Teaching Scheme and Syllabi of B.E. (Chemical Engineering)
(2023-2027)

S. No.	List of Departmental Electives	S. No.	List of Open Electives
1	Numerical Methods in Chemical Engineering	1.	Fuel Cell Technology
2	Petroleum Processing Engineering	2.	Industrial Safety and Hazards
3	Project Management	3.	Nanotechnology
4	Plant Utilities	4.	Polymer Science and Engineering
5	Petrochemical Technology	5.	Supply Chain and Logistic Management
6	Biochemical Engineering	6.	Project Management and Entrepreneurship
7	Food Processing	7.	**Environment Impact Assessment**
8	Corrosion Engineering	8.	Energy Management and Audit
9	Heterogeneous Catalysis and Reactor Design	9.	Applications of computational fluid dynamics
10	**Industrial Environmental Management**	10.	Chemical Process Optimization
11	Introduction to Multiphase Flow	11.	Fluidization Engineering
12	Natural Gas Engineering	12.	**Crystal physics**
13	Catalysis	13.	Advance Physics
14	Introduction to Colloids and Interfacial Science and Engineering	14.	Energy Materials
15	Biorefinery and Bioproducts Engineering	15.	Material Characterization
16.	**MOOCS COURSES(all chemich**		

Teaching Scheme and Syllabi of B.E. (Chemical Engineering)
(2023-2027)

Week 3 and 4 : Stateful applications
Week 5 and 6 : The front end
Week 7 and 8 : Databases and nd- -17.4203(b7879(i)8.83844654( )]TJ /R9 9.3624 Tf -25.(b)12.94b2 -1(069.78)]TJ /R978297(p)0.128297

Teaching Scheme and Syllabi of B.E. (Chemical Engineering) (2023-2027)

SYLLABUS OF B.E. CHEMICAL ENGINEERING 2023-2027
FIRST YEAR

1st SEMESTER

Title	**MATHEMATICS-I**	**Credits**	04
Code	BS101		

Pearson Education.
2.

Nanomaterials and its applications, chemical and physical synthesis techniques of nano-powder and thin films. (2)

Total 60 (L + T)

Text Books	1. Introduction to Solid State Physics: Charles Kittle 8th Ed.
Reference Books	a. Material science and Engineering – An Introduction by William D Callister, Jr, Sixth Edition, John Wiley and Sons. b. Material science and Engineering – A First Course by V.Raghvan Fourth Edition, EasternEconomy Edition c. Introduction to Solids (Tata McGraw Hill, Third Edition) - Leonid V Azaroff
Course Assessment Methods	Assessment will consist of the following components 1.Mid-Term a. One best of two minor tests (50% of Mid -term marks) b. Assignments (20% of Mid-term marks) c. Class Surprise Tests/ Quizzes/Presentations/Term paper (20% of Mid-term marks) d. Attendance. (10% of Mid-term marks) 2.End –Term

Course outcomes

Students will be familiar with

Understanding the Optics concepts and its applications, i.e. interference, diffraction, polarization and lasers.

Conceptual knowledge of structural properties, crystal structure, XRD, etc. to engineering applications.

Conceptual knowledge of mn76Rmf agaw Hilir-6.34w in

7550 re 0544 3.99609 re f 4356 42756 09 re 0544816 09 re f 4356 42156e 0544 3.99609 re f 4356 42156 4e 0544191 94 3.9960996 42348 2 0543 23.99609 re f 43

Teaching Scheme and Syllabi of B.E. (Chemical Engineering)
(2023-2027)

Title **COMPUTER PROGRAMMING FOR PROBLEM**

Teaching Scheme and Syllabi of B.E. (Chemical Engineering)
(2023-2027)

Title	**ENGINEERING GRAPHICS**		**Credits**	2
Code	ESC 102		**L T P**	2 - -
Max. Marks	**End term- 50**	**Mid Term- 50**	**Elective**	N
Pre requisites				
Note for Examiners:	**Question No. 1, which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of the Questions (2 to 9) will be divided into FOUR Units having TWO questions each and candidate is required to attempt at least ONE question from each Unit. The duration of End Term exam will be 3 hrs.**			

THEORY	
Note for the Examiner	
Objectives	Objectives of the Engineering Drawing course is 1. To develop the basic understanding of engineering drawing, use of drawing instruments, freehand sketching, lettering, dimensioning techniques, and introduction to CAD software. 2. To develop the understanding of projections for of points, lines and planes using orthographic projection methods, and enhancing spatial visualization skills. 3. To develop the understanding of creating the accurate projections and sectional views of different solids for effective representation and analysis in engineering drawings. 4. To develop the understanding of the isometric projection, development of the outer surface of solids, assembly drawing so as to accurately represent the actual shape of the objects with the help of orthographic views, their surfaces, and assembly instructions in engineering drawings.

