Bhat and V.M. Panchal, Engineering Graphics, Charotar Publishers, 2013.
2. Sham Tickoo, AutoCAD 2017 for Engineers & Designers, Dreamtech Press, 23^{rd} Edition, 2016

4 Credits

)2	PSO3
	-
	-
	-
	-
	-
	-

Dimensioning,

c Projection.
ıs of Lines: Projections
eference planes,

ıd inclined to the other,

ıpe of the section.
iews – simple objects.

.

CY101	CHEMISTRY	BSC	3-0-0	3 C

Pre-requisites: None

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

CO1	The basic knowledge of the organic reaction mechanism and intermediates.
CO2	The basic knowledge of methods of chemical structure analysis and the instrumentation involved.
CO3	The potential energy aspects of fuel cells, rechargeable batteries and new materials for their fabrication.
CO4	About optical fibres, liquid crystals, LCD, LED, OLED, conducting polymers and their applications.
CO5	The quantum and thermodynamic aspects of various types of bonding, coordination complexes and chemical and enzymatic reactions.
CO6	The synthetic methodologies, importance and applications of nanomaterials in different fields.

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	3	3	-	2	-	2	-	2	-	-	-	-
CO2	3	3	3	-	2	-	2	-	2	-	-	-	-
CO3	3	3	3	-	2	-	2	-	2	-	-	-	-
CO4	3	3	3	-	2	-	2	-	2	-	-	-	-
CO5	3	3	3	-	2	-	2	-	2	-	-	-	-
CO6	3	3	3	-	2	-	2	-	2	-	-	-	-

Detailed syllabus

Quantum Chemistry and Chemical Bonding: Emergence of Quantum Theory; Postulate Operators and Observables, Schrodinger Equation, Particle in a One- Dimensional Box Molecules, Hetero-diatomic Molecule as Harmonic Oscillator and Rigid Rotor, Hydrogen (MO Diagram of CO and NO Molecules).

Chemical Thermodynamics, Equilibrium and Kinetics: Enthalpy and Free Energy Chang C_p and C_v in Gas Phase Reactions, Chemical Potential; Heat Capacity of Solids, Absolute Entropy and Third Rates of Enzyme-

Catalysed Homogeneous and Heterogeneous Surface-Catalysed Chemical Reactions

Electrochemistry and Chemistry of Energy Systems: Electrodes and Electrochemical C Amperometric Sensors; Li-Ion and Ni-Cd Rechargeable Batteries; Fuel Cells (Methanol-Oxyg of Corrosion; Factors Affecting Rate of Corrosion; Sacrificial Anodic and Impressed Curren corrosion.

Coordination Chemistry and Organometallics: Shapes of Inorganic Compounds; Crystal Field Theories; MO-Diagram for an Octahedral Complex; Metal Ions in Biology; Organometal Carbonyls).

Basics of Organic Chemistry: Classification of Organic reaction and their mechanisms. Reac structure and properties. Named Reactions: Skraup's synthesis, Diels- Alder reaction, Click F

Engineering Materials and Application: Introduction to Optical fibres, types of optical fi fibres. Liquid Crystals: LCD, LED, OLED, Conducting Polymers and applications.

Instrumental Methods of Chemical Analysis: Gas- and Liquid-Chromatographic Separat Mixtures; UV-Visible, FTIR, NMR and Mass Spectral Methods of Analysis of Structures of Organic Compounds.

Reading:

1. P. Atkins and Julio de Paula, Physical Chemistry, Freeman & Co. 8th Edition, 2017.
2. Atkins and Shriver, Inorganic Chemistry, Oxford University Press, 4th Edition, 2008.
3. Clayden, Greaves, Warren and Wothers, Organic Chemistry, Oxford University Press, 20
4. Shashi Chawla, Engineering Chemistry, Dhanpat Rai & Co. 2017.
5. Paula Bruce, Organic Chemistry, Pearson, 8th Edition, 2013.

;redits

PSO2	PSO3
1	-
1	-
1	-
1	-
1	-
1	-

ɜs of Quantum Mechanics,
‹ and Colour of Conjugate
ı Atom, LCAO-MO Theory

ges in Chemical Reactions; Relevance of
Law of Thermodynamics,

ells; Potentiometric and
jen); Electrochemical Theory
nt Cathodic Protection of

d and Molecular Orbital
llic Chemistry (Metal

tion intermediates: formation,
Reactions.
ibres, applications of optical

ion of Components of

14.

EE101	BASIC ELECTRICAL ENGINEERING	ESC	3-0-0	3

Pre-requisites: None

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

CO1	Analyze and solve electric and magnetic circuits
CO2	Identify the type of electrical machines for a given application
CO3	Recognize the ratings of different electrical apparatus
CO4	Identify meters for measuring electrical quantities and requirements of illumination

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	3	2	-	-	-	1	-	-	-	-	-	-
CO2	3	3	2	-	-	-	1	-	-	-	-	-	-
CO3	3	3	2	-	-	-	1	-	-	-	-	-	-
CO4	3	3	2	-	-	-	1	-	-	-	-	-	-

Detailed Syllabus:

DC Circuits: Kirchoff's Voltage and Current Laws, Superposition Theorem, Star-D

AC Circuits: Complex representation of Impedance, Phasor diagrams, Power & Power Facto Parallel Circuits, Solution of 3-ϕ circuits and Measurement of Power in 3-ϕ circuits

Magnetic Circuits: Fundamentals and solution of Magnetic Circuits, Concepts of Self and Mu of Coupling

Single Phase Transformers: Principle of Operation of a Single Phase Transformer, EMF Equ Equivalent Circuit of a 1-ϕ Transformer, Determination of Equivalent circuit parameters Efficiency of a Transformer

DC Machines: Principle of Operation, Classification, EMF and Torque Equations, Characteris Motors, Speed Control Methods and Applications

Three Phase Induction Motor: Principle of Rotating Magnetic Field, Principle of Operation of Induction Motor, Torque – Speed Characteristics of 3-ϕ Induction Motor, Applications

Measuring Instruments: Moving Coil and Moving Iron Ammeters and Voltmeters

Illumination: Laws of illumination and luminance.

Reading:

1. Edward Hughes, Electrical & Electronic Technology, Pearson, 12th Edition, 2016.
2. Vincent Del Toro, Electrical Engineering Fundamentals, Pearson, 2nd Edition, 2015.
3. V N Mittle and Arvind Mittal, Basic Electrical Engineering, Tata McGraw Hill, 2nd Edition, 2
4. E. Openshaw Taylor, Utilization of Electrical Energy, Orient Longman, 2010.

Credits

PSO2	PSO3
-	-
-	-
-	-
-	-

)elta Transformations
ɪr, Solution of 1-ϕ Series &

tual Inductances, Coefficient

ıation, Phasor Diagram,
, calculation of Regulation &

stics of Generators and

3-ϕ

2005.

ME101	BASIC MECHANICAL ENGINEERING	ESC	3 - 0 - 0	3 Credits

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Identify Materials for Engineering Applications
CO2	Describe the functions and operations of Conventional, NC, CNC and 3D Printing methods of manufacturing.
CO3	Select a power transmission system for a given application.
CO4	Understand the concepts of thermodynamics and functions of components of a power plant.
CO5	Understand basics of heat transfer, refrigeration, internal combustion engines and Automobile Engineering.

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1	3	3	3	1	-	1	1	-	-	-	-	-	-	2
CO2	3	3	3	1	3	1	1	-	-	-	-	-	-	2
CO3	3	3	3	1	-	1	1	-	-	-	-	-	-	2
CO4	3	3	3	1	-	1	1	-	-	-	-	-	-	2
CO5	3	3	3	1	-	1	1	-	-	-	-	-	-	2

Detailed Syllabus:

Engineering Materials: Introduction to Engineering Materials, Classification and Properties Manufac Castings – Patterns & Moulding, Hot Working and Cold Working, Metal Forming processes: Extrus Forging, Welding – Arc Welding & Gas Welding, Soldering, Brazing.

Machine Tools: Lathe – Types – Operations, Problems on Machining Time Calculations, Drilling M/ Operations, Milling M/c – Types – Operations – Up & Down Milling, Shaping M/c –Operations–Quick Return Mechanism, Planer M/c.– Operations–Shaper Vs Planer, Grinding Introduction to NC/CNC Machines, 3D Printing

Power Transmission: Transmission of Power, Belt Drives, Gears and Gear Trains –Simple F Fasteners and Bearings: Fasteners – Types and Applications, Bearings – Types and Selection,

Thermodynamics: Energy Sources – Conventional/Renewable, Thermodynamics – System, St
Thermodynamic Equilibrium, Process & Cycle, Zeroth law of Thermodynamics, Work & Heat, First law – Cyc
C_v, Limitations of First law, Thermal Reservoirs, Heat Engine, Heat Pump/Refrigerator, Efficiency/CoP, Second
Cycle, Entropy – T-s and P-v diagrams.

Thermal Power Plant: Layout of Thermal Power Plant & Four circuits – Rankine cycle, T-s & P-v dia
Babcock & Wilcox, Cochran Boilers, Comparison of Fire Tube &Water Tube Boilers, Steam Turbi
Reaction, Compounding – Pressure & Velocity Compounding, Condensers – Jet Condenser an
Cooling Towers.

I.C. Engines: 2-Stroke & 4-Stroke Engines, P-v Diagram; S.I. Engine, C.I. Engine, Differences Refr
Compression Refrigeration Cycle – Refrigerants, Desirable Properties of Refrigerants

Heat Transfer: Modes of Heat Transfer, Thermal Resistance Concept, Composite Walls & C
Heat Transfer Coefficient – problems

Automobile Engineering: Layout of an Automobile, Transmission, Clutch, Differential, Internal
Expanding Shoe Brake

Reading:

1. M.L. Mathur, F.S. Mehta and R.P. Tiwari, R.S. Vaishwnar, Elements of Mechanica
Brothers, New Delhi, 2008.
2. Praveen Kumar, Basic Mechanical Engineering, Pearson Education, India, 2013.
3. P.N. Gupta, M.P. Poonia, Elements of Mechanical Engineering, Standard Publishers, 2004.
4. C.P. Gupta, Rajendra Prakash, Engineering Heat Transfer, NemChand Brothers, New Delhi, 19
5. B.S. Raghuvanshi, Workshop Technology, Vol. 1&2, Dhanpath Rai & Sons, New Delhi, 1989.

2	PSO3
	-
	-
	-
	-
	-

cturing Processes:
sion, Drawing, Rolling,

c – Types –

M/c–Operations.

Problems

:ate, Properties,
:lic process, Change of State, C_p,

l law, PMM2, Carnot

agrams, Boilers –
nes – Impulse Vs.
ıd Surface Condenser;

igeration: Vapor

Cylinders, and Overall

|

al Engineering, Jain

)94.

CE101	ENGINEERING MECHANICS	ESC	3 – 0 – 0	3

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Determine the resultant force and moment for a given system of forces
CO2	Analyze planar and spatial systems to determine the forces in members of trusses, frames and problems related to friction
CO3	Calculate the motion characteristics of a body subjected to a given force system
CO4	Determine the deformation of a shaft and understand the relationship between different material constants
CO5	Determine the centroid and second moment of area

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	3	2	-	-	1	-	-	-	-	-	-	-
CO2	3	3	2	-	-	1	-	-	-	-	-	-	-
CO3	3	3	2	-	-	1	-	-	-	-	-	-	-
CO4	3	3	2	-	-	1	-	-	-	-	-	-	-
CO5	3	3	2	-	-	1	-	-	-	-	-	-	-

Detailed syllabus:

Introduction - Specification of force vector, Formation of Force Vectors, Moment of Force – Resultant of a general force system in space, Degrees of freedom - Equilibrium Equa De' Alemberts principle, Degree of Constraints – Freebody diagrams.

Spatial Force systems - Concurrent force systems - Equilibrium equations – Problems, Probl Tension Coefficient method, Problems (Tension Coefficient method), Parallel force systems force system – Problems.

Coplanar Force Systems - Introduction – Equilibrium equations – All systems, Probler force system, Coplanar Parallel force system, Coplanar General force system – Point o Method of sections, Method of sections, Method of members, Friction – Coulombs laws of dr Problems on Wedge friction,

Belt Friction-problems.

Mechanics of Deformable Bodies - Stress & Strain at a point- Normal and shear stresses, Ax
on prismatic shaft, tapered shaft and deformation due to self-weight, Deformation of Steppe
Poisson's Ratio – Bulk Modulus - Problems, change in dimensions and volume.
Centroid & Moment of Inertia - Centroid and M.I – Arial – Radius of Gyration, Parallel
theorem – Simple Problems.
Dynamics of Particles - Rectilinear Motion – Kinematics Problems, Kinetics – Problems, Wor
Energy – Impulse Moment, Curvilinear Motion – Normal and tangential components.

Reading:

1. J.L. Meriam, L.G. Kraige, Engineering Mechanics, John Wiley &Sons, 7th Edition, 2012.
2. Timoshenko, Young, Engineering Mechanics, McGraw Hill Publishers, 3rd Edition, 2006.
3. Gere, Timoshenko, Mechanics of Materials, CBS Publishers, 2nd Edition, 2011.

Credits

PSO2	PSO3
1	-
1	-
1	-
1	-
1	-

Cross product – Problems,
tions, Kinematics – Kinetics –

ems (Vector approach) –
- problems, Center of Parallel

ns on Coplanar Concurrent
f action, Method of joints,
y friction – Limiting friction,

ial deformations – Problems
d shaft due to axial loading,

axis– Perpendicular axis

k &

ME103	WORKSHOP PRACTICE	ESC	0 - 0 – 3	2

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Study and practice on machine tools and their operations
CO2	Practice on manufacturing of components using workshop trades including fitting, carpentry, foundry and welding
CO3	Identify and apply suitable tools for machining processes including turning, facing, thread cutting and tapping
CO4	Apply basic electrical engineering knowledge for house wiring practice

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	3	1	-	-	1	-	-	2	2	-	-	-
CO2	3	3	1	-	-	1	-	-	2	2	-	-	-
CO3	3	3	1	-	-	1	-	-	2	2	-	-	-
CO4	3	3	1	-	-	1	-	-	2	2	-	-	-

Detailed Syllabus:

Fitting Trade: Preparation of T-Shape Work piece as per the given specifications, Preparatio which contains: Filing, Sawing, Drilling, Grinding, and Practice marking operations.

Plumbing: Practice of Internal threading, external threading, pipe bending, and pipe fitting, P diameter and with reducer for different diameters and Practice of T-fitting, Y-fitting, Gate valv

Machine shop: Study of machine tools in particular Lathe machine (different parts, di cutting tools), Demonstration of different operations on Lathe machine, Practice of Faci turning, taper turning, knurling and parting and Study of Quick return mechanism of Shape working of CNC and 3D Printing Machines.

Power Tools: Study of different hand operated power tools, uses and their demonstration an Practice of all available Bosch Power tools.

Carpentry: Study of Carpentry Tools, Equipment and different joints, Practice of Cross Half la joint, Half lap Dovetail joint and Mortise Tenon Joint.

2 Credits

PSO2	PSO3
2	-
2	-
2	-
2	-

n of U-Shape Work piece

ipes with coupling for same
ves fitting.
fferent operations, study of
ng, Plane Turning, step
er. Demonstration of the

d

ap

CY102	CHEMISTRY LABORATORY	BSC	0- 1 - 2

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Select a suitable methodology and compare the strategies involved in the estimation of metal content, iodine content, active chlorine or hardness of water for various applicatio
CO2	Apply a selective instrumental method in the place of tedious and complex titration processes for repeated and regulated analysis of acids, bases, redox compounds, etc.
CO3	Test and validate optical activity, corrosion inhibitor efficiency and absorption isotherm of selective compounds and processes.

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO
CO1	3	3	3	-	2	-	2	-	2	-	-	-	-	1
CO2	3	3	3	-	2	-	2	-	2	-	-	-	-	1
CO3	3	3	3	-	2	-	2	-	2	-	-	-	-	1

Detailed Syllabus:

Cycle-I

1. Standardization $KMnO_4$ solution: Understanding the redox process, electron transfer, importance of qualitative and quant
2. Estimation of Hematite: Understanding the importance on purity of a ore, % of metal c
3. Hardness of Water: Understanding the of metal complexes, multi dentate ligands, impo ground water, (EDTA method; complexometry).
4. Analysis of bleaching powder for available chlorine: Understanding the importance and purity titration (Iodometry).
5. Preparation of nanomaterials: Understanding the importance of nanomaterials, their preparation and characterization.

Cycle II

1. pH metry: Concept of pH, Instrumentation, calibration, determination of the concentrations by
2. Conductometry: Concept of conductivity, importance of conductivity

3. Potentiometry: Determination of the redox potential of the reaction
4. Colorimetry: Importance of Beers and Lamberts law,
5. Photochemical experiment: Importance of visible light and its application for a redox proces coloring agent
6. Preparation of bakelite / polypyrrole: Concepts of organic reactions and application for the preparation.
7. Corrosion experiment: Concept of corrosion, importance of corrosion agents
8. Adsorption experiment: Understanding phenomena of adsorption and absorption
9. Analysis of a drug: Importance of the purity, concentrations of a drug molecule.
10. Preparation of bakelite / red azo dye / Aspirin / Fe(acac) / polypyrrole: Concepts of organic application for the organic material preparation

Reading:

1. Charles Corwin, Introductory Chemistry laboratory manual: Concepts and Critical Thinking, Pe
2. David Collins, Investigating Chemistry: Laboratory Manual, Freeman & Co., 2006.

2 Credits

ns.

)2	PSO3
	-
	-
	-

titative analysis.
:ontent (for Fe).
rtance of purity of

of potable water, back

instrumental methods

ss, importance of

organic material

c reactions and

earson Education, 2012.

MA201	MATHEMATICS– III	BSC	3 - 0 - 0	3 C

Pre-requisites: MA151 - Mathematics - II

Course Outcomes: At the end of the course, student will be able to:

CO1	Obtain the Fourier series for a given function
CO2	Find the Fourier transform of a function and Z- transform of a sequence
CO3	Determine the solution of a PDE by variable separable method
CO4	Understand and use of complex variables and evaluation of real integrals

Mapping of course outcomes with program outcomes

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	3	1	2	1	-	-	-	-	-	-	-	-
CO2	3	3	1	2	1	-	-	-	-	-	-	-	-
CO3	3	3	1	2	1	-	-	-	-	-	-	-	-
CO4	3	3	1	2	1	-	-	-	-	-	-	-	-

Detailed Syllabus

Fourier Series: Expansion of a function in Fourier series for a given range - Half range sine
Fourier Transforms: Fourier transformation and inverse transforms - sine, cosine transforma
simple illustrations.
Z-transforms: Z- transform and Inverse Z-transforms – Properties – convolution theorem- si
Partial Differential Equations: Method of separation of variables - Solution of one dimensio
dimensional heat conduction equation and two dimensional steady state heat conduction eq
Complex Variables: Analytic function - Cauchy Riemann equations - Harmonic func
complex integration - line integrals in complex plane - Cauchy's theorem (simple proof only
formula - Taylor's and Laurent's series expansions - zeros and singularities - Residues -
residue theorem to evaluate the real integrals of the type $\int_0^{2\pi} f(Cos\,\theta, Sin\,\theta)\, d\theta$, $\int_{-\infty}^{\infty} f(x)dx$ without poles on the real axis.

Reading:

1. R.K. Jain and S.R.K. Iyengar, *Advanced Engineering Mathematics,* Narosa Publishing H
2016.
2. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley and Sons, 8th Edition, 2
3. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 44th Edition, 2017

;redits

PSO2	PSO3
1	2
1	2
1	2
1	2

; and cosine expansions
tions and inverse transforms -

mple illustrations.
nal wave equation, one
juation with illustrations.
:tions - Conjugate functions -
y), Cauchy's integral
residue theorem, use of

-louse Pvt. Ltd., 5^{th} Edition,

2008.

CY201	INDUSTRIAL ORGANIC CHEMISTRY	BSC	3 – 0 – 0	3 (

Pre-requisites: CY101-Chemistry

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand the reactivity of the intermediates, hydrocarbon chemistry, and of functional group transformations.
CO2	Differentiate the structure and properties of biomolecules, polymers and heterocyclic
CO3	Identify the role of chemical engineer in modern drug discovery programs
CO4	Separate the racemic mixtures using resolution methods.
CO5	Elucidate the structure of organic compounds (small molecules) using spectroscopic

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	3	2	1	2	1	1	1	1	1	-	2	3
CO2	3	3	2	1	2	1	1	1	1	1	-	2	3
CO3	1	2	1	2	2	3	3	2	1	1	1	2	2
CO4	2	2	2	1	3	1	1	1	1	1	-	2	3
CO5	2	2	2	1	3	1	1	1	1	1	-	2	3

Detailed syllabus

Reactivity of organic compounds: Generation and reactions of: Carbonium ion, carban benzyne, Reactions and properties of: Hydrocarbons (Alkane, alkene and alkyne, Alkyl halid compounds, carboxylic acids, nitro compounds and nitriles), Functional group transformation

Chemistry of heterocyclic compounds and drug molecules: Preparation and properties of fur pyridine

Chemistry of biomolecules: Structure and properties of Carbohydrates, Amino acids, Protein proteins, nucleic acids

Application of stereochemistry in pharmaceutical industry: Introduction to stereochemis nomenclature

Conformational analysis of cyclohexane and its derivatives, Racemization, Resolution techni

Introduction to modern drug discovery: Synthesis of drugs (a) Antipyretics-Paracetamol, (b) A
Ibuprofen, (c) Antibiotics-Penicillin, (d) Antimalarial drugs-Quinine, (e) Anticancer dru
drugs
Polymer chemistry: Basics of polymerization techniques, Properties and Characterizatic
Analysis of organic compounds:
Chromatographic techniques: Column Chromatography, Thin-layer chromatography,
Chromatography.
Spectroscopic techniques: Application of UV-Vis, Infra-Red, Nuclear Magnetic Resonan
spectrometric methods for the structural elucidation small molecules Recent techniques in or
alternative reaction media (use of water, ionic liquids), Alternative energy sources (microwav
reactions, Homogeneous
and heterogeneous catalysis, Combinatorial chemistry.

Reading:

1. Francis A. Carey, Organic Chemistry, Tata McGraw Hill Publishing Company Limited,
2. Donald L. Pavia, Gary M Lanyman, Introduction to spectroscopy, Thompson publishers,
3. E. Eliel, Stereochemistry of carbon compounds, John Wiley & Sons, Inc., 2009.
4. P. S. Kalsi, Spectroscopy of Organic Compounds, New Age International, 6th Edition, 20
5. John W Nicholson, Chemistry of Polymers, Royal Society of Chemistry, 3rd Edition, 2006
6. Mike Lancaster, Green Chemistry, Royal Society of Chemistry, 2002.

Credits

importance
compounds
methods.

PSO2	PSO3
2	1
2	1
1	1
2	1
2	1

ion, carbenes, nitrenes and
es, alcohols, ethers, carbonyl
s
an, pyrrole and thiophene,

s, peptides, purification of

try, isomerism, D, L and R, S-

ques

Anti- inflammatory drugs-
gs and (f) Antihypertensive

on of polymers

Gas chromatography, Liquid

nce spectroscopic and Mass
rganic synthesis: Use of
e, sonication) for organic

5th Edition, 2007.
3rd Edition, 2008.

06.
.

CH201	CHEMICAL PROCESS CALCULATIONS	PCC	3 – 1 – 0	4 C

Pre-requisites: None

Course Outcomes: At the end of the course, student will be able to:

CO1	Convert physico-chemical quantities from one system of units to another
CO2	Identify basis and degrees of freedom
CO3	Perform material and energy balances on single units without and with chemical reactions.
CO4	Solve the material and energy balance problems on multi-unit processes with recycle, purge and bypass.
CO5	Analyze the ideal and real behavior of gases, vapors and liquids.

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	2	3	3	2	-	-	-	2	2	1	1	3
CO2	3	2	3	3	2	-	-	-	2	2	1	1	3
CO3	3	2	3	3	3	-	-	-	2	2	1	1	3
CO4	3	2	3	`3	3	-	-	-	2	2	1	1	3
CO5	3	2	3	3	3	-	-	-	2	2	1	1	3

Detailed syllabus

Introduction to process calculations: Units and Dimensions - Conversion of Units; Process a process flow sheet, process unit, process streams, density, specific gravity, specific gravity s flow rates, mole concept, molecular and equivalent weights; Composition of streams; othe concentration; Basic Material Balance Principles.

Material balances on Non-Reactive Systems: Degrees of freedom analysis; Material balance Evaporation, Crystallization, Absorption, Distillation, Drying, Extraction, etc.; Material balanc –Bypass, Recycle, Purge, Makeup;

Material balances on Reactive systems: Stoichiometry basics- excess and limiting rea conversion, yield; extent of reaction method for a single reaction, element or atomic or component balance approach; Multiple reactions; Combustion reactions –

Orsat analysis, proximate and ultimate analysis of coal, theoretical and excess air; Multiple u
reaction, Recycle and Purge.
Single- and Multi-phase systems: Single phase systems; ideal gas equation of state; mixture
Amagat's laws; Properties of real gases – real gases, critical properties, equations of state,
compressibility charts; mixture of real gases; Multiphase systems – phase diagram; vapor
Vapor pressure estimation; Ideal solutions and Raoult's law – VLE calculations; Partial sat
chart.
Energy Balances: Thermophysics -Heat Capacity, Calculation of enthalpy changes without a
of solution and mixing;Energy balances without chemical reactions; Thermochemistry - Ene
reactions - Standard heat of reaction, formation and combustion, Hess Law, Effect of te
material and energy
balances - Adiabatic flame temperature.

Reading:

1. Nayef Ghasem, Redhouane Henda, Principles of Chemical Engineering Processes: Mat
2nd Edition, CRC Press, 2015.
2. Narayanan K.V., Lakshmikutty B., Stoichiometry and Process Calculations, PHI Learning
3. Himmelblau D.H., James B. Riggs, Basic Principles and Calculations in Che
Edition, Prentice Hall, 2012.
4. Hougen O.A., Watson K.M., Ragatz R.A., Chemical Process Principles (Part-I): Material
Edition, CBS Publishers, 2004.
5. Bhatt B.I., Thakore S.M., Stoichiometry, 5th Edition, Tata McGraw-Hill Publishing Compa
6. Richard M. Felder, Ronald W. Rousseau, Elementary Principles of Chemical Processes,
Edition, Wiley, 2004.

redits

PSO2	PSO3
3	2
3	2
3	2
3	2
3	2

nd process variables –
scales, mass and volumetric
r expressions for

e on single unit process–
e on Multiunit process

ctants
balance method; molecular

ınit systems involving

e of ideal gases-Dalton's and
compressibility factor,
-liquid equilibrium curve;
turation & Humidity; Humidity

and with phase change, Heat
ergy balances with chemical
mperature; Simultaneous

erial and Energy Balances,

g Pvt. Ltd., 7th Edition, 2015.
emical Engineering, 8th

and Energy Balances, 2nd

ny Ltd., New Delhi, 2010.
3rd

CH202	FLUID AND PARTICLE MECHANICS	PCC	3 – 1 – 0	4 C

Pre-requisites: MA151-Mathematics-II, CE101-Engineering Mechanics.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Derive dimensionless groups by using dimensional analysis.
CO2	Solve problems related to manometers and decanters using the principles of fluid sta
CO3	Determine the pipe size / flow rate / power requirements under laminar and turbulent conditions.
CO4	Solve problems involving motion of particles in fluid, fluid–solid operations in packed fluidized beds.
CO5	Select machinery and measuring devices for fluid flow.

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	1	1	1	-	-	-	-	-	-	-	-	3
CO2	3	2	2	2	-	-	-	-	-	-	-	-	3
CO3	3	1	3	3	1	2	-	-	-	-	-	-	3
CO4	3	3	3	3	1	2	-	-	-	-	-	-	3
CO5	2	3	2	3	1	-	-	-	-	-	-	-	3

Detailed syllabus

Unit Systems: Unit systems, Dimensional analysis.

Fluid Statics and Its Applications: Nature of Fluids, Hydrostatic Equilibrium, Applications of F

Fluid Flow Phenomena: Laminar flow, Shear rate, Shear stress, Rheological properties of flu layers.

Basic Equations of Fluid Flow: Mass balance in a flowing fluid; Continuity, differential mome motion, Macroscopic momentum balances, Mechanical energy equations. Incompressible Fl shear stress and skin friction in pipes, laminar flow in pipes and channels, turbulent flow in p from changes in velocity or direction.

Flow of Compressible Fluids: Definitions and basic equations.

Flow Past Immersed Bodies: Friction in flow through beds of solids, Motion of particles throu
Transportation and Metering of Fluids: Pipes, fittings and valves.Pumps - positive displacem
pumps, fans, blowers, and compressors, Measurement of flowing fluids - full bore meters, in
Introduction to Microfluidics and CFD.

Reading:

1. McCabe W. L., Jullian Smith C. and Peter Harriott - Unit operations of Chemical Enginee
international edition, 7th Edition, 2005.
2. Coulson J.M, Richardson. J.F, Chemical Engineering Volume I and II, Elsevier Ind
3. De Nevers N H- Fluid Mechanics for Chemical Engineers, McGraw Hill, NY, 3rd Edition, 2
4. Wilkes James O., Fluid Mechanics for Chemical Engineers, Prentice Hall, 3rd Edition, 20

redits

atics.
t flow
beds and

PSO2	PSO3
0	3
1	0
1	2
1	2
1	0

luid Statics.
uids, Turbulence, Boundary

ntum balance; equations of
low in Pipes and Channels:
pipes and channels, friction

ıgh fluids, Fluidization.
ıent pumps and centrifugal
ısertion meters.

ering, McGraw-Hill

lia, 5^{th} Edition, 2006.
2004.
)17.

CH203	MECHANICAL OPERATIONS	PCC	3 – 0 – 0	3 C

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Identify the role of mechanical unit operations in chemical industries.
CO2	Select suitable size reduction equipment based on performance and power rec
CO3	Analyze particle size distribution of solids
CO4	Evaluate solid-fluid separation equipment.
CO5	Determine the power required for agitation, blending and mixing

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	3	1	2	1	-	-	-	-	-	-	-	3
CO2	3	3	2	2	1	-	1	-	-	-	-	-	3
CO3	3	3	2	3	1	-	-	-	-	-	-	-	3
CO4	3	3	3	3	1	-	-	-	-	-	-	-	3
CO5	3	3	2	2	1	-	1	-	-	-	-	-	3

Detailed syllabus

Introduction: Unit operations and their role in chemical industries; Types of mechanic
Properties and handling of particulate solids: Characterization of solid particles, Propertie
Mixing of solids, Size reduction, Ultrafine grinders.

Screening: Screening equipment, Screen capacity.

Cake filters: Centrifugal filters, Filter media, Principles of cake filtration, Washing filter cakes
clarification, Gas cleaning, Principles of clarification.

Cross flow filtration: Types of membranes, Permeate flux for ultrafiltration, Concentrat
of ultrafiltration, Diafiltration, Microfiltration.

Sedimentation: Gravity sedimentation processes, Centrifugal sedimentation processes.

Agitation and mixing of liquids: Agitated vessels, Blending and mixing, Suspension o
particles, Dispersion operations, Agitator selection and scaleup, Power Number, Mixing Inde

Reading:

1. McCabe W. L., Jullian Smith C. and Peter Harriott - Unit Operations of Chemical Engine
international Edition, 2005.
2. Coulson J.M., Richardson J.F, Chemical Engineering, Vol. II, 4th Edition, Elsevier India, 2
3. Alan S. Foust, Leonard A. Wenzel, Curtis W. Clump, Louis Maus, L. Bryce And
Operations, Wiley, 2nd Edition, 2008.
4. Walter L. Badger, Julius T. Banchero, Introduction to Chemical Engineering, Tata McGra
5. Christie John Geankoplis, Transport Processes and Separation Process Principles (Inclu
Unit Operations), Prentice Hall India Learning Private Limited, 4th Edition, 2004.

Credits

quirement.

PSO2	PSO3
1	-
3	-
3	-
3	-
3	-

cal operations;
es of masses of particles,

s. Clarifying filters: Liquid

tion polarization, Applications

f solid
ex.

ering, 7th Edition, McGraw-Hill

2006.
ersen, Principles of Unit

aw Hill Edition, 2001.
udes

CH204	CHEMICAL ENGINEERING THERMODYNAMICS-I	PCC	3 – 0 – 0

Pre-requisites: ME101-Basic Mechanical Engineering

Course Outcomes: At the end of the course, the student will be able to:

CO1	Apply the first and second laws of thermodynamics to chemical processes.
CO2	Compute the properties of ideal and real gas mixtures.
CO3	Evaluate the efficiency of expansion and compression flow processes.
CO4	Estimate heat and work requirements for industrial processes.
CO5	Analyze refrigeration and liquefaction processes.

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1	2	2	1	-	-	-	-	-	-	-	-	-	1	3
CO2	2	3	2	2	1	-	-	-	-	-	-	-	2	2
CO3	2	2	3	3	2	-	-	-	-	-	-	-	2	1
CO4	2	2	2	3	2	-	-	-	-	-	-	-	3	1
CO5	2	2	3	2	1	-	-	-	-	-	-	-	3	2

Detailed syllabus

Introduction and First Law of Thermodynamics: First Law of Thermodynamics, Energy Balance for Equilibrium, The Phase Rule, The Reversible Process, Enthalpy, Heat Capacity, Mass and En Open Systems.

Volumetric Properties of Pure Fluids: General P-V-T Behaviour of Pure Substances, Virial E Ideal Gas, Application of the Virial Equations, Cubic Equations of State, Generalized Correlations f Correlations for Liquids.

The Second Law of Thermodynamics: Statements of the Second Law, Heat Engines Temperature Scales, Entropy, Entropy Changes of an Ideal Gas, Mathematical Statement of the S Balance for Open Systems, Calculation of Ideal Work, Lost Work, Exergy, The Third Law of Therm from the Microscopic Viewpoint. Thermodynamic Properties of Fluids: Thermodynamic Property Phase

Systems, Residual Property Relations, Residual Property Calculation by Equations of State, Two-

Phase Systems, Thermodynamic Diagrams, Tables of Thermodynamic Properties, Generalized Pro
Gases.
Applications of Thermodynamics to Flow Processes: Duct Flow of Compressible Fluids, Turbines (E
Compression Processes.
Conversion of Heat into Work by Power Cycles: The Steam Power Plant, Internal-Combustion Eng
Rocket Engines
Refrigeration and Liquefaction: Carnot Refrigerator, Vapor-Compression Cycle, Choice of Refrigerant, Absorption Refrigeration, Heat Pump, Liquefaction Processes.

Reading:

1. Smith J. M, H. C. Van Ness and M. M. Abbott, Introduction to Chemical Engineering Th McGraw-Hill, 7th Edition, 2004.
2. K. V. Narayanan, Chemical Engineering Thermodynamics, Prentice Hall of India Pvt. Ltd., 2009
3. Michael Modell, Robert C. Reid, Thermodynamics and its Applications, Prentice-Hall Inter Physical and Chemical Engineering Sciences, 2nd Edition, 1983.
4. Milo D. Koretsky, Engineering and Chemical Thermodynamics, Wiley, 2009.

3 Credits

2	PSO3
	3
	3
	1
	2
	2

Closed Systems,
iergy balances for

quations of State, The
or Gases, Generalized

, Thermodynamic
econd Law, Entropy
nodynamics, Entropy
Relations for Single

ɔperty Correlations for

Ξxpanders),

ines, Jet Engines;

ɦermodynamics,

ɘ.
national series in

CH205	FLUID AND PARTICLE MECHANICS LABORATORY	PCC	0 – 1 – 2	2 C

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Determine viscosity of liquids using Cannon Fenske viscometer and terminal settling velocity.
CO2	Distinguish laminar and turbulent flows.
CO3	Determine the characteristics of flow meters
CO4	Determine the characteristics of packed & fluidized beds and centrifugal pumps.
CO5	Calculate pressure drop across pipe, valves and fittings.

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	2	1	2	3	-	-	-	2	3	3	2	1	1
CO2	2	1	2	3	-	-	-	2	3	3	2	1	2
CO3	2	1	2	3	-	-	-	2	3	3	2	1	2
CO4	2	1	2	3	-	-	-	2	3	3	2	1	2
CO5	2	1	2	3	-	-	-	2	3	3	2	1	2

Detailed syllabus (List of Experiments)

1. Determination of viscosity using Cannon Fenske Viscometer.
2. Distinguish between laminar and turbulent flow using Reynolds Experiment.
3. Verification of Bernoulli’s theorem experimentally.
4. Friction in flow through pipes - Friction in pipe fittings and valves.
5. Determination of the viscosity of given solution using Terminal settling velocity data.
6. Study the characteristics of a packed bed with air flow.
7. Study the characteristics of a packed bed with water flow.
8. Study the characteristics of fluidized bed.
9. Determination of Orifice coefficient and Venturi coefficient.
10. Measurement of point velocity and determination of velocity profile using Pitot tube.
11. Determination of pressure drop in flow through non-circular pipes.
12. Study the characteristics of a centrifugal pump.
13. Determination of Efflux time.
14. Determination of pressure drop in flow through helical coil.
15. Demonstration of rheometer.

Reading:

1. Laboratory Manuals.
2. McCabe W. L., Jullian Smith C. and Peter Harriott - Unit operations of Chemical Enginee
International Edition, 2005.
3. Coulson J.M and Richardson. J.F, Chemical Engineering Volume I and II, 5^{th} Edition, Els
4. De Nevers N H- Fluid Mechanics for Chemical Engineers,3^{rd} Edition, McGraw Hill, NY, 2

redits

PSO2	PSO3
3	1
3	1
3	1
3	1
3	1

ering, 7th Edition, McGraw-Hill

sevier India, 2006.
004.

CH206	CHEMICAL PROCESSING LABORATORY	PCC	0 – 1 – 2	2 C

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Select suitable methods for size reduction of minerals or other intermediates
CO2	Evaluate suitable mechanical separations of powders, solid-liquid and solid-gas
CO3	Synthesize products such as soap, formaldehyde and silica colloids
CO4	Determine the VLE of a binary system
CO5	Analyze fuel samples
CO6	Evaluate thermodynamic properties such as specific heat capacity of a liquid and he of binary liquids

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	3	1	1	-	3	3	2	3	3	-	1	3
CO2	3	3	1	1	-	3	3	2	3	3	-	1	3
CO3	3	3	1	3	-	3	3	2	3	3	-	1	3
CO4	3	3	1	`3	-	3	3	2	3	3	-	1	3
CO5	3	3	1	2	-	3	3	2	3	3	-	1	3
CO6	3	3	1	2	-	3	3	2	3	3	-	1	3

Detailed syllabus

List of experiments:

1. Analysis of raw materials, intermediates and products such as: Water; Urea; Soda ash;
2. Testing of fuels: Orsat Analysis; Reid's vapor pressure; Smoke point; Aniline point; Phot point; Bomb calorimeter
3. Product synthesis: soap, formaldehyde resin, Silica Colloids.
4. Ball Mill
5. Jaw Crusher
6. Sigma Mixer
7. Vibrating Screens

8. Cyclone Separator
9. Filtration
10. Sedimentation
11. Vapor Liquid Equilibrium
12. Bomb Calorimeter
13. Flash& Fire point of fuel samples

Reading: Lab manuals

:redits

; mixtures
:at of mixing

PSO2	PSO3
3	-
3	-
3	-
3	-
3	-
3	-

:o- colorimeter; Abel's Flash

MA251	MATHEMATICS IV	BSC	3– 0 – 0	3 C

Pre-requisites:MA201- Mathematics-III

Course Outcomes: At the end of the course, student will be able to:

CO1	Interpret an experimental data using interpolation / curve fitting
CO2	Solve numerically algebraic/transcendental and ordinary differential equations
CO3	Understand the concepts of probability and statistics
CO4	Obtain the series solutions for ordinary differential equations

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	3	1	2	1	-	-	-	-	-	-	-	-
CO2	3	3	1	2	1	-	-	-	-	-	-	-	-
CO3	3	3	1	2	1	-	-	-	-	-	-	-	-
CO4	3	3	1	2	1	-	-	-	-	-	-	-	-

Numerical Methods: Curve fitting by the method of least squares, Fitting of (i) Straight line (ii Exponential curves, Gauss-Seidal iteration method to solve a system of equations, Numerica transcendental equations by Regula-Falsi method and Newton-Raphson's method, Lagrar and backward differences, Newton's forward and backward interpolation formulae, Numerical d backward differences, Numerical Integration with Trapezoidal rule, Simpson's 1/3 rule and Sin method, Euler's method, modified Euler's method, 4th order Runge-Kutta method for solving firs

Probability and Statistics: Random variables, discrete and continuous random variables, M Poisson and Normal distributions and applications, Testing of Hypothesis –Null and alternate hy and critical region-Z-test for single mean and difference of means, single proportion and differ single mean and difference of means - F-test for comparison of variances, Chi-square test for g coefficient of correlation, line

Series Solution: Series solution of Bessel and Legendre's function of first kind, Recurrence formulae, Generating function, Ort

- Legendre polynomial, Rodrigue's formula, Generating function, Recurrence form Orthogonality of Legendre polynomials.