UNIT-I

Introduction: Significance and scope of Engineering drawing, drawing instruments, drawing sheet layout and its folding method, types of lines, reduced scale, enlarged scale, sense of proportionate, freehand sketching, basic introduction to CAD software. (4 Hours)

Lettering and dimensioning: Single stroke Letters, Double stroke Letters, procedure of Lettering, principles of dimensioning, types of dimensioning, unidirectional dimensioning, aligned dimensioning, chain dimensioning, parallel dimensioning, combined dimensioning. (4 Hours)

UNIT-II

Projections of Points, lines and planes: Types of projections, orthographic projection, methods of obtaining different views, four quadrants, rotation of horizontal plane, 1st angle projection, 3rd angle projections, Projection of points, lines and planes on principal and Auxiliary planes in different quadrants, Inclination, trace and true length of lines, Introduction to planes, their traces and true shapes. (7Hours)

UNIT-III

Projection of solids: Types of solids, polyhedral solids, solids of surfaces of revolution prisms, pyramids, cone, cylinder, frustum and truncated solids, Projection of solids, section plane, Sectioning of solids, full section view, half section view. (7 Hours)

UNIT-IV

Isometric Projection:Principle of isometric projection, isometric scale, isometric view and isometric projection, isometric projections of planes and solids in different positions. (4 Hours)

Development of Surfaces: Importance of development of surface of objects, parallel line method and radial line method, development of surfaces of simple and .4712( )-644(u)12.9455(n)0.1.34603(l15(,)-6.3462V552)-16.7976(n)-12.6889(g)25.

	edition. 3. P.S.Gill: Machine Drawing 4. Sham Tickoo : Understanding AutoCAD 2006, Wiley Publication 5. James D. Bethune : AutoCAD, Pearson Publishers
Course Assessment Methods	The students will be assessed based upon the practical assignments and viva voce.
Course Outcomes	Student will be able to 1. understand the basics of engineering drawing. 2. visualize the different types of ge 4486 5217 3.866 6073 35.9961 9.99605.24799(h)-7.9506(e)-4.1417(

Code	ESC 152		**L T P**	- - 2
Max. marks	**Practical –** 50		**Elective**	N
Pre-requisites				
PRACTICAL				
Objectives	1. To make the students understand the need and importance of different manufacturing techniques. 2. To introduce the different tools and equipments used in mechanical workshops and develop the skill to use the same.			
Carpentry Shop: Description and use of carpenter's tools, Wood and timber, defects found in wood, seasoning of wood. Different types of timber in common use, making of lap joint, Bridle joint, dovetail joint and Mitre joint.				
Electric Tools: Exercise of wiring in link clip and casting and causing wiring of lights with switches in parallels, series and with 2 ways switches, Connecting energy meter, main switch and distribution board, testing a wiring installation for insulation resistance, Relevant Indian Electricity Rules.				
Machine Shop:Classification of fabrication processes, machine tools and materials, introduction to working of lathe, shapper, milling and drilling machines, power hacksaw, shearing machine and grinding wheel. Simple turning, threading, drilling board and knurling operations on a lathe.				

***Welding*:**

12. To synthesize the nanoparticles by chemical methods and structural characterization through X-ray diffraction.	
13. To investigate the optical band gap of nanomaterial using UV-vis spectroscopy.	
14. Fabrication of thin films by spray pyrolysis technique.	
15. Fabrication of thin films using spin coater technique.	
Text Books	1. Practical Physics by CL Arora, S Chand & Co. 2. Engineering physics by S.K. Srivastva
Reference Books	A text book of practical physics by William & Watson
Course Assessment Methods	One *project out of 6 carries 40% marks, 20% for respective viva and 20% for external exams and 10% for attendance.
Laboratory /Course outcomes	The student will gain • Proficiency in technical aspects of performing the experiments. • State various laws which they have studied through experiments. • Experimental data observations and analysis. •

Teaching Scheme and Syllabi of B.E. (Chemical Engineering)
(2023-2027)

Title	**COMPUTER LAB.**		**Credits**	1
Code	**ESC 153**		**L T P**	- - 2
Max. Marks	**Practical- 50**		**Elective**	N
Pre requisites				
Course Assessment Methods	The students will be assessed based upon the practical assignments and viva voce			
Objectives	1. To develop programs using C++. 2. To make the students design programs by using logic and become confident in handling numerical problems.			
Course Outcomes	1. The students will be able to demonstrate proficiency in C++. 2. The student will become confident in solving any computation problem usinm u			

Soil pollution: Components of soil, soil pollution, detrimental effects of pesticides and metal ions	4
UNIT-III	
Noise pollution: Classification of noise pollution, effects of noise pollution and control measures	2
Nuclear hazards, radiation pollution, solid waste- Introduction and case studies	3
UNIT-IV	
Social issues and the environment, concept of sustainable development, rain water harvesting, watershed management, wasteland reclamation	6
Population and economic growth	2
Environmental ethics, laws relating to environment	4

Text Books

1. J.G. Henry and G.W. Heinke ,"Environmental Science and Engineering", 2nd edition, , PHI Publisher, 2011.
2. A. Bhaskar ,"Environmental Studies" , Pearson Publisher, 2011.
3. C.N. Sawyer, P.L. McCarty, G.F. Parkin, "Chemistry

.99609 3.99609006 f3 l 4996 4677 3040 3.99609 re003 l 40.92 Td [(.99609 3.99209123 l 4096 4677 304

Title	**ELECTRICALANDELECTRONICS ENGINEERING**	**Credits**	4

incipleandconstructionofDCMachines,typesofDCMachine&E.M.Fequations. **(10)**
Unit III **SemiconductorDiodesandTransistors** GeneralintroductiontoElectronics.ConceptofstiffVoltageandCurrentSource.PNJunction,Depletionlayer,BarrierPotential,ForwardandReverseBias,Breakdownvoltage,V-Icharacteristics,Halfwaveandfullwaverectifiers,Zenerdiode.Introductiontojunctiontransistors,Transistoramplifying action,CB,CE, CC-configurationcharacteristics. **(10)**
Unit IV **DigitalElectronics** BinaryandHexadecimalnumbersystem,conversionofnumbersfromonesystemtoother,BooleanAlgebraandLaws:Commutative,AssociativeandDistributiveLaws.Concept of flip-flops, K-maps, RS, JK flip flops, shift register. (10)
TextBooks 1. EdwardHughes:ElectricalandElectronicTechnology,PearsonEducationPublication,Asia, 2s

Teaching Scheme and Syllabi of B.E. (Chemical Engineering) (2023-2027)

Unit operations and unit processes, material and energy balances, thermodynamics, chemical reaction engineering, process instrumentation, process contr

Teaching Scheme and Syllabi of B.E. (Chemical Engineering)
(2023-2027)

Teaching Scheme and Syllabi of B.E. (Chemical Engineering)
(2023-2027)

S. No.	Topic	No. of Hours
1	**Organizational Communication** Verbal and Non-Verbal Communication at different levels of organization, Role Play, Interaction with Bosses and Co-employees	5
2	**Speaking Techniques** Preparation of Interviews, Participation in Group Discussions and Case Studies, Making and Presenting Power Point Lectures.	15
3	**Advanced Speaking Techniques** Conducting Meetings and Conferences, Exposure to different Accents, Listening and responding in the global scenario, Telephonic Interviews/Conversations, Video Conferencing	5
4	**Technical Writing** Writing Letters, Memos, Minutes, Notes, CV, Job Applications, Reports and e-mails, Preparing Instruction Manuals and Technical Proposals	5

Course Code	MC102
Course Title	Universal Human Values
Course Type	Core
Course LTP	310
Course Credits	3
Course Assessment	
Continuous	
End of Semester 50 (Sessionals, Assignments, Quizzes) 50(University Examination)	
Course Prerequisites None.	

Teaching Scheme and Syllabi of B.E. (Chemical Engineering)
(2023-2027)

Teaching Scheme and Syllabi of B.E. (Chemical Engineering)
(2023-2027)

3rdSEMESTER

Title	**MATERIAL AND ENERGY BALANCE**		**Credits**	04
Code	PCC 102		**L T P**	3 1 -
Max.Marks	**End term- 50**	**Mid term- 50**	**Elective**	N
Pre requisites				
Objectives	To study and apply the basics of calculations related to material and energy balance in chemical processes.			
Note for the Examiner	**Question No. 1, which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five quest**			

	candidate is required to attempt at least ONE question from each Unit. The duration of End Term exam will be 3 hrs.

Course Objective: The course objective is to inculcate fundamental aspects of fluid flow and apply basic principles of fluid static and fluid dynamics to various chemical engineering problems.

Course Outcome :

- Understand and solve hydrostatic problems related to forces on submerged bodies and pressure measurement.
- To understand fluid flow phenomena and study basic equations of fluid flow
- Study of incompressible fluids to energy losses in pipes and Dimentional analysis
- To understand the concept of compressible flow and study of flow measuring devices.