Reading:

1. M. K. Jain, S.R.K. Iyengarand R.K. Jain, Numerical methods for Scientific and Engineerir International Publications, 2008.
2. S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, S. Chand & Co, :
3. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley and Sons, 8th Edition, :
4. B.S. Grewal, Higher Engineering Mathematics, Khanna Publications, 2009.

:redits

PSO2	PSO3
1	2
1	2
1	2
1	2

Detailed Syllabus

) Second degree parabola (iii)
al solution of algebraic and
nge interpolation, Forward
ifferentiation with forward and
npson's 3/8 rule, Taylor series
st order ordinary differential
equations.
ean and variance of Binomial,
/pothesis, level of significance
ence of proportions - t-test for
goodness of fit - Karl Pearson
s of regression and examples.
s differential equations, Bessel
thogonality of Bessel functions

ula,

ng Computation, New Age

2006.
2008.

CH251	CHEMICAL ENGINEERING THERMODYNAMICS – II	PCC	3 – 1 – 0	4

Pre-requisites: CH204-Chemical Engineering Thermodynamics – I

Course Outcomes: At the end of the course, the student will be able to:

CO1	Evaluate heat effects involved in industrial chemical processes
CO2	Determine thermodynamic properties of gaseous mixtures and solutions
CO3	Estimate Bubble-P & T, Dew-P & T for binary and multi-component systems
CO4	Calculate vapor-liquid equilibrium (VLE) composition for ideal and non-ideal systems
CO5	Determine equilibrium constant and composition of product mixture for single a multiple reactions

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	2	1	1	2	2	-	-	-	-	-	-	-	2
CO2	1	2	1	2	2	-	-	-	-	-	-	-	1
CO3	2	2	1	1	2	-	-	-	-	-	-	-	1
CO4	2	1	1	`2	2	-	-	-	-	-	-	-	2
CO5	1	1	1	1	2	-	-	-	-	-	-	-	1

Detailed syllabus

Heat Effects: Sensible heat effects, Temperature dependency of heat capacity, Latent Heat heats of reaction, formation and combustion, Heat effects of industrial reactions.

Solution Thermodynamics: Fundamental property relation, Chemical potential, Partial proper model, Fugacity and fugacity coefficient, The ideal solution model, Excess properties.

Applications of Solution Thermodynamics: Liquid phase properties from VLE data, Act Gibbs Energy, Models for the excess Gibbs energy, Property changes of mixing, Heat VLE at low to moderate pressures: The nature of equilibrium, Criteria of equilibrium, The pha rule, Duhem's theorem, Raoult's law, Henry's law, Modified Raoults's law, Dew point and bul Relative volatility, Flash calculations.

Thermodynamic properties and VLE from equations of state.
Chemical Reaction Equilibria: The reaction coordinate, Equilibrium criteria to chemical reacti change, Equilibrium constant, Effect of temperature on equilibrium constant, Evaluation of e of equilibrium constant to composition, Equilibrium conversions for single reactions, Phase r reacting systems, Multi-
reaction equilibria.

Reading:

1. Smith J.M, Van Ness H.C and Abbott M.M., Introduction to Chemical Engine Edition, McGraw Hill International, 2004.

2. Milo D. Koretsky, Engineering and Chemical Thermodynamics, Wiley, 2009.

3. Hougen O. A, Watson. K. M and Ragatz R. A, Chemical Process Principles (Part-II), 2004.

4. Narayanan, K.V, Chemical Engineering Thermodynamics, Prentice Hall of India Pvt. Ltd 2009.

Credits

and

PSO2	PSO3
3	1
2	2
2	2
2	2
2	1

of pure substance, Standard

ties, The ideal gas mixture

tivity coefficient, Excess
t effects of mixing process.
ase
bble point calculations,

ons, Gibbs free energy
quilibrium constants, Relation
ule and Duhem's theorem for

ering Thermodynamics, 7th

2nd Edition, CBS Publishers,

l.,

CH252	HEAT TRANSFER	PCC	3 – 1 – 0	4 C

Pre-requisites: CH201 Chemical Process Calculations, CH202 Fluid and Particle Mechanic

Course Outcomes: At the end of the course, the student will be able to:

CO1	Identify the modes of heat transfer.
CO2	Calculate heat transfer coefficients for forced and natural convection.
CO3	Perform heat transfer calculations involving phase changes.
CO4	Analyze the heat exchanger performance for co-current and counter-current flows.
CO5	Design double pipe and shell & tube heat exchangers.

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	2	3	1	1	2	3	-	2	3	1	1	3
CO2	3	2	3	1	1	2	3	-	2	3	1	1	3
CO3	3	2	3	1	1	2	3	-	2	3	1	1	3
CO4	3	2	3	`1	1	2	3	-	2	3	1	1	3
CO5	3	2	3	1	1	2	3	-	2	3	1	1	3

Detailed syllabus

Introduction: Modes of heat transfer, material properties of importance in heat transfer.

Heat Transfer by Conduction in Solids & Principles of heat flow in fluids: Steady sta Conduction through bodies in series; unsteady state heat conduction; Concept of heat tr and overall heat transfer coefficient; Concept of fins; Critical insulation thickness.

Heat Transfer to fluids without phase change: Principle of convection; Concept of Bo by forced convection in laminar flow; Turbulent flow and transition region; Heat transfer to convection on outside tubes; Natural convection; Momentum and heat transfer analogie

Heat Transfer to fluids with phase change: Heat transfer from condensing vapors; Heat tran to boiling liquids.

Radiation Heat Transfer: Concepts of radiation; Laws of radiation; Radiation between factor; Exchange of energy between parallel planes and concentric cylinders/spheres. Heat Exchange equipment: Heat Exchangers; Condensers and Boilers; Shell and Tub types of Heat Exchangers; Preliminary Design of Heat Exchangers; Effectiveness Evaporation: Basics of evaporation; Performance of tubular evaporators; Capacity & Econo Multiple effect evaporator; Principles of Crystallization; Crystallization equipment.

Reading:

1. McCabe W. L., Smith J. C., Harriott P., Unit Operations of Chemical Engineering, 7th Ed
2. Holman J. P, Heat Transfer, 10th Edition, McGraw Hill, New York, 2010.
3. Ozisik N, Heat Transfer: A Basic Approach, Vol. 1, McGraw Hill, 1985.
4. Cengel Y. A, Heat Transfer: A Practical Approach, 2nd Edition, McGraw Hill, 2003.
5. Kern D. Q., Process Heat Transfer, Tata McGraw Hill Education Pvt. Ltd., 2001.
6. Serth R. W, Process Heat Transfer: Principles, Applications and Rules of Thumb, 2nd Ec
7. Frank P. Incropera, Theodore L. Bergman, David P. DeWitt, Bergmann, Adrienne S. Lav

Fundamentals of Heat and Mass Transfer, John Wiley & Sons,7th Edition, 2013.

redits

s.

PSO2	PSO3
3	2
3	2
3	2
3	2
3	2

ate heat conduction;
ansfer coefficient; Individual

oundary layers; Heat transfer
liquid metals; Forced
s.
sfer

black surfaces; Interchange

pe Heat Exchangers; Other
-NTU Method.
omy;

ition, McGraw Hill, 2005.

dition, Academic Press, 2014.
vine,

CH253	Mass Transfer – I	PCC	3-1-0	4

Pre-requisites: CH201-Chemical Process Calculations, CH202- Fluid and Particle Mechanic

Course Outcomes: At the end of the course, the student will be able to:

CO1	Identify diffusion phenomena in various chemical processes.
CO2	Determine diffusivity coefficient in gases and liquids.
CO3	Calculate mass transfer coefficients at interfaces of multiphase mass transfer systen
CO4	Design equipment for gas-liquid mass transfer operations.

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	2	2	2	2	2	-	-	-	-	-	-	2	2
CO2	3	3	2	2	2	-	-	-	-	-	-	2	2
CO3	3	3	2	2	2	-	-	-	-	-	-	2	2
CO4	3	3	3	2	2	-	-	-	-	-	-	2	3

Detailed Syllabus

Introduction: Unit operations with mass transfer phenomena, Introduction to solute transport tube experiment to determine diffusion coefficient in gases, Fick's law of diffusion, Determin liquids, Diffusion of naphthalene into air – example, Two bulb method to determine diffusior Correlations for diffusion coefficient in gases and liquids, Dependence on temperature state diffusion: semi-infinite slab example, Correlation for diffusion coefficient in multi-c Formulation of flux with a reaction occurring on surface, Diffusion in solids.

Inter-Phase Mass Transfer: Pure liquid (stationary) to gas mixture (gently mixed), Concep and driving force, Pure gas (stationary) to liquid mixture (gently mixed), Pure gas to liquid Concept of Sherwood number, Sherwood number correlations for various geometries a Dimensional Analysis: The Route to Correlations, Theories of mass transfer coefficient flow, Two film resistance theory, Analogies between heat, mass and momentum transfer.

Equipment for Gas-Liquid Operations: Components of equipment in packed towers, B column, Tray towers, etc. Material balance for packed tower absorption process – Distribute parameter model, Equilibrium curve & Operating line, Concept of HtOG and NtOG - height c transfer units, Stage efficiency.

Humidification Operations: Terminology and definitions, Psychrometric charts, Adia & components, Non-adiabatic operation, Design of cooling tower and domestic air cool

Gas Absorption: Equilibrium solubility of gases in liquids, one component transferred - mater component transferred counter-current multistage operation, stage efficiency, continuous contact equipment, multicomponent systems and absorption with chemical reacti

Reading:

1. Treybal R.E., Mass Transfer Operations, 3rd Edition, McGraw Hill, 1981.
2. Geankoplis C.J., Transport processes and Separation Process Principles, 4th Editi
3. Binay K. Dutta, Principles of Mass Transfer and Separation Processes, 2nd Edition, Pren
4. E. L. Cussler, Diffusion – Mass transfer in fluid systems, 3rd Edition, Cambridge Universi
5. KV Narayanan and B Lakshmikutty, Mass Transfer – Theory and Applications, CE Pvt. Ltd., 2014.
6. Ernest J. Henley, J.D.Seader, D. Keith Roper, Separation Process Principles, Wile Edition, 2011.

Credits

cs

ns.

PSO2	PSO3
2	1
2	2
2	2
2	2

. Molecular Diffusion: Stefan
ation of diffusion coefficient in
ı coefficient in gases,
and pressure, Unsteady
component gaseous mixture,

t of mass transfer coefficient
(laminar falling film),
and flow regimes,
t for gas to turbulent liquid

ubble
ed

of transfer unit and number of

batic operation, Equipment
er.
rial balances, one

ion.

on, Prentice-Hall India, 2003.
tice- Hall India, 2007.
ty Press, 2009.
3S Publishers & Distributors

ey, 3rd

CH254	CHEMICAL REACTION ENGINEERING - I	PCC	3 – 1 – 0	4 C

Pre-requisites: CH201-Chemical Process Calculations, CH204-Chemical Enginee

Course Outcomes: At the end of the course, the student will be able to:

CO1	Derive the rate law for non-elementary chemical reactions.
CO2	Determine the kinetics of chemical reaction using integral, differential and fractional life methods.
CO3	Design reactors for homogenous reactions under isothermal conditions.
CO4	Select optimal sequence in multiple reactor systems
CO5	Design adiabatic plug flow reactor.
CO6	Analyze the performance of non-ideal reactors using segregation model, tanks series model and dispersion model.

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	3	3	3	1	-	-	-	-	-	-	-	3
CO2	3	3	3	3	-	-	-	-	-	-	-	-	3
CO3	3	3	3	3	-	-	-	-	-	-	-	-	3
CO4	3	3	3	3	-	-	-	-	-	-	-	-	3
CO5	3	3	3	3	-	-	-	-	-	-	-	-	3
CO6	3	3	3	3	1	-	3	-	-	-	-	-	3

Detailed syllabus

Kinetics of Homogeneous Reactions**:** Concentration-Dependent Term of a Rate Equat Term of a Rate Equation, Searching for a Mechanism, Predictability of Reaction Rate from T Conversion and Reactor Sizing**:** Definition of Conversion, Batch Reactor Design Equa Design Equations for Flow Reactors, Applications of the Design Equations for Continuous-F Series.

Analysis of Rate Data: The Algorithm for Data Analysis, Batch Reactor Data, Method of Ir
Lives, Differential Reactors, Experimental Planning, Evaluation of Laboratory Reacto
Isothermal Reactor Design: Mole Balances in Terms of Conversion- Design Structure
Scale-Up of Liquid-Phase Batch Reactor Data to the Design of a CSTR, Design of Continuo
(CSTRs), Tubular Reactors. Mole Balances Written in Terms of Concentration and Molar Fl
CSTRs, PFRs, and Batch Reactors, recycle reactor.
Non-Isothermal Reactor design: Energy balances, Adiabatic tubular reactor design.
RTD for Chemical Reactors: General Characteristics, Measurement of the RTD, Characteris
Reactors, Diagnostics and Troubleshooting, Reactor Modelling Using the RTD, Zero-Param
Multiple Reactions.
Analysis of non-ideal reactors**:** One- parameter models, two-parameter models, Tanks-in-Se
(T-I-S) Model, Dispersion Model, and Two-Parameter Models-Modelling Real Reactors
Reactors, Other Models of Non-ideal Reactors Using CSTRs and PFRs.

Reading:

1. H. Scott Fogler, Elements of Chemical Reaction Engineering, Prentice Hall India Learnir
2008.
2. O. Levenspiel, Chemical Reaction Engineering,Wiley India, 3rd Edition, 2006.
3. Ronald W. Missen, Charles A. Mims, Bradley A. Saville, Introduction to Chemical Reacti
Wiley, 1998.
4. E. Bruce Nauman, Chemical Reactor Design, Optimization and Scaleup, Wiley, 2nd Editi
5. Mark E. Davis & Robert J. Davis, Fundamentals of Chemical Reaction Engineering, McG
6. Martin Schmal, Chemical Reaction Engineering: Essentials, Exercises and Examples, C
7. S. Suresh and S. Sundaramoorthy, Green Chemical Engineering: An introduction
Catalysis, Kinetics, and Chemical Processes, CRC Press, 2015.

redits

ering Thermodynamics-I

-in	

PSO2	PSO3
3	1
3	2
3	3
3	3
3	1
3	3

tion, Temperature-Dependent
Theory.
ations,
Flow Reactors, Reactors in

ıitial Rates, Method of Half-
ɔrs.
for Isothermal Reactors,
ɔus Stirred Tank Reactors
ow Rate- Mole Balances on

stics of the RTD, RTD in Ideal
ɪeter Models, RTD and

ɛries
with Combinations of Ideal

ıg Private Limited, 4th Edition,

on Engineering & Kinetics,

ion, 2008.
Graw Hill, 2002.
RC Press, 2014
to

CH255	PROCESS INSTRUMENTATION	PCC	3 – 0 – 0	3 C

Pre-requisites: CH202-Fluid and Particle Mechanics.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Characterize the performance of instruments
CO2	Identify the measurement techniques for Pressure and Temperature
CO3	Select instruments for Flow and Level measurement
CO4	Choose recording, indicating and signaling instruments

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	-	1	3	2	-	-	-	-	-	-	1	-
CO2	3	-	1	3	1	-	-	-	-	-	-	1	-
CO3	3	-	1	3	1	-	-	-	-	-	-	1	-
CO4	3	-	1	3`	2	-	-	-	-	-	-	1	-

Detailed syllabus

Characteristics of Measurement System -Elements of instruments, static and dyr concepts of response of first order type instruments, mercury in glass thermometer, pressure spring thermometer, static accuracy and response of thermometers.

Pressure Measurement- Pressure, vacuum and head manometers, measuring elements for measuring pressure in corrosive liquids, measuring of absolute pressure, static accuracy an gages.

Temperature Measurement–Industrial thermocouples, thermocouple wires, thermowells thermocouples, Resistance Temperature Detector.

Flow Measurement-open channel meters, flow of dry materials, viscosity measurement.

Level Measurement- direct measurement of liquid level, level measurement in pressure vess interface level, level of dry materials. Differential Pressure Transmitter.

Concentration Measurements – Turbidity meter, Refractometer, colorimeter.

Instruments for Analysis - recording instruments, transducers, indicating and sigr instrumentation diagram.

Reading:

1. Patranabis D, Principles of Industrial Instrumentation, McGraw Hill Education, 3rd Editio
2. Eckman Donald P, Industrial Instrumentation, Wiley Eastern Ltd., 2004.
3. William C. Dunn, Fundamentals of Industrial Instrumentation and Process control, McGr
4. V.R. Radhakrishnan, Instrumentation and Control for the Chemical, Mineral and Metallu
Publishers Pvt. Limited, 1997.
5. K. Krishna swamy, Industrial Instrumentation, New Age International Publishers, 2003.

redits

PSO2	PSO3
3	1
3	1
3	1
3	1

namic characteristics, basic
bimetallic thermometer,

gage pressure and vacuum,
d response of pressure

and response of

sels, measurement of

naling instruments,

n, 2017.

aw Hill Education, 2017.
rgical Processes, Allied

CH256	CHEMICAL REACTION ENGINEERING LAB	PCC	0 – 1 – 2

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Determine the kinetics of a reaction in a Batch reactor, Semi batch reactor, CSTR, & PFR
CO2	Determine the kinetics of a variable volume reaction
CO3	Determine the kinetics by fractional conversion method
CO4	Determine the temperature dependency of a reaction
CO5	Evaluate the performance of reactors through RTD studies
CO6	Compare the performance of single reactor with combination of reactors

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	2	1	1	1	-	1	-	2	-	-	-	2
CO2	3	2	1	1	1	-	1	-	2	-	-	-	2
CO3	3	2	1	1	1	-	1	-	2	-	-	-	2
CO4	3	2	1	`1	1	-	1	-	2	-	--	-	2
CO5	3	2	1	1	1	-	1	-	2	-	-	-	2
CO6	3	2	1	1	1	-	1	-	2	-	-	-	2

Detailed syllabus:

1) Determine the concentration dependency of a reaction in a Batch reactor (BR)
2) Determine the concentration dependency of a reaction in a CSTR
3) Determine the concentration dependency of a reaction in a PFR
4) Determine the concentration dependency of a reaction in a Semi-batch reactor (SBR)
5) Determination of rate constant and temperature dependency of a reaction
6) Determination of rate constant in a combined reactor (PFR followed by CSTR)
7) Determination of rate constant in a Cascade CSTR (or CSTRs in series)
8) Determination of RTD characteristics of a packed bed reactor
9) Determine the kinetics by partial conversion method
10) Determine the kinetics of a variable volume reaction by Dilatometry
11) Determine the kinetics of Polymerization of acrylic acid in a batch reactor.

Reading:

1. Laboratory Manuals
2. Octave Levenspiel, Chemical Reaction Engineering, 2nd Edition, Wiley India, 2006.

2 Credits

PSO2	PSO3
3	1
3	1
3	1
3	1
3	1
3	1

CH257	HEAT TRANSFER LABORATORY	PCC	0 – 1 – 2	2 C

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Determine thermal conductivity of solids and fluids
CO2	Calculate efficiency of fins
CO3	Verify Newton's law of cooling of hot objects
CO4	Determine efficiency of Double Pipe and Shell & Tube Heat exchangers
CO5	Analyze condensation and boiling phenomena

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	2	1	2	2	2	-	1	-	3	2	1	2	2
CO2	2	1	2	2	2	-	1	-	3	2	1	2	2
CO3	2	1	2	2	2	-	1	-	3	2	1	2	2
CO4	2	1	2	2	2	-	1	-	3	2	1	2	2
CO5	2	1	2	2	2	-	1	-	3	2	1	2	2

Detailed syllabus

List of experiments:

1. Demonstration of the analogue between heat conduction in solids and electric conductic electrical resistances.
2. Determination of overall and individual plate thermal conductivity for a composite wall.
3. Determination of a rod type fin efficiency.
4. Determination of thermal conductivity of metal Rod.
5. Determination of heat transfer coefficient during natural convection from a heated vertic
6. Determination of Pin – Fin efficiency.
7. Determination of overall heat transfer coefficient of a double pipe heat exchanger.
8. Determination of overall heat transfer coefficient of a shell and tube heat exchanger.
9. Determination of radiation emissivity of a test plate.
10. Determination of Stefan-Boltzmann constant for radiation.
11. Determination of critical heat flux for a heat wire immersed in water
12. Determination of characteristics of drop-wise and film-wise condensation.

Reading: Lab manuals

redits

PSO2	PSO3
3	1
3	1
3	1
3	1
3	1

on in an L-shaped network of

al cylinder.

CH301	CHEMICAL REACTION ENGINEERING – II	PCC	3 – 0 – 0

Pre-requisites: CH253-Mass Transfer-I, CH254-Chemical Reaction Engineering-I

Course Outcomes: At the end of the course, the student will be able to:

CO1	Derive the rate law for gas-phase reactions catalyzed by solids.
CO2	Design fixed bed reactor in the absence and presence of mass transfer effects
CO3	Analyze the effect of velocity, particle size and fluid properties on rate of reactions cor mass transfer.
CO4	Determine internal and overall effectiveness factors.
CO5	Design reactors for fluid-fluid reactions

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	2	1	-	1	-	-	-	-	-	-	-	3
CO2	2	2	3	-	-	-	-	-	-	-	-	-	3
CO3	3	2	2	-	-	-	-	-	-	-	-	-	3
CO4	3	2	2	1	1	-	-	-	-	-	-	-	2
CO5	2	2	3	1	1	-	-	-	-	-	-	-	3

Detailed syllabus

Catalysis and Catalytic Reactors: Catalysts, Steps in a Catalytic Reaction, Synthesizing a Rat Rate-Limiting Step, Heterogeneous Data Analysis for Reactor Design.

External Diffusion Effects on Heterogeneous Reactions: Diffusion Fundamentals, B Resistance to Mass Transfer, Parameter Sensitivity, the Shrinking Core Model. Rate equation Design of heterogeneous catalytic reactors.

Diffusion and Reaction: Diffusion and Reaction in Spherical Catalyst Pellets, Interna Falsified Kinetics, Overall Effectiveness Factor, Estimation of Diffusion- and Reaction-Limit Transfer and Reaction in a Packed Bed, Determination of Limiting Situations from Reaction D Fluidized Bed Reactors.

Non-catalytic systems: Fluid-Fluid reactions: Kinetics, Fluid-Fluid Reactors: Design.

Reading:

1. H. Scott Fogler, Elements of Chemical Reaction Engineering, Prentice Hall India Learning 2008.
2. O. Levenspiel, Chemical Reaction Engineering, Wiley India, 3rd Edition, 2006.
3. J. M. Smith, Chemical Engineering Kinetics, 3rd Edition, McGraw Hill, 1981.
4. T. J. Carberry, Chemical and Catalytic Reaction Engineering, McGraw Hill, 1976.

3 Credits

ıtrolled by

PSO2	PSO3
2	1
3	1
2	1
1	1
2	1

e Law, Mechanism, and

inary Diffusion, External
for fluid solid reactions.

al Effectiveness Factor,
ed Regimes, Mass
Data, Multiphase Reactors,

Private Limited, 4th Edition,

CH302	MASS TRANSFER – II	PCC	3-1-0	4

Pre-requisites: CH251-Chemical Engineering Thermodynamics-II, CH253-Mass Transfer-I

Course Outcomes: At the end of the course, the student will be able to:

CO1	Analyse VLE, LLE, and SLE data
CO2	Select a suitable mass transfer operation for a given separation
CO3	Determine number of stages in distillation, extraction and adsorption operations
CO4	Estimate the height of packed column in distillation, extraction and adsorption operations
CO5	Calculate drying rates and moisture content for batch and continuous drying operations

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	2	2	2	2	-	-	-	-	-	-	2	2
CO2	3	2	2	2	2	-	-	-	-	-	-	2	2
CO3	3	2	3	2	2	-	-	-	-	-	-	2	3
CO4	3	2	3	2	2	-	-	-	-	-	-	2	3
CO5	3	2	2	2	2	-	-	-	-	-	-	2	2

Detailed syllabus

Distillation: Vapor-Liquid Equilibria, single stage operation - flash vaporization, differen continuous rectification - binary systems, multistage tray towers: Panchon and Savarit meth Steam distillation, Continuous contact equipment (packed towers), multicomponent syst Azeotropic distillation, hybrid distillation.

Liquid-Liquid Extraction: Liquid-Liquid equilibria, Extraction equipments, stage-wise con extractors and differential (continuous contact) extractors: immiscible and partially miscible s

Drying: Equilibrium, drying operations - batch drying, mechanism of batch drying and contin

Adsorption and Ion exchange: Adsorption equilibria, Batch and continuous adsorption, Sele of adsorbent, Specific surface area of an adsorbent, Adsorption Dynamics, Thermal regener

of adsorbents, Pressure swing adsorption, ion – exchange processes: Principles, Technique

Leaching: Methods of operation and equipment, unsteady state and steady state operation

Reading:

1. Treybal R.E., Mass Transfer Operations, McGraw Hill, 3rd Edition, 1981.
2. Geankoplis C.J., Transport processes and Separation Process Principles, Prentice-Hall In
3. Binay K. Dutta, Principles of Mass Transfer and Separation Processes, Prentice-Hall India
4. Narayanan, K. V. and Lakshmikutty, B., Mass Transfer – Theory and Applications, Distributors Pvt. ltd., 2014.
5. Seader, J. D. and Henley, E. J., Separation Process Principles with application using proc simulators, John Wiley & Sons, NY, 4th Edition, 2016.

Credits

PSO2	PSO3
2	1
2	1
2	1
2	1
3	1

tial or simple distillation,
od, McCabe-Thiele method.
ems, Extractive distillation,

tact, design of stage type
ystems.
uous drying, drying equipment.
ction
ation

s and applications.

dia, 4^{th} Edition, 2003.
ı, 2^{nd} Edition, 2007.
CBS Publishers &

ess

CH303	ELEMENTS OF TRANSPORT PHENOMENA	PCC	3 – 1 – 0

Pre-requisites:CH202-Fluid and particle mechanics, CH252-Heat Transfer, CH253-M Chemical Reaction Engineering-I

Course Outcomes: At the end of the course, the student will be able to:

CO1	Identify the transport properties of solids, liquids and gases
CO2	Formulate a mathematical representation of flow / heat / mass transfer phenomena.
CO3	Solve flow/heat/mass transfer problems either individually or coupled for simple geometries analytically.
CO4	Identify the similarities among the correlations for flow, heat and mass transfer interfaces.

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	
CO1	1	2	2	1	2	-	1	-	1	-	-	2	1	
CO2	3	2	2	2	1	-	1	-	1	1	-	2	2	
CO3	3	3	3	2	1	-	1	-	1	1	-	2	2	
CO4	3	2	2	2	1	-	1	-	1	1	-	2	2	

Detailed Syllabus:

Introduction: Properties of solids, liquids and gases; units and non-dimensionalization Momen of viscosity & mechanism of momentum transport, Continuity equation, Equation of motion, Laminar velocity profiles in simple geometries such as flow between parallel plates, flow in an inclined plane, Dimensional analysis of equations of change, Time dependent velocity pro turbulent flow, Time-smoothed equations of change for incompressible fluids, Turbulent Heat Transfer: Fourier's law of heat conduction & mechanism of heat transport, Heat conduct equation, and Temperature profile for simple geometries with/without heat generation, Tempe flowing fluids with/without heat generation, Equations of change for Non-isothermal system Temperature profile, and Natural
convection.

Mass Transfer: Fick's law of diffusion & mechanism of mass transport, Species balance equat diffusion and reaction, Diffusion in solids, Dispersion model for laminar flow in tubes, Equatio and Non-isothermal systems, Stefan tube experiment
– determination of diffusion constant.

Analogies: Analogies between momentum, heat & mass transfer correlations for frictio Number/Sherwood Number.

Reading:

1. Bird R.B., Stewart W.E. and Light Foot E.N. Transport Phenomena, John Wiley &Sons, 2
2. Geankoplis C.J., Transport Processes and Separation Process Principles, 4^{th} Editio
3. Bodh Raj, Introduction to Transport Phenomena: Momentum, Heat, and Mass, Prentice H Limited, 2012.
4. Sunil Kumar Thamida, Transport Phenomena: Chemical Processes, Studium Press (India Pvt. Ltd. 2016

4 Credits

ass Transfer-I, CH254-

at

PSO2	PSO3
3	1
3	2
3	2
3	2

tum Transfer: Newton's law
Navier-Stokes Equation,
a circular pipe, flow down
file, Velocity distributions in
flow correlations.
ion- convection-generation
rature profile in laminar
s, Time dependent

tion with convection-
ns of change for isothermal

n factor/Nusselt

nd Edition, 2007.

n, Prentice Hall Inc., 2009.
all India Learning Private

)

CH304	CHEMICAL TECHNOLOGY	PCC	3 – 0 – 0	3 C

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Selection of a process for manufacture of chemicals
CO2	Draw process flow diagrams.
CO3	Identify the engineering problems in chemical processes
CO4	List chemical reactions and their mechanism involved.

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	1	1	3	1	2	3	3	-	-	-	-	-	3
CO2	2	2	2	2	2	-	-	-	-	-	-	-	3
CO3	3	3	2	1	2	-	-	-	-	-	-	-	3
CO4	2	2	2	2	-	-	-	-	-	-	-	-	3

Detailed syllabus

Introduction: Chemical industries-facts and figures, Unit operation and unit process conce and role of chemical engineers.

Chloro-Alkali Industries: Soda ash, Solvay process, dual process, Natural soda ash from de Caustic soda.

Phosphorus Industries: Phosphoric acid, Wet process, Electric furnace process, Calci phosphates, Nitrophosphates, Sodium phosphate.

Potassium Industries: Potassium recovery from sea water.

Nitrogen Industries: Ammonia, Nitric acid, Urea from ammonium carbonate, Ammonium nitra Industries: Elemental sulfur mining by Frasch process, Sulfur production by oxidation-reduction of H Sulfuric acid. Contact process, Chamber process.

Soap and Detergents: Batch saponification production, Continuous hydrolysis and saponific process, Sulfated fatty alcohols, Alkyl-aryl sulfonates.

Sugar and Starch Industries: Sucrose, Extraction of sugar cane to produce crystalline white
cane to produce sugar, Starch production from maize, Production of dextrin by starch hydro
Fermentation Industries: Ethyl alcohol by fermentation, Fermentation products from petroleu
Industries: Sulfate pulp process, Chemical recovery from sulfate pulp digestion liquor, Types
materials, Methods of production.

Plastic Industries: Polymerization fundamentals, Polymer manufacturing processes, Eth
Polycondensation processes, Polyurethanes.

Rubber: Elastomer polymerization processes, Rubber polymers, Butadiene-Styrene copolym
based on silicon.

Cement Industries: Classification- based on source of cement, based on broad sense ceme
appearance and constituent of cement. Manufacturing methods- Wet
method, Dry method.

Reading:

1. Austin G.T., Shreve's Chemical Process Industries - International Student Edition, McGr
2. Sittig M. and Gopala Rao M., Dryden's Outlines of Chemical Technology for the 21st Cer
West Press, 2010.
3. B.K. Sharma, Industrial chemistry, 15th edition, Goel Publishing House (Krishna Prakash
2016.
4. James A. Kent, Riegel's Hand Book of Industrial Chemistry, Springer Science+Bu
Edition, Volume-1, 2013
5. Andreas Jess, Peter Wasserscheid, Chemical Technology, Wiley-VCH, 2013.
6. Smith W. and Chapman R., Chemical Process Industries, Vol 1 & 2, CBS Publishers, 1s
Edition, 2016.

:redits

PSO2	PSO3
2	-
2	-
2	-
2	-

:pts, Chemical processing

posits, Electrolytic process,

um phosphate, Ammonium

ate. Sulfur and Sulfuric Acid

$_2$S, Sulfur and sulfur dioxide from pyrites,

:ation

sugar, Extraction of sugar
olysis in a fluidized bed.
ım. Pulp and Paper
s of paper products, Raw

ıenic polymer processes,

ner, Polymer oils and rubbers

nt, based on the application,

aw Hill Inc., 5th Edition, 1998.
ntury, 3rd Edition, WEP East

ıan Media P. LTD.-Meerut),

siness Media, LLC, 9th

t

CH305	INDUSTRIAL SAFETY AND HAZARD MITIGATION	PCC	3 – 0 – 0	3

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Analyze the effects of release of toxic substances.
CO2	Select the methods of prevention of fires and explosions.
CO3	Identify the hazards and preventive measures.
CO4	Assess the risks using fault tree diagram.

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	2	2	3	-	-	3	3	2	-	-	-	-	2
CO2	2	2	3	-	-	3	3	2	-	-	-	-	2
CO3	2	2	3	-	-	3	3	2	-	-	-	-	2
CO4	2	2	3	-	-	3	3	2	-	-	-	-	2

Detailed syllabus

Introduction and Industrial Hygiene: Safety Programs, Engineering Ethics, Accident an Risk, Public Perceptions, Nature of the Accident Process, Inherent Safety, Anticipation and I Evaluation, Hygiene Control.

Fires and Explosions and Concepts to Prevent Fires and Explosions: Fire Triangle, Distinctic Explosions, Flammability Characteristics of Liquids and Vapors, Limiting Oxygen Conce Flammability Diagram, Inerting, Controlling Static Electricity, Explosion-Proof Equipment and Sprinkler Systems.

Introduction to Reliefs: Relief Concepts, Location of Reliefs, Relief Types, Relief Scenarios, Systems.

Hazards Identification: Process Hazards Checklists, Hazards Surveys, Hazards and Operab Safety Procedures and Designs: Process Safety Hierarchy, Managing Safety, Best Prac Procedures—Operating, Procedures—Permits, Procedures—Safety Reviews and Acc for Process Safety.

Reading:

1. D.A. Crowl and J.F. Louvar, Chemical Process Safety (Fundamentals with Applicat
Edition, 2011.
2. John Metcalf Coulson, John Francis Richardson, R.K. Sinnott, Coulson & Richards
Vol. 6, Butterworth-Heinemann, 1999.
3. Rulph King, Safety in the Process Industries, Butterworth-Heinemann, 1990.
4. K S N Raju, Chemical process Industry Safety, Tata McGraw-Hill Education, 2014.
5. F.P. Lees, Loss Prevention in Process Industries, Elsevier, 1996.

Credits

PSO2	PSO3
3	1
3	1
3	1
3	1

d Loss Statistics, Acceptable
Identification, Hygiene

on between Fires and
ntration and Inerting,
l Instruments, Ventilation,

Data for Sizing Reliefs, Relief

ility Studies, Safety Reviews.
tices,
cident Investigations, Designs

tions), Prentice Hall, 3rd

son's Chemical Engineering,

CH306	COMPUTATIONAL METHODS IN CHEMICAL ENGINEERING LAB	PCC

Pre-requisites:MA251-Mathematics-IV

Course Outcomes: At the end of the course, the student will be able to:

CO1	Determine roots of algebraic equations, solution of simultaneous equations, ar ordinary differential equations
CO2	Solve problems using regression analysis, interpolation, extrapolation and numerical differentiation and numerical integration
CO3	Solve problems involving material and energy balances, fluid flow operations, heat and mass transfer, evaporation, thermodynamics and mechanical operations.
CO4	Solve initial value problems, boundary value problems, & Initial and boundary valu problems

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	
CO1	3	3	1	1	2	-	-	1	2	2	1	2	1	
CO2	3	3	1	1	2	-	-	1	2	2	1	2	1	
CO3	3	3	3	2	3	-	-	1	2	2	1	2	2	
CO4	3	3	1	2	3	-	-	1	2	2	1	2	2	

Detailed syllabus:

Numerical Methods: Roots of algebraic equations and solution of simultaneous equatior Interpolation and Extrapolation, Differentiation and Numerical Integration, Solution of ordinary and Boundary Value Problems

Applications of Numerical Methods to Chemical Engineering Problems: Material and Ene Balance, Fluid flow operations, Heat transfer, Mass Transfer, Thermodynamics, Mechani properties.

Reading:

1. Rudra Pratap, Getting started with MATLAB: A quick introduction for scientists & Engineers 2010.

2. Laurene V. Fausett, Applied Numerical Analysis using MATLAB, Pearson, 2nd Editio

3. Alkis Constantinides, Navid Moustoufi, Numerical Methods for Chemical Engineers w Prentice Hall, 1999.

4. Niket S. Kaisare, Computational Techniques for Process Simulation and Analysis us Francis, CRC press, 2018.

5. Lab Manuals

0-1-2	2 Credits

nd
e

PSO2	PSO3
2	2
2	2
2	2
2	2

ns, Regression analysis,
differential equations, Initial

ergy
ical operations, Prediction of

s, Oxford University Press,

n, 2009.
vith MATLAB Applications,

sing MATLAB, Taylor &

CH307	MASS TRANSFER LABORATORY	PCC	0 – 1 – 2

Pre-requisites: CH253-Mass Transfer-I

Course Outcomes: At the end of the course, the student will be able to:

CO1	Determine separation performance of batch distillation, steam distillation, sieve plate and distillation
CO2	Determine the efficiency of liquid-liquid extraction
CO3	Determine the critical moisture content in drying
CO4	Determine the effect of mass transfer with and without chemical reaction
CO5	Estimate the diffusion coefficient of vapour in gas
CO6	Determine the performance of gas-liquid and liquid-solid operations

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	2	2	1	1	1	2	1	-	-	-	2	1	2
CO2	2	2	2	1	1	2	1	-	-	-	2	1	2
CO3	3	2	2	2	1	2	1	-	-	-	2	1	2
CO4	2	2	2	1	2	2	1	-	-	-	2	1	2
CO5	2	2	3	1	1	2	1	-	-	-	2	1	2
CO6	2	2	2	2	1	2	1	-	-	-	2	1	2

Detailed Syllabus:

1. Verify the law of steam distillation
2. Verify the Rayleigh's equation for differential distillation
3. Determine the height equivalent to a theoretical plate (HETP) of a packed bed distillation c at total reflux
4. Determine the number of theoretical plates of a given sieve plate distillation column for the
5. Determine the diffusivity of a vapor in air
6. Determine the drying characteristics of a given sample (wet sand) by drying in a force draf

7. Find the overall recovery of solute in a single as well as two stage cross current extraction
8. Determine distribution coefficient for liquid-liquid extraction
9. Determine the saturation isotherm for the ternary liquid – liquid system
10. Study the absorption of carbon dioxide by aqueous sodium hydroxide solution in a packec
11. Calculate the theoretical and experimental mass transfer coefficient for vaporization a packed bed of spherical particles of naphthalene
12. Study the dissolution of benzoic acid in water and in aqueous solution of sodium hydroxid
13. Study the adsorption in a packed bed for a solid liquid system.

Reading: Lab Manuals

2 Credits

packed bed

PSO2	PSO3
3	-
3	-
2	-
3	-
3	-
2	-

:olumn for the given system

; given system at total reflux

ft tray drier.

unit

d bed absorption tower
of naphthalene in air using

e

CH311	PHARMACEUTICALS AND FINE CHEMICALS	DEC	3 – 0 – 0

Pre-requisites: CY201-Industrial Organic Chemistry

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand the grades of chemicals.
CO2	State properties, uses and testing of pharmaceuticals and fine chemicals
CO3	Draw flow sheets for manufacture of pharmaceuticals and fine chemicals
CO4	Understand tablet making and coating, preparation of capsules and extraction of crud
CO5	Understand sterilization.

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	2	3	2	-	2	2	2	-	-	-	-	2
CO2	3	2	3	2	-	2	2	2	-	-	-	-	2
CO3	3	2	3	2	-	2	2	2	-	-	-	-	2
CO4	3	2	3	2	-	2	2	2	-	-	-	-	2
CO5	3	2	3	2	-	2	2	2	-	-	-	-	2

Detailed Syllabus:

A brief outline of different grades of chemicals – Reagent grade and Laboratory grade.
Outlines of preparation – Different methods of preparation of Reagent grade and Laboratory g
Uses and testing of the pharmaceuticals and fine chemicals – Applications of medicinal value quality testing procedures.
Properties, assays and manufacture of Pharmaceuticals and fine chemicals with flow sh Chemical properties, methods of assessing the quality and industrial methods of formulating chemicals that have no medicinal value but are used as the intermediates.
Compressed Tablet making and coating – Types of tablets and Methods of compressed table making and coating.

Preparation of capsules and extraction of crude drugs – Industrial procedures of capsu methods of recovering the drugs formulated from the reaction mixture.
Sterilization – Need for sterilization, Sterilization methods, batch and continuous sterilization.

Reading:

1. Remington, Pharmaceutical Sciences, Mak. Publishing Co., 16th Edition, 1980.
2. William Lawrence Faith, Donald B. Keyes and Ronald L. Clark, Industrial Chemical Sons, 1975.

3 Credits

e drugs.

PSO2	PSO3
2	-
2	-
2	-
2	-
2	-

grade Chemicals.
e Chemicals and their

ıeets- Physical and
the drugs and fine

t

ule formulation and

s, 4^{th} Edition, John Wiley &

CH312	RENEWABLE ENERGY SOURCES	DEC	3-0-0	3 C

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Identify the challenges and problems associated with the use of energy sources.
CO2	Illustrate the renewable energy technologies.
CO3	Distinguish conversion technologies for solar, wind, biomass and hydrogen en
CO4	Evaluate the performance of energy conversion technologies

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	2	3	1	-	-	1	3	-	-	-	-	-	1
CO2	2	3	1	2	-	2	3	-	-	-	-	-	3
CO3	1	2	2	1	-	2	2	-	-	-	-	-	3
CO4	2	3	2	1	1	2	3	-	-	-	-	-	2

Detailed syllabus:

Sources of energy: Energy sources and their availability, renewable energy sou Introduction, Biomass as a source of energy, Biomass conversion technologies, Bioga of biogas plants, Biomass gasification. Solar Energy: Sun and solar energy, solar radi solar energy collectors, solar energy storage, Photovoltaic systems, Applicat Wind Energy: Wind as an Energy source, Basic principles of wind energy conversion, Types Components of wind energy conversion system, Performance of wind machines, application Geothermal Energy: Introduction, Origin and distribution of geothermal energy, types (Hybrid geothermal power plant, Application of geothermal energy Hydrogen energy: In production, Hydrogen storage, Hydrogen transportation Energy from the Oceans: Introductic Conversion (OTEC), Energy from Tides, Ocean Waves Chemical Energy Sources.

Introduction to Fuel cells, and Batteries

Reading:

1. Rai, G.D, Non-Conventional Energy Sources, Khanna Publishers, New Delhi, 2010.
2. Rajesh Kumar Prasad, T.P. Ojha, Non-Conventional Energy Sources, Jain Brother
3. Sukhatme S.P and J. Nayak, Solar energy – Thermal Collection and storage, 3^{rd} Edition,
Pvt. Ltd., 2008.
4. MM. El Wakil, Power Plant Technology, Tata McGraw Hill, New York, 1999.

ːredits

ıergies

PSO2	PSO3
2	-
1	-
2	-
3	-

ırces. Energy from Biomass:
ıs generation, classification
ation and its measurement,
ːion of solar energy
ː of Wind machines,
of wind energy.
of geothermal resources,
troduction, Hydrogen
ɔn, Ocean Thermal Electric

s, 2012.
, Tata McGraw Hill Education

CH313	FUEL CELLS AND FLOW BATTERIES	DEC	3 – 0 – 0

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Describe working principles of fuel cells and flow batteries
CO2	Analyze the performance of fuel cell systems.
CO3	Identify intricacies in construction and operation of fuel cell stack and fuel cell system.
CO4	Discuss construction and operation of flow battery cells and stack

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	2	2	3	2	1	1	2	-	2	2	-	1	1
CO2	2	2	3	2	1	1	2	-	2	2	-	1	1
CO3	2	2	3	2	1	1	2	-	2	2	-	1	1
CO4	2	2	3	2	1	1	2	-	2	2	-	1	1

Detailed syllabus

Introduction - Electrochemical Flow Systems - Fuel cells and Flow Batteries.

Overview of Fuel Cells: Introduction, brief history, classification, working principle, applications and thermodynamics, heat of reaction, theoretical electrical work and potential, theoretical fue

Fuel cell electrochemistry: electrode kinetics, types of voltage losses, polarization curve, fuel c equation, exchange currents.

PEM Fuel cell process design: Main PEM fuel cell components, materials, properties a operating conditions.

Fuels &Fuel processing: Hydrogen, Hydrocarbon fuels, Direct and in-direct internal reforn steam, CO_2 and partial oxidation, Direct electro-catalytic oxidation of hydrocarbons, carbon decomposition, Su removal.

Flow batteries: Introduction, Redox flow battery technology - brief history, working principle, r flow battery components and systems, flow battery testing

Flow Battery Types and Challenges: iron/chromium, Bromine/polysulphic Zinc/cerium and All Vanadium flow batteries, current research trends and challenges.

Reading:

1. F. Barbir, PEM Fuel Cells: Theory and Practice, Elsevier/Academic Press, 2nd Edition, 2013
2. Huamin Zhang, Xianteng Li, Jiujun Zhang,Redox flow batteries: Fundamentals a Press, 2017.
3. O'Hayre, R. P., S. Cha, W. Colella, F. B. Prinz, Fuel Cell Fundamentals, Wiley, New York, 2
4. Kirt A. Page, Christopher L. Soles, James Runt, Polymers for Energy storage and Delivery: Batteries and Fuel cells, OUP USA, 2012.
5. James Larminie, Andrew Dicks, Fuel Cell Systems Explained, Wiley, 2nd Edition, 2003.
6. Hoogers G., Fuel Cell Technology Hand Book, CRC Press, 2003.

3 Credits

PSO2	PSO3
3	1
3	1
3	1
3	1

s, Fuel cell basic chemistry
el cell efficiency.
cell efficiency, Tafel

and processes, Fuel cell

ning, Reformation of hydrocarbons by
ulphur tolerance and

edox

de, Vanadium/bromine,

'.
ınd Applications, CRC

!006.
Polyelectrolytes for

CH314	ENERGY MANAGEMENT	DEC	3-0-0

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Discuss effective energy management policies, methods and planning
CO2	Carry out energy audit and economic analysis
CO3	Explain energy management control schemes
CO4	Design energy utilization systems for heat recovery
CO5	Select energy security and reliability methods

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	-	-	3	-	-	3	3	-	-	1	2	1	1
CO2	1	1	2	1	1	3	3	-	-	1	2	1	1
CO3	1	1	2	1	1	3	3	-	-	1	2	1	1
CO4	2	3	2	1	1	3	3	-	-	1	2	1	1
CO5	-	-	3	1	1	3	3	-	-	1	2	1	1

Detailed syllabus:

Introduction: The value of Energy management, suggested principles of energy managemer Management: Energy Policy and planning.

Energy auditing and Economic analysis: Energy auditing services, Basic components Industrial, commercial and residential audits, General characteristics of capital investme worth.

Boilers and fired systems, Steam and condensate systems, Cogeneration, Waste heat reco control systems, energy systems maintenance.

Thermal Energy Storage: Storage system, Storage mediums.

Control systems: The fundamental control loop, sensors, controllers, control strategies, cont control of primary equipment, control of distribution systems, and advanced technology for e

Energy security and Reliability: Risk analysis methods, economics of energy security reliability, links to energy management.

Financing and commissioning energy management projects.

Reading:

1. Murphy W.R and Mckay G., Energy Management, Elsevier, 2007.

2. Wayne C. Turner, Steve Doty, Energy Management Handbook, CRC Press, 6th Edition, 2

3 Credits

PSO2	PSO3
-	-
2	2
2	-
2	2
2	2

ıt Effective Energy

of an energy audit,
ɜnts, project measures of

ʋery. Energy management

rol of Air handling units,
ɜffective facility control.
and

007.

CH315	CORROSION ENGINEERING	DEC	3 – 0 – 0

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Identify various forms of corrosion.
CO2	Determine corrosion rates for metals from their polarization curves.
CO3	Analyze corrosion rate characteristics from electrochemical impedance spectroscopy.
CO4	Select suitable corrosion resistant coatings, oxide layers for various applications.

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	1	2	1	2	2	1	2	-	1	-	-	2	1
CO2	2	2	1	2	2	1	2	-	1	-	-	2	1
CO3	2	2	1	2	2	1	2	-	1	-	-	2	1
CO4	1	2	3	2	2	1	2	-	1	-	-	2	1

Detailed syllabus

Introduction & Corrosion Principles: Definition of corrosion, Impact on economy, electrochemi expressions, Polarization, Passivity, Metallurgical aspects.

Eight Forms of Corrosion: Galvanic corrosion, crevice corrosion, pitting, intergranular corrosio corrosion, hydrogen damage.

Corrosion testing: Specimen preparation, exposure tests, open corrosion potential, linea corrosion current, stress corrosion cracking, AC impedance/EIS. Corrosion Prevention: Cath anode methods of corrosion prevention, Anti-corrosion coatings.

Modern Theory-Principles & Applications: Alloy evaluation, Nobel metal alloying, flow accelera corrosion as a moving boundary problems.

Introduction to high voltage corrosion.

Reading:

1. Fontana M, Corrosion Engineering, Tata McGraw Hill Education Pvt. Ltd., 3rd Edition, 201
2. Pierre Roberge, Corrosion Engineering: Principles and Practice, McGraw Hill, 2008.
3. Denny A. Jones, Principles and Prevention of Corrosion, Pearson-Prentice Hall, 2nd Editio
4. Nestor Perez, Electrochemistry and Corrosion Science, Springer, 2nd Edition, 2016.
5. Branko N. Popov, Corrosion Engineering: Principles and Solved Problems, Elsevier, 2015

3 Credits

PSO2	PSO3
3	1
3	1
3	1
3	1

cal reactions, Corrosion rate

n, erosion corrosion, stress

ır polarization, Tafel slopes,
odic protection, sacrificial

ated corrosion, galvanic

0.

n, 2005.

.

CH316	NANOTECHNOLOGY	DEC	3 – 0 – 0

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand the properties of nanomaterials and their applications
CO2	Apply chemical engineering principles to nanoparticles production and scale-up
CO3	Solve the quantum confinement equations.
CO4	Analyze the nanomaterials characterization.
CO5	State the applications of nanotechnology in electronics and chemical industries.

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	1	1	1	-	-	-	-	-	-	-	-	1
CO2	3	2	2	1	-	-	-	-	-	-	-	-	3
CO3	3	3	1	1	-	-	-	-	-	-	-	-	2
CO4	2	1	1	1	-	-	-	-	-	-	-	-	1
CO5	1		1	-	-	-	2	-	-	-	-	1	2

Detailed syllabus

Introduction to Nanotechnology: Introduction to nanotechnology and materials, Nanomaterial and properties comparison with the bulk materials, different shapes and sizes and morpholog

Fabrication of Nanomaterials: Top Down Approach, Grinding, Planetary milling and Compari Approach, Wet Chemical Synthesis Methods, Microemulsion Approach, Colloidal Nanoparticl Methods, Sonochemical Approach, Microwave and Atomization, Gas phase Production Meth Depositions.

Kinetics at Nanoscale: Nucleation and growth of particles, Issues of Aggregation of Particle hindrance, Layers of surface Charges, Zeta Potential and pH.

Carbon Nanomaterials: Synthesis of carbon buckyballs, List of stable carbon allotropes exten fullerenes, metallofullerenes solid C60, bucky onions nanotubes, nanocones Difference betw processes and nanosynthesis processes.

Quantum mechanics: Quantum mechanics Quantum dots and its Importance, Pauli exclusio equation, Application of quantum Dots: quantum well, wire, dot, characteristics of of quantum dots, Semiconductor quantum dots, Introduction - Nanoclay Synthesis method Nanomaterials characterization: Instrumentation Fractionation principles of Particle si size and its distribution, XRD, Zeta potential Microscopies SEM, TEM, Atomic Forced Microsc Tunneling Microscopy

Applications in Chemical Engineering: Self-assembly and molecular manufacturing : Surfacta applications, ZnO, TiO_2, Silver Nanoparticles Functional materials Applications, Production Techniques of Nanotu synthesis, commercial processes of synthesis of nanomaterials, Nanoclay, Commercial case applications inchemical engineering, Nanoinorganic materials - $CaCO_3$ synthesis, Hybrid wastewater treatment syste sensor applications,

Nanobiology: biological methods of synthesis. Applicationsin drug delivery, Nanocontainers a active agents, Layer by Layer assembly for nanospheres, Safety and health Issues of na Impacts, Case Study for Environmental and Societal Impacts.

Reading:

1. KulkarniSulabha K., Nanotechnology: Principles and Practices, Capital Publishing Compa
2. Gabor L. Hornyak., Harry F. Tibbals, JoydeepDutta, John J. Moore, Introduction to Nanotechnology, CRC Press, 2009.
3. Robert Kelsall, Ian Hamley, Mark Geoghegan, Nanoscale Science and Technology, John
4. Stuart M. Lindsay, Introduction to Nanoscience, Oxford University Press, 2009.
5. Davies, J.H. The Physics of Low Dimensional Semiconductors: An Introduction, Cambridg
6. B. Viswanathan, Nano Materials, Alpha Science2009.
7. T. Pradeep, Nano - The essentials understanding nanoscience and nanotechnology, The

3 Credits

PSO2	PSO3
1	1
2	1
-	-
-	-
-	-

s, Introduction to nanosizes
y.
on of particles, Bottom Up
es Production, Sol Gel
ods : Chemical Vapour

es, Oswald Ripening, Stearic

ded
een Chemical Engineering

n principle Schrödinger's
quantum dots, Synthesis
, Applications of nanoclay.
ize measurements, Particle
opy, Scanning and

nt based system Colloidal system

bes, Carbon arc, bulk
study of nano synthesis -
ms, Electronic Nanodevices,

nd Responsive Release of
nomaterials, Environmental

ny, 2007.
Nanoscience and

Wiley & Sons, 2005.

ge University Press, 1998.

McGraw Hill, 2007.

CH317	**POLYMER TECHNOLOGY**	**DEC**	**3 – 0 – 0**

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand thermodynamics of polymer structures
CO2	Select polymerization reactor for a polymer product.
CO3	Characterize polymers.
CO4	State polymer additives, blends and composites.
CO5	Understand polymer rheology.
CO6	Identify suitable polymer processing methods

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	1	1	1	1	-	-	-	-	-	-	-	3
CO2	2	2	3	1	1	-	-	-	-	-	-	-	2
CO3	2	1	-	-	-	-	-	-	-	-	-	-	2
CO4	2	-	-	-	-	-	-	-	-	-	-	-	1
CO5	2	-	2	-	-	-	-	-	-	-	-	-	2
CO6	2	2	1	2	-	-	-	-	-	-	-	-	2

Detailed Syllabus:

Introduction and Classification of Polymers. Thermosets, Factors influencing the polyme used for polymer synthesis, synthesis procedure for monomers Styrene, ethylene, Vinyl monc Linear Branch, Cross Linked Polymers, Ewart Kinetics for emulsion polymerization.

Addition polymers – kinetics, synthesis and reactions, Condensation polymers, Kinetics reacti Polymerization Techniques - Emulsion polymerization and Suspension polymerization with their merits

Molecular Weights, Polydispersity Index, Different Methods of determination of Molecular weig weight on Engineering Properties of Polymers, Smith Ewart Kinetics for emulsion polymerization, Kinetics of free radical polymerization, Chain transfer agents, Kinetic of Step growth polymerization, Ziegler Natta polymerization Processes, Differentiation based (cationic polymers.

Polymerization reactors types and mode of operation, Polymerization reactor design, control c polymerization unit operations and unit processes

High Performance and Specialty Polymers, Polymer additives, compounding. Fillers, plasticize UV stabilizers, fire retardants and antioxidants.

Impact, flexural tensile testing methods of polymers, Mechanical Properties of Polymers Polymer Mixtures, ASTM and ISO methods for testing of polymers.

Polymer processing: Extrusion process, Twin and Single Screw extrusion, Blow mouldir and Dry spinning processes, thermo set moulding. Processing of polymer nanocomposites.

Manufacturing of polymers: flow-sheet diagrams, properties & applications of PE, PP, I Polyesters, Nylons, ABS and PC.

Reading:

1. Fried J R, Polymer Science and Technology, Prentice Hall of India Pvt. Ltd., New De EconomyEdition, 2000.
2. Premamoy Ghosh, Polymer Science and Technology, Tata McGraw Hill Publis 3rd Edition, 2010.
3. R. Sinha, Outlines of Polymer Technology: Manufacture of Polymers, Prentice Hall of Indi 2002.
4. George Odian, Principles of Polymerization, John Wiley & Sons, Inc., 2004.

3 Credits

PSO2	PSO3
2	1
3	1
-	-
-	-
-	-
2	-

er properties, Monomers
omers etc., Thermoplastics,

on and processes,
, Interfacial Polymerization

ght, Effect of Molecular

cs

on kinetics of Anionic and

of polymerization, Post

ers, lubricants, colorants,

s, Thermodynamics of

ng, injection moulding, Wet

PS,

elhi, Eastern

shing Company, New Delhi,

a Pvt. Ltd., New Delhi,

CH318	MATERIAL SCIENCE FOR CHEMICAL ENGINEERS	DEC	3 – 0 – 0

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Select methods of characterization of engineering materials
CO2	Identify materials for applications in chemical process industry
CO3	Assess the life time of materials under different process environments
CO4	Analyze the interactions between materials of construction of equipment and th chemicals processed

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	2	2	1	2	3	1	2	-	1	-	-	2	1
CO2	1	2	1	2	2	1	2	-	1	-	-	2	1
CO3	1	2	1	2	2	1	2	1	1	-	-	2	1
CO4	1	2	1	2	2	1	2	1	1	-	-	2	1

Detailed Syllabus:

Introduction: Composition of Earth, Natural versus synthetic materials, The Periodic Tal Refractory materials, Plastics and Polymers

Characterization techniques of metal alloys: Atomic structure, Metal alloy compositio Mechanical properties, Corrosion properties, Erosion Properties, Electrical properties, I Manufacturing Methods: minerals and extraction of iron, aluminium, magnesium copper & gol surface finishing, semiconductors for electronic chips, polymers & plastics Selection of MOC: cantilever, pressure vessels, corrosion factor for chemical

contact, waste water treatment plants, water pipelines, crude oil pipelines

Reading:

1. Brian S. Mitchell, An Introduction to Materials Engineering and Science: For Chemical anc Wiley & Sons, Inc., 2004.
2. Anderson J.C., Leaver K.D., P. Leevers & Rawlings R.D., Material Science for Engineers, CRC Press, 5th Edition, 2003.
3. Subramaniam R., Callister's Material Science and Engineering, Wiley, 2nd Edition, 2014.
4. V. Raghavan, Materials Science and Engineering: A First Course, Prentice Hall Inc 6th Edition, 2015.
5. O.P. Gupta, Elements of Fuels, Furnaces, & Refractories, Khanna Publishers, 2002.

3 Credits

e	

PSO2	PSO3
3	1
3	1
3	1
3	1

ble, Metals, Ceramics,

n, microstructure,
Magnetic properties
d, Electrometallurgy,
mechanical design –

d Materials Engineers, John

lia Learning Private Limited,

CH351	PROCESS DYNAMICS AND CONTROL	PCC	3 – 1 – 0

Pre-requisites: MA201-Mathematics-III

Course Outcomes: At the end of the course, the student will be able to:

CO1	Evaluate the dynamic behavior of processes
CO2	Analyze stability of feedback control system
CO3	Design PID controllers
CO4	Determine frequency response for controllers and processes
CO5	Apply advanced control schemes for processes
CO6	Identify the characteristics of control valves

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	3	3	3	3	-	-	-	-	-	-	1	2
CO2	3	3	3	2	3	-	-	-	-	-	-	1	2
CO3	3	2	3	3	3	-	-	-	-	-	1	1	2
CO4	3	3	2	`3	3	-	-	-	-	-	-	1	1
CO5	3	3	3	3	3	-	-	-	-	-	1	1	2
CO6	3	3	3	2	3	-	-	-	-	-	-	1	3

Detailed Syllabus:

Introduction to process control. Laplace transforms.

Response of first order systems: Transfer Function, Transient Response, Forcing Functions a of first and second order systems. Linearization, Transportation Lag.

State space models – linear and nonlinear models. Linearization.

Components of a control system, Development of Block Diagrams, Controllers and Final Cont Transfer functions: Standard Block-Diagram Symbols, Transfer Functions for Single-Loop Sys Systems.

Transient response of simple control systems: Servo Problem, Regulatory Problem, Controlle Proportional-Integral, PID Controllers. Ziegler-Nichols and Cohen-Coon Controller Settings. M design methods: direct synthesis method and IMC method.

Stability: Routh Test and Root Locus Techniques.

Introduction to frequency Response: Substitution Rule, Bode Diagrams. Control system desig
response: Bode and Nyquist Stability Criterion, Gain and Phase Margins.
Advanced Control Strategies: Cascade Control, Feed-forward Control, Ratio Control, Dead-Ti
Predictor), Split Range Control.
Control Valves: Types of Control Vales, Valve Sizing, Valve Characteristics, Valve Positioner.

Reading:

1. Coughanowr D.R., Process System analysis and Control, McGraw Hill, 3rd Edition, 2012.
2. Seborg D.E., Edgar T. E.,Millichamp D.A. and Doyle, F., Process Dynamics and Control, J
Edition, 2010.
3. Stephanopolis G., Chemical Process Control, Prentice Hall India, 2008.
4. B. Wayne Bequette, Process Control: Modeling, Design and Simulation, Prentice Hall India
2003.
5. Romagnoli, J. A. and Palazoglu, A., Introduction to Process Control, CRC Press, 2nd Editio
6. Corriou, J.P., Process Control: Theory and Applications, Springer, 2nd Edition, 2018.
7. K. Krishnaswamy, Process Control, New age publishers, 2009.

4 Credits

PSO2	PSO3
3	3
3	3
3	3
3	3
3	3
3	2

nd Responses. Examples

rol Elements. Closed loop
stems and Multi-loop

rs: Proportional,
odel based controller

ɡn based on frequency

me Compensation (Smith

ohn Wiley & Sons, 3rd

Learning Private Limited,

ı, 2012.

CH352	PROCESS EQUIPMENT DESIGN	PCC	3-1-0	4 cre

Pre-requisites:CH202-Fluid and Particle Mechanics; CH252-Heat Transfer; CH301-Che CH302-Mass Transfer-II

Course Outcomes: At the end of the course, the student will be able to:

CO1	Evaluate the process design considerations of separation columns and heat transfe equipment
CO2	Draw process flow diagrams and process instrumentation diagrams
CO3	Apply mechanical design concepts to process equipment
CO4	Design heat exchangers, evaporators, absorbers, distillation columns, reactors

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	-	2	-	-	1	-	-	-	-	-	2	3	3
CO2	-	2	-	-	1	-	-	-	-	-	-	-	3
CO3	2	-	3	3	2	2	-	-	-	-	-	-	3
CO4	2	-	3	3	2	3	-	-	-	-	-	-	3

Detailed syllabus:

Introduction to process design of Separation columns (Distillation, Absorption, and Extraction design considerations, process design methods, Column sizing, Plate and packed column hy Process design of heat-transfer equipment: Types of heat exchanger, Process design of she Condenser, and reboilers.

Drawing: Drawing of process equipment symbols for fluid handling, heat transfer, mass trans operations Detailed drawing of equipment, Drawing of process flow diagram, Piping and (P&ID), Vessel and piping layout isometrics.

Mechanical Design of Process Equipment: Introduction to mechanical aspects of chem Design Preliminaries, Design of cylindrical and spherical vessels under internal pressure, ext loading, Design of heads and closers, Design of tall vessels. Design of a heat exchanger, Design of a distillation column,

Design of evaporator, Design of condenser, Design of a chemical reactor.

Reading:

1. R.K. Sinnott, Coulson & Richardson's Chemical Engineering, Volume 06, Elsevier, 3rd Ed
2. Robert E. Treybal, Mass Transfer Operations, McGraw Hill Education, 3rd Edition, 1980.
3. Donald Q. Kern, Process Heat Transfer, Tata McGraw-Hill Education, Indian Editio
4. Bhattacharya B.C., Introduction to Chemical Equipment Design- Mechanical Aspects, C Distributors, 2008.
5. Mahajani V.V. and Umarji S.B., Joshi's process equipment design, Trinity Press, 4th Editi
6. Brownell L.E, Process Equipment Design - Vessel Design, Wiley Eastern Ltd., 1986.
7. Towler G. P. and R. K. Sinnott, Chemical Engineering Design, Principles, Practice Process Design, Butterworth Heinemann, 2nd Edition, 2012.
8. Nicholas O Cheremisinoff, Handbook of chemical process equipment, Butterwo Heinemann, 2000.

edits

mical Reaction Engineering-II;

r

PSO2	PSO3
-	1
-	1
-	1
-	1

): Design variables, general
draulics design.
ll and tube heat exchanger,

fer, and mechanical
instrumentation diagram

ical equipment design,
ernal pressure and combined
Design of an absorber,

lition, 2005.

n, 1st Edition, 2017.
BS Publishers and

on, 2014.

and Economics of Plant and

orth-

CH353	PETROLEUM REFINING PROCESSES	3	1	0	4

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Characterize the petroleum and petroleum products
CO2	Identify the methods involved in crude preprocessing
CO3	Design the fractionating column for crude
CO4	Differentiate the treatment techniques involved in post processing of crude
CO5	Apply the process flow technologies for crude conversion to fuels

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	
CO1	3	3	-	-	2	3	3	-	-	-	-	-	3	
CO2	1	3	-	-	-	-	3	-	-	-	-	-	3	
CO3	3	3	-	-	3	1	3	-	-	-	-	-	3	
CO4	3	3	-	`-	-	1	3	-	-	-	-	-	3	
CO5	3	3	-	-	-	-	3	-	-	-	-	-	3	

Detailed syllabus:

Origin, formation and composition of petroleum: Origin and formation of petroleum, Reserves a Petro Glimpses and petroleum industry in India, Composition of petroleum . Petroleum proce Petroleum, Thermal properties of petroleum fractions, important products-properties and test m Fractionation of petroleum: Dehydration and desalting of crudes, heating of crudes, Distillation gasoline.

Treatment techniques: Fractions-Impurities, Gasoline treatment, Treatment of keroser Wax and purification.

Thermal and catalytic processes: Cracking, Catalytic cracking, Catalytic reforming-introductic and theory, Naptha cracking, Coking, Hydrogen processes, Alkylation, Isomerization processe:

Reading:

1. B.K. Bhaskara Rao, Modern Petroleum Refining Processes, 4^{th}Edition, Oxford& IBH 2008.
2. J.G. Speight, and B. Ozum, Petroleum Refining Processes, Marcel Dekker, 2002.
3. Mohamed A. Fahim, Taher A. Al-Sahhaf, Amal Elkilani, Fundamentals of Petroleum Refinir
4. R. A. Meyers, Hand Book of Petroleum Refining Processes, McGraw Hill, 3^{rd} Edition, 2003

PCC

PSO2	PSO3
3	3
3	3
3	3
3	3
3	3

ınd deposits of world,
əssing data: Evaluation of
ıethods
of petroleum, blending of

ıe, Treatment of lubes,

ɔn
s, Polymer gasoline.

Publishing Co. Pvt. Ltd.,

ıg, Elsevier Science, 2010
.

CH354	POLLUTION CONTROL IN PROCESS INDUSTRIES	DEC	3 – 0 – 0

Pre-requisites: CH304-Chemical Technology

Course Outcomes: At the end of the course, the student will be able to:

CO1	Analyze the effects of pollutants on the environment.
CO2	Distinguish air pollution control methods
CO3	Assess treatment technologies for wastewater
CO4	Identify treatment technologies for solid waste

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	1	2	2	-	1	2	1	1	1	1	1	1
CO2	3	1	2	2	-	1	2	1	1	1	1	1	1
CO3	3	2	3	2	2	3	3	1	1	1	1	1	3
CO4	3	2	3	2	2	3	3	1	1	1	1	1	3

Detailed Syllabus:

Introduction: Biosphere, Hydrological cycle, Nutrient cycle, Consequences of population grow and soil.

Air pollution sources & effects: Classification and properties of air pollutants, Emission source pollutants, Effect of air pollution.

Meteorological aspects of air pollutant dispersion: Temperature lapse rates and stability, Winc Plume behavior, Dispersion of air pollutants, Estimation of plume rise.

Air pollution sampling and measurement: Types of pollutant sampling and measurement, Amt sampling, Analysis of air pollutants.

Air pollution control methods & equipment: Control methods, Source correction method effluents, Particulate emission control, Selection of a particulate collector, Control of gaseous for control equipment.

Control of specific gaseous pollutants: Control of sulphur dioxide emissions, Control of nitroge monoxide control, Control of hydrocarbons and mobile sources.

Water pollution: Water resources, Origin of wastewater, types of water pollutants and their eff

Waste water sampling, analysis and treatment: Sampling, Methods of analysis, Determination Determination of inorganic substances, Physical characteristics, Bacteriological

measurement, Basic processes of water treatment, Primary treatment, Secondary treatr treatment, Recovery of materials from process effluents.
Solid waste management: Sources and classification, Public health aspects, Methods c Methods, Potential methods of disposal.
Hazardous waste management: Definition and sources, Hazardous waste classifica Treatment methods, Disposal methods.

Reading:

1. Rao C.S., Environmental Pollution Control Engineering, Wiley Eastern Limited, India, 199:
2. Noel de Nevers, Air Pollution and Control Engineering, McGraw Hill, 2000.
3. Glynn Henry J., Gary W. Heinke, Environmental Science and Engineering, Prentice Hall o
4. Rao M.N, Rao H.V.N, Air Pollution, Tata McGraw Hill Publishing Ltd., 1993.
5. De A.K, Environmental Chemistry, Tata McGraw Hill Publishing Ltd., 1999.
6. George Tchobanoglous, Franklin Louis Burton, H. David Stensel, Metcalf & E waste water engineering: treatment and reuse, McGraw Hill Education; 4th Edition, 2003.
7. E-waste recycling, NPCS Board of consultants and Engineers, Asia Pacific Business Pres
8. Nicholas P. Cheremisinoff, Handbook of Pollution Prevention Practices, CRC press, 2001

3 Credits

PSO2	PSO3
-	-
-	-
3	3
3	3

th, Pollution of air, Water

s, Behavior and fate of air

d velocity and turbulence,

bient air sampling, Stack

s, Cleaning of gaseous
emissions, Design methods

en oxides, Carbon

fects.
n of organic matter,

ment, Advanced wastewater

of collection, Disposal

ation,

3.

of India, 2^{nd} Edition, 2004.

Eddy, Inc., Franklin Burton,

ss Inc. 2015

.

CH355	MINOR RESEARCH PROJECT	PCC	0 – 1 – 2	2

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Conduct an independent research project involving experimentation/modelling/simulation/optimization in chemical engineering
CO2	Analyze the results
CO3	Communicate the research results orally to an audience
CO4	Present a detailed written report

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO 1
CO1	3	3	3	3	3	1	1	2	2	1	2	2	2
CO2	3	3	3	3	3	1	1	2	2	1	2	2	2
CO3	-	-	-	-	-	-	-	2	2	3	-	-	2
CO4	-	-	-	-	-	-	-	2	2	3	-	-	2

Detailed Syllabus

The student is required to choose any one of the following:

1. Project involving experimentation/modelling/simulation/design/optimization inchemic areas related to research/industry/society
2. Develop prototype/lab experiments.
3. Generation and interpretation of additional experimental data using existing UG/PG
4. Develop virtual model

The report shall contain: Certificates from the student and the guide / supervisor regarding th

i. Introduction

ii. Literature review

iii. Problem definition / scope and motivation for the work

iv. Experimental work / mathematical modeling and Analysis / Simulation

v. Results and Discussion

vi. Conclusions

Nomenclature. References
Minimum number of pages in the report should be 25.
Written report shall adhere to the prescribed format

Reading:

1. Relevant Journals and magazines

2 Credits

PSO 2	PSO 3
3	2
3	2
3	2
3	2

cal engineering and allied

lab experimental setups

ne bonafide nature of the work.

CH361	WASTEWATER TREATMENT	PCC	3 – 0 – 0	3 C

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Identify methods for characterization of wastewater
CO2	Describe stages of treatment methods
CO3	Select advanced methodologies for treating wastewater
CO4	Appraise sustainability and carbon footprint

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	1	3	2	1	-	-	-	-	-	-	-	-
CO2	3	1	3	3	1	-	-	-	-	-	-	-	-
CO3	3	1	3	3	1	-	-	-	-	-	-	-	-
CO4	3	1	3	2`	1	-	-	-	-	-	-	-	-

Detailed syllabus

Introduction to Wastewater Treatment.

Biology: Bacteria and Fungi, Protozoa, Viruses, Algae, Waterborne Diseases, Biological Ox Oxygen Demand, Biological Treatment Systems, Biological Kinetics.

Water Quality: Safe Drinking Water Act, Microbiological Quality of Drinking Water, Cl Water, Clean Water Act, National Pollutant Discharge Elimination System (NPDES), Pc Groundwater Quality, Seawater Quality.

Wastewater Flows and Characteristics: Domestic Wastewater, Industrial Wastewater, Infiltra Wastewater, Composite Sampling, Evaluation of Wastewater.

Wastewater Processing: Considerations in Plant Design, Preliminary Treatment, Pump Biological Filtration, Biological Aeration, Mathematical Model for Completely Mixed A Ponds, Effluent Disinfection, Individual Household Disposal Systems, Characteristics an Sludge, Sludge Pumps, Sludge Thickening, Regulatory Requirements for Treatment Sewage Sludge, Requirements for Class B Bio-solids, Requirements for Class A Bio-solids Disposal, Odor Control.

Advanced Wastewater Treatment: Limitations of Conventional Treatment, Suspended Removal, Toxic substance removal, Phosphorus in Wastewaters, Chemical – Biological Ph in Wastewaters, Biological Nitrification and De- nitrification. Membrane processes: Micro reverse osmosis.

Sustainability and Carbon Footprint: Water and Wastewater Systems, Balance b Sustainability and Advanced Wastewater Treatment.

Reading:

1. Hammer and Hammer, Jr., Water and Wastewater Technology, Pearson Education Inc.
2. MetCalf, Eddy, Wastewater Engineering: Treatment and Reuse, Tata McGraw Hill, 2003
3. Arceivala, S. J. and Asolekar, S. R., Wastewater Treatment for Pollution Control and Re Edition, 2007.
4. Hanley, N. and Bhatia, S. C., Pollution Control in Chemical and Allied Industries,
5. Tchobanoglous G., Burton F. L., Stensel H.D., Wastewater Engineering: Treatmer Hill, 4th Edition, 2002.
6. Nicholas P. Cheremisinoff, Handbook of Water and Wastewater Treatment Technology, Press, 1994.

Credits

PSO2	PSO3
2	1
2	1
2	1
2	1

ygen Demand, Chemical

hemical Quality of Drinking
llution Effect on Aquatic Life,

ation and Inflow, Municipal

ing Stations, Sedimentation,
eration, Stabilization
nd Quantities of Waste
and Disposal of
s, Dewatering, Bio-solids

solids removal, Pathogen
osphorus removal, Nitrogen
filtration, ultrafiltration,

etween

, 7th Edition, 2012.
3.
euse, Tata McGraw Hill, 3rd

CBS Publishers, 2010.
nt and Reuse, Tata McGraw

, CRC

CH362	FERTILIZER TECHNOLOGY	DEC	3-0-0	3 Cre

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Classify fertilizers
CO2	Explain manufacturing processes for production of fertilizers
CO3	Identify the effect of technologies on the health, safety and environment.
CO4	Explain the mechanism of chemical reactions

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	1	3	-	-	-	-	3	-	-	-	-	-	3
CO2	1	3	-	-	-	-	3		-	-	-	-	3
CO3	1	3	-	-	-	-	3	-	-	-	-	-	3
CO4	1	3	-	-	-	-	3	-	-	-	-	-	3

Detailed syllabus:

Introduction: Elements required for plants growth, Classification of fertilizers, Compour blended fertilizers. N-P-K values and calculations.

Nitrogenous Fertilizers: Manufacturing Processes for Ammonia, Manufacture ammonium chloride, Ammonium phosphate, Ammonium nitrate, nitric acid, Urea etc. Econo Material of construction and corrosion problem.

Phosphatic fertilizers: Calculation of percentage tricalcium phosphate of lime in phosphatic r super phosphate and single super phosphate, Nitro phosphate, Sodium phosphate, pho phosphatic fertilizers.

Potash Fertilizers: Manufacture of potash fertilizers like potassium sulphate, potassium chlo

Complex Fertilizers: Processes for nitro-phosphates and complex NPK fertilizers

Reading:

1. Sittig M and GopalaRao M., Dryden's Outlines of Chemical Technology for the 21st Cent
3rd Edition, 2010.
2. Austin G T., Shreve's Chemical Process Industries, McGraw Hill Book Company, New D
3. Handbook on Fertilizer Technology, Fertilizer Association of India, JNU, New Delh
4. Shukla S D and Pandey G N, A Text Book of Chemical Technology, Vol I & II, Ltd., New Delhi, 2000.
5. Eugene Perry, Fertilizers: Science and Technology, Callisto Reference Publisher, 2018.
6. A.K. Kolay, Manures and Fertilizers, Atlantic, 2008.

dits

PSO2	PSO3
1	-
1	-
3	-
1	-

nd, Complex and bulk

e of ammonium sulphate,
mics and other strategies,

rock: Manufacture of triple
osphoric acid and other

ride.
liquid fertilizers

tury, WEP East West Press,

elhi, 5th Edition, 1986.
i, 2nd Edition, 1977.
Vikas Publishing House Pvt.

CH363	FOOD TECHNOLOGY	DEC	3 – 0 – 0

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Explain techniques in food processing
CO2	Design process equipment to achieve the desired quality of food.
CO3	Develop novel food processes that have a minimal effect on food quality
CO4	Select control strategies to maintain food quality.

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	
CO1	2	3	-	-	-	-	3	-	-	-	-	-	3	
CO2	1	3	2	3	-	-	3		-	-	-	-	3	
CO3	1	3	2	2	-	-	3	-	-	-	-	-	3	
CO4	1	3	-	3	-	1	3	-	-	-	-	-	3	

Detailed Syllabus:

Introduction: General aspects of food industry, World food demand and Indian scenari Quality and nutritive aspects, Product and Process development, engineering challer Processing Industry.