Unit I

Fluid Statics: Hydrostatic equilibrium, Manometers, Pressure measurements, Normal forces in fluids, Forces on submerged bodies, Buoyancy and stability

Unit II

Fluid Flow Phenomena: Potential flow, Newtonian and non-Newtonian fluids, Viscosity, Reynolds number,Nature of turbulence, Eddy viscosity, Flow in boundary layers (laminar and turbulent flow), Transition length, Boundary layer separation.

Unit III

Fluid flow of incompressible fluids: Bernoulli's equation, Kinetic energy and momentumcorrection factors, Pump work in Bernoulli's equation, Navier-Stokes equation.

Dimensional analysis: Rayleigh's and Buckingham's theorem, applications of dimensional analysis to Fluid Flow

Unit IV

Flow of compressible fluids: acoustic velocity, Mach number, sonic, subsonic, supersonic flows, Mach angle, stagnation properties, flow through nozzle, effect of area variation on properties in an isentropic flow, choking in a converging duct, isentropic flow through converging-diverging duct: pressure distribution, working chart for an isentropic flow.

Flow measurements devices and machines: Pilot tube, Orifice, Venturi and Rotameter, Notches and weirs, wet gas meter. Fluid Machinery: Pumps, classification and performance of pumps, selection and specification of pumps, priming, cavitation, net positive suction head, turbines, blowers and Compressors.

Books Recommended

1. Mc Cabe, W.L., Smith, J.C. and Harriott, P. : Unit Operation of Chemical Engineering, McGraw Hill, Singapore, 5th edition, 1993.
2. Coulson, J.M. and Richardson, J.F. : Chemical Engineering, Vol. I, Pergamon press, 6 th edition, 1999.
3. Foust, A.S., Wenzel, L.A., Clump, C.W., Maus, L. and Anderson, L. B. : Principles of Unit Operations, John Wiley.
4. Badger, W.L. and Banchero, J.T. : Introduction to Chemical Engineering, Tata McGraw Hill Pub. Co. Ltd., 1997.
5. Chattopadhya, P. : Unit Operations of Chemical Engineering, Vol. I, Khanna Publishers, Delhi, 1997.

Title	**MECHANICAL OPERATIONS**			**Credits**	4
Code	PCC 104			**L T P**	3 1 -
Max. Marks	**End term- 50**	**Mid Term- 50**		**Elective**	N
Pre requisites					

THEORY		**Time**	3 Hours
Note for the Examiner	**Question No. 1, which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of the Questions (2 to 9) will be divided into FOUR Units having TWO questions each and candidate is required to attempt at least ONE question from each Unit. The duration of End Term exam will be 3 hrs.**		

	equipments, capacity and effectiveness of screens, standard screens
CO2:	Understanding and applying concepts of Flow around a single particle drag force and drag coefficient, settling velocity of particles in a fluid, hindered and free settling of particles, thickening and gravity separation, types of settling devices.

CO3:

Teaching Scheme and Syllabi of B.E. (Chemical Engineering)
(2023-2027)

Pre requisites				
THEORY			**Time**	3 Hours

Note for the Examiner **Question No. 1, which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two8.33333 0 0 8(v)0.128297(e)-4.66 on**

internal pressure, volumetric strain, modifications for built-up shells, numerical problems. (4 hours)

Unit IV

***Stresses and Strains in Springs*:** Types of Springs, stresses in Close coiled helical springs, open coiled helical springs, leaf springs, springs in parallel and in series, numerical problems. (5 hours)

***Strain Energy and Theories of Elastic Failure*:** Strain energy, resilience, Strain energy in tension and compression due to suddenly applied load and impact loads, strain energy due to shear, strain energy due to bending, strain energy due to torsion, theories of elastic failure and their graphical representation, numerical problems. (5 hours)

***Books Recommended*:**

1. Ryder, G. H. : Strength of Materials, 3rd Edition S.I. Units Macmillan, 1969.
2. Bedi, D. S. : Strength of Materials, 6th Edition Khana Book Publishing Co. (P)Ltd.
3. Timoshenko, S. : Strength of Materials Part-I, 3rd Edition, Cbs Publishers, 1986.
4. Singal & Sharma : Strength of Materials , Modern Publisher.

Title	**ENGINEERING MATERIALS**			**Credits**	4
Code	ESC 105			**L T P**	3 1 -
Max. Marks	**End term- 50**	**Mid Term- 50**		**Elective**	N
Pre requisites					
THEORY			**Time**	3 Hours	
Note for the Examiner	**Question No. 1, which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of the Questions (2 to 9) will be divided into FOUR Units having TWO questions each and candidate is required to attempt at least ONE question from each Unit. The duration of End Term exam will be 3 hrs.**				

Course Objectives
- To understand crystal structures and imperfections in atomic arrangement
-

(grain size reduction, solid-solution strengthening, strain hardening), Schmid's law

Unit III

Phase diagrams and phase transformation: binary phase diagrams – Fe-Fe_3C, Cu-Ni, Pb-Sn, microstructure development, TTT diagrams, heat treatment processes-hot and cold working, hardening and softening processes.