Basic principles: Properties of foods and processing theory, Heat transfer, Effect of heat on m Food Biochemistry and Microbiology: Food Constituents; Food fortification, Water activity sensory characteristics of foods, Effects of processing on nutritional properties, Food safety, g and quality Process Control in Food Processing.

Ambient Temperature Processing: Raw material preparation, Size reduction, Mixing and formi concentration of food components, Centrifugation, Membrane concentration, Fermentatior Irradiation, Effect on micro-organisms, Processing using electric fields, high hydrostatic pressu Heat processing using steam, water and air: Blanching, Pasteurisation, Heat sterilizatio Evaporation and distillation, Extrusion, Dehydration, Baking and roasting.

Heat processing by direct and radiated energy: Dielectric heating, Ohmic heating, Infra irradiation.

Post Processing Applications Packaging: Coating or enrobing, Theory and Types of packagin materials, Printing, Interactions between packaging and foods, Environmental considerations.

Reading:

1. Fellows P., Food Processing Technology: Principles and Practice, Woodhead Publishing,
2. Toledo R, Fundamentals of Food Process Engineering, Springer, 3rd Edition, 2010.
3. Singh R.P. & Heldman D.R., Introduction to Food Engineering, Academic Press, 3rd Editio

3 Credits

PSO2	PSO3
2	-
3	-
3	-
3	-

io, Constituents of food,
ıges in the Food

ıicro- organisms, Basic
, Effects of processing on
ɡood manufacturing practice

ng, Separation and
ı and enzyme technology,
ıre, light or ultrasound.
n,

red heating, Gamma

g

4th Edition, 2016.

n, 2001.

CH364	GREEN TECHNOLOGY	DEC	3 – 0 – 0

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand principles and concepts of green chemistry
CO2	Develop manufacturing processes to reduce wastage and energy consumption.
CO3	Design the technologies to reduce the level of emissions from buildings and core infrastructure
CO4	Analyze the effects of pollutants on the environment

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	3	1	1	1	2	3	1	-	-	-	-	3
CO2	3	3	3	1	1	2	3	-	-	-	-	-	3
CO3	3	3	3	1	1	2	3	-	-	-	-	-	3
CO4	3	3	2	`2	2	2	3	1	-	-	-	-	3

Detailed Syllabus:

Principles and concepts of Green Chemistry: Introduction, Sustainable Development and Gree Rearrangement Reactions, Addition Reactions, Atom Un-economic Reactions, Substitu Reactions, Wittig Reactions, Toxicity.

Waste- Production, Problems and Prevention: Introduction, Some Problems Caused by Waste the Chemical Industry, the Cost of Waste, Waste Minimization Techniques.

Measuring and controlling environmental performance: The Importance of Measurement, Lact Gasoline, and Introduction to Life Cycle Assessment, Green Process Metrics, and Enviro Systems.

Catalysis and green chemistry: Introduction to Catalysis, Comparison of Catalyst Types Basics of Heterogeneous Catalysis and Homogeneous Catalysis.

Organic solvents, Environmentally benign solutions: Organic Solvents and Volatile Orga Compounds, Solvent-free Systems, Supercritical Fluids, Supercritical Carbon Dioxide

Supercritical Water, Water as a Reaction Solvent, Water-based Coatings, Ionic Liquids, Ion
Ionic Liquids as Solvents, Fluorous Biphase Solvents.
Renewable Energy as a means of Green energy: Role of Renewable energy sources in prom
Emerging Greener technologies and Alternative energy solutions: Design for Energy Efficienc
Reactions, Advantages of and Challenges Faced by Photochemical, Processes, Examples of
Reactions, Chemistry Using Microwaves, Microwave Heating, Microwave-assisted Reacti
Sonochemistry and Green Chemistry, Electrochemical Synthesis, Examples of Electroch
Designing greener processes: Conventional Reactors, Batch Reactors, Continuous Reac
Design, Minimization, Simplification, Substitution, Moderation, Limitation, Process Inter
Equipment, Examples of Intensified Processes, In-process Monitoring, Near-infrared Spect
Inherent safety – safety in design, case studies of major accidents
An integrated approach to a greener chemical industry: Society and Sustainability, Barriers an
Legislation, EU White Paper on Chemicals Policy, Green Chemical Supply Strategies.

Reading:

1. Mike Lancaster, Green Chemistry, Royal Society of Chemistry, 2010.
2. Paul T. Anastas, John C. Warner, Green Chemistry: Theory and Practice, Oxford Universi
3. Jay Warmke, Annie Warmke, Green Technology, Educational Technologies Group, 2009.
4. James Clark and Duncan Macquarrie, Handbook of Green Chemistry & Technology 2002.
5. S. Suresh and S. Sundaramoorthy, Green Chemical Engineering: An introduction to Catalysis, Kinetics, and Chemical Processes, CRC Press, 2015.

3 Credits

PSO2	PSO3
2	1
2	2
2	2
2	3

en Chemistry,
tion Reactions, Elimination

e, Sources of Waste from

tic Acid Production, Safer
onmental Management

, Heterogeneous Catalysts,

nic
e,

ıic Liquids as Catalysts,

oting Green Technology.
y, Photochemical
f Photochemical
ions, Sonochemistry,
ıemical Synthesis.
ctors, Inherently Safer
ısification, Some PI
troscopy.

ıd Drivers, The Role of

ity Press, 2000.

, Blackwell Publishing,

)

CH365	PULP AND PAPER TECHNOLOGY	DEC	3 – 0 – 0

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Explain process for manufacturing paper.
CO2	Identify harmful impacts of paper and pulp industries on environment.
CO3	Describe mechanical-chemical pulping processes
CO4	Distinguish methods for pulp treatment.

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	2	3	2	2	2	2	2	-	-	2	-	1	3
CO2	2	3	3	2	2	2	3	-	2	2	-	2	2
CO3	2	3	2	2	2	2	2	-	-	2	-	1	3
CO4	2	3	2	-	-	2	2	-	-	2	-	1	3

Detailed Syllabus:

Introduction and Paper making raw materials: History of Paper Making, Paper making anatomy and chemistry, Wood chip preparation and handling at the pulp mill, Solid wood mea selected wood species.

Pulping processes and Pulp treatment: Introduction to pulping, Mechanical pulping, Che chemical pulping, Soda pulping, Kraft pulping, Sulfite pulping, Other pulping methods, B Measurement of lignin content, Bleaching chemical pulps, Chemical recovery, Refining, Pulp

Paper making equipment and process: Fiber preparation and approach, Raw materia Control additives, Wet end chemistry, Paper manufacture, Paper machine, headbox, fourdrini formers, cylinder machine, press section, dryer section, Post drying operations, Coating.

Environmental protection: Water pollution, Water quality tests, Aqueous effluent treatments, A and control, Solid waste disposal.

Properties of paper: General grades of paper, Structure, Mechanical and chemical properties, Basic optical tests of paper.

Reading:

1. J.P. Casey, Pulp and Paper: Chemistry and Chemical Technology, Volumes 1 & 2, Wiley 1980.

2. G.A. Smook, Handbook for Pulp and Paper Technologists, Angus Wilde Publ, Inc, 3rd Edi

3. Christopher J. Biermann, Handbook of Pulping and Paper Making, Academic Press, 1996

4. Monika EK, Goran Gellerstedt, Gunnar Henrikson, Pulping Chemistry and Technolo 2009.

5. George T. Austin, Shreve's Chemical Process Industries, McGraw Hill Education, 5th Editi 2017.

3 Credits

PSO2	PSO3
2	1
2	1
2	1
3	2

raw materials: Wood
ısurement, Properties of

əmical pulping, Semi-
leaching mechanical pulps,
characterization.
ıls, Functional additives,
er wet end, Twin wire

ir pollution, Air quality tests

Interscience, 3rd Edition,

tion, 2002.

.

gy, Walter De Gruyter & Co,

on,

CH366	CATALYSIS	DEC	3 – 0 – 0

Pre-requisites: CH301-Chemical Reaction Engineering-II

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand the basic concepts of catalysis
CO2	Analyze the role of heat and mass transfer in the catalytic reactor design
CO3	Describe the methods of preparation and characterization of catalysts
CO4	Distinguish the performance of catalytic reactors
CO5	Identify the role of catalysts in the environmental protection

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	3	2	1	-	-	-	-	-	-	-	-	3
CO2	2	3	2	1	-	-	-	-	-	-	-	-	3
CO3	2	1	2	1	-	-	-	-	-	-	-	-	1
CO4	2	3	1	1	-	-	-	-	-	-	-	-	1
CO5	-	-	-	-	-	-	3	-	-	-	-	-	1

Detailed syllabus:

Basic concepts in heterogeneous catalysis and green chemistry. Catalyst preparation a Optimal distribution of catalyst in a pellet. Surface reactivity and kinetics of reaction on regeneration.

Heat and mass transfer and its role in heterogeneous catalysis. Calculations of effective diffu conductivity of porous catalysts.

Industrially important catalysts and processes such as oxidation, processing of petroleum an gas and related processes, Environmental catalysis. Zeolite catalysts, preparation, characteri Commercial Catalytic Reactors (Adiabatic, fluidized bed, trickle bed, slurry etc.). Selection an design and preparation of catalysts.

Reading:

1. John Meurig Thomas, W. J. Thomas, Principles and Practice of Heterogeneous Cataly
2014.
2. James John Carberry, Chemical and Catalytic Reaction Engineering, Dover Publications, I
3. L. K. Doraiswamy, M. M. Sharma, Heterogeneous Reactions: Fluid-fluid-solid Reactic
4. B. Viswanathan, S. Sivasanker, and A.V. Ramaswamy, Catalysis: Principles ar
Publishing House, 2002.
5. B. Viswanathan, S. Kannan, R.C. Deka, Catalysts and Surfaces: Characterizati
Techniques, Alpha Science International, 2010.

3 Credits

PSO2	PSO3
2	1
1	1
1	1
1	1
1	1

ınd characterization,
surfaces, poisoning and

sivity and thermal

d hydrocarbons, synthesis
zation and applications.
d

:sis, Wiley VCH; 2nd Edition,

NC, 2001.
ons, Wiley, 1984.
ıd Applications, Narosa

ion

CH367	EXPERIMENTAL AND ANALYTICAL TECHNIQUES	DEC	3-0-0

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Differentiate Microscopy techniques
CO2	Decide the spectroscopy methods
CO3	Select the electro-analytical techniques
CO4	Choose the separation techniques

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	3	-	3	2	-	-	-	-	3	-	1	-
CO2	3	3	-	3	2	-	-	-	-	3	-	1	-
CO3	3	3	-	3	2	-	-	-	-	3	-	1	-
CO4	3	3	-	3	2	-	-	-	-	3	-	1	-

Detailed syllabus:

Microscopy Techniques: scanning electron microscopy (SEM); secondary Auger microsc microscopy (SPM); scanning tunneling microscopy (STM); transmission electron microscopy (TEM); upright microscope, inverted microscope, image analysis.

Spectroscopy methods: FTIR, AAS, UV-VIS, UV-fluorescent, Wavelength and energy dispers spectroscopy (WDS and EDS); X-ray absorption spectroscopy (XANES and EXAFS); second (SIMS); temperature programmed desorption (TPD); thermal desorption spectroscopy TDS), ICP-OES, XRD.

Atomic absorption spectroscopy (AAS); inductively coupled plasma-atomic emis spectroscopy (ICP-AES).

Electroanalytical Techniques: Voltametry; coulometry; amperometry; potentiom polarography; electrolytic conductivity; impedance spectroscopy, rotating disc electrode, rotat

Separation Methods: Normal and reversed phase liquid chromatography (NP- & RP-LC); Ga GC-MS; High Performance Liquid Chromatography (HPLC); Size-Exclusion Chromatography (SEC); Ion Chromatography (IC).

Reading:

1. R. Wiesendanger, Scanning Probe Microscopy and Spectroscopy, Cambridge University
2. Frank A. Settle, Handbook of instrumental techniques for analytical chemistry, Prince Hal
3. D. A. Skoog, D. M. West, F. J. Holler and S. R. Couch, Fundamentals of analytical chemi learning, New Delhi, 2004.
4. P. Atkins and J. de Paula, Atkins' physical chemistry, Oxford University Press, New Delhi
5. K. W. Kolasinski, Surface Science: Foundations of Catalysis and Nanoscience, John Wil
6. Gregory S. Patience, Experimental Methods and Instrumentation for Chemical Engineers Elsevier, 2nd Edition, 2018.

3 Credits

PSO2	PSO3
-	-
-	-
-	-
-	-

:opy (SAM); scanning probe

:ive X-ray fluorescence
ary ion mass spectrometry

sion

etry;
ing ring disc electrode.

s Chromatography (GC);

Press, 1994.
ll, New Jersey, 1997.
istry. Brooks/ColeCengage

, 8th Edition, 2008.
ey and Sons, 2002.
,

CH368	COMPLEX FLUIDS	DEC	3 – 0 – 0

Pre-requisites: None

Course Outcomes: At the end of the course, student will be able to:

CO1	Distinguish the complex fluids from classical fluids
CO2	Understand the macroscopic behavior of the complex fluids.
CO3	Identify forces involved in complex fluids.
CO4	Analyze rheology of polymers, glassy liquids and gels
CO5	Understand rheology of suspensions, surfactant solutions and block copolymers

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	2	2	1	2	1	-	-	-	2	2	-	1	2
CO2	2	2	1	2	1	-	-	-	2	2	-	1	2
CO3	2	2	1	2	1	-	-	-	2	2	-	1	2
CO4	2	2	1	2	1	-	-	-	2	2	-	1	2
CO5	2	2	1	2	1	-	-	-	2	2	-	1	2

Detailed Syllabus:

Introduction to Complex fluids: Complex fluids vs. classical solids and liquids; Example measurements and properties; Kinematics and Stress; Structural probes of complex fluids; Cc Stress tensor

Basic forces: Excluded volume interactions; Vander Waals interactions; Electrostatic interactic hydrophilic and other interactions.

Rheology of Polymers, glassy liquids and polymer gels: Polymers –Theory and Rheolo liquids – Theory and rheology of glassy liquids; Polymer gels – Theory and rheology of gels.

Suspensions: Particulate gels – particle interactions, Rheology of particulate gels; Foan – Emulsion preparation, Rheology of emulsions, immiscible blends and foams;

Rheology of surfactant solutions and block copolymers

Reading:

1. Larson RG, The Structure and Rheology of Complex Fluids, Oxford University Press, 199
2. Chhabra RP, Richardson JF, Non-Newtonian Flow and Applied Rheology: Engineeri Butterworth-Heinemann, 2nd Edition, 2008.
3. Abhijit PD, Murali Krishna J, Sunil Kumar PB, Rheology of Complex Fluids, Springer, 201
4. Christopher W. Macosko, Rheology: Principles, Measurements and Applications, Wil
5. Alexander Ya. Malkin, Rheology Fundamentals, Chem Tech Publishing, 1994.

3 Credits

PSO2	PSO3
1	2
1	2
1	2
1	2
1	2

s; Rheological
ɔmputational methods;

ɔns; Hydrogen bonding;

gy of polymers; Glassy

ns, Emulsions and Blends

9.
ing Applications,

).
ey - VCH, 1994.

CH369	NATURAL GAS ENGINEERING	DEC	3 – 0 – 0	3

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Describe the properties, phase behavior of natural gas.
CO2	Evaluate oil and gas reserve estimations, and bottom hole pressure calculations.
CO3	Select the compressors used in the natural gas industry.
CO4	Illustrate the production economics and production trends of natural gas.
CO5	Discuss LNG production and treatment technologies

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO 1
CO1	3	3	1	1	-	2	1	-	-	-	-	-	-
CO2	2	3	3	3	1	2	1	-	-	-	1	-	-
CO3	2	2	3	3	-	-	-	-	-	-	-	-	1
CO4	2	3	1	2	1	1	1	1	-	-	2	2	1
CO5	3	3	2	3	-	3	3	-	-	-	-	2	2

Detailed Syllabus:

Basics of natural gas reservoir: Composition of associated and non-associated gas, retrogra
Physical properties of natural gas and associated liquid.

Phase Behavior: Physical properties of natural gas, Phase behavior of two-phase hydrocarb
equilibria (VLE), pressure gradient in gas column, well head and bottom hole pressure.

Compression and Compressor: Various types of compressors, multi-phase compre
(LNG).

Flow measurement: orifice meter, flow formula, critical flow meter, flow prover.

Field separation of oil from gas: Type of separators and Sizing, Oil absorption, low temperat

Natural gas and LNG treatment; world market implications and future trends, safety measure

Reading:

1. Chi U. Ikoku, Natural Gas Production Engineering, John Wiley & Sons.1992.
2. Sanjay Kumar, Gas Production Engineering, Gulf Publishing Company, Volume 4, 1987.
3. Donald La Verne Katz, Robert L. Lee, Natural Gas Engineering: Production and Storage
4. Donald La Verne Katz, Hand Book of Natural Gas Engineering, McGraw Hill, 1959.
5. Hussain K. Abdel-Aal, Mohammed Aggour, M.A. Fahim, Petroleum and Gas field Proces
6. Saed Mokhatab, John Y. Mak, Jaleel V. Valappil, David A. Wood, Handbook of Liquefie 2014.
7. B. Guo, A. Ghalambor, Natural Gas Engineering Handbook, Gulf Publishing Comp
8. Alireza Bahadori, Natural Gas Processing: Technology and Engineering Design, G Professional Publishing, 2014

Credits

PSO 2	PSO 3
1	-
1	1
2	-
1	-
2	-

ıde condensate wells,

ɔon systems, vapor liquid

ssion; Liquefied natural gas

ure separation
ɜs.

.
:, McGraw Hill Inc., 1990.

ssing, Marcel Dekker, 2003.
d Natural Gas, Elsevier Inc.,

pany, Houston, 2005.
ulf

CH401	PLANT DESIGN AND PROCESS ECONOMICS	PCC	3 – 1 – 0

Pre-requisites:CH303-Elements of Transport Phenomena

Course Outcomes: At the end of the course, the student will be able to:

CO1	Analyze alternative processes and equipment for manufacturing a product.
CO2	Determine costs involved in process plants.
CO3	Perform economic analysis and optimum design of processes.
CO4	Evaluate project profitability.

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	1	3	2	-	-	2	2		2	3	3	-	2
CO2	2	-	-	2	2	-	-	-	2	2	3	-	1
CO3	3	2	2		2	-	-	-	2	2	3	-	-
CO4	2	3	3	1`	2	-	-	-	2	3	3	-	2

Detailed Syllabus:

Introduction: Chemical Engineering plant design, Overall design consideration, Prac design, engineering ethics in design.

General Design Considerations: Health and Safety hazards, Loss prevention, Environm Location, Plant Layout, Plant Operation and Control.

Process Design Development: Development of design database, Process creation, Proc Process flow diagram (PFD), Equipment design specifications.

Flow sheet synthesis and development: General procedure, Process information, Functi synthesis, Software use in process design.

Cost and asset accounting: General accounting procedure, Balance sheet and In Analysis of Cost Estimation: Cash flow for industrial operations, Factors affecting investment a Capital investments, Fixed capital and working capital, Estimation of capital investment, (total cost, Gross profit, Net profit and cash flow, Cost
scaling factors, Net present value analysis.

Interest and Insurance: Interest, Simple interest, Compound interest, Nominal and effec Continuous interest, Costs of capital, Time value of money, Annuity, Cash flow patterns, Inc Future worth, Taxes and Insurance.
Depreciation: Depreciable investments, Methods for calculating Depreciation.
Profitability Analysis: Profitability standards, Costs of capital, Minimum acceptable rate of retu profitability, Rate of return on investment, Payback period, Net return, discounted cash fl present worth, Pay-out period, Alternative investments, Replacements.
Optimum design and design strategy: Defining the optimization problem, Selecting an objectiv function, Structural optimization, parametric optimization, Variable screening and selectic Applications. Design Report.

Reading:

1. Peters M.S., K.D. Timmerhaus and R.E. West, Plant Design and Economics for Chemical Edition, 2011.
2. Turton R., R.C. Baile, W.B. Whiting, J. A. Shaeiwitz. Analysis, Synthesis and Desi PHI, New Delhi, 3rd Edition, 2011.
3. Seider W.D., J.D. Seader, D.R. Lewin, Product and Process Design Principles: Synthesis, Wiley, 2nd Edition, 2004.
4. James R. Couper, W. Roy Penny, James R. fair, Stanley M. Walas, Chemical Pro and Design, Elsevier Butterworth-Heinemann, 2012.
5. R. Panneerselvam, Engineering Economics, Prentice Hall India, 2013.

4 Credits

PSO2	PSO3
3	-
3	-
3	3
3	2

ctical considerations in

ental Protection, Plant

cess design criteria,

ions diagram, Flow sheet

ncome statements.
and production costs,
Cost indices, Estimation of

ctive interest rates,
come taxes, Present worth,

rn, Methods of calculating
ow rate of return, Net

ve
on, Optimization

Engineers, McGraw Hill, 5th

gn of Chemical Processes,

, Analysis, and Evaluation,

ocess Equipment: Selection

CH402	DESIGN AND SIMULATION LABORATORY	PCC	0 – 1 – 4	3

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Carry out thermodynamic property estimations using Aspen
CO2	Simulate Mixer, splitter, pumps, compressors and flash units
CO3	Apply sensitivity, design specification and case study tools in Aspen
CO4	Design heat exchangers, reactors and distillation columns
CO5	Optimize process flow sheets using sequential modular and equation oriented approaches.

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	3	3	3	3	3	-	-	-	-	-	-	3
CO2	3	3	3	3	3	1	-	-	-	-	-	-	3
CO3	3	3	3	3	3	3	-	-	-	-	-	-	3
CO4	3	3	3	3	3	2	-	-	-	-	-	-	3
CO5	3	3	3	3	3	2	-	-	-	-	-	-	3

Detailed syllabus

Solve the following steady state simulation exercises using **Aspen:**

1. Physical property estimations.
2. Simulation of individual units like, mixers, splitters, heat exchangers, flash columns and r
3. Design and rating of heat exchangers
4. Design and rating of distillation columns.
5. Mass and Energy balances.
6. Handling user specifications on output streams – Sensitivity and design Spec tools.
7. Simulation of a flow sheet
8. Simulation exercises using calculator block
9. Optimization Exercises
10. Simulation using equation oriented approach

Reading:

1. Lab manuals / Exercise sheets
2. A.K.Jana, Chemical Process Modelling and Computer Simulation, Prentice Hall India,

3 Credits

PSO2	PSO3
3	3
3	3
3	3
3	3
3	3

eactors

3rd Edition, 2018.

CH403	PROCESS INSTRUMENTATION AND CONTROL LABORATORY	PCC	0 – 1 – 2

Pre-requisites: CH255 - Process Instrumentation, CH351 - Process Dynamics and Control.

Course Outcomes: At the end of the course the student will be able to:

CO1	Identify the dynamics of first order, second order, interacting and non-interactin processes
CO2	Implement PID controller on a level control process
CO3	Evaluate the characteristics of I-P and P-I converters
CO4	Apply cascade and ratio control schemes
CO5	Determine control valve characteristics

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	1	2	3	1	-	-	-	-	-	-	-	3
CO2	3	1	2	3	3	-	-	-	-	-	-	-	1
CO3	3	1	1	3	3	-	-	-	-	-	-	-	1
CO4	3	1	2	`3	3	-	-	-	-	-	-	-	1
CO5	3	1	2	3	2	-	-	-	-	-	-	-	1

Detailed Syllabus:

List of experiments:

1. Dynamics of non-interacting process
2. Dynamics of interacting process
3. Dynamics of first and second order processes
4. Flapper nozzle system
5. Measurement of liquid level using DPT
6. Characteristics of I&P and P&I converters
7. Control valve characteristics
8. Control of liquid level in a cylindrical tank process
9. Cascade control
10. Ratio control

Reading:

1. Lab manuals

2 Credits

ig

PSO2	**PSO3**
3	2
3	2
3	2
3	2
3	2

CH449	PROJECT WORK - PART A	PRC	0 – 0 – 3

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Carry out literature review
CO2	Formulate the problem involving manufacture of a chemical product/ experimentation/ modelling/simulation/optimization/design
CO3	Analyze the results
CO4	Communicate the results orally to an audience
CO5	Present a written report

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PS
CO1	2	3	1	2	1	1	1	-	-	2	-	-	2	2
CO2	3	3	1	1	1	1	2	-	-	2	-	-	3	2
CO3	3	3	3	3	2	1	1	1	2	1	-	-	3	3
CO4	3	3	3	`3	2	1	1	1	2	3	-	-	3	3
CO5	3	1	-	-	-	1	1		2	3	-	-	2	1

Detailed Syllabus

The student is required to choose any one of the following:

1. Project involving experimentation/modelling/simulation/Design/optimization in chemical engine research/industry/society

At the end of the semester, the student is required to present (i) Literature survey, (ii) Problem for Methodology, (iv) Preliminary results, (v) Proposed work for the next semester, (vi) References

2. Project involving manufacture of any chemical product on industrial scale

At the end of the semester, the student is required to present (i) market survey, (ii) Properties and different processes for production, (iv) selection of process,
(v) detained process description (vi) material balance, and (vii) References

Minimum number of pages in the report should be 30.

Written report shall adhere to the prescribed format.

Reading

1. Handbooks,
2. Journals and magazines
3. Martyn S. Ray and Martin G. Sneesby, Chemical Engineering Design Project: A Case Study A Breach Science Publishers, Second Edition, 1989.

2 Credits

O2	PSO3
[illegible]	-
[illegible]	
[illegible]	3
[illegible]	3
	1

ering related to

mulation, (iii)

Applications (iii)

Approach, Gordon and

CH411	BIOCHEMICAL ENGINEERING	DEC	3 – 0 – 0

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand cell and enzyme kinetics
CO2	Discuss methods of immobilization.
CO3	Calculate volume of a bioreactor
CO4	State sterilization methods
CO5	Select downstream process to separate the products

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	
CO1	3	3	2	1	-	1	2	1	-	-	-	-	3	
CO2	3	3	2	1	-	1	2	1	-	-	-	-	3	
CO3	3	3	2	1	-	1	2	1	-	-	-	-	3	
CO4	3	3	2	1	-	1	2	1	-	-	-	-	3	
CO5	3	3	2	1	-	1	2	1	-	-	-	-	3	

Detailed Syllabus:

Introduction: Biotechnology, Biochemical Engineering, Biological Process, Definition Enzyme Kinetics: Introduction, Simple Enzyme Kinetics, Enzyme Reactor with Simple Kinetics Reactions, and Other Influences on Enzyme Activity.

Immobilized Enzyme: Immobilization techniques and effect of mass transfer resistance. Indus Carbohydrates, starch conversion and cellulose conversion. Cell Cultivation: Microbial cell cul cultivation, plant cell cultivation, cell growth measurement and cell immobilization.

Cell Kinetics and Fermenter Design: Introduction, growth cycle for batch cultivation, stirred tar fermenters connected series, cell recycling, alternate fermenters and structured model.

Sterilization: Sterilization methods, thermal death kinetics, design criterion, batch sterilizatic continuous sterilization and air sterilization.

Agitation and Aeration: Introduction, basic mass transfer concepts, correlation for mass transf
interfacial area, correlations for 'a' and D_{32}, gas-holdup, power consumption, determination of oxygen absorption rate, correlation for k_L

Downstream Processing: introduction, solid-liquid separation, cell rupture, recovery purification.

Reading:

1. James M. Lee, Biochemical Engineering, Prentice Hall, 1992.
2. James E. Bailey and David F. Ollis, Biochemical Engineering Fundamentals, McGraw Hill 1986.
3. Michael L. Shuler and Fikret Kargi, Bioprocess Engineering – Basic Concepts, Prentice Ha of India, 2nd Edition, 2002.

3 Credits

PSO2	PSO3
3	
3	
3	
3	
3	

of Fermentation.
;, Inhibition of Enzyme

trial application of enzymes:
tivation, animal cell

ık fermenters, multiple

›n,

'er co-efficient, measurement of
_a', scale-up and shear sensitivity.
and

International, 2nd Edition,

all

CH412	INTERFACIAL SCIENCE	DEC	3 – 0 – 0

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Identify the interfacial phenomena occurring at macro scale and quantify the effect owing to interfacial properties.
CO2	Analyze ab-initio calculations for inter-colloidal forces.
CO3	Identify equipment and sensors for characterizing various interfaces.
CO4	Design processes that utilize interfacial phenomena to achieve a desired effect.

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	3	3	3	-	-	-	-	-	-	-	-	-
CO2	3	3	1	1	-	-	-	-	-	-	-	-	-
CO3	1	3	1	1	-	-	-	-	-	-	-	-	-
CO4	3	3	3	3	-	-	-	-	-	-	-	-	-

Detailed Syllabus:

Introduction to types of interfaces: The importance of interfaces, Surfaces and interfaces, Sta
Capillarity and surface tension: Surface tension and work, Measurement of surface tension, T
Kelvin equation, The surface tension of pure liquids.

Adsorption and thermodynamics of surfaces: Introduction, Models of the interface, Adsorption
properties of interfaces, Surface excess quantities, Measurement of Adsorption, Adsorption fo
Adsorption.

Surfactants & Micelles, Films and foams: Introduction, Application of surfactants, Adsorption o
films and foams, Aerosols.

Monolayers formation: Introduction, Formation of floating monolayers, Surface pressure-
Deposition of Langmuir Blodgett (LB) films, The study of film structure, the structure and prop
monolayers, Interactions in monolayers, the structures of LB films,
characterization and application.

The liquid-liquid interface: Emulsions, Colloids, Membranes: Introduction, Emulsions, Emulsio the emulsion, Micro-emulsion, Emulsion polymerization, Liquid-liquid extraction, Membran The liquid-solid interface: Introduction, Colloidal dispersions, The properties of coll Coagulation of lyophobic colloids by electrolytes, solvent effects in colloidal interactions, Nanoparticles.

Reading:

1. Geoffrey Barnes and Ian Gentle, Interfacial Science: An Introduction, Oxford Univer 2011.
2. Jacob N. Israelachvili, Intermolecular and Surface Forces, Academic Press, 3rd Edition, 20
3. John B. Hudson, Surface Science: An Introduction, John Wiley & Sons, 1998.
4. Paul C. Hiemenz and Raj Rajagopalan, Principles of Colloids and Surface Chemistry, Tay 1997.

3 Credits

PSO2	PSO3
-	-
-	-
-	-
-	-

ble interfaces.
he Laplace equation, The

ı, Thermodynamic
orm solution, Kinetics of

of surfactants, Micelles,

area relationships,
perties of floating

n stability and selection of
es.
oidal dispersions,

rsity Press, 2nd Edition,

)11.

lor and Francis, 3rd Edition,

CH413	STATISTICAL THERMODYNAMICS	DEC	3 – 0 – 0

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Identify the molecular level properties influencing the macroscopic thermodynami properties.
CO2	Develop models for simulating real gases, liquids and solids using ensemble methods to estimate thermodynamic properties
CO3	Design molecular level architecture to enhance macroscopic properties.
CO4	Estimate macroscopic properties based on molecular level interactions.

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	
CO1	1	2	1	2	2	1	2	-	1	-	-	2	1	
CO2	2	2	2	2	3	-	-	-	1	-	-	2	1	
CO3	1	2	1	2	2	1	2	-	1	-	-	2	1	
CO4	1	2	1	2	2	1	2	-	1	-	-	2	1	

Detailed Syllabus:

Basics of Statistical Thermodynamics: The Statistical Foundation of Classical Thermodynamic for Statistical Thermodynamics, Importance of Statistical Thermodynamics.

Ensembles: Ensembles and Postulates, Canonical Ensemble, Canonical Ensemble Grand Canonical Ensemble, Micro Canonical Ensemble, Thermodynamic Equivalence of I

Evaluation of Probabilities: Probability- Definitions and Basic Concepts, Permutations a Distribution Functions: Discrete and Continuous, Binomial Distribution, Poisson distribution, G Combinatorial Analysis for Statistical Thermodynamics.

Criteriafor Equilibrium: Equilibrium Principles, States of Equilibrium: Neutral, Metastable, Maximizing Multiplicity.

Modelfor Mono-atomic Ideal Gas and Polyatomic Ideal Gases: Energy Levels and Can Function, Thermodynamic Functions for Mono-atomic Ideal Gases, Grand Ensemble, Internal Degrees of Freedom, Independence of Degrees of Freedom, Potential En

Surface, Vibration, Rotation, Thermodynamic Functions for Poly-atomic Ideal Gases, Hindere
Ethane, Hindered Translation on a Surface.
Einstein's and Debye's Model of the Solid, Simple Liquids, Phase Equilibrium, Models for Mult
Ideal Lattice Gas, Lattice Gas with Interactions, Solutions (Bragg-William
Model and Regular Solutions, Quasi-Chemical Model), Chemical Equilibrium.

Reading:

1. Leonard K. Nash, Elements of Statistical Thermodynamics, Dover Publications, 2nd Editio
2. Normand M. Laurendeau, Statistical Thermodynamics: Fundamentals and Applicatio
Press, 2005.
3. Stanley I. Sandler, An Introduction to Applied Statistical Thermodynamics, John Wiley &S
4. Herbert B. Callen, Thermodynamics and Introduction to Thermo-statistics, Wiley, 2ndEditic
1985.

3 Credits

ic

PSO2	PSO3
3	1
3	2
3	1
3	1

:s, Classification Scheme

and Thermodynamics,
Ensembles.
and Combinations,
Gaussian Distribution,

and Unstable equilibrium,

onical Ensemble, Partition

ergy

d Internal Rotation in

:i- Component Systems:

n, 2006.
ıs, Cambridge University

ons, 2010.
ɔn,

CH414	PETROCHEMICAL TECHNOLOGIES	DEC	3 - 0 - 0

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Differentiate process technologies associated with methane, ethane, ethylene, acetylene as feedstock
CO2	Discuss process technologies in manufacture of chemicals from synthesis gas and olefins by various routes
CO3	Identify production technologies of Petroleum aromatics, synthetic fibers, and synthetic rubber
CO4	Describe classification of plastics and learn various process technologies in manufacture of various plastics

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	1	2	2	2	2	1	-	-	-	-	-	2
CO2	3	1	2	2	2	2	1	-	-	-	-	-	2
CO3	3	1	2	2	2	2	1	-	-	-	-	-	2
CO4	3	1	2	2	2	2	1	-	-	-	-	-	2

Detailed syllabus:

Petrochemical Industry – Feed stocks.

Chemicals from methane: Introduction, production of Methanol, Formaldehyde, Ethylene gly

Chemicals from Ethane-Ethylene-Acetylene: Oxidation of ethane, production of Ethyle Chloride monomer, vinyl Acetate manufacture, Ethanol from Ethylene, Acetylene manuf Acetylene.

Chemicals from Synthesis gas, Polymers of Olefins: Polyethylene, Poly Propylene, Po of Ethylene-Propylene, Liquid crystals.

Petroleum Aromatics: Production of BTX

Synthetic Fibers and Synthetic Rubber: Production techniques, Polyesteres, Acrylic fib synthetic paper, optical fibers, Natural rubber Latex, Butadiene Rubber, Chloropre polypentamer rubber, Ethylene-propylene rubber, Polyurethanes

Plastics: Engineering Plastics, Resins, Poly carbonates, Polyamides, Poly Acetals.

Reading:

1. B.K. BhaskaraRao, A Text Book of Petrochemicals, Khanna Publications, 2nd Edition, 20
2. Robert A. Meyers, Robert A. Meyers, Handbook of Petrochemicals Production Processes
3. Mall I.D., Petrochemical Process Technology, Macmillan India, 2015

3 credits

PSO2	PSO3
-	-
-	-
-	-
-	-

col, PTFE, Methylamines.
ne, Manufacture of Vinyl
acture, Acetaldehyde from

lyvinyl Chloride, Copolymers

ers, Polypropylene,
ne rubber, Trans

)02.
s, McGraw-Hill Inc., 2005.

CH415	SCALE-UP METHODS	DEC	3 – 0 – 0

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand principles of scale up.
CO2	Apply dimensional analysis technique for scale up problems.
CO3	Carry out scale up of mixers, heat exchangers and chemical reactors
CO4	Scale up distillation columns and packed towers.

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	2	2	1	1	-	1	-	2	2	-	1	3
CO2	3	2	2	1	1	-	1	-	2	2	-	1	3
CO3	3	2	2	1	1	-	1	-	2	2	-	1	3
CO4	3	2	2	1	1	-	1	-	2	2	-	1	3

Detailed Syllabus:

Principals of Similarity, Pilot Plants & Models: Introduction to scale-up methods, pilot p principles of similarity, Industrial applications.

Dimensional Analysis and Scale-Up Criterion: Dimensional analysis, regime concept, similarit methods used in chemical engineering, experimental techniques for scale- up.

Scale-Up of Mixing and Heat Transfer Equipment: Typical problems in scale up of mi› transfer equipment.

Scale-Up of Chemical Reactors: Kinetics, reactor development & scale-up techniques f

Scale-Up of Distillation Column & Packed Towers: Scale-up of distillation columns and packe towers for continuous and batch processes.

Reading:

1. Marko Zlokamik, Scale-up in Chemical Engineering, Wiley-VCH, 2nd Edition, 2006.
2. Johnstone, Thring, Pilot Plants Models and Scale-up methods in Chemical Enginee York, 1962.
3. Hoyle W, Pilot Plants and Scale-Up, Royal Society of Chemistry, 1999.
4. Bruce Nauman E, Chemical Reactor Design, Optimization and Scale-up, McGraw H 2002.

3 Credits

PSO2	PSO3
3	1
3	1
3	1
3	1

ılants, models and

:y criterion and scale up

κing equipment and heat

or chemical reactors.
d

ring, McGraw Hill, New

Hill Handbooks, New York,

CH416	CO_2 CAPTURE AND UTILIZATION	DEC	3 – 0 – 0

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Identify the necessity of CO_2 capture, storage and utilization
CO2	Distinguish the CO_2 capture techniques
CO3	Evaluate CO_2 Storage and sequestration methods
CO4	Assess Environmental impact of CO_2 capture and utilization

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	2	3	1	2	3	3	-	2	2	-	1	2
CO2	3	2	3	1	2	3	3	-	2	2	-	1	2
CO3	3	2	3	1	2	3	3	-	2	2	-	1	2
CO4	3	2	3	1	2	3	3	-	2	2	-	1	2

Detailed syllabus

Introduction: Global status of CO_2 emission trends, Policy and Regulatory interventions in abatement of carbon footprin and utilization (CCS&U)

CO_2 capture technologies from power plants: Post-combustion capture, Pre-combustion capture, Oxy-fuel combustion, chemic calcium looping combustion

CO_2 capture agents and processes: Capture processes, CO_2 capture agents, adsorption, ionic liquids, metal organic framewc

CO_2 storage and sequestration: Geological sequestration methods, Biomimetic carbon sequestration

CO_2 Utilization: CO_2 derived fuels for energy storage, polymers from CO_2, CO_2 based solvents, CO2 to oxygenated organics carbon fuels, High temperature catalysis Environmental assessment of CO_2 capture and utilization: Need for assessment environmental assessment tools, Life cycle assessment (LCA), ISO standardization of LCA, Method of conducting an LCA for CO_2 capture and Utilization.

Reading:

1. Peter Styring, Elsje Alessandra Quadrelli, Katy Armstrong, Carbon dioxide utilization: Clos
Elsevier, 2015.
2. Goel M, Sudhakar M, Shahi RV, Carbon Capture, Storage and, Utilization: A Possible Clin
Energy Industry, TERI, Energy and Resources Institute, 2015.
3. Amitava Bandyopadhyay, Carbon Capture and Storage, CO_2 Management Technologies, CRC Press, 2014.
4. Fennell P, Anthony B, Calcium and Chemical Looping Technology for Power Generation a
Woodhead Publishing Series in Energy: No. 82, 2015.
5. Mercedes Maroto-Valer M, Developments in Innovation in Carbon Dioxide Capture and
Storage Technology: Carbon Dioxide Storage and Utilization, Vol 2, Woodhead Publishing Se

3 Credits

PSO2	PSO3
2	1
2	1
2	1
2	1

ıt, carbon capture, storage

al looping combustion,

ɔrks

, Conversion into higher
t, Green chemistry and

sing the Carbon Cycle,

nate Change Solution for

and Carbon Dioxide (CO_2) Capture,

eries in Energy, 2014.

CH417	NATURAL GAS PROCESSES, MODELING AND SIMULATION	DEC	3 – 0 – 0	3

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Analyze the properties of natural gas, Dehydration process plant in detail.
CO2	Design gas dehydration contactor using graphical and analytical methods.
CO3	Illustrate the importance of sulfur recovery in natural gas processing
CO4	Discuss the technology for Natural gas storage
CO5	Perform modelling of process & sweetening units using software tools

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	3	2	2	2	1	1	-	-	-	-	1	3
CO2	3	3	2	2	2	1	1	-	-	-	-	1	3
CO3	2	2	3	2	1	1	1	-	-	-	-	1	3
CO4	2	3	3	2	1	1	-	-	-	-	-	1	2
CO5	3	3	3	2	3	1	-	-	-	-	-	-	2

Detailed Syllabus:

Gas Dehydration: Glycol Process: Operation, System Parameters, Contactor Sizing and Sta and Analytical Methods. Regeneration.

Solid Bed Absorption: Types of solid desiccants, System Parameters, Operation and Design Toxicity, Solid Bed Process , Absorbent Selection, Selection Variables and Design , Physica Processes, Sulphur Recovery

Storage of Natural Gas: Pipeline Storage, Underground Storage, Mined Caverns

Modeling and Simulation: Introduction, Absorber, Distillation Column, Heat Exchar Simulation by software (Matlab and Aspen Plus, etc.)

Reading:

1. Chi U.Ikoku, Natural Gas Production Engineering, John Wiley & Sons.1992.
2. James G Speight, Natural Gas –A Basic Hand Book, Gulf Publishing Company, 2007.

3. Sanjay Kumar, Gas Production Engineering, Gulf Publishing Company, Volume 4, 1987.
4. John M Campbell, Gas Conditioning & Processing Volume 2, Volume 3, Volume 4 Camp
5. Donald Katz, Hand Book of Natural Gas engineering, McGraw Hill, 1959.
6. LP Dake, Fundamentals of Reservoir Engineering, Elsevier, 1978.
7. Hussain K. Abdel-Aal, Mohammed Aggour, M.A. Fahim, Petroleum and Gas field Proces

CREDITS

PSO2	PSO3
2	-
3	3
3	-
1	-
2	3

ge Calculations, Graphical

Sweetening: Acid Gases
l & Chemical absorption

nger, Regeneration unit,

ɔbell Petroleum Series.

ssing, Marcel Dekker, 2003.

CH418	INTRODUCTION TO TRIBOLOGY	DEC	3 – 0 – 0	3

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand the theories associated with evaluation and causes of friction
CO2	Understand type and mechanism of wear
CO3	Differentiate lubrication types and additives
CO4	Apply tribology to various bearings

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	3	2	2	2	1	1	-	-	-	-	1	3
CO2	3	3	2	2	2	1	1	-	-	-	-	1	3
CO3	2	2	3	2	1	1	1	-	-	-	-	1	3
CO4	2	3	3	2	1	1	-	-	-	-	-	1	2

Detailed Syllabus:

Introduction: Introduction to tribology; History of tribology; Interdisciplinary Approach; Econor

Friction: Causes of Friction; Adhesion Theory; Abrasive Theory; Junction Growth Theory; La

Instability.

Wear: Wear Mechanisms; Adhesive Wear; Abrasive Wear; Corrosive Wear; Fretting Wear;

Lubrication and Lubricants; Importance of Lubrication; Boundary Lubrication; Mixed Lubricat

Lubrication ; Hydrodynamic; Elastohydrodynamic lubrication; Types & Properties of Lubrican

Fluid film lubrication: Fluid mechanics concepts; Equation of Continuity & Motion; Generalise

Compressible & Incompressible Lubricants.

Application of Tribology: Introduction; Rolling Contact Bearings; Gears; Journal Bearings - Fi

Bearings.

Reading:

1. Dowson D, History of Tribology, Longman London, 1979.
2. Stachowiak G N, Batchelor A W and Stachowick G B "Experimental methods in Tribolog D Dowson, 2004.
3. Michael M Khonsari, Applied Tribology (Bearing Design and Lubrication), John Wiley & S
4. Jost H P, Lubrication (Tribology): A Report on the present position and industry`s needs, Office, London, 1966.
5. J Halling, Principles of Tribology, The Macmillan Press Ltd, London, 1975.
6. Archard J F and Hirst W, The Wear of Metals under Unlubricated Conditions, Proc. R. S 1956.

CREDITS

PSO2	PSO3
2	-
3	3
3	-
1	-

mic Benefits.
ws of Rolling Friction; Friction

Wear Analysis
ion; Full Fluid Film
its; Lubricants Additives.
ed Reynolds Equation with

inite

y", Tribology Series 44, Editor

Sons, 2001.
Her Majesty`s Stationary

oc., London, A 236, 397-410,

CH5111	PROCESS MODELING AND ANALYSIS	DEC	3 – 0 – 0	3

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand model building techniques
CO2	Develop first principles, grey box and empirical models for systems.
CO3	Develop mathematical models for engineering processes
CO4	Model discrete time systems

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	3	2	2	1	-	-	-	-	-	-	-	3
CO2	3	3	3	3	2	-	-	-	-	-	-	-	3
CO3	3	3	2	2	1	-	-	-	-	-	-	-	3
CO4	3	2	2	2	1	-	-	-	-	-	-	-	3

Detailed syllabus

Introduction to modeling, a systematic approach to model building, classification of models. D and dynamic lumped and distributed parameter models based on conservation principles. T models: Momentum, energy and mass transport models. Analysis of ill-conditioned system Classification of systems, system's abstraction and modeling, types of systems and example output system description, system response, analysis of system behavior, linear system, s linearization, non-linear system analysis, system performance and performance targets Development of grey box models. Empirical model building. Statistical model calibratio balance models. Examples.

Mathematical model development for electromagnetic forces in high field magnet coils, free a automobile, cantilever beam subjected to an end load. Mathematical model development for engineering processes – distillation columns, reactors, heat exchangers.

Discrete systems: difference equations, state-transition diagrams, cohort simulation of models, random processes, descriptive statistics, hypothesis testing, probabilistic distribution

pseudo-random numbers, Monte Carlo methods, numerical simulation of continuous- event systems, cellular automata, Moore machines, real-world system examples: Mechanical, Electrical, Electro-Mechanical, Chemical Systems.

Reading:

1. Ashok Kumar Verma, Process Modeling and Simulation in Chemical, Biochemical Engineering, CRC Press, 2014.
2. Amiya K. Jana, Chemical Process Modeling and Computer Simulation, Prentice Hall,
3. Jim Caldwell, Douglas K. S. Ng, Mathematical Modeling: Case Studies, Kluwer Academi
4. K. M. Hangos and I. T. Cameron, Process Modelling and Model Analysis, Academic Pres
5. M. Chidambaram, Mathematical Modelling and Simulation in Chemical Enginee Press, 2018.
6. Sandip Benerjee, Mathematical Modeling: Models, Analysis and Applications, CRC Pres
7. Ancheyta, J. Modelling and Simulation of Catalytic Reactors for Petroleum Refining. Wile
8. Pota, G. Mathematical problems for chemistry students, Oxford: Elsevier, 2006.

Credits

PSO2	PSO3
3	3
3	3
3	3
3	3

Development of steady state
The transport phenomena
ns.
es, system variables, input-
superposition principle,
.
on and validation. Population

and forced vibration of an
different chemical

Markov
ns,

-time dynamics, discrete-and Environmental

2nd Edition, 2011.
c Publishers, 2004.
ss, 2001.
ering, Cambridge University

s, 2014.
ey, 2011.

CH5114	STATISTICAL DESIGN OF EXPERIMENTS	DEC	3 – 0 – 0	3

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Plan experiments for a critical comparison of outputs
CO2	Include statistical approach to propose hypothesis from experimental data
CO3	Implement factorial and randomized sampling from experiments
CO4	Estimate parameters by multi-dimensional optimization

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	3	3	3	2	-	-	-	-	-	-	-	2
CO2	3	3	3	3	2	-	-	-	-	-	-	-	2
CO3	3	3	3	3	2	-	-	-	-	-	-	-	2
CO4	3	3	3	3	2	-	-	-	-	-	-	-	2

Detailed syllabus

Introduction: Strategy of experimentation, basic principles, guidelines for designing experime Experiments: Basic statistical concepts, sampling and sampling distribution, inferences abo means: Hypothesis testing, Choice of samples size, Confidence intervals, Randomized a Experiments with Single Factor; An example, The analysis of variance, Analysis of the fixed adequacy checking, Practical interpretation of results, Sample computer output, Determining dispersion effect, The regression approach to the analysis of variance, Nonparameteric met variance, Problems.

Design of Experiments: Introduction, Basic principles: Randomization, Replication, Bloc Confounding, Design resolution, Metrology considerations for industrial designed experi characteristics for industrial experiments.

Parameter Estimation.

Response Surface Methods: Introduction, The methods of steepest ascent, Analysis of a se order response surface, Experimental designs for fitting response surfaces: Designs for fittin Designs for fitting the second-order model, Blocking in response surface

designs, Computer-generated (Optimal) designs, Mixture experiments, Evolutionary opera
Problems.

Design and Analysis: Introduction, Preliminary examination of subject of research, Scr
Preliminary ranking of the factors, active screening experiment-method of random balance, a
Plackett-Burman designs, Completely randomized block design, Latin squares, Graeco-La
Squares, Basic experiment-mathematical modeling, Statistical Analysis, Experimental opti
subject: Problem of optimization, Gradient optimization methods, Nongradient methods of
rotatable design, Canonical analysis of the response surface, Examples of complex optimiza

1. Lazic Z. R., Design of Experiments in Chemical Engineering, A Practical Guide, Wiley, 2
2. Antony J., Design of Experiments for Engineers and Scientists, Butterworth Heine
3. Montgomery D. C., Design and Analysis of Experiments, Wiley, 5th Edition, 2010.
4. Doebelin E. O., Engineering Experimentation: Planning, Execution, Reporting, McGraw-I

3 Credits

PSO2	PSO3
2	3
2	3
2	3
2	3

ents. Simple Comparative
ut the differences in
and paired comparison design.
effect model, Model
g sample size, Discovering
hods in the analysis of

cking, Degrees of freedom,
ments, Selection of quality

cond-
ng the first-order model,

ation, Robust design,

reening experiments:
active screening experiment
tin Square, Youdens
imization of research
optimization, Simplex sum
ations. **Reading:**
005.
mann, 2004.

Hill, 1995.

CH5115	CHEMICAL PROCESS SYNTHESIS	PCC	3 – 0 – 0	3

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Analyze alternative processes and equipment
CO2	Synthesize a chemical process flow sheet that would approximate the real process
CO3	Design best process flow sheet for a given product
CO4	Perform economic analysis related to process design and evaluate project profitability

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	2	3	2	1	-	1	1	-	-	-	-	-	2
CO2	3	2	2	-	-	1	1	-	-	-	-	-	3
CO3	2	2	3	-	-	1	-	-	-	-	3	-	3
CO4	2	3	1	-	-	-	-	-	-	-	-	-	1

Detailed syllabus

Synthesis of steady state flow sheet: Introduction, Flow sheets, The problem of steady state semantic equation of equipment, Generalization of the method of synthesis of process flow s the flow sheet, separation systems.

Heuristics for process synthesis:

Raw materials and Chemical reactions, Distribution of chemicals, Separations, Heat exchang pressure reduction and conveying of solids

Algorithmic methods for process synthesis: Reactor design and reactor network synthe trains, sequencing of ordinary distillation columns

Optimization of flow sheet with respect to heat exchanger network: Introduction, Network of l necessary conditions for the existence of an optimal exchanger network, Maximum hea exchanger (rule 1), Hot and cold utilities (rule2), Condition of optimality for the minimum area situations in energy transfer, Heat content diagram representation of the network problem, M diagram for minimum network area, Rules of adjustment of the minimum heat exchanger net solution.

Safety in Chemical plant design: Introduction, Reliability of equipment, prevention of acciden
Safety considerations in plant layout, Classification of chemicals and handling problem, Vent
Design of safety valves, Safety consideration in reactor design, Leakages, Handling of flu
analysis of equipment and chemical plants, Fault tree analysis of accidents. Reliability cons
policies of a chemical plant

Economic evaluation: Time value of money, Methods for Profitability evaluation, Rate of retu
Net Present Worth, Capitalised cost , Discounted Cash flow analysis.

Reading:

1. Seider W. D., Seader J.D. and Lewin D. R., Product and Process Design Principles: Synt
2. Robin Smith, Chemical Process Design and Integration, John Wiley & Sons Ltd., 2005.
3. Bieglar L.T, Grossman E.I and Westerberg A.W., Systematic Methods of Chemical Proce
Inc.,1997
4. Douglas J. M., Conceptual Design of Chemical Processes, McGraw Hill International, 198

3 Credits

PSO2	PSO3
3	-
2	-
2	-
3	-

flow sheeting, General
sheet, Recycle structure of

gers and furnaces, pumping

esis, Synthesis of separation

heat exchanger, Some
at transfer in a single
n network, Three special
Matching of heat content
twork to find the optimal

ts, Flammability of chemicals,
ting of tanks and vessels,
uids, Trouble-shooting
sideration in maintenance

rn,

hesis, Wiley, 2005.

ss Design, Prentice Hall

38.

CH5117	NUCLEAR POWER TECHNOLOGY	DEC	3 – 0 – 0

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:.

CO1	Understand radioactivity, nuclear fission and fusion, interaction of particles with matte
CO2	Design and operate nuclear power plants
CO3	Select materials for nuclear reactor systems
CO4	Design and operate plants for the nuclear fuel cycle with emphasis on environmental and ethical aspects.

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	
CO1	3	3	3	2	1	2	1	-	-	-	-	-	3	
CO2	3	3	3	2	2	1	1	-	-	-	-	-	3	
CO3	2	2	3	1	1	1	1	-	-	-	-	-	1	
CO4	3	2	3	2	1	2	3	2	-	-	-	-	2	

Detailed syllabus

Nuclear Reactions and radiations: Atomic structure, Radioactivity and Radio isotopes, interact particles with matter, decay chains, neutron reactions, fission process, growth and decay of reactor with neutron burnout and continuous processing. Nuclear fission and fusion, types nuclear reactors, nuclear fuels, other reactor materials.

Nuclear Reactor theory: The neutron cycle, critical mass, neutron diffusion, the diffusion equa neutrons, reactor period, transient conditions and reflectors. Introduction to nuclear powe hydraulics: Thermal parameters: definitions and uses. Sources and distribution of thermal l reactors. Thermal analysis of nuclear fuel, Single-phase flow and heat transfer, Two-phase

Nuclear reactor materials: General requirements (neutronic and physical) of nuclear materials moderator, coolant and control rod, properties of moderator and coolant materials: grap water, heavy water, liquid metals. Brief description of

different systems. Selection Criteria of Materials for different systems. Materials behavior und

extreme environments, radiation, high temperature, corrosion. Zr alloys and Austenitic stainle: Nuclear fuel cycle: Uranium mining, milling and enrichment. Fuel reprocessing, PUREX extraction, Selection of solvents, Non aqueous reprocessing. Waste management, classificati of radioactive wastes, partitioning and transmutation. deep geological disposal.
Environmental effects of nuclear Power generation. Ethical aspects of nuclear power producti

Reading:

1. Glasstone S and Alexender Seasonske, Nuclear Reactor Engineering, CBS Publisher, US
2. W Marshall, Nuclear Power Technology, Vol I, II, and III, Oxford University Press, New Yo
3. G. Vaidyanathan, Nuclear Reactor Engineering (Principles and Concepts), S. Chanc
4. J.R. Lamarsh and A.J. Baratta, Introduction to Nuclear engineering, 3rd Edition, 2001.
5. K.D. Kok, Nuclear Engineering Handbook, CRC Press, 2009.
6. Manson Benedict, Thomas H. Pigford, Dr. Hans Wolfgang Levi: Nuclear Cher Hill Professional, 2nd Edition, 1981.

3 Credits

r

PSO2	PSO3
2	1
3	2
2	1
2	1

tion of alpha and beta
fission products in a
; and classification of

ıtion, slowing down of
ər systems, Thermal-
oads in nuclear power
flow and heat transfer.
: Core, structural,
ɔhite, beryllium, Boron,

er

ss steels.
flow sheet, Solvent
ion of wastes, treatment

ion.

SA, 3rd Edition, 1994.
rk, 1983.
d Publishers, 2013.

nical Engineering, McGraw-

CH5119	PIPING ENGINEERING	DEC	3– 0 – 0	3

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand the key steps in a pipeline's lifecycle: design, construction, installation an maintenance.
CO2	Draw piping and instrumentation diagrams (P&ID).
CO3	Understand codes, standards and statutory regulations.
CO4	Select pipe and pipe fittings.

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	3	2	2	-	-	1	-	-	-	1	1	2
CO2	2	3	2	1	-	-	-	-	-	-	-	-	-
CO3	2	2	-	-	1	2	2	-	-	-	-	-	-
CO4	2	2	2	3	1	-	-	-	-	-	-	-	2

Detailed Syllabus:

Introduction to piping: piping classification, other pipe ratings, and definitions of forces, mom power, and energy.

Piping components: pipe and tube products, traps, strainers, expansion joints, threaded joir welded and brazed joints.

Piping materials: material properties of piping materials, metallic materials, degradation Piping codes and standards: ASME, BIS, ISO standards relevant to chemical engineering. Pi process flow diagram, piping and instrumentation diagram, codes and standards.

Application of computer-aided design to piping layout.

Fabrication and installation of piping systems: introduction, fabrication, installation, Selection Pressure and leak testing.

Flow of fluids and calculations: introduction, theoretical background, steady single-phas incompressible flow in piping, steady single-phase compressible flow in piping, single-phase and orifices, steady two-phase flow.

Reading:

1. McAllister E.W., Pipeline Rules of Thumb Handbook, Gulf Publication, 7th Edition, 2009.
2. Kellogg, Design of Piping System, M.W. Kellogg Co., 2nd Edition, 2009.
3. Weaver R., Process Piping Design Vol.1 and 2, Gulf Publication, 1989.
4. Nayyar M. L., Piping Handbook, McGraw Hill, 7th Edition, 2000.

3 Credits

ıd

PSO2	PSO3
1	-
-	1
2	-
-	-

ents, equilibrium, work,

ıts, bolted flange joints,

of materials in service.
iping layout: Line diagram,

and application of valves,

se
flow in nozzles, venturi tubes,

CH5212	DATA ANALYTICS	DEC	3– 0 – 0	3 (

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Apply the concepts of probability, statistics, linear algebra, and calculus for da analysis
CO2	Understand Machine learning and graph structure learning concepts
CO3	Analyze data using Regression and Classification techniques
CO4	Apply Learning techniques and Dimensionality reduction techniques

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	3	3	3	3	-	-	-	-	-	-	1	1
CO2	3	3	3	3	3	-	-	-	-	-	-	1	1
CO3	3	3	3	3	3	-	-	-	-	-	-	1	1
CO4	3	3	3	3`	3	-	-	-	-	-	-	1	1

Detailed Syllabus:

Review of basics basic concepts on probability, statistic, linear algebra, and calculus. Descri Inferential Statistics through hypothesis tests, Permutation & Randomization Test. Regressio Variance).

Machine Learning: Introduction and Concepts Differentiating algorithmic and model bas Ordinary Least Squares, Ridge Regression, Lasso Regression, K Nearest Neighbors Re Graph structure learning: Traditional structure learning techniques – constraint based and sc based structure learning algorithm, Structure learning with priors and applications.

Supervised Learning with Regression and Classification techniques-1: Bias-Variance Dichoto Model Validation Approaches Logistic Regression, Linear Discriminant Analysis Quadra Regression and Classification Trees Support Vector Machines

Supervised Learning with Regression and Classification techniques-2: Ensemble Metho Networks, Deep learning. Unsupervised Learning and Challenges for Big Data Analytics Clus Mining Challenges for big data analytics

Prescriptive analytics Creating data for analytics through designed experiments Creating dat learning Creating data for analytics through Reinforcement learning.

Dimensionality reduction techniques - PCA, KPCA, PCR. Data collection and pre-processing

Reading:

1. Trevor Hastie, Robert Tibshirani, Jerome Friedman,The Elements of Statistical Lea
2. Montgomery, Douglas C., and George C. Runger, Applied Statistics and Probabilit
& Sons, 2010.
3. David J. Hand, Statistics, Sterling Press, 2008.
4. J. Han, M. Kamber, J. Pei, Data Mining: Concepts and Techniques, Morgan Kaufmann, 2
5. I.H. Witten, E. Frank, M. A. Hall, Data Mining: Practical Machine Learning Tools a
Kaufmann, 2011.
6. N. Matloff, The Art of R Programming, No Starch Press, 2011.
7. Denis Constales Gregory S. Yablonsky, Dagmar R. D'hooge,Joris W. Thybaut, and Guy
Analysis and Modelling in Chemical Engineering, Elsevier, 2017.

Credits

ta

PSO2	PSO3
3	3
3	3
3	3
3	3

ptive Statistics, Distributions.
n & ANOVA (Analysis of

sed frameworks Regression:
gression & Classification.
ore- based algorithms, L1-

omy,
tic Discriminant Analysis

ds: Random Forest, Neural
stering Associative Rule

a for analytics through Active

.

rning, Springer, 2009.
y for Engineers, John Wiley

2012.
and Techniques, Morgan

B. Maric, Advanced Data

SM701	INDUSTRIAL MANAGEMENT	HSC	3 – 0 – 0

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Explain the four evolutionary phases of the organizational theories their circumstances and the consequences.
CO2	Examine organizational systems, inventory and quality for productivity improvements.
CO3	Understand the marketing management process to discuss marketing mix in formulation of marketing strategies
CO4	Calculate project schedule along with the interdependencies using PERT/CPM techniques.

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	
CO1	-	-	-	-	1	1	-	-	3	1	3	-	-	
CO2	-	-	-	-	1	1	-	-	3	1	3	-	-	
CO3	-	-	-	-	1	1	-	-	3	1	3	-	-	
CO4	-	-	-	-	1	1	-	-	3	1	3	-	-	

Detailed syllabus

Introduction - Overview of organizational theory and theoretical perspectives

Rational and natural systems-The evolution of organizational theory - rational systems

Quality management: Dimensions of quality; Process control charts both attributes and

- LTPD and AOQL concepts. Taguchi's Quality Philosophy; Quality function deployment; I

Inventory Management: Purpose of inventories; Inventory costs; ABC classification; Econor P and Q systems of inventory control.

Organizational behavior – I and II-The individual, The Group, Organization system (structure a its environment, design, and change

Open systems and behavioral decision-making

Other management topics-Marketing management process; 4P's of marketing mix; Targ cycle and marketing strategies, Project Management: Project activities;

Network diagrams; Critical path method (CPM); Program Evaluation and Review Techni (PERT). Project crashing. Slack computations, Resource leveling

Reading:

1) Robbins, S. P. and Judge, T. A., Organizational Behavior, Pearson, 2001.
2) Jones, G. R and Jones, G. R. Organizational theory, design, and change. Upper Saddle Riv
3) Taylor F.W Principles of Scientific Management, 30-144, 2017.
4) Besterfield, Total Quality Management. Pearson Education India; 4th Edition, 2015.
5) Khanna O. P., Industrial engineering and management, Dhanpat Rai, 1980.
6) Kottler P and Keller, K. L., Marketing Management 14e Global Edition, 2011.
7) Weber M. Economy and Society 1978 pp.212-254, 956-975

3 Credits

PSO2	PSO3
-	-
-	-
-	-
-	-

and Natural systems,
variables. Sampling Plan
ntroduction to TQM,
nic Order Quantity (EOQ);

ınd culture), Organization

et marketing; Product life

ique

ver, NJ: Pearson, 2013.

CH499	PROJECT WORK - PART B	PRC	0 – 0 – 6

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Carry out the project involving manufacture of a chemical product/ experimentation modelling/simulation/optimization/design
CO2	Discuss the results
CO3	Communicate the results orally to an audience
CO4	Present a detailed written report

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PS(
CO1	2	3	1	2	1	1	1	-	-	2	-	-	2	2
CO2	3	3	1	1	1	1	2	-	3	2	-	-	3	2
CO3	3	3	3	3	2	1	1	1	3	3	-	-	3	3
CO4	3	3	3	`3	2	1	1	1	2	3	-	-	3	3

Detailed syllabus

The student is required to choose any one of the following:

1. Project involving experimentation/modelling/simulation/Design/optimization in chemical e research/industry/society

At the end of the semester, the student is required to present (i) Literature survey, (ii) Problem for Methodology, (iv) Results and Discussion, (v) Conclusions (vi) Future work (vii) References

2. Project involving manufacture of any chemical product on industrial scale

At the end of the semester, the student is required to present (i) market survey, (ii) Properties anc different processes for production, (iv) selection of process, (v) detained process description (vi) r balance, (vii) design of equipment, (viii) cost and profitability analysis, (ix) plant layout and loc environmental considerations and safety and (xi) References

Minimum number of pages in the report should be 50.

Written report shall adhere to the prescribed format

Reading

1. Handbooks,
2. Journals and magazines
3. Martyn S. Ray and Martin G. Sneesby, Chemical Engineering Design Project: A Case Study A Breach Science Publishers, Second Edition, 1989.

4 Credits

ı/

O2	PSO3
	-
	-
	3
	3

engineering related to

rmulation, (iii)

d Applications (iii)
material and Energy
ation, (x)

Approach, Gordon and

CH461	**MICROSCALE UNIT OPERATIONS**	**DEC**	**3 – 0 – 0**

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Identify the micro-scale phenomena in various miniaturized equipment like MEMS.
CO2	Solve fluid flow phenomena for single and two immiscible liquids in micro-channels.
CO3	Design architectures of micro-fluidic devices for chemical & medical applications
CO4	Integrate theoretically the modular components for assembling of Lab-on-a-chip devices.

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	1	2	1	2	2	-	-	-	-	-	1	2	2
CO2	2	3	3	2	2	-	-	-	-	-	1	2	3
CO3	2	3	3	2	2	-	-	-	-	-	1	2	2
CO4	2	2	2	2	2	-	-	-	-	-	1	2	2

Detailed Syllabus:

Physics and Chemistry at microscale: Introduction, Ranges of forces of microscopic ori scales intervening in liquids and gases, Micromanipulation of molecules and cells in Microsys miniaturization, miniaturization of electrostatic systems, miniaturization of electromagne miniaturization of mechanical systems, miniaturization of thermal systems, miniaturizatic analysis.

Fluid dynamics in micro channels: Introduction, hypotheses of hydrodynamics, Hydrodynamic Microchannels, Flow of liquids with slip at the surface, Microhydrodynamics, Microfluidics invo Interfacial phenomena: a few ideas about capillarity, Microfluidics of drops and bubbles emulsion in Microsystems.

Reaction, Mixing and separation in micro chambers: Introduction, The microscopic origi Advection-diffusion equation and its properties, Analysis of dispersion phenomena, Microsystems, Adsorption phenomena, Dispersion with chemical kinetics, Chromatography.

Instruments for micro devices: Introduction, Examples of microfluidic structures, connect fabricated valves and pumps.
Fabrication methods of micro devices, Applications of micro devices: Introduction, Curre technologies, The environment of micro-fabrication, Photolithography, Micro-
fabrication methods for silicon and glass MEMS, Methods of Fabrication for plastic MEMS.

Reading:

1. Tabeling P, Introduction to Microfluidics, Oxford University Press, 2010.
2. N.T. Nguyen, Steven Wereley, Fundamentals and Applications of Microfluidics, Artech Ho
3. Ronald F. Probstein, Physicochemical Hydrodynamics: An Introduction, Wiley-Interscience 2nd Edition, 2003.

3 Credits

PSO2	PSO3
2	1
2	2
3	3
2	2

igin, Microscopic length
stems, The physics of
tic systems,
on of systems for chemical

s of gases in
lving inertial effects.
s, two- phase flows,

n of diffusion process,
chaotic mixing, mixing in

tors, Examples of micro-

ent situation of micro-

use Inc., 2^{nd} Edition, 2002.
e,

CH462	PROCESS AND PRODUCT DESIGN	DEC	3 – 0 – 0	3

Pre-requisites: None

Course Outcomes: At the end of the course, student will be able to:

CO1	Understand Chemical product design principles
CO2	Select processes and flowsheets
CO3	Assess energy requirements and safety/sustainability indicators of processes
CO4	Execute computer aided molecular and mixture design
CO5	Design chemical devices

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	2	2	1	2	-	-	-	-	-	-	-	1
CO2	3	3	3	2	1	-	-	-	-	-	-	-	2
CO3	2	3	3	2	1	2	2	-	-	-	-	-	3
CO4	3	3	3	2`	3	-	-	-	-	-	-	-	2
CO5	3	3	3	2	1	-	-	-	-	-	-	-	2

Detailed Syllabus

Introduction to Chemical Product Design : Introduction, The Diversity of Chemical Products, Products, Companies Engaging in Production of Chemical Products, B2B and B2C Chemica and Classes of Chemical Products, Product Design and Development, Tasks and Phases Development Project Management, Market Study, Product Design, Feasibility Study, Proto Introduction to Process Design : Objectives, Introduction, Information Gathering, Environme Chemical Prices, Experiments, Preliminary Process Synthesis, Chemical State, Process Ope Continuous or Batch Processing, Next Process Design Tasks, Flowsheet Mass Balances, Flowsheet Material and Energy Balances, Equipment Sizing and Costing, Economic Eva Integration, Environment, Sustainability, and Safety, Controllability Assessment, Optimiz Flowsheet Mass Balances, Flow Diagrams.

Design Literature, Stimulating Innovation, Energy, Environment, Sustainability, Safe
Objectives, Design Literature, Information Resources, General Search Engines and Infor
Stimulating Invention and Innovation, Energy Sources - Coal, Oil, and Natural Gas, Shal
Hydrogen, Hydrogen Production, Fuel Cell Energy Source, Hydrogen Adsorption, Biofuels
Farms, Hydraulic Power, Geothermal Power, Nuclear Power, Selection of Energy Sourc
Environmental Protection, Environmental Issues, Environmental Factors in Product and
Sustainability—Key Issues, Sustainability Indicators, Life-Cycle Analysis, Safety Considerati
Approaches Toward Safe Chemical Plants, Engineering Ethics

Molecular and mixture design: Framework for Computer-Aided Molecular-Mixture Desig
Representation, Generation of Molecule-Mixture Candidates, Mathematical Formulations of
Design Problems, Solution Approaches, Case Studies

- Refrigerant Design, Large Molecule (Surfactant) Design, Active Ingredient Design/Selec
Dichloromethane (DCM) Replacement in Organic Synthesis, Azeotrope Formation, Sol
Design

Design of Chemical Devices, Functional Products, and Formulated Products: Objectives, De
and Functional Products, The Use of Models in Design of Devices and
Functional Products, Design of Formulated Products, Design of Processes for B2C Products

Reading:

1. Warren D. Seider, Daniel R. Lewin, J. D. Seader, S. Widagdo, R. Gani, K.A. Ming Ng, Pr
principles, Synthesis, Analysis and Evaluation, Wiley,4th Edition,1999.
2. E. L. Cussler and G. D. Moggridge, Chemical Product Design (Cambridge Series in Che
Engineering), Cambridge University Press, 2nd Edition, 2011.

CREDITS

PSO2	PSO3
1	2
2	2
3	3
3	3
3	3

The Chain of Chemical
al Products, Market Sectors
s in Product Design and
typing
ental and Safety Data,
erations, Synthesis Steps,
Process Stream Conditions,
aluation, Heat and Mass
ation, Preliminary

ety, Engineering Ethics :
rmation Resources,
e Oil, Shale Gas,
, Solar Collectors, Wind
es in Design,
Process Design,
ons, Safety Issues, Design

gn, Molecular Structure
Molecular and/or Mixture

ction, Polymer Design,
lvent Substitution, Mixture

esign of Chemical Devices

s

roduct and Process design

mical

CH463	MATHEMATICAL METHODS IN CHEMICAL ENGINEERING	DEC	3 – 0 – 0

Pre-requisites: None.

Course Outcomes: At the end of the course the student will be able to:

CO1	Formulate lumped and distributed parameter mathematical models for chemical processes
CO2	Evaluate degrees of freedom for the developed mathematical models
CO3	Solve the model equations describing chemical processes and equipment
CO4	Analyze the results of the solution methods.
CO5	Perform nonlinear analysis

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	
CO1	3	1	3	3	-	3	-	-	-	-	-	-	3	
CO2	3	2	3	3	-	-	-	-	-	-	-	-	3	
CO3	3	3	3	3	-	-	-	-	-	-	-	-	3	
CO4	3	3	3	3	-	-	-	-	-	-	-	-	3	
CO5	3	-	-	3	3	-	-	-	-	-	-	-	3	

Detailed Syllabus:

Mathematical Formulation of the Physical Problems- Introduction, Representation of the probl continuous stirred tank reactor, unsteady state operation, heat exchangers, distillation colu Analytical (explicit) Solution of Ordinary Differential Equations encountered in Che Problems-Introduction, Order and degree, first order differential equations, second order diffe differential equations, Simultaneous differential equations. Differential algebraic equations.

Non-linear analysis: Phase plane analysis, Bifurcation behavior

Formulation of partial differential equations- Introduction, Interpretation of partial derivati differential equations, particular solutions of partial differential equations, Orthogonal func of variables, The Laplace Transform method, Other transforms.

Unsteady state heat conduction in one dimension - Mass transfer with axial symmetry - Contir
Boundary conditions - Iterative solution of algebraic equations- The difference operator
difference operator- Linear finite difference equations- Non-linear finite difference equations-
differential equations - analytical solutions -
Application of Statistical Methods.

Reading:

1. B. A. Finlayson, Introduction to Chemical Engineering Computing, Wiley India Edition, 20'
2. Singaresu S. Rao, Applied Numerical Methods for Engineers and Scientists, Prentice Hall
3. Amiya K. Jana, Chemical Process Modelling and Computer Simulation, Prentice Hall Indiā
4. Norman W. Loney, Applied Mathematical Methods for Chemical Engineers, CRC P
5. B.W. Bequette -Process Dynamics- Modelling, Analysis and Simulation, Prentice Hall, 19
6. S.K.Gupta, Numerical Methods for Engineers, New Age International Publishers, 2015.
7. M. Chidambaram, Mathematical Modelling and Simulation in Chemical Engineer Press, 2018.

3 Credits

PSO2	PSO3
3	3
3	3
3	3
3	3
-	3

em, blending process,
mns, biochemical reactors.
mical Engineering
erential equations, Linear

ives, Formulation partial
ctions, Method of separation

ıuity equations;
- Properties of the
- Simultaneous linear

10.
l, 2002.
a, 2nd Edition, 2011.
ress, 3rdEdition, 2015.
98.

ring, Cambridge University

CH464	INTRODUCTION TO MACROMOLECULES	DEC	3 – 0 – 0

Pre-requisites: None

Course Outcomes: At the end of the course, student will be able to:

CO1	Describe macromolecules based on chemical constitution and architecture of chains.
CO2	Correlate macroscopic properties of polymer using microscopic chemical structure.
CO3	Predict the thermodynamic behavior of polymer mixtures by using Flory-Huggins theory.
CO4	Characterize polymeric materials using mechanical or electrical response.

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	3	1	2	-	-	-	-	-	-	-	-	-
CO2	3	3	2	2	-	-	-	-	-	-	-	-	-
CO3	3	3	3	3	-	-	-	-	-	-	-	-	-
CO4	3	3	3	3	-	-	-	-	-	-	-	-	-

Detailed syllabus

Introduction: Concepts, nomenclature and synthesis of polymers; Origins of polymer science basic definitions and nomenclature, molar mass and degree of polymerization.
Single chain conformations: Conformations of a single macromolecule, ideal chain, expa
Polymer solutions: Dilute and semi-dilute solutions, excluded volume interaction, polyelectro
Polymer blends and copolymers: Flory-Huggins theory, phase separation mechanisms spinodal decomposition.
Mechanical and Electrical response: Types of response and response functions.

Reading:

1. Gert Strobl, The physics of polymers: Concepts for Understanding Their Structure Edition, 2007.
2. Robert J. Young, Peter A. Lovell, Introduction to polymers, CRC Press, 3rd Edition, 2011
3. Michael Rubinstein, Ralph H. Colby, Polymer Physics, OUP Oxford, 2003.
4. L. Mandelkern, An introduction to Macromolecules, Springer-Verlag, 2nd Edition, 2012.

3 Credits

PSO2	PSO3
-	-
-	-
-	-
-	-

e and the polymer industry,

anded chain, persistent chain.
olyte solutions.
and critical fluctuations and

es and Behavior, Springer,3rd

.

CH5161	OPTIMIZATION TECHNIQUES	DEC	3 – 0 – 0	3

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Formulate objective function for a given problem
CO2	Understand unconstrained single variable optimization and unconstrained multi variable optimization
CO3	Understand linear programming and nonlinear programming techniques
CO4	Use dynamic programming and semi definite programming for optimization

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	3	3	-	2	1	2	-	-	1	-	-	1
CO2	3	3	3	-	-	1	2	-	-	1	-	-	-
CO3	3	3	3	-	-	1	2	-	-	1	2	-	1
CO4	3	3	3	`	-	1	2	-	-	1	2	-	2

Detailed syllabus

The Nature and Organization of Optimization Problems: What Optimization is all abou and Hierarchy of Optimization, Examples of applications of Optimization, The Essential Fea Problems, General Procedure for Solving Optimization Problems, Obstacles to Optimizati Basic Concepts of Optimization: Continuity of Functions, Unimodal vs. multimodal func functions, convex region, Necessary and Sufficient Conditions for an Extremum of an U Interpretation of the Objective Function in terms of its Quadratic Approximation.

Optimization of Unconstrained Functions: One Dimensional search Numerical Methods One Variable, Scanning and Bracketing Procedures, Newton and Quasi- Newton Methods Polynomial approximation methods, How One- Dimensional Search is applied in a Mul Evaluation of Uni-dimensional Search Methods.

Unconstrained Multivariable Optimization: Direct methods, indirect methods – first order, indi methods – second order.

Linear Programming and Applications: Basic concepts in linear programming, Degenerate LI
Natural occurrence of Linear constraints, The Simplex methods of solving linear programi
form, Obtaining a first feasible solution, Sensitivity analysis, Duality in linear programming
Nonlinear programming with constraints The Lagrange multiplier method, Necessary ai
local minimum, introduction to quadratic programming.
Optimization of Stage and Discrete Processes: Dynamic programming, Introduction to intege
programming.
Applications to different processes.

Reading:

1. Thonas F. Edgar, D.M. Himmelblau and Leon S. Lasdon, Optimization of Chemica
2nd Edition, 2001.
2. Stoecker W. F, Design of Thermal Systems, McGraw-Hill, 3rd Edition, 2011.
3. Singiresu S Rao, Engineering Optimization: Theory and Practice, John Wiley & Sons Ltd
4. Mohan C. Joshi and Kannan M. Moudgalya, Optimization: Theory and Practice, A
Limited, 2004.
5. Stephen Boyd, Lieven Vandenberghe, Convex optimization, Cambridge University Pı
6. P. Venkataraman, Applied Optimization with MATLAB Programming, Wiley, 2nd Edition, 2
7. Suman Dutta, Optimization in Chemical Engineering, Cambridge University Press, 2016.

3 Credits

PSO2	PSO3
1	3
1	3
1	3
1	3

ıt, Why Optimize?, Scope
tures of Optimization
on.
ctions, Convex and concave
Jnconstrained Function,

for Optimizing a Function of
of Uni-dimensional Search,
ltidimensional Problem,

rect

P's – Graphical Solution,
ming problems, standard LP

nd sufficient conditions for a

er and mixed integer

al Processes, McGraw Hill,

., 4th Edition, 2009.
lpha Science International

ress, 2004.
2009.