Unit IV

Materials: Standards and specifications, unified alloy numbering system, ferrous metals and alloys, nonferrous metals and alloys; overview of ceramic, polymeric and composite materials;

Mechanical tests: standard test procedures for mechanical property determination-strength, toughness, fracture toughness, hardness, impact, fatigue, creep etc.

Corrosion: Types and mechanism of corrosion, factors influencing corrosion, combating corrosion, few examples of selection of materials of construction for handling different chemicals like sulfuric acid, nitric acid, NaoH, HCl, acetic acid.

Title	**Startup & Funding**			**Credits**	2
Code	VAC 102			**L T P**	2 - -
Max. Marks	**End term- 50**	**Mid Term- 50**		**Elective**	N
Pre requisites					
THEORY				**Time**	3 Hours
Note for the Examiner	**Question No. 1, which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of the Questions (2 to 9) will be divided into FOUR Units having TWO questions each and candidate is required to attempt at least ONE question from each Unit. The duration of End Term exam will be 3 hrs.**				

Startups are emerging as engines of rapid growth across various economies. Startups have witnessed tremendous growth from being just 452 in 2016 to 84,012 in 2022, amongst which more that 100 are unicorns (valuation more than $1 billion). Recognising the immense potential, the course aims to prepare students and budding entrepreneurs to gain understanding of financial concepts in the context of startups and introduce them to the concepts related to stages and types of funding available for startups.

Course outcomes

After successful completion of the course, students will be able to:

- Understand the basic financial terms used in context of funding of startups
- Construct and interpret basic financial statements needed in starting and operating startups
- Interpret and compare various valuation methods
- Prepare VC term sheets to get funds

Eligibility

Open to students currently enrolled in science/engineering/management undergraduate,postgraduate, and PhD programme at Panjab University. The course has a maximum capacity of 60 participants.

Syllabus

Unit I

Financial statements: Introduction to balance sheet and income statement. Introduction to cash flow statement, ratios – profitability, efficiency, liquidity and leverage.

Unit II

Financial Planning: are you ready to raise capital?,financial plans and pro-forma financial statements, planning a cash flow statement, burn rate.

Unit III

Funding options: Bootstrapping, types of funding – debt, equity. creative ways to structure long-term debt.Investor classes - angel, VC and PE.Structuring of financing rounds - pre-seed, seed, series A, B and beyond.

Unit IV

Getting funded: steps in funding process, due diligence, startup valuation – pre-money and post-money valuation, key factors influencing valuation, valuation methods – purpose, challenges and methods, VC term sheet.

References:

1. Rin, Marco Da, and Hellmann, Thomas. Fundamentals of Entrepreneurial Finance, Oxford University Press
2. Rogers, Steven. Entrepreneurial Finance, Fourth Edition, McGrawHill
3. Levin, Jack S. Structuring Venture Capital, Private Equity, and Entrepreneurial Transactions. Aspen Publishers, 2009. ISBN: 9780735581609.
4. Metrick, Andrew, and Ayako Yasuda. Venture Capital and the Finance of Innovation. Wiley, 2010. ISBN: 9780470454701.

1. Battacharyya, B.C. : Introduction to Chemical Equipment Design Mechanical aspects, Chemical Engineering Education Development Centre.
2. Brownell and Young : Process Equipment Design , Willey Publication
3. Joshi, M.V. : Process Equipment Design, Macmillan India.

3. To locate vena contracta in Orifice meter.
4. To study flow through a V-notch.
5. To study frictional losses through pipelines, valves & fittings.
6. To measure point velocity using Pitot tube.
7. To study flow through a straight tube and prove *f* /
8. To verify Bernoulli's theorem.
9. To study characteristics of a centrifugal pump.
10. To study characteristics of a reciprocating pump.
11. To study compressible flow through an Orifice meter.
12. To study different types of flow using Reynolds number experiment.

Teaching Scheme and Syllabi of B.E. (Chemical Engineering)
(2023-2027)

4thSEMESTER

Title	**HEAT TRANSFER**			**Credits**	4
Code	PCC105			**L T P**	3 1 -
Max. Marks	**End term- 50**	**Mid term- 50**		**Elective**	N
Pre requisites					

objectives

Unit I

Brief review of the terms: state functions, types of systems, internal energy, heat and work and reversible and irreversible processes.

Teaching Scheme and Syllabi of B.E. (Chemical Engineering)
(2023-2027)

THEORY

4.	Sukhatme, S.P.	:	Solar Energy – Principles of Thermal Collection and Storage, 2nd Edition, Tata McGraw – Hill Publishing Company Ltd., 2006.
5.	Sharma, S.P. and Mohan, C.	:	Fuels and Combustion, Tata Mc-Graw Hill Publishing Company Ltd., 1984.

Paper Title : HEAT TRANSFER Lab.
Paper Code PCC153 Max. Marks 50 Credits : 1.5

1. Determination of heat transfer coefficient for different types of heat transfer equipment. Wilson plots.
2. Unsteady state heat transfer in jacketed vessels. (Open pan evaporator)
3. Correlation of instantaneous heat transfer coefficients with time study deposition of scale on a heating surface.
4. Determination of heat losses for insulated pipes
5. Study of double pipe heat exchanger and to determine overall heat transfer coefficient
6. Study the performance characteristics of a 1,2 - shell and tube heat exchanger
7. Study and **operation** of long tube, forced circulation and multiple effect evaporators.
8. Duhring plot for solutions involving nonvolatile so

5. Scott Fogler, H. : Elements of Chemical Reaction Engineering, 4th Edition, Prentice Hall, 2007.

Title	**MASS TRANSFER – I**	**Credits**	4
Code	PCC110	**L T P**	3 1 -

Teaching Scheme and Syllabi of B.E. (Chemical Engineering)
(2023-2027)

Title	**Environmental Engineering**		**Credits**	3 1 -
Code	PCC 112		**L T P**	4- -

sludge process and recycle options and their analysis. Different aeration schemes and extended aeration and analysis of design parameters used in waste water treatment. Different bio-film systems e.g. rotating biological contactors (RBCs), trickling filters, Sequential batch reators and diffent types of oxidation ponds and facultative ponds. Sludge treatment and disposal. Classification of Solid wastes, Collection methods and disposal, sanitary landfill, incineration, pyrolysis gasification and recycling.

***Books Recommended*:**

1. Perkins, H.C. : Air Pollution, McGraw Hill, N.Y.
2. Rao, C.S. : Environmental Pollution Control Engineering, 2nd

Characteristics: Speed of response and lag, fidelity and dynamic error, dead time. 5 Hrs.

Temperature measurement: Bimetallic thermometers, filled-in system thermometers. Thermocouples, metal resistance thermometers and thermistors, optical and radiation pyrometers, radiation receiving elements. 10 Hrs.

UNIT-II

Pressure measurement: Bourdon gauge, Bellows type gauge. Vacuum measurement– Mcleod gauge & pirani vacuum gauge. Measurement of pressure in corrosive fluids: Diaphragm seal, liquid seal and purge system. 10 Hrs.

Viscosity measurement: Float viscometer, rotational viscometer 5Hrs.

UNIT-III

Liquid level measurement: Direct measurement of liquid level– Float & tape liquid level gauge, float and shaft liquid level unit, hydraulic remote transmission of liquid level. Level measurement in open vessels: Bubbler system, diaphragm box system, air trap system. Level measurement in pressure vessels– Differential pressure manometer, use of liquid seals with a manometer, displacement float liquid level gauge. 8 Hrs.

Teaching Scheme and Syllabi of B.E. (Chemical Engineering)
(2023-2027)

Course Objectives	The course objective is to give the knowledge to the students about design of various equipments pumps, fans , blowers, settling equipments, agitated vessels and Conveyor system for solids
Course Outcomes	CO1: Ability to understand the design of piping & piping networks CO2: The students are able to handle the design of various equipments likePumps, Fans & Blowers. CO3: Ability to understand the design of settling equipments and agitated v s s sli 47(O)-3.85049(u)4.8128

Teaching Scheme and Syllabi of B.E. (Chemical Engineering)
(2023-2027)

6thSEMESTER

applications and characteristics for common adsorbents. Stagewise& continuous contacting of fluid and solid phase.

2. Design of distillation column, calculation of number of plates, height and design of fractionator internals-sievetray.
3. Absorber/Stripper design of stage-wise and continuous contact equipment (packed column), height of column and diameter calculations. HTU and NTU.
4. Design aspects of fixed bed reactors and fluidized bed reactors.