CH5162	PROCESS SCHEDULING AND UTILITY INTEGRATION	DEC	3 – 0 – 0

Prerequisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Identify the objectives of scheduling problem
CO2	Develop a model for batch process scheduling
CO3	Integrate process scheduling and resource conservation
CO4	Design and synthesize batch plants

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	3		3	2		3			1	3		
CO2	1	2	3		2					1			
CO3	1	1	3		3		2			1	3		
CO4		1	3	2`	3					1	2		

Detailed Syllabus:

Introduction to Batch Chemical Processes: Definition of a batch process, Opera batch plants, Recipe representations, Batch chemical process integration. Short-Term Sche for scheduling of multipurpose and multi-product batch plants, Different storage policies f products, Evolution of multiple time grid models in batch process scheduling, Short-term sch pipeless plants, Planning and scheduling in biopharmaceutical industry.

Resource Conservation: Integration of batch process schedules and water allocation net fixed scheduled batch processes, Wastewater minimization in multiproduct batch plants: sin design for maximum wastewater reuse in batch plants, Wastewater minimization in multipu multiple contaminants, Wastewater minimization using multiple storage vessels, Wastev inherent storage, Zero effluent methodologies,

Heat integration in multipurpose batch plants: direct and indirect heat integration, Simultane optimization of energy and water use in multipurpose batch plants, Flexibility analyses and t

applications in solar-driven membrane distillation desalination system designs, Automa
process integration.
Design and Synthesis: Design and synthesis of multipurpose batch plants, Process syn
enhancing sustainability of batch process plants, Scheduling and design of multipurpo
versus non periodic operation mode through a multi objective approach, Mixed-intege
model for optimal synthesis of
polygeneration systems with material and energy storage for cyclic loads.

Reading:

1. Thokozani Majozi, Esmael Reshid Seid, Jui-Yuan Lee, Synthesis, Design, and Reso
Chemical Plants, CRC Press Taylor & Francis, 2015.
2. Thokozani Majozi, Batch Chemical Process Integration - Analysis, Synthesis
2010.
3. Gintaras V. Reklaitis, Aydin K. Sunol, David W. T. Rippin, Oner Hortacsu, Batch Process
Springer, 1996.
4. Mariano Martin, Introduction to Software for Chemical Engineers, CRC Press, 2015.
5. Amir Shafeeq, Multiproduct Batch Process Scheduling, VDM Verlag, 2011.

3 Credits

PSO2	PSO3

ıtional philosophies, Types of
eduling: Effective technique
or intermediate and final
ıeduling of multipurpose

twork, Water conservation in
gle contaminants, Storage
ırpose batch plants:
water minimization using

ous
heir

ted targeting model for batch

thesis approaches for
se batch facilities: Periodic
er linear programming

urce Optimization in Batch

and Optimization, Springer,

sing Systems Engineering,

CH5164	ADVANCED MASS TRANSFER	DEC	3 – 0 – 0	3

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand the concept of separation factor and separating agent.
CO2	Classify the separation processes based on the energy requirements.
CO3	Determine the degrees of freedom using phase rule and description rule.
CO4	Compare multi-stage operations.
CO5	Design binary distillation column using McCabe Thiele and Ponchon-Savarit methods.
CO6	Design multi-component distillation columns using short cut and rigorous calculation methods.

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	2	2	1	2	-	-	-	-	-	-	2	2
CO2	3	2	2	1	2	-	-	-	-	-	-	2	2
CO3	3	2	2	1	2	-	-	-	-	-	-	2	2
CO4	3	2	2	1	2	-	-	-	-	-	-	2	2
CO5	3	2	3	1	2	-	-	-	-	-	-	2	3
CO6	3	2	3	1	2	-	-	-	-	-	-	2	3

Detailed syllabus

Characterization of Separation processes: Inherent Separation Factors: Equilibration Proces Factors: Rate-governed Processes.

Simple equilibrium processes: Equilibrium Calculations, Checking Phase Conditions for a Mi processes: Increasing Product Purity, Reducing Consumption of Separating Agent, Counter current Flow.

Binary multistage separation: Binary Systems, Equilibrium Stages, McCabe-Thiele Diagram, Design Problem, Choice of Column Pressure.

Binary multistage separations-general graphical approach: Straight Operating Lines, Cu
Extraction, Absorption, Processes without Discrete Stages, Packed tower distillation, Ge
Diagram.
Energy requirements of a separation process: Minimum Work of Separation, Net W
Thermodynamic Efficiency, network of potentially reversible process, partially reversible
processes.
Multi-component system fractionation: preliminary calculations, feed condition, column press
number of equilibrium stages, feed location, estimation of number of theoretical
plates – shortcut methods and rigorous calculation methods.

Reading:

1. King C. J., Separation Processes, Tata McGraw Hill Book Company, 2^{nd} Edition, 1983.
2. Vanwinkle M, Distillation, McGraw Hill Chemical Engineering Series, New York, 1967.
3. Holland C. D., Multi-component Distillation, Prentice Hall of India Pvt. Ltd., 1981.
4. Geankoplis C. J., Transport Processes and Unit Operations, Prentice Hall of India Delhi, 2004.
5. Nakajima H. Mass Transfer: Advanced Aspects, Intech Publishers, 2014.

3 Credits

PSO2	PSO3
2	1
2	1
2	1
2	1
2	1
2	1

ses, Inherent Separation

xture. Multistage separation
Co-current, Crosscurrent, and

The

ırved Operating Lines,
ːneral Properties of the yx

Vork Consumption,
process and irreversible

ure, design procedure,

Pvt. Ltd.,4^{th}Edition, New

CH5165	COMPUTATIONAL FLUID DYNAMICS	DEC	3 – 0 – 0

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to

CO1	Derive governing equations of fluid flow and heat transfer and classify them
CO2	Discretize the equations using Finite difference and volume formulation
CO3	Solve the discretized equations using different techniques
CO4	Implement pressure velocity coupling algorithms
CO5	Understand grid generation techniques

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	2	2	2	3	-	-	-	2	2	-	1	-
CO2	3	2	2	2	3	-	-	-	2	2	-	1	-
CO3	3	2	2	2	3	-	-	-	2	2	-	1	-
CO4	3	2	2	2	3	-	-	-	2	2	-	1	-
CO5	3	2	2	2	3	-	-	-	2	2	-	1	-

Detailed syllabus

Introduction – CFD approach, Need for CFD.

Governing equations of fluid flow and heat transfer - Laws of conservation: Mass – Momentu boundary conditions - Conservative form – Differential and Integral forms of general transpo of physical behaviours – Classification of fluid flow equations.

Discretization of equations – Finite difference / volume methods – 1D, 2D and 3D D Convection and diffusion problems - Properties of discretization schemes- Central, upwind, differencing schemes.

Solution methods of discretized equations- Tridiagonal matrix algorithm (TDMA)-Application problems – Iterative methods – Multigrid techniques.

Pressure – velocity coupling algorithms in steady flows – Staggered grid – SIMPLE, SIMPLE and PISO - Unsteady flows- Explicit scheme, Crank Nicholson scheme, fully implicit scheme

Turbulence modelling - Prantl mixing length mode - One equation model, k - ε mode Applications.

Structured and unstructured grids – Grid generation methods

Reading:

1. H. K. Versteeg, W. Malalasekera, An Introduction to Computational Fluid Dynamics - Th
Pearson Education Limited,2nd Edition, 2007.
2. T. J. Chung, Computational Fluid Dynamics, Cambridge University Press, 2nd Edition, 20
3. C. Hirch, Numerical Computation of internal and external flows, Wiley, 2nd Edition, 2007.
4. J. D. Anderson Jr., Computational Fluid Dynamics - The basics with Applications, McGra
5. J. H. Ferziger, M. Peric, Computational Methods for Fluid Dynamics, Springer, 2002.
6. Gautam Biswas and Somenath Mukherjee, Computational Fluid Dynamics, Alpha Scienc
7. Sreenivas Jayanti, Computatinal Fluid Dynamics for Engineers and Scientists, Spri
2018.

3 Credits

PSO2	PSO3
1	3
1	3
1	3
1	3
1	3

ım - Energy, Initial and
rt equations – Classification

)iffusion problems -
hybrid and higher order

of TDMA for 2D and 3D

:C

ǝl, RSM equation model -

ıe finite volume method,

ı10.

ıw Hill, 1995.

ıce International Limited, 2014.
ınger,

CH5166	**PROCESS INTENSIFICATION**	**DEC**	**3 – 0 – 0**	**3**

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Identify the scope for process intensification in chemical processes.
CO2	Implement methodologies for process intensification
CO3	Understand scale up issues in the chemical process.
CO4	Solve process challenges using intensification technologies.

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	2	2	2	2	-	-	-	-	-	-	-	2
CO2	3	2	2	1	1	-	-	-	-	-	-	-	1
CO3	2	1	3	1	1	-	-	-	-	-	-	-	2
CO4	3	3	2	2`	1	-	-	-	-	-	-	-	2

Detailed syllabus

Introduction: Techniques of Process Intensification (PI) Applications, The philosophy a Intensification, Main benefits from process intensification, Process- Intensifying Equipme toolbox, Techniques for PI application.

Process Intensification through micro reaction technology: Effect of miniaturization on reactions, Implementation of Microreaction Technology, from basic Properties to Technical D Process Restrictions in Miniaturized Devices and Their Potential Solutions, Microfabricati operation Devices - Wet and Dry Etching Processes.

Scales of mixing, Flow patterns in reactors, mixing in stirred tanks: Scale up of mixin intensified equipment, Chemical Processing in High-Gravity Fields Atomizer Ultrasound Ato intensity inline MIXERS reactors Static mixers, Ejectors, Tee mixers, Impinging jets, Design Principles of static Mixers Applications of static mixers, Higee reactors.

Combined chemical reactor heat exchangers and reactor separators: Principles of ope Applications, Reactive absorption, Reactive distillation, Applications of RD Process

Fundamentals of Process Modelling, Reactive Extraction Case Studies: Absorption of NOx C
Compact heat exchangers: Classification of compact heat exchangers, Plate heat exchange
Flow pattern, Heat transfer and pressure drop, Flat tube-and-fin heat exchangers, Microcha
Phase-change heat transfer, Selection of heat exchanger technology, Feed/effluent heat
exchangers in separation processes, Design of compact heat exchanger - example.
Enhanced fields: Energy based intensifications, Sono-chemistry, Basics of cavitation, Cavita
rotating surface, Hydrodynamic cavitation applications, Cavitation reactor design, Nusselt-flo
transfer, The Rotating Electrolytic Cell, Microwaves,
Electrostatic fields, Sonocrystallization, Reactive separations, Super critical fluids.

Reading:

1. Stankiewicz, A. and Moulijn, (Eds.), Reengineering the Chemical Process Plants, Pr
Dekker, 2003.
2. Reay D., Ramshaw C., Harvey A., Process Intensification, Butterworth Heinemann, 2008.
3. Kamelia Boodhoo (Editor), Adam Harvey (Editor), Process Intensification Technologi
Engineering Solutions for Sustainable Chemical Processing, Wiley, 2013.
4. Segovia-Hernández, Juan Gabriel, Bonilla-Petriciolet, Adrián (Eds.), Process Intensificatio
Design Optimization and Control, Springer, 2016.
5. Reay, Ramshaw, Harvey, Process Intensification, Engineering for Efficiency, Sustainabilit
Flexibility, Butterworth-Heinemann, 2013.

3 Credits

PSO2	PSO3
3	1
2	3
3	1
1	1

ınd opportunities of Process
ənt, Process intensification

unit operations and
Design Rules, Inherent
ion of Reaction and unit

g, Heat transfer. Mixing in
mization, Nebulizers, High
Rotor stator mixers,

ɘration;
ses,

:oke Gas Purification.
rs, Spiral heat exchangers,
nnel heat exchangers,
exchangers, Integrated heat

tion Reactors, Flow over a
ow model and mass

rocess Intensification, Marcel

es for Green Chemistry:

n in Chemical Engineering

y and

CH5262	SOFT COMPUTING TECHNIQUES	DEC	3 – 0 – 0	3 (

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand the concept of neural networks
CO2	Use neural networks to control the process plants
CO3	Develop fuzzy logic based controllers for different processes
CO4	Combine fuzzy logic with neural networks for plant control

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	1	3	2	1	-	-	-	-	-	-	-	-
CO2	3	1	3	2	1	-	-	-	-	-	-	-	-
CO3	3	1	3	2	1	-	-	-	-	-	-	-	-
CO4	3	1	3	2`	1	-	-	-	-	-	-	-	-

Detailed syllabus

Introduction to Neural Networks: Artificial Neural Networks: Basic properties of Neurons, Neu forward networks. Computational complexity of ANNs.

Neural Networks Based Control: ANN based control: Introduction: Representation the plant, control structures – supervised control, Model reference control, Internal model co Examples – Inferential estimation of viscosity an chemical process, Auto – turning feedba distillation tower.

Introduction to Fuzzy Logic: Fuzzy Controllers: Preliminaries – Fuzzy sets and Basic notions calculations – Fuzzy members – Indices of Fuzziness – comparison of Fuzzy quantitie determination of membership functions.

Fuzzy Logic Based Control: Fuzzy Controllers: Preliminaries – Fuzzy sets in commercial proc – basic construction of fuzzy controller – Analysis of static properties of fuzzy controller – An of fuzzy controller – simulation studies – case studies – fuzzy control for smart cars.

Neuro – Fuzzy and Fuzzy – Neural Controllers: Neuro – fuzzy systems: A unified approxima reasoning approach – Construction of role bases by self-learning: System structure and lear algorithms. Controller design using genetic algorithms.

Reading:

1. Bose and Liang, Artificial Neural Networks, Tata McGraw Hill, 1996.
2. Huaguang Zhang, Derong Liu, Fuzzy Modeling and Fuzzy Control, Birkhauser Publishers
3. Kosco B, Neural Networks and Fuzzy Systems: A Dynamic Approach to Machine Intellige 1992.
4. Lakshmi C. Jain, N. M. Martin, Fusion of Neural Networks, Fuzzy Systems and G Applications, CRC Press, 1998.
5. MuhammetÜnal, AyçaAk, Vedat Topuz, Hasan Erdal, Optimization of PID Controllers usi Algorithms, Springer, 2013.
6. S.N. Sivanandam, S.N. Deepa, Principles of Soft Computing, John Wiley & Sons, 2007.

Credits

PSO2	PSO3
2	1
2	1
2	1
2	1

ıron Models, and Feed

and identification, modeling
ɔntrol, Predictive control:
ack control, industrial

– Fuzzy relation
es – Methods of

ducts
alysis of dynamic properties

ate
ning. Introduction to Genetic

s, 2006.
ence, Prentice Hall of India,

enetic Algorithms: Industrial

ng Ant colony and Genetic

OPEN ELECTIVES

CE390	ENVIRONMENTAL IMPACT ANALYSIS	OPC	3 – 0 – 0

Pre-requisites: None

Course Outcomes: At the end of the course, student will be able to:

CO1	Identify the environmental attributes to be considered for the EIA study.
CO2	Formulate objectives of the EIA studies.
CO3	Identify the suitable methodology and prepare Rapid EIA.
CO4	Prepare EIA reports and environmental management plans.
CO5	Plan the methodology to monitor and review the relief and rehabilitation works.

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	2	1	2	-	-	3	3	1	-	2	1	-	-
CO2	2	1	2	-	-	3	3	1	-	2	1	-	-
CO3	2	1	2	-	-	3	3	1	-	2	1	-	-
CO4	2	1	2	-	-	3	3	1	-	2	1	-	-
CO5	2	1	2	-	-	3	3	1	-	2	1	-	-

Detailed Syllabus:

Introduction: The Need for EIA, Indian Policies Requiring EIA , The EIA Cycle and Procedu Baseline Data, Impact Prediction, Assessment of Alternatives, Delineation of Mitigation Me Report, Public Hearing, Decision Making, Monitoring the Clearance Conditions, (in the EIA Process. Government of India Ministry of Environment and Forest Notification requiring Environmental clearance, Application form, Composition of Expert Committee, International agreements.

Identifying the Key Issues: Key Elements of an Initial Project Description and Scoping, Pr Impacts, Consideration of Alternatives, Process selection: Construction Phase, Input and Emissions, Air Emissions, Liquid Effluents, Solid Wastes, Risks to Environment anc Economic Impacts, Ecological Impacts,

Global Environmental Issues.

EIA Methodologies: Criteria for the selection of EIA methodology, impact identification, imp interpretation & Evaluation, impact communication, Methods-Adhoc methods, Check methods, Networks methods, Overlays methods, Environmental index using factor ar analysis, Predictive or Simulation methods. Rapid assessment of Pollution sources models for impact assessment, Applications for RS and GIS.

Reviewing the EIA Report: Scope, Baseline Conditions, Site and Process alternatives Construction Stage Impacts, Project Resource Requirements and Related Impacts, Pre Media Quality, Socio-economic Impacts, Ecological Impacts, Occupational Health Ir Assessment, Impact on Transport System, Integrated Impact Assessment.

Review of EMP and Monitoring: Environmental Management Plan, Identification of Significa Requiring Mitigation, Mitigation Plans and Relief & Rehabilitation, Stipulating the Conditions monitored? Monitoring Methods, Who should monitor? Pre- Appraisal and Appraisal.

Case Studies: Preparation of EIA for developmental projects- Factors to be considered in m Water Resources Project, Pharmaceutical industry, thermal plant, Nuclear fuel complex, Hig treatment plant, Municipal Solid waste processing plant,
Tannery industry.

Reading:

1. Jain R.K., Urban L.V., Stracy G.S., *Environmental Impact Analysis* , Van Nostrand Reinh
2. Barthwal R. R., *Environmental Impact Assessment* , New Age International Publishers, 2
3. Rau J.G. and Wooten D.C., *Environmental Impact Assessment,* McGraw Hill Pub. Co.,
4. Anjaneyulu Y., and Manickam V., Environmental Impact Assessment Methodologies, B. 2007.
5. Wathern P., Environmental Impact Assessment- Theory and Practice, Routledge Publisl London, 2004.

3 Credits

PSO2	PSO3
-	-
-	-
-	-
-	-
-	-

ures, Screening, Scoping,
easure and EIA
Components of EIA, Roles
(2000), List of projects
Ecological sensitive places,

oject Location(s), Land Use
Requirements, Wastes
d Human, Health, Socio-

act measurement, impact
:lists methods, Matrices
ıalysis, Cost/benefit
s method, predictive

;, Public hearing.
ediction of Environmental
npact, Major Hazard/ Risk

nt or Unacceptable Impacts
;, What should be

aking assessment decisions,
ghway project, Sewage

ıold Co., New York, 1991.
2002
New York, 1996.
.S. Publications, Hyderabad,

hers,

EE390	LINEAR CONTROL SYSTEMS	OPC	3 – 0 – 0

Pre-requisites: None

Course Outcomes: At the end of the course, student will be able to:

CO1	Analyze electromechanical systems using mathematical modelling
CO2	Determine Transient and Steady State behavior of systems using standard test signals
CO3	Analyze linear systems for steady state errors, absolute stability and relative stability
CO4	Design a stable control system satisfying requirements of stability and reduced steady state error

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	3	2	-	-	1	-	-	-	-	-	-	1
CO2	3	3	2	-	-	1	-	-	-	-	-	-	1
CO3	3	3	2	-	-	1	-	-	-	-	-	-	1
CO4	3	3	2	-	-	1	-	-	-	-	-	-	1

Detailed syllabus:

Introduction: Control system, types, feedback and its effects-linearization

Mathematical Modeling of Physical Systems: Block diagram Concept and use of Transfe Graphs, Mason's gain formula.

Time Domain Analysis of Control Systems - BIBO stability, absolute stability, Routh-Hur P, PI and PID controllers. Root Locus Techniques - Root loci theory,Application to syst Introduction to state variables technique, Analysis of R-L, R-L-C networks.

Frequency Domain Analysis of Control Systems - polar plots, Nyquist stability criterio Bode plots.

Reading:

1. B.C.Kuo, Automatic Control Systems, 7th Edition, Prentice Hall of India, 2009.
2. I.J. Nagarath and M. Gopal: Control Systems Engineering, 2nd Edition, New Age Pu

3 Credits

PSO2	PSO3
3	2
3	2
3	2
3	2

r function. Signal Flow

witz Criterion.
em stability studies.

n, Bode plots, application of

b. Co.2008.

EE391	SOFT COMPUTING TECHNIQUES	OPC	3 – 0 – 0

Pre-requisites: None

Course Outcomes: At the end of the course, student will be able to:

CO1	Understand the concepts of population based optimization techniques
CO2	Examine the importance of exploration and exploitation in heuristic optimization techniques to attain near-global optimal solution
CO3	Evaluate the importance of parameters in heuristic optimization techniques
CO4	Apply for the solution of multi-objective optimization

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	3	1	2	2	-	-	-	-	-	-	-	1
CO2	3	3	1	2	2	-	-	-	-	-	-	-	1
CO3	3	3	1	2	2	-	-	-	-	-	-	-	1
CO4	3	3	1	2	2	-	-	-	-	-	-	-	1

Detailed syllabus:

Fundamentals Of Soft Computing Techniques: Definition-Classification of optimization probl Constrained optimization Optimality conditions- Introduction to intelligent systems- Soft c Classification of meta-heuristic techniques - Single solution based and population based a and exploration in population based algorithms - Properties of Swarm intelligent Syste Discrete and continuous problems - Single objective and multi-objective problems.

Genetic Algorithm And Particle Swarm Optimization: Genetic algorithms- Genetic Algo Optimization Techniques - Genetic representations and selection mechanisms; Gen types of crossover and mutation operators -Bird flocking and Fish Schooling – anatomy o on velocity and positions - PSO topologies - control parameters. Application to SINX maximi

Ant Colony Optimization And Artificial Bee Colony Algorithms: Biological ant colony sys assumptions - Stigmergic communications - Pheromone updating- local-global

- Pheromone evaporation - ant colony system- ACO models-Touring ant colony system-max

min ant system - Concept of elistic ants-Task partitioning in honey bees - Balancing foragers
colony (ABC) algorithms-binary ABC algorithms.
Shuffled Frog-Leaping Algorithm and Bat Optimization Algorithm: Bat Algorithm- Echolocatic
microbats- Acoustics of Echolocation- Movement of Virtual Bats- Loudness and Pulse Emiss
virtual population of frogs-comparison of memes and genes -memeplex formation- memeple
multi-modal function
optimization Introduction to Multi- Objetive optimization-Concept of Pareto optimality.

Reading:

1. Xin-She Yang, "Recent Advances in Swarm Intelligence and Evolutionary Computa Publishing, Switzerland, 2015.
2. Kalyanmoy Deb, Multi-Objective Optimization using Evolutionary Algorithms, John Wiley
3. James Kennedy and Russel E Eberheart, Swarm Intelligence, The Morgan Kaufmann S Computation, 2001.
4. Eric Bonabeau, Marco Dorigo and Guy Theraulaz, Swarm Intelligence-From natura Oxford university Press, 1999.
5. David Goldberg, Genetic Algorithms in Search, Optimization and Machine Learning, Pea
6. Konstantinos E. Parsopoulos and Michael N. Vrahatis, Particle Swarm Optimizatio and Applications, Information science reference, IGI Global, 2010.
7. N P Padhy, Artificial Intelligence and Intelligent Systems, Oxford University Press, 2005.

3 Credits

PSO2	PSO3
1	3
1	3
1	3
1	3

ems- Unconstrained and
:omputing techniques-
algorithms – Exploitation
:ms - Application domain -

rithm versus Conventional
etic operators- different
of a particle- equations based
zation problem.
stem - Artificial ants and

; and receivers - Artificial bee

ɔn of bats- Behavior of
sion- Shuffled frog algorithm-
ex updation. Application to

ation, Springer International

& Sons, 2001.
eries in Evolutionary

al to Artificial Systems,

ırson Education, 2007.
n and Intelligence: Advances

ME390	AUTOMOTIVE MECHANICS	OPC	3 – 0 – 0

Pre-requisites: None

Course Outcomes: At the end of the course, student will be able to:

CO1	Analyze operation and performance indicators of transmission systems, internal con engines and after treatment devices.
CO2	Understand operation of engine cooling system, lubrication system, electrical syster ignition system.
CO3	Understand fuel supply systems in an diesel and petrol vehicles
CO4	Analyze current and projected future environmental legislation and its impact on des operation and performance of automotive power train systems.
CO5	Understand operation and performance of suspension, steering and braking system
CO6	Understand layout of automotive electrical and electronics systems.

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	1	1	-	-	-	1	2	-	-	-	-	-	-
CO2	1	1	-	-	-	1	2	-	-	-	-	-	-
CO3	1	1	-	-	-	1	2	-	-	-	-	-	-
CO4	1	1	-	-	-	1	2	-	-	-	-	-	-
CO5	1	1	-	-	-	1	2	-	-	-	-	-	-
CO6	1	1	-	-	-	1	2	-	-	-	-	-	-

Detailed syllabus

Introduction: Layout of an automotive chassis, engine classification.

Cooling Systems: Air cooling, air cleaners, Water cooling: Thermosyphon and pump circulati water cooling systems- Radiator, thermostat etc.

Engine Lubrication: Petroils system, Splash system, Pressure lubrication and dry sump syste

Ignition System: Battery, Magneto and Electronic, Engine Starting drives

Fuel supply system: Components in fuel supply system, types of feed pumps, air cleaners, f
and dry sump systems.
Engine testing and Performance: Performance parameters, constant and variable spe
performance characteristics. Engine Emissions: SI and CI engine emissions, emission contr
Automotive electrical and electronics: Electrical layout of an automobile, ECU, se
Electric horn.
Transmission: Clutch- Single and multiplate clutch, semi & centrifugal clutch and fluid flywhe
constant mesh and synchromesh gear box, selector mechanism, over drive, Propeller shaft
Suspension System: Front and rear suspension, shock absorbers, Rear Axles mountings, F
Mechanism: Manual and power steering systems, Braking System: Mechanical, Hydraulic ar
Engine service: Engine service procedure.

Reading:

1. S. Srinivasan, Automotive Mechanics, Tata McGraw-Hill, 2004.
2. K.M. Gupta, Automobile Engineering, Vol.1 and Vol.2, Umesh Publications, 2002
3. Kirpal Singh, Automobile Engineering, Vol.1 and Vol.2, Standard Publishers, 2003.
4. William H. Crouse and Donald L. Anglin, Automotive Mechanics, Tata McGraw-Hill, 200
5. Joseph Heitner, Automotive Mechanics, East-West Press, 2000.

3 Credits

nbustion
n and
sign,
l.

PSO2	PSO3
-	-
-	-
-	-
-	-
-	-
-	-

ion systems, Components of

em

uel and oil filters, pressure

ed test, heat balance test,
ol methods
nsors, windscreen wiper,

eel, Gear box: Sliding mesh,
and Differential.
ront Axle. Steering
nd Air braking systems.

4

ME391	ENTREPRENEURSHIP DEVELOPMENT	OPC	3 – 0 – 0

Pre-requisites: None

Course Outcomes: At the end of the course, student will be able to:

CO1	Understand entrepreneurship and entrepreneurial process and its significance in ec development.
CO2	Develop an idea of the support structure and promotional agencies assisting ethical entrepreneurship.
CO3	Identify entrepreneurial opportunities, support and resource requirements to launch venture within legal and formal frame work.
CO4	Develop a framework for technical, economic and financial feasibility.
CO5	Evaluate an opportunity and prepare a written business plan to communicate ideas effectively.
CO6	Understand the stages of establishment, growth, barriers, and causes of sickness in initiate appropriate strategies for operation, stabilization and growth.

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	-	-	-	-	-	3	1	3	2	2	3	-	1
CO2	-	-	-	-	-	3	1	3	2	2	3	-	1
CO3	-	-	-	-	-	3	1	3	2	2	3	-	1
CO4	-	-	-	-	-	3	1	3	2	2	3	-	1
CO5	-	-	-	-	-	3	1	3	2	2	3	-	1
CO6	-	-	-	-	-	3	1	3	2	2	3	-	1

Detailed syllabus

Entrepreneur and Entrepreneurship: Introduction; Entrepreneur and Entrepreneurship; R economic development; Entrepreneurial competencies and motivation; Institutional Interfa Industry/Enterprises.

Establishing Small Scale Enterprise: Opportunity Scanning and Identification; Creativity process; Market survey and assessment; choice of technology and selection of site.
Planning a Small Scale Enterprises**:** Financing new/small enterprises; Techno Econom Preparation of Business Plan; Forms of business organization/ownershir
Operational Issues in SSE**:** Financial management issues; Operational/project manage Marketing management issues in SSE; Relevant business and industrial Laws.
Performance appraisal and growth strategies**:** Management performance assessment a control; Causes of Sickness in SSI, Strategies for Stabilization and Growth.

Reading:

1. G.G. Meredith, R.E. Nelson and P.A. Neek, The Practice of Entrepreneurship, ILO, 1982
2. Dr. Vasant Desai, Management of Small Scale Enterprises, Himalaya Publishing H
3. A Handbook for New Entrepreneurs, Entrepreneurship Development Institute of Inc
4. Bruce R Barringer and R Duane Ireland, Entrepreneurship: Successfully Launchinç Ventures, 3rd Edition, Pearson Edu., 2013.

3 Credits

onomic
a new
business
industry to

PSO2	PSO3
2	-
2	-
2	-
2	-
2	-
2	-

ole of entrepreneurship in
ace for Small Scale

' and product development

ic Feasibility Assessment;
).
ment issues in SSE;

and

2.
House, 2004.
dia, Ahmedabad, 1988.
g New

EC390	**COMMUNICATION SYSTEMS**	**OPC**	**3 – 0 – 0**

Pre-requisites: None

Course Outcomes: At the end of the course, student will be able to:

CO1	Understand different modulation and demodulation schemes for analog communications.
CO2	Design analog communication systems to meet desired application requirements
CO3	Evaluate fundamental communication system parameters, such as bandwidth, signal to quantization noise ratio etc.
CO4	Elucidate design tradeoffs and performance of communications systems.

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	1	1	-	-	1	1	-	-	-	-	-	-	-
CO2	1	1	-	-	1	1	-	-	-	-	-	-	-
CO3	1	1	-	-	1	1	-	-	-	-	-	-	-
CO4	1	1	-	-	1	1	-	-	-	-	-	-	-

Detailed syllabus

Signal Analysis**:** Communication Process, Sources of Information, Communication Chann
Types of Communication, Random Process, Gaussian Process, Correlation Function, Powe
Transmission of Random Process through an LTI Filter.

Noise Analysis: External Noise, Internal Noise, White Noise, Narrow Band Noise, Represent
In phase and Quadrature Components, Noise Figure, Noise Bandwidth, Noise Temperature.

Amplitude (Linear) Modulation: Linear Modulation Schemes, Generation of AM, Envelc
Product Modulator, Switching Modulator, Ring Modulator, Coherent Detection, Costas receiv
Representation, Filtering Method, Phase Shift Method, Coherent Demodulation, VSB Mo
Carrier Acquisition using Squaring Loop and Costas Loop, Receiver Model, SNR, Noise in S
coherent detection,

Noise in AM Receiver using Envelope detection, Threshold Effect.

Angle (Exponential) Modulation: Types of Angle Modulation, Relation between FM an
Wideband FM, Transmission Bandwidth of FM Signals, Generation of FM using Direct and
Demodulation using Slope Circuit, Frequency Discriminator, Interference in Angle Modula
FM Threshold Effect, Pre-emphasis and De-emphasis in FM, Model of PLL for FM Demodula
Pulse Modulation: Sampling Process, PAM, PWM, PPM, Quantization, PCM, TDM, D
DM, DSM, Linear Prediction, DPCM, ADPCM, Noise in PCM System, Companding, Co
Performance of AM,FM,PCM and DM.

Information Theory: Uncertainty, Information, Entropy, Source Coding Theorem, D
Compaction, Mutual information, Channel Capacity, BSC Channel, Information Capa
Power Tradeoff, Huffman Coding.

Reading:

1. S. Haykin, Communication Systems, 4th Edn, John Wiley & Sons, Singapore, 2001.
2. B.P. Lathi, Modern Digital & Analog Communication Systems, 3rd Edition, Oxford Univers
3. Leon W. Couch II, Digital and Analog Communication Systems, 6th Edition, Pearso 2001.
4. A Bruce Carlson, PB Crilly, JC Rutledge, Communication Systems, 4th Edition, MGH, Nev York, 2002.

3 Credits

power,

PSO2	PSO3
1	-
1	-
1	-
1	-

els, Modulation Process,
r Spectral Density,

ation of Narrow Band noise
.
pe Detector, DSB-SC
ver, SSB Signal
dulator and Demodulator,
SB and DSB receivers using

d PM, Narrow Band FM,
Indirect methods, FM
ation, Noise in FM Receiver,
ation.
Digital Multiplexer Hierarchy,
omparison of the Noise

Data
acity Theorem, Bandwidth -

sity Press, Chennai, 1998.
on Education Inc., New Delhi,

w

EC391	MICROPROCESSOR SYSTEMS	OPC	3 – 0 – 0

Pre-requisites: None

Course Outcomes: At the end of the course, student will be able to:

CO1	Develop basic understanding of microprocessor architecture.
CO2	Design Microprocessor and Microcontroller based systems.
CO3	Understand C, C++ and assembly language programming
CO4	Understand concept of interfacing of peripheral devices and their applications

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	1	1	1	-	2	-	-	-	-	-	-	-	-
CO2	1	1	1	-	2	-	-	-	-	-	-	-	-
CO3	1	1	1	-	2	-	-	-	-	-	-	-	-
CO4	1	1	1	-	2	-	-	-	-	-	-	-	-

Detailed syllabus

Microcomputer Organization: CPU, Memory, I/O, Operating System, Multiprogramm Windows

80386 Micro Processors : Review of 8086,salient features of 80386,Architecture and 80386,Register Organization of 80386,Addressing Modes,80386 Memory manageme Segmentation, Paging, Virtual 8086 Mode, Enhanced Instruction set of 80386, the Co- Proc Pentium & Pentium-pro Microprocessor: Salient features of Pentium microprocessor, Pe Pentium registers, Instruction Translation look aside buffer and branch Prediction, Ra Memory management, hyper-threading technology, Extended Instruction set in advance Microcontrollers: Overview of micro controllers-8051 family microcontrollers, 80 architecture, instruction set, pin out, memory interfacing.

ARM Processor Fundamentals: Registers, current Program Status Registers, Pipe Exceptions, Interrupts and Vector Table, Architecture Revisions, ARM Processor families, A

instruction set, Thumb Instruction set-Exceptions Handing, Interrupts, Interrupt Ha
Embedded operating systems, Caches-cache architecture, Cache policy, Introduction to
the ARM7TDMI,ARM9TDMI.
Case study-Industry Application of Microcontrollers

Reading:

1. Barry B. Brey, Intel Microprocessor Architecture, Programming and Interfacing-8086/808
80486, PHI, 1995.
2. Muhammad Ali Mazidi and Mazidi, The 8051 Microcontrollers and Embed
3. Intel and ARM Data Books on Microcontrollers.

3 Credits

PSO2	PSO3
1	-
1	-
1	-
1	-

ing, Multithreading, MS

Signal Description of
nt, Protected mode,
essor 80387
entium architecture, Special
pid Execution module,
d Pentium Processors
196 microcontrollers family

line
RM

ndling schemes, firmware,
DSP on the ARM, DSP on

8, 80186, 80286, 80386 and

ded systems,PHI,2008

MM364	FUNDAMENTALS OF MATERIALS PROCESSING TECHNOLOGY	OPC	3 – 0 –0	03 Cr

Pre-requisites: None

Course Outcomes: At the end of the course, student will be able to:

CO1	Describe engineering materials.
CO2	Appreciate material processing techniques.
CO3	Select material processing technique for a given material and application.
CO4	Explain surface engineering techniques and their engineering significance.

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	3	2	-	-	1	1	-	-	-	-	-	1
CO2	3	3	2	-	-	1	1	-	-	-	-	-	1
CO3	3	3	2	-	-	1	1	-	-	-	-	-	1
CO4	3	3	2	-	-	1	1	-	-	-	-	-	1

Detailed syllabus

Introduction to engineering materials: Metals, alloys and phase diagrams, ferrous metals, no superalloys, guide to processing of metals; ceramics-structure and properties of ceramics, t ceramics, glass, some important elements related to ceramics; polymers-fundamentals technology, thermoplastic and thermosetting polymers, elastomers; composite materials- materials, metal matrix, polymer matrix and ceramic matrix composites.

Fundamental properties of materials: mechanical properties-stress-strain relationships, hard effect of temperature on properties, visco-elastic behaviour of polymers, thermal prope of metals, polymers, ceramics and composites.

Metal casting fundamentals and metal casting processes: Overview of casting technology, n solidification and casting, sand casting, other expendable-mold casting processes, permane casting quality, metals for casting.

Particulate processing of metals and ceramics: Powder metallurgy-characterization engineering powders, production of metallic powders, conventional processing and sin alternative processing and sintering techniques, materials and products for powder metallurg powder metallurgy, processing of traditional ceramics, processing of new ceramics, cermets Fundamentals of metal forming and shaping processes, such as rolling, forging, extru forming: Overview of metal forming, friction and lubrication in metal forming; bulk deformatio forming-rolling, other deformation processes related to rolling, forging, other deformation extrusion, wire and bar drawing; cutting and bending operations, sheet-metal drawing, other operations, dies and presses for sheet-metal processes, sheet-metal operations not perform Fundamentals welding: Overview of welding technology, the weld joint, physics of we welded joint; Welding processes-arc welding, resistance welding, oxy-fuel gas welding, oth processes, solid-state welding, weld quality, weldability; brazing, soldering and adhesive Surface engineering and tribology: Importance of surface engineering, classification of surfa engineering processes, introduction to thermal, mechanical, thermo-chemical and elect engineering processes with their advantages, limitations and applications.

Reading:

1. Kalpakjian and Schmid, Manufacturing Engineering and Technology, Prentice Hall, New
2. Mikell P. Groover, Fundamentals of Modern Manufacturing, John Wiley & Sons, Inc., Ne
3. DeGarmo, Black, and Kohser, Materials and Processes in Manufacturing, John Wiley &
4. R. S. Parmar, Welding processes and Technology, Khanna Publishers, 2010.
5. H.S. Bawa, Manufacturing Technology-I, Tata McGraw Hill Publishers New Delhi, 2007.
6. Serope Kalpakjian, Manufacturing processes for Engineering Materials, Addison Wesley

edits

PSO2	PSO3
1	-
1	-
1	-
1	-

ın- ferrous metals,
raditional ceramics, new
of polymer science and
classification of composite

ness, tensile properties,
rties and electrical properties

nelting and pouring,
nt-mold casting processes,

of
ıtering,

gy, design considerations in
and their processing.
usion, drawing, sheet metal
on processes in metal
processes related to forging,
sheet metal forming
ned in presses.
elding, features of a fusion-
ner fusion welding
bonding.
nce
tro- chemical surface

Jersey, 2013.
w Jersey, 2010.
Sons, Inc, New York, 2011.

, 2001.

CH390	NANOTECHNOLOGY AND APPLICATIONS	OPC	3 – 0 – 0	3 C

(Not offered to Chemical Engineering Students) Prerequisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand the properties of nanomaterials
CO2	Synthesize nanoparticles
CO3	Characterize nanomaterials.
CO4	Scale up the production of nanoparticles
CO5	Evaluate safety and health related issues of nanoparticles

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1													
CO2													
CO3													
CO4				`									
CO5													

Detailed Syllabus:

Introduction to Nanotechnology: Introduction to nanotechnology and materials, Nanomateria and properties comparison with the bulk materials, Different shapes and sizes and morpholo Fabrication of Nanomaterials: Top Down Approach Grinding, Planetary milling and Comparis Approach, Wet Chemical Synthesis Methods, Microemulsion Approach, Colloidal Nanopartic Methods, Sonochemical Approach, Microwave and Atomization, Gas phase Production Meth Depositions.

Kinetics at Nanoscale: Nucleation and growth of particles, Issues of Aggregation of Partic hindrance, Layers of surface charges, Zeta Potential and pH.

Carbon Nanomaterials: Synthesis of carbon bucky-balls, List of stable carbon allotrop extended, fullerenes, metallofullerenes, solid C_{60}, bucky onions, nanotubes, nanocones.

Quantum mechanics: Quantum dots and its Importance, Pauli exclusion principle, Schröding
quantum Dots: quantum well, wire, dot, characteristics of quantum dots, Synthesis of quantu
quantum dots

Nanomaterials characterization: Fractionation principles of Particle size measurements, Part XRD, Zeta potential, Electronic band structure Electron statistics Application: Optical t photonic crystals, Microscopies SEM, TEM, Atomic Forced Microscopy, Scanning and Tu

Applications: Self-assembly and molecular manufacturing, Surfactant based system Co Functional materials Applications, commercial processes of synthesis of nanomaterials. Nanoinroganic materials of $CaCO_3$ synthesis, Hybrid Waste Water Treatments systems, Electronic Nanodevices,

Nanobiology: Biological synthesis of nanoparticles and applications in drug delive Responsive Release of active agents, Layer by Layer assembly for nanospheres, Safe materials, Environmental Impacts, Case Study
for Environmental and Societal Impacts

Reading:

1. Kulkarni Sulabha K, Nanotechnology: Principles and Practices, Capital Publishing Comp
2. Stuart M. Lindsay, Introduction to Nanoscience, Oxford University Press, 2009.
3. Robert Kelsall, Ian Hamley, Mark Geoghegan, Nanoscale Science and Technology, Joh
4. Gabor L. Hornyak, H.F. Tibbals, JoydeepDutta, John J. Moore, Introduction to Nanoscie CRC Press, 2008.
5. Davies, J.H., The Physics of Low Dimensional Semiconductors: An Introduction, Cambri University Press, 1998.

;redits

PSO2	PSO3

ıls, Introduction to nanosizes
ogy.
son of particles, Bottom Up
cles Production, Sol Gel
ıods : Chemical Vapour

les, Oswald Ripening, Stearic

es

ger's equation, Application of
um dots Semi-conductor

icle size and its distribution,
ransitions in solids,
nneling Microscopy.
olloidal system applications,

ery, Nanocontainers and
ety and health Issues of nano

any, 2007

n Wiley & Sons, 2005.
ence and Nanotechnology,

dge

CH391	INDUSTRIAL SAFETY MANAGEMENT	OPC	3 – 0 – 0	3 C

(Not offered to Chemical Engineering Students)

Prerequisites: None.

Course Outcomes: At the end of the course the student will be able to:

CO1	Analyze the effects of release of toxic substances.
CO2	Select the methods of prevention of fires and explosions.
CO3	Understand the methods of hazard identification and prevention.
CO4	Assess the risks using fault tree diagram.

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1													
CO2													
CO3													
CO4				`									
CO5													
CO6													

Detailed syllabus:

Introduction-Safety Programs, Engineering Ethics, Accident and Loss Statistics, Acceptable Nature of the Accident Process, Inherent Safety.

Industrial Hygiene-Anticipation and Identification, Hygiene Evaluation, Hygiene Control.

Toxic Release and Dispersion Models-Parameters Affecting Dispersion, Neutrally Buoy Dense Gas Dispersion, Toxic Effect Criteria, Effect of Release Momentum and Buoyancy, R

Fires and Explosions-The Fire Triangle, Distinction between Fires and Explosions, Flammab and Vapors, Limiting Oxygen Concentration and Inerting, Flammability Diagram

Hazards Identification- Process Hazards Checklists, Hazards Surveys, Hazards and Operab

Risk Assessment- Review of Probability Theory, Event Trees, Fault Trees.

Safety Procedures: Process Safety Hierarchy, Managing Safety, Best Practices, Proce Operating, Procedures-Permits, Procedures-Safety Reviews and Accident Investigations.

Reading:

1. D. A. Crowl and J.F. Louvar, Chemical Process Safety (Fundamentals with Applications)
2. R.K. Sinnott, Coulson & Richardson's Chemical Engineering, Elsevier India, Volume 6, 2

:redits

PSO2	PSO3

Risk, Public Perceptions, The

/ant Dispersion Models,
:elease Mitigation.
ility Characteristics of Liquids

ility Studies, Safety Reviews.

edures-

), Prentice Hall, 2011.
2006.

CH392	INDUSTRIAL POLLUTION CONTROL	OPC	3 – 0 – 0

(Not offered to Chemical Engineering Students)

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Analyze the effects of pollutants on the environment.
CO2	Distinguish air pollution control methods
CO3	Assess treatment technologies for wastewater
CO4	Identify treatment technologies for solid waste
CO5	Select treatment methodologies for hazardous and E-waste

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	
CO1														
CO2														
CO3														
CO4				`										
CO5														

Detailed Syllabus:

Introduction: Biosphere, Hydrological cycle, Nutrient cycle, Consequences of population grow and soil.

Air pollution sources & effects: Classification and properties of air pollutants, Emission source pollutants, Effect of air pollution.

Meteorological aspects of air pollutant dispersion: Temperature lapse rates and stability, Winc Plume behavior, Dispersion of air pollutants, Estimation of plume rise.

Air pollution sampling and measurement: Types of pollutant sampling and measurement, Amb sampling, Analysis of air pollutants.

Air pollution control methods & equipment: Control methods, Source correction method effluents, Particulate emission control, Selection of a particulate collector, Control of gaseous for control equipment.Control of specific gaseous
pollutants: Control of NOx emissions, Control of hydrocarbons and mobile sources.

Water pollution: Water resources, Origin of wastewater, types of water pollutants and their eff sampling, analysis and treatment: Sampling, Methods of analysis, Determination of organic m inorganic substances, Physical characteristics, Bacteriological measurement, Basic processe Primary treatment, Secondary treatment, Advanced wastewater treatment, Recovery of mat effluents.

Solid waste management: Sources and classification, Public health aspects, Methods c Methods, Potential methods of disposal.

Hazardous waste management: Definition and sources, Hazardous waste classifica Disposal methods.

E-waste: Sources, environmental and social issues, management practices

Reading:

1. Rao C.S., Environmental Pollution Control Engineering, Wiley Eastern Limited, India, 199:
2. Noel de Nevers, Air Pollution and Control Engineering, McGraw Hill, 2000.
3. Glynn Henry J. and Gary W. Heinke, Environmental Science and Engineering, Prentice H: 2004.
4. Rao M.N., Rao H.V.N, Air Pollution, Tata McGraw Hill Publishing Ltd., 1993.
5. De A.K., Environmental Chemistry, Tata McGraw Hill Publishing Ltd., 1999.
6. George Tchobanoglous, Franklin Louis Burton, H. David Stensel, Metcalf & E Waste Water Engineering: Treatment and Reuse, McGraw Hill Education; 4th Edition, 20(
7. E-waste recycling, NPCS Board of consultants and Engineers, Asia pacific business press Inc. 2015

3 Credits

PSO2	PSO3

th, Pollution of air, Water

s, Behavior and fate of air

d velocity and turbulence,

bient air sampling, Stack

s, Cleaning of gaseous
emissions, Design methods

ːects. Waste water
ːatter, Determination of
ːes of water treatment,
ːerials from process

ːf collection, Disposal

ːtion, Treatment methods,

ː3.

ːall of India, 2nd Edition,

ːddy, Inc., Franklin Burton,
ː03.
ːs

CH393	SOFT-COMPUTING METHODS FOR CONTROL	OPC	3 – 0 – 0	3

(Not offered to Chemical Engineering Students)

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO2	Use neural networks to control the process plants
CO3	Develop fuzzy logic based controllers for different processes
CO4	Combine fuzzy logic with neural networks for plant control
CO5	Design controllers using genetic algorithms

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1													
CO2													
CO3													
CO4				`									
CO5													

Detailed syllabus

Introduction to Artificial Neural Networks: Basic properties, Neuron Models, Feed forwa
Neural Networks Based Control: Representation and identification, modeling the plant, contr
control, Model reference control, Internal model control, Predictive control: Examples –
viscosity an chemical process, Auto – turning feedback control.

Introduction to Fuzzy Logic: Fuzzy Controllers, Fuzzy sets and Basic notions – Fuzzy relatio
members – Indices of Fuzziness – comparison of Fuzzy quantities – Methods of determinatio
Fuzzy Logic Based Control: Fuzzy sets in commercial products – basic construction o
of static properties of fuzzy controller – Analysis of dynamic properties of
fuzzy controller – simulation studies – case studies – fuzzy control for smart cars.

Neuro – Fuzzy and Fuzzy – Neural Controllers: Neuro – fuzzy systems: A unified approxima
Construction of role bases by self-learning: System structure and learning.

Introduction to Genetic algorithms. Controller design using genetic algorithms.

Reading:

1. S. N. Sivanandam and S. N. Deepa, Principles of Soft Computing, John Wiley & Sons, 2
2. Bose and Liang, Artificial Neural Networks, Tata McGraw Hill, 1996.
3. Huaguang Zhang, Derong Liu, Fuzzy Modeling and Fuzzy Control, Birkhauser Publishers
4. Kosco B, Neural Networks and Fuzzy Systems: A Dynamic Approach to Machine Intellige 1992.
5. Lakshmi C. Jain, N. M. Martin, Fusion of Neural Networks, Fuzzy Systems and Ge Applications, CRC Press, 1998.
6. MuhammetÜnal, AyçaAk, VedatTopuz, Hasan Erdal, Optimization of PID Controllers usir Ant Colony and Genetic Algorithms, Springer, 2013.

Credits

PSO2	PSO3

ard networks.
rol structures – supervised
Inferential estimation of

n calculations – Fuzzy
on of membership functions.
f fuzzy controller – Analysis

ate reasoning approach –

:007.

s, 2006.
ence, Prentice Hall of India,

enetic Algorithms: Industrial

ng

CS390	OBJECT ORIENTED PROGRAMMING	OPC	3 – 0 – 0

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand fundamental concepts in object oriented approach.
CO2	Analyze design issues in developing OOP applications.
CO3	Write computer programs to solve real world problems in Java.
CO4	Analyze source code API documentations.
CO5	Create GUI based applications.

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	3	-	-	2	-	-	-	-	-	-	-	-
CO2	3	3	-	-	2	-	-	-	-	-	-	-	-
CO3	3	3	-	-	2	-	-	-	-	-	-	-	-
CO4	3	3	-	-	2	-	-	-	-	-	-	-	-
CO5	3	3	-	-	2	-	-	-	-	-	-	-	-

Detailed Syllabus:

Object- oriented thinking, History of object-oriented programming, overview of java, O Structure of java program. Types and modifiers, Classes, declaring objects in classes, Meth collection, Method overloading, passing objects as parameters, Inheritance, various for inheritance, Multilevel hierarchy, use of super, method overriding, Applications of meth classes, Packages with examples

Interfaces and implementation, Exception handling, types, throwing, creating own exce concepts, its usage and examples, Input/output streams, String operations and examples stack collection, bitset collection, Utility classes-string

tokenizer, bitset, date, Applets- methods, creation, designing and examples, Event ha

event classes, Event listener interfaces, AWT classes, working with frames, AWT controls-la manager, user interface components, Graphics programming

Reading:

1. Timothy Budd, Understanding object-oriented programming with Java, Pearson, 2000.
2. Herbert Schildt, The complete reference Java 2, TMH, 2017.

3 Credits

PSO2	PSO3
-	1
-	1
-	1
-	1
-	1

bject- oriented design,
ıods, constructors, garbage
ms and types of
ıod overriding, abstract

ptions, Multithreading and
;, Collection classes-array,

ndling-

ıyout

BT390	GREEN TECHNOLOGY	OPC	3 – 0 – 0	

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Address smart energy and green infrastructure
CO2	Build models that simulate sustainable and renewable green technology systems
CO3	Understand the history, global, environmental and economical impacts of green technolo
CO4	Address non-renewable energy challenges

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	3	1	1	1	2	3	1	-	-	-	-	3
CO2	3	3	3	1	1	2	3	-	-	-	-	-	3
CO3	3	3	3	1	1	2	3	-	-	-	-	-	3
CO4	3	3	2	2	2	2	3	1	-	-	-	-	3

Detailed Syllabus:

Biomass Energy, basic concepts, sources of biomass energy, uses of biomass energy, scier of biomass energy, production of biomass electricity, transmission of biomass electricity, stor Energy transformation from source to services; Energy sources, sun as the source of energ photosynthesis; food chains, classification of energy sources, quality and concentration of e reserves - estimates, duration; theory of renewability, renewable resources; overview of glob Environmental effects of energy extraction, conversion and use; sources of pollution from er for choosing appropriate green energy technologies, life cycle cost; the emerging trer innovation-, technological/ environmental leap-frogging; Eco/green technologies for addr Water, Energy, Health, Agriculture and
Biodiversity.

First and second laws of thermodynamics and their applications – Thermodynamic processe
Entropy. Properties of steam and classification of steam engines. Carnot cycle - Rankine c
requirements, growth in future energy requirements, Review of conventional energy reso
reserves and resources, Tar sands and Oil, Shale, Nuclear energy Option.
Biomass fuels, market barriers of biomass fuels, biomass fuel standardization, biomass fuel
biomass fuels, economics of biomass fuels, Fuel stoichiometry and analysis: Fuel stoi
Estimation of air required for complete combustion; Estimation of minimum amount of ai
composition; Estimation of dry flue gases for known fuel composition; Calculation of the com
supplied, from exhaust gas analysis; Dew point of products; Flue gas analysis (O_2, CO_2, CO, NOx, SOx). Biomass as a majo
Fuel-wood use in rural households. Consequences for ecosystems. Future energy scenario
biomass in industrial and semi-industrial settings. Future utilization of biomass in India. Futu
optimal management.

Reading:

1. Ayhan Demirbas, Green Energy and Technology, Biofuels, Securing the Planet's I
Springer, 2009.
2. Jay Cheng, Biomass to Renewable Energy Processes, CRC press, 2009.
3. Samir K. Khanal, Rao Y. Surampally, American Society of Civil Engineers, 2010.

3 Credits

gy

PSO2	PSO3
2	1
2	2
2	2
2	3

ıce and engineering aspects
rage of biomass electricity.
ıy; biological processes;
nergy sources; fossil fuel
ɔal/ India’s energy scenario.
ıergy technologies, Criteria
ıds-process/product
ɾessing the problems of

:s - Irreversibility of energy –
:ycle, Current energy
urces- Coal, gas and oil

life cycle, Sustainability of
chiometry relations;
r required for a fuel of known
nposition of fuel & excess air
or source of energy in India:
in rural areas. Utilization of
re of landscape management:

Future Energy Needs,

SM390	**MARKETING MANAGEMENT**	**OPC**	**3 – 0 – 0**	

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand concepts and scope of marketing and market oriented strategic planning
CO2	Analyze macro level environment
CO3	Identify factors influencing consumer behavior in competitive global business environmer
CO4	Identify tools and techniques for marketing management through integrated marketing communication systems.

Course Articulation Matrix

PO / CO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**
CO1	2	2	-	-	-	-	-	-	2	1	2	-	-
CO2	2	2	-	-	-	-	-	-	2	1	2	-	-
CO3	2	2	-	-	-	-	-	-	2	1	2	-	-
CO4	2	2	-	-	-	-	-	-	2	1	2	-	-

Detailed Syllabus:

Importance of Marketing, Scope of Marketing, Core Marketing concepts company orie place-production concept, Product concept, selling concept and Marketing concept.

Market oriented Strategic planning – Defining corporate Mission and Vision Statement Business unit level. Assigning resources to Strategic Business units through B.C.G Mat

Analyzing Macro environment-Demographic environment. Economic Environment, Techr Cultural Environment and political – Legal Environment.

Components of Marketing information systems- Internal Records, Marketing intelli and Marketing Decision support system.

Consumer Behavior- Buying Decision process and the factors influencing consumer Behavio Psychological factors, social factors, cultural factors and personal factors.

Importance of Market segmentation, Target market selection and positioning. Importance of
process and the various stages involved.
The concept of product lifecycle and the various strategies used by the marketer in each sta
and classification, Product mix and product line decisions Branding Decisions, Building
Importance of Pricing, Factors influencing pricing decisions. Various pricing methods-cost ba
methods.
Role of Marketing channels-Channel functions and channel levels channel Design and chan
Managing Retailing. Wholesaling and logistics. Importance of Electronic channels.
Importance of integrated Marketing communication. Advantages and Disadvantages of Vario
Advertising, Sales promotion, personal selling, publicity and public Relations
and Direct marketing.

Reading:

1. Philip Kotler, Marketing Management, PHI, 14th Edition, 2013.
2. William Stonton & Etzel, Marketing Management, TMH, 13th Edition, 2013.
3. Rama Swamy & Namakumari, Marketing Management, McMillan, 2013.

3 Credits

ıt

PSO2	PSO3
-	-
-	-
-	-
-	-

ntation towards market

t at Corporate level and at
trix and G.E Model.
nical Environment, Social-

gence, Marketing research

or-new product development

ge. Product characteristics
Brand Equity.
ased and demand based

nel Management Decisions,

ous promotional tools-

MA390	NUMERICAL SOLUTION OF DIFFERENTIAL EQUATIONS	OPC	3 – 0 – 0

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Solve nonlinear differential equations by numerical methods.
CO2	Determine the convergence region for a finite difference method.
CO3	Solve elliptic PDE by finite difference method
CO4	Solve a parabolic PDE by finite difference method
CO5	Solve a hyperbolic PDE by finite difference method

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	3	1	1	1	-	-	-	-	-	-	-	-
CO2	3	3	1	1	1	-	-	-	-	-	-	-	-
CO3	3	3	1	1	1	-	-	-	-	-	-	-	-
CO4	3	3	1	1	1	-	-	-	-	-	-	-	-
CO5	3	3	1	1	1	-	-	-	-	-	-	-	-

Detailed Syllabus:

Ordinary Differential Equations: Multistep (explicit and implicit) methods for initial value probl Convergence analysis, Linear and nonlinear boundary value problems, Quasi- lineariza Finite difference methods: Finite difference approximations for derivatives, boundary boundary conditions, implicit boundary conditions, error analysis, stability analysis, converge Partial Differential Equations: Classification of partial differential equations, finite differ approximations for partial derivatives and finite difference schemes for Parabolic equa multilevel explicit methods, Crank-Nicolson's two level, multilevel implicit

methods, Dirichlet's problem, Neumann problem, mixed boundary value problem, stal
Hyperbolic Equations: Explicit methods, implicit methods, one space dimension, two s
methods.
Elliptic equations: Laplace equation, Poisson equation, iterative schemes, Dirichlet's proble
Neumann problem, mixed boundary value problem, ADI methods.

Reading:

1. M.K. Jain, Numerical Solution of Differential Equations, Wiley Eastern, 1984.
2. G.D. Smith, Numerical Solution of Partial Differential Equations, Oxford Univ. Press, 200
3. M.K.Jain, S.R.K. Iyengar and R.K. Jain, Computational Methods for Partial Differe Eastern, 2005.

3 Credits

PSO2	PSO3
1	2
1	2
1	2
1	2
1	2

lems, Stability and
ition, Shooting methods
/ value problems with explicit
ence analysis.
ence
ations, Schmidt's two level,

bility analysis.
space dimensions, ADI

em,

04.
ntial Equations, Wiley

MA391	FUZZY MATHEMATICS AND APPLICATIONS	OPC	3 – 0 – 0	

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Apply operations on Fuzzy sets
CO2	Solve problems related to Propositional Logic.
CO3	Apply Fuzzy relations to cylindric extensions.
CO4	Apply logic of Boolean Algebra to switching circuits.
CO5	Develop Fuzzy logic controllers

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	3	1	1	2	1	-	-	-	-	-	-	-
CO2	3	3	1	1	2	1	-	-	-	-	-	-	-
CO3	3	3	1	1	2	1	-	-	-	-	-	-	-
CO4	3	3	1	1	2	1	-	-	-	-	-	-	-
CO5	3	3	1	1	2	1	-	-	-	-	-	-	-

Detailed Syllabus:

Crisp set theory (CST): Introduction, Relations between sets, Operations on sets, Character products of crisp sets, crisp relations on sets.

Fuzzy set theory (FST): Introduction, concept of fuzzy set (FS), Relation between FS, operat standard operations, certain numbers associated with a FS, certain crisp sets associated wit with given FS, Extension principle.

Propositional Logic (PL1): Introduction, Syntax of PL1, Semantics of PL1, certain pro connectives, inference rules, Derivation, Resolution.

Predicate Logic (PL2): Introduction, Syntax of PL2, Semantics of PL2, certain properties sati quantifiers, inference rules, Derivation, Resolution

-cuts of FR, Composition of FR,

Projections of FR, Cylindric extensions, Cylindric closure, FR on a domain.

Fuzzy Logic (FL): Introduction, Three-valued logics, N-valued logics and infinite valued logic propositions and their interpretations in terms of fuzzy sets, Fuzzy rules and their interpretati inference, More on fuzzy inference, Generalizations of FL.

Switching functions (SF) and Switching circuits (SC): Introduction, SF, Disjunctive normal for SF and SC, Equivalence and simplification of circuits, Introduction of Boolean Algebra Disjunctive normal form.

Applications: Introduction to fuzzy logic controller (FLC), Fuzzy expert systems, classical cor theory versus fuzzy control, examples, working of FLC through examples, Details of formulation of FLC, Introduction of fuzzy methods in decision making.

Reading:

1. M. Ganesh, Introduction to Fuzzy Sets and Fuzzy Logic, PHI, 2001.
2. G.J. Klir and B.Yuan, Fuzzy sets and Fuzzy Logic–Theory and Applications, PHI, 1997.
3. T. J. Ross, Fuzzy Logic with Engineering Applications, McGraw-Hill, 1995.

3 Credits

PSO2	PSO3
1	2
1	2
1	2
1	2
1	2

ristic functions, Cartesian

tions on FS, properties of
th FS, Certain FS associated

perties satisfied by

isfied by connectives and

:s, Fuzzy logics, Fuzzy
ions in terms of FR, fuzzy

·m, SC, Relation between
BA, Identification, Complete

ıtrol
FLC, Mathematical

PH390	MEDICAL INSTRUMENTATION	OPC	3 – 0 – 0

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand the origin of bio-potentials and their physical significance.
CO2	Understand anatomy and functioning of human heart and its common problems.
CO3	Analyze ECG, ENG and EMG signals and instrumentation.
CO4	Compare different techniques of measuring blood pressure, blood flow and volume.
CO5	Interpret the principle and operation of therapeutic and prosthetic devices.
CO6	Differentiate between the various techniques for measurement of parameters.

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	2	2	-	1	2	-	-	-	-	-	-	1
CO2	3	2	2	-	1	2	-	-	-	-	-	-	1
CO3	3	2	2	-	1	2	-	-	-	-	-	-	1
CO4	3	2	2	-	1	2	-	-	-	-	-	-	1
CO5	3	2	2	-	1	2	-	-	-	-	-	-	1
CO6	3	2	2	-	1	2	-	-	-	-	-	-	1

Detailed Syllabus:

General Introduction: The cell, body fluids, Musculoskeletal system, respiratory s system, Nervous system, endocrine system and circulatory system.

Origin of Bio potentials: electrical activity of Excitable cells: the resting state, The active sta Functional organization of the peripheral nervous system: Reflex are & Junctional transmiss The Electroneurogram (ENG): The H-Reflex, The Electromyogram (EMG), Electrocardiogram (ECG), heart and the circulatory system, Electro conduction system problems, ECG waveform and Physical significance of its wave features,

Electrical behavior of cardiac cells, The standard lead system, The ECG preamplifier, DC E
protection circuit, Electro surgery Unit filtering, Functional blocks of ECG system, Multich
monitoring system, Common problems encountered and remedial techniques.

Blood Pressure: indirect measurement of blood pressure, korotkoff sounds, auscultatory me
manometer, Oscillometric and ultrasonic noninvasive pressure measurement, Direct me
pressure H2O manometers, electronic manometry, Pressure transducers,. Pressure amp
diastolic mean detector circuits

Blood flow and Volume Measurement: indicator dilution methods, Transit time flow meter, D
flow meter AC electromagnetic flow meter, Quadrature suppression flow meter, Ultrasonic
wave Doppler flow meter, Electric impedance plethysmography, chamber plethysmog
plethysmography.

Pulse Oximetr: Principles of Operation, Absorption Spectrum, Sensor design, Pulse oximet
Prosthetic Devices.

Cardiac Pacemakers: Lead wires and electrodes, Synchronous Pacemakers, rate resp
Defibrillators, cardioverters, electrosurgical unit, Therapeutic applications of laser,
Lithotripsy Haemodialysis.

Reading:

1. John G Webster, Medical Instrumentation: Application and Design, John Wiley, 3rd Editi
2. Joseph J. Carr & John M. Brown , Introduction to biomedical Equipment Technology, 4
Edition, Prentice Hall India, 2001

3 Credits

PSO2	PSO3
-	-
-	-
-	-
-	-
-	-
-	-

ystem, gastrointestinal

te, Volume conductor fields,
sion.
The
of the heart and heart

CG Amplier, Defibrillator
annel physiological

ethod using sphygmo
asurement of blood
lifier designs, Systolic,

C flow meter, Electromagnetic
flow meter, Continuous-
raphy, Photo

er, Therapeutic and

onsive pacemaking,

on, 2012.
th

PH391	ADVANCED MATERIALS	OPC	3 – 0 – 0

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand the synthesis and properties of nanomaterials
CO2	Evaluate the usefulness of nanomaterials in medicine, biology and sensing
CO3	Understand modeling of composite materials by finite element analysis
CO4	Differentiate superconducting materials
CO5	Understand the characteristics and uses of functional materials

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	3	3	-	-	1	-	-	-	-	-	-	-
CO2	3	3	3	-	-	1	-	-	-	-	-	-	-
CO3	3	3	3	-	-	1	-	-	-	-	-	-	-
CO4	3	3	3	-	-	1	-	-	-	-	-	-	-
CO5	3	3	3	-	-	1	-	-	-	-	-	-	-

Detailed Syllabus:

Nano Materials: Origin of nanotechnology, Classification of nanomaterials, Physical, chem properties of nanomaterials. Preparation of nanomaterials by plasma arcing, physical chemical vapour deposition (CVD), Sol-Gel, electro deposition, ball milling, carbon Synthesis, preparation of nanotubes, nanosensors, Quantum dots, nanowires, nanobiolo

Biomaterials: Overview of biomaterials. Biomaterials, bioceramics, biopolymers, tissue g applications, cardiovascular implants, biomaterials in ophthalmology, orthopedic implants

Composites: General characteristics of composites, composites classes, PMCs, MMCs, CM CCCs, IMCs, hybrid composites, fibers and matrices, different types of fibers, whiskers, diffe

matrices materials, polymers, metal, ceramic matrices, toughening mechanism, interfac
composite modeling, finite element analysis and design.
Optical materials: Mechanisms of optical absorption in metals, semiconductors and insulat
materials, optical modulators, optical fibers. Display devices and materials photo-emiss
coupled devices (CCD), laser materials.
Super conducting materials: Types of super conductors, an account of mechanism
of magnetic field currents, thermal energy, energy gap, acoustic attenuation, penetrati
and AC Josephson effects, high Tc superconductors, potential applications of su
switching element, superconductor power transmission and transformers, magnetic mirror,
motors, generators, SQUIDS etc.
Smart materials: An introduction, principles of smart materials, input – output decision abili
conductivity changes, devices based on changes in optical response, biological systems sm
on magnetization, artificial structures, surfaces, hetero structures, polycrystalline, amorphou
Surface Acoustic Wave (SAW) Materials and Electrets: Delay lines, frequency filters, reson
and Pressure and temperature sensors, Sonar transducers. Comparison of electrets v
Preparation of electrets, Application of electrets.

Reading:

1. T. Pradeep, Nano: The Essentials; TATA McGraw-Hill, 2008.
2. B.S. Murthy et al., Textbook of Nano science and Nanotechnology, University press, 201
3. Krishan K Chawla, Composite Materials; 2nd Edition, Springer 2006.

3 Credits

PSO2	PSO3
1	-
1	-
1	-
1	-
1	-

ical, electrical, mechanical
vapour deposition,
nanotubes (CNT).
ogy, nanomedicines.
grafts, soft tissue
s, dental materials.
Cs,
erent

:es, blending and adhesion,

ors. Nonlinear optical
ive, photovoltaic cells, charge

of superconductors, effects
ion depth, BCS theory, DC
ıperconductivity, electrical
bearings, superconductor

ty, devices based on
art materials. Devices based
s, liquid crystalline materials.
ıators,
vith permanent magnets,

ı2.

CY390	INSTRUMENTAL METHODS IN CHEMICAL ANALYSIS	OPC	3 – 0 – 0

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand the concepts of ultraviolet and visible absorption and fluorescence techniques for material characterization.
CO2	Understand the various liquid, gas and size-exclusion chromatographic techniques the automated continuous analysis of environmental, industrial, production-line materials
CO3	Understand the concepts of various electro analytical techniques for characterization of interfaces and traces of surface adsorbed-materials.
CO4	Understands the principles of thermogravimetry and differential thermal analyses (TGA for applications into pharmaceuticals, drugs, polymers, minerals, toxins and in Finger Print Analysis
CO5	Identification of suitable analytical technique for characterization of chemical, inorganic and engineering materials

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	3	-	3	1	1	1	-	-	-	-	-	1
CO2	3	3	-	3	1	1	1	-	-	-	-	-	1
CO3	3	3	-	3	1	1	1	-	-	-	-	-	1
CO4	3	3	-	3	1	1	1	-	-	-	-	-	1
CO5	3	3	-	3	1	1	1	-	-	-	-	-	1

Detailed Syllabus:

UV-Visible Spectrophotometry and Fluorescence: Beer-Lambert's law, limitations, Molec influencing factors, basic instruments, standardization, quantitative methods, application Atomic spectrometry, atomic absorption, X-ray fluorescence methods: Flame atomic er flame emission photometer, flame absorption spectrometer, spectral interferences, c fluorescence principle, instrumentation, quantitative analysis.

Chromatorgraphy methods: Gas chromatography, High performance liquid chromatography, chromatography, Principle, Basic instrumentation, terminology, NPC, RPC, Qualitative and Q
Capillary Electrophoresis: Principle and application.
Thermoanalytical methods: Thermogravimetry, Differential thermal analysis, differential scan Block diagram, Applications, Quantitative determinations
Electroanalytical methods: Coulometric methods, Polarography, Pulse voltammetric met Principles, Applications, Electrochemical sensors, Ion selective, Potentiometric and ampe Applications.
Spectroscopic methods: Molecular absorption, Woodward rules, applications, Infrared absor analysis, qualitative analysis, 1H- and 13C-NMR spectroscopy, Principle, Basic instrumentat Interpretation of data, Quantitative applications
Mass spectrometry: Principles, Instrumentation, Ionization techniques, Characterization applications.

Reading:

1. Gurdeep Chatwal and Sham Anand, Instrumental Methods of Chemical Analysis, Himala
2. Skoog, Holler and Kouch, Instrumental methods of analysis, Thomson, 2007.
3. Mendham, Denny, Barnes and Thomas, Vogel: Text book of quantitative chemical analy
4. William Kemp, Organic spectroscopy, McMillan Education, UK, 1991.
5. Instrumental methods of analysis – Willard, Meritt and Dean, PHI, 2005.

3 Credits

and DTA)

PSO2	PSO3
2	-
2	-
2	-
2	-
2	-

cular fluorescence,
s.
mission and absorption,
quantitative aspects, X-ray

size exclusion
Quantitative applications.

ıning calorimetry, Principle,

thods, Amperometry,
erometric Sensors,

ption, functional group
ion, terminology,

and

ıya Publishing House, 1986.

sis, Pearson, 6Edotion, 2007.

HS390	SOFT SKILLS	OPC	3 – 0 – 0	3

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand corporate communication culture
CO2	Prepare business reports and proposals expected of a corporate professional
CO3	Employ appropriate speech in formal business situations
CO4	Exhibit corporate social responsibility and ethics
CO5	Acquire corporate email, mobile and telephone etiquette

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	-	-	-	-	-	-	-	3	1	3	2	-	-
CO2	-	-	-	-	-	-	-	3	1	3	2	-	-
CO3	-	-	-	-	-	-	-	3	1	3	2	-	-
CO4	-	-	-	-	-	-	-	3	1	3	2	-	-
CO5	-	-	-	-	-	-	-	3	1	3	2	-	-

Detailed Syllabus:

English Language Enhancement: Verbs and tenses, Phrasal verbs, Synonyms, Antony Words, Combining Sentences, Business Idioms, Indianisms in English. Art of Communicatio Non-verbal Communication- Effective Listening. Interpersonal and Intra Personal Commu Awareness- Self-Esteem and Confidence- Assertiveness and Confidence- Dealing with E Elements of Teamwork- Stages of Team Formation- Effective Team-Team Player Styles-Lea Campus to Company- Dressing and Grooming- The Corporate Fit- Business Etic media etiquette- Group Discussions, Interviews, and Presentation Skills.

Interview handling skills- Effective Resume-- Common Interview Mistakes- Body-langua Content Aid, Visual Aids- Entrepreneurial Skills Development.

Reading:

1. Robert M. Sherfield, Developing Soft Skills, Montgomery and Moody 4th Edition, Pearso
2. K. Alex, Soft Skills: Know Yourself & Know The world, S. Chand; 2009.
3. Robert Bramson, Coping with Difficult People, Dell, 2009.

3 Credits

PSO2	PSO3
-	-
-	-
-	-
-	-
-	-

yms, Homonyms - Descriptive
n, Communication process-
nication Skills- Self-
motions-Team Concept-
adership.
quette- Communication;

ige-

on, 2009.

CE440	BUILDING TECHNOLOGY	OPC	3 – 0 – 0

Pre-requisites: None.

Course Outcomes: At the end of the course the student will be able to:

CO1	Apply basic principles to develop stable, sustainable and cost-effective building plans
CO2	Identify different materials, quality and methods of fabrication & construction.
CO3	Adopt standard building provisions for natural ventilation and lighting.
CO4	Identify effective measures for fire proofing, damp proofing, and thermal insulation.

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	2	2	1	-	-	1	1	-	-	-	-	-	-
CO2	2	2	1	-	-	1	1	-	-	-	-	-	-
CO3	2	2	1	-	-	1	1	-	-	-	-	-	-
CO4	2	2	1	-	-	1	1	-	-	-	-	-	-

Detailed Syllabus:

Overview of the course, basic definitions, Buildings – Types, components, economy and de buildings and their importance. Definitions and importance of Grouping and circulation; Lig to consider these aspects during planning of building.

Termite proofing: Inspection, control measures and precautions, Lightning protection of buil design of openings, various types of fire protection measures to be considered while General requirements and extra requirements for safety against fire, special precautions, Ve building – types of vertical transportation, Stairs, different forms of stairs, planning of vertical transportation – lifts, ramps, escalators.

Prefabrication systems in residential buildings – walls, openings, cupboards, shelves planning and modules and sizes of components in prefabrication. Planning and desig

residential buildings against the earthquake forces, Principles, Seismic forces and their effe
Air conditioning – process and classification of air conditioning, Dehumidification. Systems o
functional requirements of ventilation.
Acoustics, effect of noise, properties of noise and its measurements, Principles of acoustics
– importance and measures.
Plumbing services – water supply system, maintenance of building pipe line, sanitary fitting
principles governing design of building drainage.

Reading:

1. Building Construction - Varghese, PHI Learning Private Limited, 2008.
2. Building Construction - Punmia, B C, Jain, A J and Jain A J, Laxmi Publications, 2005.
3. Building Construction by S.P. Arora and S.P. Bindra – Dhanpatrai and Sons, New Delh
4. Building Construction – Technical Teachers Training Institute, Madras, Tata McGraw Hi
5. National Building code of India, Bureau of Indian Standards, 2005.

3 Credits

PSO2	PSO3
-	-
-	-
-	-
-	-

sign, Principles of planning of
ghting and ventilation; How

dings: General principles of
planning a building.
ertical transportation in
stair cases, Other modes of

etc.,
nning of

ct on buildings.
of air- conditioning, ventilation,

s of building. Sound insulation

s,

i, 1996.
ill, 1992.

EE440	NEW VENTURE CREATION	OPC	3–0– 0	3

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand the process and practice of entrepreneurship and new venture creation
CO2	Identify entrepreneurial opportunities, preparation of a business plan for launching a new venture
CO3	Explore the opportunities in the domain of respective engineering disciplines fo launching a new venture
CO4	Expose the students with the functional management issues of running a new ventur

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	-	-	-	-	-	3	1	3	2	2	3	-	1
CO2	-	-	-	-	-	3	1	3	2	2	3	-	1
CO3	-	-	-	-	-	3	1	3	2	2	3	-	1
CO4	-	-	-	-	-	3	1	3	2	2	3	-	1

Detailed syllabus:

Entrepreneur and entrepreneurship: Entrepreneurship and Small Scale Enterprises (SSE), F Development, Entrepreneurial Competencies, and Institutional Interface for SSE. Establishir Enterprise: Opportunity Scanning and Identification,Market Assessment for SSE, Choice of Site, Financing the New/Small Enterprises, Preparation of the Business Plan, Owr Organizational Framework.

Operating the Small Scale Enterprises: Financial Management Issues in SSE, Operati SSE, Marketing Management Issues in SSE, and Organizational Relations in SSE.

Reading:

1. Holt, Entrepreneurship: New Venture Creation, PHI (P), Ltd., 2001.
2. Madhulika Kaushik: Management of New & Small Enterprises, IGNOU course material,

3. B S Rathore S Saini: Entrepreneurship Development Training Material, TTTI, Chandigarl
4. P.C. Jain: A Hand Book for New Entrepreneurs, EDI-Faculty & External Experts,
5. J.B. Patel, D.G Allampalli: A Manual on How to Prepare a Project Report, EDII, Ahmedal
6. J B Patel, S S Modi, A Manual on Business Opportunity Identification and Selection, EDI Ahmedabad, 1995.

3 Credits

or
re

PSO2	PSO3
2	-
2	-
2	-
2	-

Role in Economic
ng The Small Scale
e of Technology and Selection
nership Structures and

ional Management Issues in

1995

h, 1988.
EDII, Ahmedabad, 1986.
bad, 1991.
II,

EE441	PRINCIPLES OF ELECTRIC POWER CONVERSION	OPC	3–0– 0

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand the basics in the electric power conversion using power switching device
CO2	Evaluate the conversion for range of renewable energy sources with the help available electrical machines drives
CO3	Analyze the different energy storage systems
CO4	Identify the various Industrial and domestic applications

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	1	2	1	1	1	1	1	-	-	-	-	-	1
CO2	1	2	1	1	1	1	1	-	-	-	-	-	1
CO3	1	2	1	1	1	1	1	-	-	-	-	-	1
CO4	1	2	1	1	1	1	1	-	-	-	-	-	1

Detailed syllabus:

Power Electronic Devices and Converters: V-I characteristics of SCR, MOSFET and IGBT. P DC converters and Inverters.

Applications to Electric Drives: Speed control of DC motor, Induction motors, PMSM and BLD

Applications to Renewable Energy: Introduction to solar cell, solar panels, MPPT, wind and sources, Integration of renewable energy sources to the grid.

Energy Storage Systems: Study of automotive batteries, SMF, pumped storage systems, su applications, Li-ion batteries and applications to electric vehicles.