***Books Recommended*:**

1. Coulson, Richardson & Sinnott, R.K. : Chemical Engineering, Volume 6 – An Introduction to C Engineering Design, 4th Edition, Pergamon Press, 2007.
2. Ludwig, E.E. : Applied Process Design in Chemical and Petrochemical Pla Edition, 1977.
3. Perry, J.H. : Chemical Engineers Handbook, 8th Edition, McGraw Hill, 200
4. Kern, D.Q. : Process Heat Transfer, McGraw Hill, 1965.
5. Shell and Tube Type Heat Exchangers, Indian Standards. : Instt., IS: 43-197.
6. Treybal, Robert E. : Mass Transfer Operations, 3rd Edition, McGraw-Hill, 1981.
7. Levenspiel, O. : Chemical Reaction Engineering, 3rd Edition, John Wiley and S 2004.
8. Walas, S.M. : Reaction Kinetics for Chemical Engg., McGraw Hill.
9. Scott Fogler, H. : Elements of Chemical Reaction Engineering, 4th Edition, Prent Hall, 2007.

Title	**Literature Survey, Report Writing & Seminar**	**Credits**	**1.5**
Code			

Teaching Scheme and Syllabi of B.E. (Chemical Engineering)
(2023-2027)

:9T7(
)Tf16.0909693.58788 33844729(et7.5492396)-15566 60Tf19.362493.553.4-33844729(e)3.6.34603c

Teaching Scheme and Syllabi of B.E. (Chemical Engineering)
(2023-2027)

Teaching Scheme and Syllabi of B.E. (Chemical Engineering)
(2023-2027)

[redacted]

Pre requisites	-		
Course objectives	To study the modeling & simulation techniques of chemical processes and to gain skills in using process simulators. Chemical Process Modeling considers a systematic approach to the creation of information systems of modeling and design of complex chemical-technological processes. The students are introduced to the methods of computer simulation of engineering systems as used within the chemical and refinery industry, for the prediction of the (steady-state) behavior and performance of various technology processes.		
Course outcomes	By the end of the course, students will be able to: To calculate the different physicochemical and thermodynamic properties chemicals; To describe chemical engineering processes in mathematical form and create simulation models of various types; To implement optimization process and chemicals.		

Practical

Functional design, property estimate as inputs for design. System concepts for computer aided design, computer aided flow sheet design. (7 hrs)

Teaching Scheme and Syllabi of B.E. (Chemical Engineering) (2023-2027)

8th Semester

CHE 106	Six month Industrial Training/Research Training	Credits:13

Teaching Scheme and Syllabi of B.E. (Chemical Engineering)
(2023-2027)

Paper Title: Open Elective (Theory)

Title	FUEL CELL TECHNOLOGY	Credits	3

Objectives of the course

Teaching Scheme and Syllabi of B.E. (Chemical Engineering)
(2023-2027)

Books Recommended

1. Nanoscale Materials in Chemistry by Kenneth J. Khabhunde (ed.) Wiley Interscience.
2. Nanotechnology – An introduction to nanostructure of technique by Michel Kohler and Wolfgang Frittsche 2004- Wiley VCH
3. Springer Handbook of Nanotechnology by Bharat Bhushan
4. Encyclopedia of Nanotechnology- Hari Singh Nalwa.
5. Nanostructures and Nanomaterials by G. Cao, Imperial College Press, 2004
6. Introduction to Nanotechnology by Owen and Poole, Wiley
7. Nano-materials by A. K. Bandopadhyay, New Age International
8. Nanostructures: Property, processing and applications. G Verma. Elsevier, 2023.

POLYMER SCIENCE AND ENGINEERING(Theory)

THEORY	**Time**	3 Hours
Note for the Examiner	**Question No. 1, which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of the Questions (2 to 9) will be divided into FOUR Units having TWO questions each and candidate is required to attempt at least ONE question from each Unit. The duration of End Term exam will be 3 hrs.**	

Unit I

Chemistry of polymers:
Monomers, functionality, degree of polymerizations, classification of polymers, glass transition, melting transition, criteria for rubberiness,
Polymerization methods: addition and condensation; their kinetics, copolymerization, monomer reactivity ratios and its significance, kinetics, different copolymers, random, alternating, azeotropic copolymerization, block and graft copolymers, techniques for copolymerization-bulk, solution, suspension, emulsion.

Unit II

Polymer Characterization:
Solubility and swelling, concept of average molecular weight, determination of number average, weight average, viscosity average and Z-average molecular weights, polymer crystallinity, analysis of polymers using IR, XRD, thermal (DSC, DMTA, TGA), microscopic (optical and electronic) techniques.

Unit III

Polymer Technology:
Polymer compounding-need and significance, different compounding ingredients for rubber and plastics, crosslinking and vulcanization

Unit IV

Polymer processing:
Compression molding, transfer molding, injection molding, blow molding, reaction injection molding, extrusion, pultrusion, calendaring, rotational molding, thermoforming, rubber processing in two-roll mill, internal mixer.