Domestic And Industrial Applications: Induction heating, melting, hardening, lighting applicati battery chargers

Reading:

1. M.H.Rashid: Power Electronics-circuits, Devices and applications, Prentice Hall India, Ne

2. P.S.Bhimbra: Power Electronics, Khanna publishers, New Delhi, 2012.

3. Ned Mohan, Undeland and Robbin: Power electronics converters, applications and desig York, 2006.

3 Credits

s
of

PSO2	PSO3
2	-
2	-
2	-
2	-

hase controlled rectifiers, DC-

C drives
other renewable energy

per- capacitors, fly wheels -

ions and their control, UPS,

w Delhi, 2009.

n, John Willey & Sons, New

ME440	ALTERNATIVE SOURCES OF ENERGY	OPC	3 – 0 – 0	3

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Identify renewable energy sources and their utilization.
CO2	Understand basic concepts of solar radiation and analyze solar thermal systems for its ut
CO3	Understand working of solar cells and its modern manufacturing technologies.
CO4	Understand concepts of Fuel cells and their applications
CO5	Identify methods of energy storage.
CO6	Compare energy utilization from wind energy, geothermal energy, biomass, biogas and h

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	2	-	2	-	-	3	3	-	-	-	-	-	1
CO2	2	-	2	-	-	3	3	-	-	-	-	-	1
CO3	2	-	2	-	-	3	3	-	-	-	-	-	1
CO4	2	-	2	-	-	3	3	-	-	-	-	-	1
CO5	2	-	2	-	-	3	3	-	-	-	-	-	1
CO6	2	-	2	-	-	3	3	-	-	-	-	-	1

Detailed Syllabus:

Introduction: Overview of the course; Examination and Evaluation patterns; Global wa
Renewable Energy Technologies

Energy Storage: Introduction; Necessity of Energy Storage; Energy Storage Methods

Solar Energy: Fundamentals; Solar Radiation; Estimation of solar radiation on horizonta
Measurement of solar radiation data

Solar Thermal systems: Introduction; Basics of thermodynamics and heat transfer; Fla
Tubular Collector; Solar air collector; Solar concentrator; Solar distillation; Solar cooker; Sol
conditioning; Thermal energy storage systems
Solar Photovoltaic systems: Introduction; Solar cell Fundamentals; Characteristics
Module, panel and Array construction; Photovoltaic thermal systems.
Wind Energy: Introduction; Origin and nature of winds; Wind turbine siting; Basics of
turbine aerodynamics; wind turbine types and their construction; Wind energy conversion sy
Fuel cells: Overview; Classification of fuel cells; operating principles; Fuel cell thermodynami
Introduction; Photosynthesis Process; Biofuels; Biomass Resources; Biomass conversion te
energy conversion; Biomass gasification.
Other forms of Energy: Introduction: Nuclear, ocean and geothermal energy applications; Or
and their types; Working principles

Reading:

1. Sukhatme S.P. and J.K. Nayak, Solar Energy - Principles of Thermal Collection and Stor
Delhi, 2008.
2. Khan B.H., Non-Conventional Energy Resources, Tata McGraw Hill, New Delhi, 2006.
3. J.A. Duffie and W.A. Beckman, Solar Energy - Thermal Processes, John Wiley, 2001.

3 Credits

ilization.
ydrogen.

PSO2	PSO3
2	2
2	2
2	2
2	2
2	2
2	2

rming; Introduction to

l and inclined surfaces;

ıt plate collector; Evacuated
ar refrigeration and air

and classification; Solar cell:

fluid mechanics; Wind
stems
ics Biomass Energy:
chnologies; Urban waste to

igin

age, Tata McGraw Hill, New

ME441	ROBUST DESIGN	OPC	3 – 0 – 0

Pre-requisites: None

Course Outcomes: At the end of the course, student will be able to:

CO1	Understand stages in engineering design and concept of robust design.
CO2	Develop quality loss functions and S/N ratios for S, N and L type objective functions
CO3	Identify control and noise factors for a given product or process.
CO4	Conduct experiments using DOE concepts to decide the optimal setting of pa
CO5	Apply quality loss function approach for fixing the component tolerances.

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	1	1	3	2	1	-	2	-	-	-	-	-	-
CO2	1	1	3	2	1	-	2	-	-	-	-	-	-
CO3	1	1	3	2	1	-	2	-	-	-	-	-	-
CO4	1	1	3	2	1	-	2	-	-	-	-	-	-
CO5	1	1	3	2	1	-	2	-	-	-	-	-	-

Detailed syllabus

Introduction: Taguchi's quality philosophy, causes of performance variation, concept of r product/process design, need for experimentation, QFD, process flow analysis, cause and e

Design of Experiments**:** Principles of experimentation, Basic concepts of probability and stat means and two variances, Comparison of multiple (more than two) means & ANOVA, Factor factorial designs, orthogonal arrays, standard orthogonal arrays & interaction tables, modifyi selection of suitable orthogonal array design, analysis of experimental data.

Parameter Design**:** Loss function, average quality loss, S/N ratios, objective functions, selec of control & noise factors and their levels, strategy for systematic sampling of noise, classific

of control factors, inner-array and outer-array design, data analysis, selection of optin parameters.

Tolerance Design: Experiments, selection of tolerances to be tightened, fixing the final tolera

Reading:

1. Taguchi G, Chowdhury S and Taguchi S, Robust Engineering, TMH, 2000.
2. Ross PJ, Taguchi Techniques for Quality Engineering, TMH, 2005.

3 Credits

.
rameters

PSO2	PSO3
1	1
1	1
1	1
1	1
1	1

obust design, stages in
ffect diagram.
istics, Comparison of two
rial designs, fractional
ng the orthogonal arrays,

tion
cation

num levels/values for

ances.

EC440	ELECTRONIC MEASUREMENTS AND INSTRUMENTATION	OPC	3 – 0 – 0	:

Pre-requisites: None

Course Outcomes: At the end of the course, student will be able to:

CO1	Apply knowledge of instruments for effective use
CO2	Select suitable instruments for typical measurements.
CO3	Identify various transducers to measure strain, temperature and displacement.
CO4	Understand data acquisition system and general purpose interfacing bus.

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	2	2	1	-	1	1	1	-	-	-	-	-	1
CO2	2	2	1	-	1	1	1	-	-	-	-	-	1
CO3	2	2	1	-	1	1	1	-	-	-	-	-	1
CO4	2	2	1	-	1	1	1	-	-	-	-	-	1

Detailed syllabus

Measurement And Error: Sensitivity, Resolution, Accuracy and precision, absolute and Relat analysis, Probability of and Limiting errors, Linearity.

Instruments: D'Arsonval movement and basic principles of Measurement of Voltage, Current instruments. Analog and Digital Multimeters, Measurement of time and Frequency – Digital Frequency Meter and applications.

Impedance Measurement: Kelvin Bridge; Megger; Maxwell, Hay and Shering Bridges. Q-met reduction techniques in Measurement Systems.

Oscilloscopes: Block diagram, probes, Deflection amplifier and delay line, Trigger Genera Time Base and Dual Trace Oscilloscopes, Pulse Measurements, Delayed Time Base, Analo Digital Storage Oscilloscopes.

Special instruments: Wave Analyzer, Harmonic Distortion Analyzer, Spectrum Analyze Analyzer.

Transducers (Qualitative Treatment Only): Classification and selection of Transduc
Load, force, Displacement, Velocity, Acceleration, Pressure and Temperature Meas
Introduction to Data Acquisition Systems (DAS): Block Diagram, Specifications and va
General purpose Instrumentation Bus (GP-IB): Protocol, SCPI Commands and Applications
DSO and DMM.

Reading:

1. Oliver and Cage, Electronic Measurements and Instrumentation, McGraw Hill, 2009
2. Helfrick Albert D. and Cooper William D., Electronic Instrumentation & Measureme
3. D.A. Bell, Electronic Instrumentation and Measurements, 3rd Edition, Oxford, 2013.

3 Credits

PSO2	PSO3
2	-
2	-
2	-
2	-

tive types of errors, Statistical

t and Resistance in

ter; Noise and Interference

ator, Coupling, Automatic
g Storage, Sampling and

r, FFT

cers, Introduction to strain,
urements.
ırious components of DAS.
to

ent Techniques, PHI, 2008.

MM499	METALLURGY FOR NON-METALLURGISTS	OPC	3-0-0	03

Pre-requisites: None

Course Outcomes: At the end of the course, student will be able to:

CO1	Discuss the characteristics and applications of metals and alloys.
CO2	Explain different fabrication techniques.
CO3	Correlate the microstructure, properties, processing and performance of materials.
CO4	Select metal/alloy for engineering applications.

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	2	2	1	-	1	1	1	-	-	-	-	-	1
CO2	2	2	1	-	1	1	1	-	-	-	-	-	1
CO3	2	2	1	-	1	1	1	-	-	-	-	-	1
CO4	2	2	1	-	1	1	1	-	-	-	-	-	1

Detailed syllabus

Introduction to Metallurgy: Metals and Alloys classification, engineering applicatio
Structure of Metals and Alloys: Nature of Metallic Bonding, Crystal Structures of Metals, Stru
in Crystals.
Mechanical Properties: Plastic Deformation Mechanisms, Tensile, Creep, Fatigue, Fracture
Strain Hardening, Grain Size Refinement, Solid Solution Strengthening, Precipitation
Fabrication and Finishing of metal products: Metal Working and Machining
Testing of Metals: Destructive and Non-Destructive Testing, Inspection and Quality Control
Engineering Alloys: Steel Products and Properties, Cast Irons, Tool Steels and High
Steels, selective non-ferrous metals and alloys.
Heat Treatment: Annealing, Normalizing, Hardening and Tempering.
Material selection processes: Case studies

Reading:

1. M. F. Ashby, Engineering Metals, 4^{th} Edition, Elsevier, 2005.
2. R. Balasubramaniam (Adapted): Calister’s Materials Science and Engineering, 7^{th} Editio
3. R. Abbaschian, L. Abbaschian, R.E. Reed-Hill, Physical Metallurgy Principles, East-W
4. V Raghavan, Elements of Materials Science and Engineering- A First Course, 5^{th} Edition
Publications, 2011

Credits

PSO2	PSO3
1	-
1	-
1	-
1	-

ıs of metals/alloys.
ıcture of Alloys, Imperfections

Strengthening Mechanisms:
ı Hardening

ɔf Metals.
Speed Steels, Stainless

n, Wiley India (P) Ltd, 2007.
Vest Press, 2009.
ı, PHI

CH440	DATA DRIVEN MODELLING	OPC	3 – 0 – 0	3

(Not offered to Chemical Engineering Students)

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Identify disturbance models
CO2	Estimate parametric and non-parametric models
CO3	Determine the model structure
CO4	Validate the developed models

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	2	2	1	2	2	-	-	-	-	-	-	1	-
CO2	2	2	1	2	2	-	-	-	-	-	-	1	-
CO3	2	2	1	2	2	-	-	-	-	-	-	1	-
CO4	2	2	1	2	2	-	-	-	-	-	-	1	-

Detailed syllabus

System Identification - Motivation and Overview. Models of Discrete-Time LTI Systems Difference equations, Transfer functions, State-space models, Discretization, Samp sampling theorem.

Disturbance models - random processes, representation of stationary processes, white covariance function (ACF), ARMA models. Parametric model structures - ARX, ARMAX structures and their applicability in real-time.

Linear Regression - Least Squares estimates, Statistical properties of LS Estimates. Weight Least Squares, Maximum Likelihood Estimation and properties.

Estimation of non-parametric models - impulse / step response coefficients, frequency respo

Estimation of parametric models - notions of prediction and simulation, predictors for parame methods, Instrumental Variable method.

Model Structure Selection and Diagnostics -estimation of delay and order, residual ch properties of parameter estimates, model comparison and selection, model validation.

Reading:

1. Arun K. Tangirala. System Identification: Theory and Practice, CRC Press, 2014.
2. Karel J. Keesman, System Identification – An Introduction, Springer, 2011.
3. Nelles, O. Nonlinear System Identification, Springer-Verlag, Berlin, 2001.
4. Zhu, Y. Multivariable System Identification for Process Control, Pergamon, 2001.
5. Ljung, L. System Identification: Theory for the User, Prentice-Hall, 2nd Edition, 1999.
6. J. R. Raol, G. Girija, J. Singh, Modeling and Parameter Estimation of Dynamic Systems, Engineers, 2004.
7. Rolf Johansson, System Modeling and Identification, Prentice Hall, 1993.

3 Credits

PSO2	PSO3
-	3
-	3
-	3
-	3

s – Convolution equation.
oling and Hold operations,

e-noise process, auto-
, OE, BJ and PEM –

ed Least Squares, Recursive

nse models.
etric models, prediction-error

ecks,

The Institution of Electrical

CH441	FUEL CELL TECHNOLOGY	OPC	3 – 0 – 0	3

(Not offered to Chemical Engineering Students)

Pre-requisites: None.

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand fuel cell fundamentals.
CO2	Analyze the performance of fuel cell systems.
CO3	Demonstrate the operation of fuel cell stack and fuel cell system.
CO4	Apply the modeling techniques for fuel cell systems

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1													
CO2													
CO3													
CO4													
CO5													
CO6													

Detailed syllabus

Overview of Fuel Cells: What is a fuel cell, brief history, classification, how does it work, why cell basic chemistry and thermodynamics, heat of reaction, theoretical electrical work and po efficiency.

Fuels for Fuel Cells: Hydrogen, Hydrocarbon fuels, effect of impurities such as CO, S and ot electrochemistry: electrode kinetics, types of voltage losses, polarization curve, fuel cell effic exchange currents.

Fuel cell process design: Main PEM fuel cell components, materials, properties and process diffusion layer, bi-polar plates, Fuel cell operating conditions: pressure, temperature, flow rat Main components of solid-oxide fuel cells, Cell stack and designs, Electrode polarization, tes short stacks, Cell, stack and system modeling

Fuel processing: Direct and in-direct internal reforming, Reformation of hydrocarbons by stea CO_2 and partial oxidation, Direct electro-catalytic oxidation of hydrocarbons, carbon decomposition, Sulphur toler renewable fuels for SOFCs

Reading:

1. Hoogers G, Fuel Cell Technology Hand Book, CRC Press, 2003.
2. O'Hayre, R. P., S. Cha, W. Colella, F. B. Prinz, Fuel Cell Fundamentals, Wiley, 2006.
3. F. Barbir, PEM Fuel Cells: Theory and Practice, Elsevier/Academic Press, 2nd Edition, 20
4. Subhash C. Singal and Kevin Kendall, High Temperature Fuel Cells: Fundamentals, Des
5. Laminie J, Dicks A, Fuel Cell Systems Explained, 2nd Edition, John Wiley, New York, 200

3 Credits

PSO2	PSO3

do we need fuel cells, Fuel
tential, theoretical fuel cell

hers. Fuel cell
iency, Tafel equation,

es: membrane, electrode, gas
es, humidity.
sting of electrodes, cells and

am,
ance and removal , Using

)13.
;ign and Applications
)3.

CH442	DESIGN OF EXPERIMENTS	OPC	3 – 0 – 0	3

(Not offered to Chemical Engineering Students)

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Design experiments for a critical comparison of outputs
CO2	Propose hypothesis from experimental data
CO3	Implement factorial and randomized sampling from experiments
CO4	Estimate parameters by multi-dimensional optimization

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1													
CO2													
CO3													
CO4				`									

Detailed syllabus

Introduction: Strategy of experimentation, basic principles, guidelines for designing experime
Experiments: Basic statistical concepts, sampling and sampling distribution, inferences abou
Hypothesis testing, Choice of samples size, Confidence intervals, Randomized and paire
Experiments with Single Factor; An example, The analysis of variance, Analysis of the fixed
adequacy checking, Practical interpretation of results, Sample computer output, Determining
dispersion effect, The regression approach to the analysis of variance, Nonparameteric meth
variance, Problems.

Design of Experiments: Introduction, Basic principles: Randomization, Replication, Bloc
Confounding, Design resolution, Metrology considerations for industrial designed experin
characteristics for industrial experiments.

Parameter Estimation.

Response Surface Methods: Introduction, The methods of steepest ascent, Analysis of a sec
Experimental designs for fitting response surfaces: Designs for fitting the first-order model,
second-order model, Blocking in response surface

designs, Computer-generated (Optimal) designs, Mixture experiments, Evolutionary opera
Problems.

Design and Analysis: Introduction, Preliminary examination of subject of research, Scr
Preliminary ranking of the factors, active screening experiment-method of random balance, a
Plackett-Burman designs, Completely randomized block design, Latin squares, Graeco-Lat
Squares, Basic experiment-mathematical modeling, Statistical Analysis, Experimental opti
subject: Problem of optimization, Gradient optimization methods, Nongradient methods of
rotatable design, Canonical analysis of the response surface, Examples of complex optimiza

1. Lazic Z. R., Design of Experiments in Chemical Engineering, A Practical Guide, Wiley, 20
2. Antony J., Design of Experiments for Engineers and Scientists, Butterworth Heiner
3. Montgomery D. C., Design and Analysis of Experiments, Wiley, 5th Edition, 2010.
4. Doebelin E. O., Engineering Experimentation: Planning, Execution, Reporting, McGraw-H

3 Credits

PSO2	PSO3

nts. Simple Comparative
ut the differences in means:
ed comparison design.
effect model, Model
g sample size, Discovering
hods in the analysis of

king, Degrees of freedom,
nents, Selection of quality

cond- order response surface,
Designs for fitting the

tion, Robust design,

eening experiments:
ıctive screening experiment
tin Square, Youdens
mization of research
ɔptimization, Simplex sum
tions. **Reading:**
)05.
nann, 2004.

Hill, 1995.

CH443	CARBON CAPTURE, SEQUESTRATION AND UTILIZATION	OPC	3 – 0 – 0

(Not offered to Chemical Engineering Students)

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Identify the necessity of CO_2 capture, storage and utilization
CO2	Distinguish the CO_2 capture techniques
CO3	Evaluate CO_2 Storage and sequestration methods
CO4	Assess Environmental impact of CO_2 capture and utilization

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	
CO1														
CO2														
CO3														
CO4				`										

Detailed syllabus

Introduction: Global status of CO_2 emission trends, Policy and Regulatory interventions in abatement of carbon footprin and utilization (CCS&U)

CO_2 capture technologies from power plants: Post-combustion capture, Pre-combustion capture, Oxy-fuel combustion, chemic calcium looping combustion

CO_2 capture agents and processes: Capture processes, CO_2 capture agents, adsorption, ionic liquids, metal organic framewc

CO_2 storage and sequestration: Geological sequestration methods, Biomimetic carbon sequestration

CO_2 Utilization: CO_2 derived fuels for energy storage, polymers from CO_2, CO_2 based solvents, CO_2 to oxygenated organics, Conversion int catalysis Environmental assessment of CO_2 capture and utilization: Need for assessment, Green chemistry and environmental ass assessment (LCA), ISO standardization of LCA,

Method of conducting an LCA for CO_2 capture and Utilization.

Reading:

1. Peter Styring, Elsje Alessandra Quadrelli, Katy Armstrong, Carbon dioxide utilization: Clos
Elsevier, 2015.
2. Goel M, Sudhakar M, Shahi RV, Carbon Capture, Storage and, Utilization: A Possible Clin
Energy Industry, TERI, Energy and Resources Institute, 2015.
3. Amitava Bandyopadhyay, Carbon Capture and Storage, CO_2 Management Technologies, CRC Press, 2014.
4. Fennell P, Anthony B, Calcium and Chemical Looping Technology for Power Generation a
Woodhead Publishing Series in Energy: No. 82, 2015.
5. Mercedes Maroto-Valer M, Developments in Innovation in Carbon Dioxide Capture
Storage Technology: Carbon Dioxide Storage and Utilization, Vol 2, Woodhead Publishing Se

3 Credits

PSO2	PSO3

ıt, carbon capture, storage

al looping combustion,

ɔrks

:o higher carbon fuels, High temperature

ѕessment tools, Life cycle

sing the Carbon Cycle,

nate Change Solution for

and Carbon Dioxide (CO_2) Capture,

and
eries in Energy, 2014.

CS440	MANAGEMENT INFORMATION SYSTEMS	OPC	3 – 0 – 0

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Determine key terminologies and concepts including IT, marketing, management, ec accounting, finance in the major areas of business.
CO2	Design, develop and implement Information Technology solutions for business
CO3	Analysis of computing systems and telecommunication networks for busin systems.
CO4	Understand ethical issues that occur in business, evaluate alternative courses evaluate the implications of those actions.
CO5	Plan projects, work in team settings and deliver project outcomes in time.

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	-	-	1		3	-	-	2	-	-	2	-	1
CO2	-	-	1		3	-	-	2	-	-	2	-	1
CO3	-	-	1		3	-	-	2	-	-	2	-	1
CO4	-	-	1		3	-	-	3	-	-	2	-	1
CO5	-	-	1		3	-	-	2	-	-	3	-	1

Detailed syllabus

Organization and Information Systems, Foundation Concepts, Information Systems in Busin Information Systems, Competing with Information Technology, Fundamentals of Strategic Information Technology for Strategic Advantage. Changing Environment and its impac Information Systems.

Computer Fundamentals, Computer Hardware, and Computer Systems: End User and Ente Peripherals: Input, Output, and Storage Technologies, Computer Software, Application Sof Computer System Management, Data Resource
Management, Technical Foundations of Database Management, Managing Data Resources

Telecommunication and Networks, Telecommunications and Networks, the Networl
Telecommunications Network Alternatives System Analysis and Development and Mode
Business/IT Strategies, Planning Fundamentals, Implementation Challenges, Develo
Developing Business Systems, Implementing Business Systems Manufacturing and Ser
systems for Accounting, Finance, Production and Manufacturing, Marketing and HRM f
Resources Planning (ERP), Choice of IT, Nature of IT decision, Managing Information Techr
Security and Ethical Challenges, Security and Ethical Challenges, Security and Ethical, and
Security Management of Information Technology, Enterprise and
Global Management of Information Technology.

Reading:

1. Kenneth J Laudon, Jane P. Laudon, Management Information Systems, 10th Editi
2. W. S. Jawadekar, Management Information Systems, 3rd Edition, TMH, 2004.

3 Credits

onomics,
problems.
ess information
of actions and

PSO2	PSO3
-	-
-	-
-	-
-	-
-	-

ess, the Components of
Advantage, Using
ct on Business, Kinds of

rprise Computing, Computer
ftware, System Software,

‹ed Enterprise,
els, Developing
oping Business/IT Solutions,
rvice Systems Information
unctions, Enterprise
nology, Managing Global IT,
Societal Challenges of IT,

on, Pearson/PHI, 2007.

BT440	BIOSENSORS	OPC	3 – 0 – 0	3

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand biosensing and transducing techniques
CO2	Understand principles of linking cell components and biological pathways with energy tra sensing and detection
CO3	Demonstrate appreciation for the technical limits of performance of biosensor
CO4	Apply principles of engineering to develop bioanalytical devices and design of biosensors

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	2	2	-	1	2	-	-	-	-	-	-	1
CO2	3	2	2	-	1	2	-	-	-	-	-	-	1
CO3	3	2	2	-	1	2	-	-	-	-	-	-	1
CO4	3	2	2	-	1	2	-	-	-	-	-	-	1

Detailed Syllabus:

General principles: A historical perspective; Signal transduction; Physico-chemical and biolo types and technologies, Definitions and Concepts Terminology and working vocabulary; Mai calibration, selectivity, sensitivity, reproducibility, detection limits, response time.

Physico-chemical transducers: Electrochemical transducers (amperometric, potentiom transducers (absorption, fluorescence, SPR); Thermal transducers; piezoelectric transdu Biorecognition systems: Enzymes; Oligonucleotides and Nucleic Acids; Lipids (Langmuir-Blo Phospholipids, Liposomes); Membrane receptors and transporters; Tissue and orga tissue); Cell culture; Immunoreceptors; Chemoreceptors; Limitations & problems. Immobilization of biomolecules.

Biosensor Engineering: Methods for biosensors fabrication: self-assembled monolayers, scre photolithography, micro-contact printing, MEMS. Engineering concepts for mass prc Application of modern sensor technologies: Clinical chemistry; Test-strips for glucose monito Implantable sensors for long-term monitoring; Environmental monitoring; Technological quality control; Forensic science benefits; Problems & limitations.

Reading:

1. Donald G. Buerk, Biosensors: Theory and Applications, CRC Press, 2009.
2. Alice Cunningham, Introduction to Bioanalytical Sensors, John Wiley& Sons, 1998.
3. Brian R. Eggins, Chemical Sensors and Biosensors, John Wiley& Sons, 2003.

3 Credits

nsduction,
s

PSO2	PSO3
-	-
-	-
-	-
-	-

gical transducers; Sensor
n technical definitions:

ıetric, conductimetric); optical
ıcers.
ıdgett bilayers,
ınelles (animal and plant

een printing,
oduction.
oring; Urea determination;
process control; Food

SM440	HUMAN RESOURCE MANAGEMENT	OPC	3 – 0 – 0	3

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand principles, processes and practices of human resource management.
CO2	Apply HR concepts and techniques in strategic planning to improve organizational performance.
CO3	Understand tools to manage HR systems and procedures.

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	2	2	-	-	-	-	-	-	2	1	2	-	-
CO2	2	2	-	-	-	-	-	-	2	1	2	-	-
CO3	2	2	-	-	-	-	-	-	2	1	2	-	-

Detailed Syllabus:

Introduction to Human Resource Management, Objectives, Scope and Significance of HRM, and Prospects in HRM, Environmental scanning.

Human Resource Planning, Demand Forecasting Techniques, Supply Forecasting Techniqu designing jobs, Recruitment and Selection, Interviewing Candidates.

Human Resource Development, Orientation, Training and Development, Managem Performance Appraisal and Employee Compensation, Factors Influencing, Employee Challenges of Remuneration.

Industrial Relations, Industrial Disputes and Discipline, Managing Ethical Issues in Human R Workers Participation in Management, Employee safety and health, Managing Global Huma Unions

International HRM, Future of HRM and Human Resource Information Systems

Reading:

1. Aswathappa, Human Resource Management –– TMH, 2010.
2. Garry Dessler and BijuVarkkey, Human Resource Management, PEA, 2011.
3. Noe & Raymond, HRM: Gaining a Competitive Advantage, TMH, 2008.
4. Bohlander George W, Snell Scott A,Human Resource Management, Cengage Lea

3 Credits

PSO2	PSO3
-	-
-	-
-	-

Functions of HRM, Problems

es, Analyzing work and

ent, Development,
e Remuneration and

esource Management,
n Resources and Trade

rning, 2009.

MA440	OPTIMIZATION TECHNIQUES	OPC	3 – 0 – 0	3

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Formulate and solve linear Programming Problems
CO2	Determine the optimum solution to constrained and unconstrained
CO3	Apply dynamic programming principle to Linear programming problems.
CO4	Determine the integer solutions to Linear Programming Problems.

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	3	1	1	2	-	-	-	-	-	-	-	-
CO2	3	3	1	1	2	-	-	-	-	-	-	-	-
CO3	3	3	1	1	2	-	-	-	-	-	-	-	-
CO4	3	3	1	1	2	-	-	-	-	-	-	-	-

Detailed Syllabus:

Linear Programming: Introduction and formulation of models, Convexity, Simplex method, Bi method, Degeneracy, non-existent and unbounded solutions, revised simplex method, simplex method, sensitivity analysis, transportation and assignment problems, traveling s

Nonlinear Programming: Introduction and formulation of models, Classical optimization meth constraints, Lagrange multipliers and Kuhn-Tucker conditions, quadratic forms, quadratic pro method.

Dynamic Programming: Principle of optimality, recursive relations, solution of LPP.

Integer Linear Programming: Gomory's cutting plane method, Branch and bound algorit 0-1 problem.

Reading:

1. Kanti Swarup, Man Mohan and P.K. Gupta, Introduction to Operations Research, S. Cha
2. J.C.Pant, Introduction to Operations Research, Jain Brothers, New Delhi, 2008.
3. N.S. Kambo, Mathematical Programming Techniques, East-West Pub., Delhi, 1991.

3 Credits

PSO2	PSO3
-	3
-	3
-	3
-	3

g-M method, Two-phase
duality in LPP, dual
alesman problem .
ods, equality and inequality
ogramming problem, Wolfe's

hm, Knapsack problem, linear

ınd & Co., 2006

MA441	OPERATIONS RESEARCH	OPC	3 – 0 – 0	3

Prerequisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Formulate and solve linear programming problems
CO2	Determine optimum solution to transportation problem
CO3	Determine average queue length and waiting times of queuing models.
CO4	Determine optimum inventory and cost in inventory models.

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	3	1	1	2	-	-	-	-	-	-	-	-
CO2	3	3	1	1	2	-	-	-	-	-	-	-	-
CO3	3	3	1	1	2	-	-	-	-	-	-	-	-
CO4	3	3	1	1	2	-	-	-	-	-	-	-	-

Detailed Syllabus:

Linear Programming: Formulation and graphical solution of LPP's. The general LPP, variables. Reduction of a LPP to the standard form. Simplex computational procedure, Big-M method. Solution in case of unrestricted variables. Dual linear programming problem. Solu from the solution of the dual problems.

Transportation Problems: Balanced and unbalanced Transportation problems. Initial ba W corner rule, row minimum method, column minimum, least cost entry method and Vogel' Optimal solutions.Degenracy in Transportation problems. Queueing Theory: Poisson pr distribution. Poisson queues - Model (M/M/1):(∞/FIFO) and its characteristics.

Elements of Inventory Control: Economic lot size problems - Fundamental problems of EOQ finite rate of replenishment. Problems of EOQ with shortages - production instantaneous, re with finite rate. Stochastic problems with uniform
demand (discrete case only).

Reading:

1. K. Swarup, Manmohan & P.K. Gupta, Introduction to Operations Research, S. Chand & (
2. J.C. Pant, Introduction to Operations Research, Jain Brothers, New Delhi, 2008.
3. N.S. Kambo: Mathematical Programming Techniques, East-West Pub., Delhi, 1991.

3 Credits

PSO2	PSO3
-	3
-	3
-	3
-	3

slack, surplus and artificial
M method, Two-phase
tion of the primal problem

asic feasible solution using N-
s approximation method.
ocess and exponential

. The problem of EOQ with
plenishment of the inventory

Co., 2006

PH440	NANOMATERIALS AND TECHNOLOGY	OPC	3 – 0 – 0	3

Prerequisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand synthesis and properties of nanostructured materials.
CO2	Analyze magnetic and electronic properties of quantum dots
CO3	Understand structure, properties and applications of Fullerenes and Carbon nanotubes.
CO4	Understand applications of nanoparticles in nanobiology and nanomedicine

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	1	1	1	-	-	-	-	-	-	-	-	1
CO2	3	1	1	1	-	-	-	-	-	-	-	-	1
CO3	3	1	1	1	-	-	-	-	-	-	-	-	1
CO4	3	1	1	1	-	-	-	-	-	-	-	-	1

Detailed Syllabus:

General properties of Nano materials: Origin of nanotechnology. Classification of nanomater nanotubes (CNT's), Nanoparticles. Physical, Chemical, Electrical, Optical, Magnetic and nanomaterials.

Fullerenes and Carbon Nanotubes (CNT's): Introduction: Synthesis and purification. Prepara condensed phase, Transport, mechanical, physical properties of CNT's.

Investigation and manipulating materials in the Nanoscale: Electron microscope, scanning p microscopes for Nanoscience and Technology, X-Ray Diffraction.

SAMs and clusters: Growth process. Patterning monolayers. Types of clusters. Bonding

Semi conducting Quantum Dots: Introduction: Synthesis of Quantum Dots. Electronic structu properties.

Nanobiology: Interaction between Biomolecules and Nanoparticle surgaces. Different types

Inorganic materials used for the synthesis of Hybrid Nano-bio assemblies. Nanoprob

Nanosensors: Nanosensors based on optical properties. Nanosensors based on quantum si
Nanomedicines: Developments of nanomedicines. Nanotechnology in Diagnostic Applicatio
materials for use in Diagnostic and therapeutic Applications.

Reading:

1. T. Pradeep, Nano: The Essentials; Tata McGraw-Hill, 2008.
2. W.R. Fahrner, Nanotechnology and Nanoelectronics; Springer, 2006.
3. Rechard Booker and Earl Boysen, Nanotechnology, Willey, 2006.

3 Credits

PSO2	PSO3
1	-
1	-
1	-
1	-

ials. Fullerene,carbon
mechanical properties of

ation of fullerenes in the

probe microscopes, optical

g and properties of clusters.
ure of Nanocrystals,

s of
es for Analytical Applications.

ze effects. Nanobiosensors.
ns,

PH441	BIOMATERIALS AND TECHNOLOGY	OPC	3 – 0 – 0	3

Prerequisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the structure and properties of biomaterials
CO2	Classify implant biomaterials
CO3	Evaluate biocompatibility of implants
CO4	Identify appropriate biomaterials for specific medical applications

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	3	1	1	-	1	2	1	-	-	-	-	1
CO2	3	3	1	1	-	1	2	1	-	-	-	-	1
CO3	3	3	1	1	-	1	2	1	-	-	-	-	1
CO4	3	3	1	1	-	1	2	1	-	-	-	-	1

Detailed Syllabus:

Overview of biomaterials: Historical developments, impact of biomaterials, interfacial phenor implants.

Structure and properties of biomaterials: Crystal structure of solids, phase changes, imperfe crystalline solids, surface properties of solids, mechanical properties, surface improven

Types of biomaterials: Metallic implant materials, ceramic implant materials, polymeric impla biomaterials.

Characterization of materials: Electric properties, optical properties, X-ray absorption, acous

Bio implantation materials: Materials in ophthalmology, orthopedic implants, dental materials materials.

Tissue response to implants: Normal wound healing processes, body response to implants, structure – property relationship of tissues.

Reading:

1. Joon Park, R.S. Lakes, Biomaterials an introduction; 3rd Edition, Springer, 2007
2. Sujatha V Bhat, Biomaterials; 2nd Edition, Narosa Publishing House, 2006.

Credits

PSO2	PSO3
1	-
1	-
1	-
1	-

ıena, tissue responses to

ctions in solids, non-
ıents.
nt materials composites as

tic and ultrasonic properties.
; and cardiovascular implant

blood compatibility, and

CY441	CHEMISTRY OF NANOMATERIALS	OPC	3 – 0 – 0	3

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Demonstrate a systematic knowledge of the range and breadth of application of nanomaterials.
CO2	Review critically the potential impact, in all classes of materials, of the control o nanostructure
CO3	Describe the methods for the synthesis and nanostructural characterisation of suc materials.
CO4	Identify the possible opportunities for nanomaterials in society development and enhancement.

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	3	1	1	1	-	2	2	-	-	-	-	-	1
CO2	3	1	1	1	-	2	2	-	-	-	-	-	1
CO3	3	1	1	1	-	2	2	-	-	-	-	-	1
CO4	3	1	1	1	-	2	2	-	-	-	-	-	1

Detailed Syllabus:

Introduction: Review the scope of nanoscience and nanotecnology, understand the nanoscie of nanostructured materials and importance of nanomaterials.

Synthetic Methods: Teach the basic principles for the synthesis of Nanostructure materials l Up approach):-Sol-gel synthesis, microemulsions or reverse micelles, solvothermal synthesis synthesis and sonochemical synthesis and Physical methods (Top-Down approach):- Inert g technique, ion sputtering, Laser ablation, laser pyrolysis, and chemical vapour deposition me

Techniques for characterization: Learning of characterization method by various techniques Powder X-ray diffraction for particle size analysis, Spectroscopy Techniques:-Opera applications of spectroscopy techniques for the analysis of nanomaterials, UV-VIS spectro application for band gap measurement,

Electron Microscopy Techniques:-Scanning electron microscopy (SEM)and EDAX analy

transmission electron microscopy (TEM), scanning probe microscopy (SPM)BET metho determination and Dynamic light scattering technique for particle size analysis.
Studies of nano-structured Materials:Synthesis, properties and applications of the followi nanomaterials: fullerenes, carbon nanotubes, core-shell nanoparticles, nanoshells, and monolayer protected metal nanoparticles, nanocrystalline materials.

Reading:

1. T Pradeep, NANO: The Essentials, MaGraw Hill, 2007.

2. B S Murty, P Shankar, BaldevRai, BB Rath and James Murday, Textbook of Nanoscier Univ. Press, 2012.

3. Guozhong Cao, Nanostructures & Nanomaterials; Synthesis, Properties & Applicati 2007.

4. M.A. Shah and Tokeer Ahmad, Principles of Nanoscience and Nanotechnology, Naros

5. Manasi Karkare, Nanotechnology: Fundamentals and Applications, IK International, 2008

6. C. N. R. Rao, Achim Muller, K. Cheetham, Nanomaterials Chemistry, Wiley-VCH, 2007.

Credits

f
ch

PSO2	PSO3
-	-
-	-
-	-
-	-

ence in nature, classification

by Chemical Routes (Bottom-
s, microwave heating
as condensation, plasma arc
ethod.
like, Diffraction Technique:-
ational principle and
photometers and its

sis,

ıd for surface area

ing
self- assembled monolayers,

nce and nanotechnology,

ons, Imperial College Press,

sa Pub., 2010.
3.

HS440	CORPORATE COMMUNICATION	OPC	3 – 0 – 0	3

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand corporate communication culture
CO2	Prepare business letters, memos and reports
CO3	Communicate effectively in formal business situations
CO4	Exhibit corporate social responsibility and ethics
CO5	Practice corporate email, mobile and telephone etiquette
CO6	Develop good listening skills and leadership qualities

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1
CO1	-	-	-	-	-	-	-	3	1	3	2	-	-
CO2	-	-	-	-	-	-	-	3	1	3	2	-	-
CO3	-	-	-	-	-	-	-	3	1	3	2	-	-
CO4	-	-	-	-	-	-	-	3	1	3	2	-	-
CO5	-	-	-	-	-	-	-	3	1	3	2	-	-
CO6	-	-	-	-	-	-	-	3	1	3	2	-	-

Detailed Syllabus:

Importance of Corporate communication: Introduction to and definition of corporate patterns and channels of communication- Barriers to communication and strategies to ov corporate culture- Role and contribution of individual group and organization - Role of ps Oral Communication: Techniques for improving oral fluency-Speech mechanics-Group Dyna Debate and oral presentations.

Written Communication: Types and purposes- Writing business reports, and business propo meetings- Circulars, persuasive letters- Letters of complaint- ; language and formats used fo communication. Internal and external communication. Corporate responsibility: Circulating mission statements- ethical practices- Human rights -Labour rights-Environment- goverr debates
surrounding -Public Relations - Building trust with stakeholders.

Corporate Ethics and Business Etiquette: Integrity in communication-Harmful practices
breakdown- Teaching how to deal with tough clients through soft skills. Body languag
oneself- Use of polite language- Avoiding grapevine and card pushing – Etiquette in e-mail,
Listening Skills: Listening- for information and content- Kinds of listening- Factors aff
techniques to overcome them- retention of facts, data and figures- Role of speaker in listeni
Leadership Communication Styles: Business leadership -Aspects of leadership-qualitie
leader- training for leadership-delegation of powers and ways to do it-humour-commitment.

Reading:

1. Raymond V. Lesikar, John D. Pettit, Marie E. FlatleyLesikar's Basic Business Communic
- 7th Edition: Irwin, 1993
2. Krishna Mohanand Meera Banerji, Developing Communication Skills: Macmillan Publish
3. R.C. Sharma & Krishna Mohan Business Correspondence and Report Writing: – 3rd Edit
4. Antony Jay & Ross Jay, Effective Presentation, University Press, 1999.
5. Shirley Taylor, Communication for Business, Longman, 1999.

Credits

PSO2	PSO3
-	-
-	-
-	-
-	-
-	-
-	-

s – Communication, process,
ercome them- Evolution of
ychology in communication.
amics and Group Discussion –

osals- Memos, minutes of
or drafting different forms of
to employees vision and
nance- Moral and ethical

and communication
e- Grooming- Introducing
mobile and telephone.
ecting listening and
ng.
s of

cation

ers India, 2000
tion Tata McGraw-Hill, 2008