Books Recommended:

1. Williams, D.J. : Polymer Science and Engineering, Prentice Hall Inc.
2. Rodriguez, F. : Principles of Polymer Systems, Tata McGraw Hill Pub.
3. Odian,G. : Principles of Polymerization, McGraw Hill.
4. Collins, E.A., Bares, J. & Billmeryer, F.W., Experiments in Polymer Science, Wiley Inter Science.
5. Kumar, A. & Gupta, S.K. : Fundamental of Polymer Science and Engineering, Tata McGraw Hill Pub.
6. Middleman, S. : Fundamentals of Polymer Processing, McGraw Hill, New York.
7. Moore, G.R. and Kline, D.E., "Properties and Processing of Polymers for Engineers", Society of Plastics Engineers, Prentice–Hall, Englewood Cliffs, NJ, 1984
8. Tadmor, Z. and Gogos, C.G.: Principles of Polymer Processing, John Wiley & Sons, 1979.

Teaching Scheme and Syllabi of B.E. (Chemical Engineering)
(2023-2027)

Objectives 2.

Role of financial institutions -Bank finance to entrepreneurs Entrepreneurship development: Role of development financial institutions **10 Hours**

Books Recommended:

- Chandra. Prasanna. Project Preparation, Appraisal and Implementation. Tata McGraw Hill.
- Gido, Jack, And Clements, James P. Project Management. Cengage Learning.
- Gray, Clifford F., Larson, Eric W., and Desai, Gautam V. Project Management: The Managerial

Assessment of Impact of development Activities on Vegetation and wildlife, environmentalImpactofDeforestation–Causes andeffects ofdeforestation.

UNIT- III

Procurement of relevant soil quality, Impact prediction, Assessment of Impact

	ii. Understand fundamentals of CFD, solve partial differential equations and finite difference equation. iii. Understand various solution algorithms for CFD iv. Generate and optimize the numerical grid. v. Simulate the CFD models and analyse its results

Unit I

Introduction to computational fluid dynamics (CFD), need for problem solving with CFD, understanding CFD approach, modelling and governing equations, mass, momentum and energy conservation equations, applications to different branches of Science and Engineering, specific applications to Chemical Engineering, various tools and software related to CFD.

Unit II

Partial differential equations, classification, parabolic, hyperbolic and elliptical equations, illustrative examples. Approximate solution to differential equations, error minimization principles, variation principles and weighted residual approach.

Fundamentals of discretization, finite element method, finite difference and finite volume method, consistency, error and stability analysis, boundary conditions, illustrative examples.

Unit III

Grid generation: basic understating of mesh generation, types of grids, structured and unstructured mesh, factors effecting grid, guidelines on mesh quality and design, mesh reinforcement and adaptation, numerical grid generation, transformation and mapping.

Unit IV

Solution techniques: Explicit and implicit methods; First order and second order upwind schemes; QUICK scheme, SIMPLE, SIMPLER and MAC algorithm, pressure velocity coupling algorithms, velocity-stream function approach, Solution techniques for Navier-Stokes equation; SIMPLE type methods; fractional step methods.

Solution of finite difference equations, iterative methods, matrix inversion methods, Alternating direction implicit (ADI) method, operator splitting, fast Fourier transforms.

Simulation of CFD problems using CFD softwares, simulation of coupled heat, mass and momentum transfer problems. Turbulence modelling: Reynolds averaged Navier-Stokes (RANS) equations, RANS modelling, Reynolds stress model (RSM), Direct numerical simulation (DNS) and Large eddy simulation (LES).

Recommended Books

i. Anderson J. D. : Computational Fluid Dynamics, McGraw Hill, 1995.

ii. Ferziger J. H. and Peric M. : Computational Methods for Fluid Dynmaics, 3rd edition, Springer-Verlag, Berlin, 2003.

iii. Murlidhar K. and Sundararajan T. : Computational Fluid Flow and Heat Transfer, Narosa Publishing House, 1995.

iv. Ghosdastidar P.S. : Computer Simulation of Flow and Heat Transfer, McGraw Hill, 1998.

v. Blazek J. : Computational Fluid Dynamics: Principles and Applications, 3

	ii.	To study fluidized bed behavior, Elutriation phenomena, expanded bed and spouted beds.

Introduction: Process optimization, Formulation of various process optimization problems and their classification, Basic concepts of optimization-convex and concave functions, Necessary and sufficient conditions for stationary points. **(10 hrs)**

Unit II

Optimization of One Dimensional Functions: Unconstrained multivariable optimizationdirect search methods, Bracketing methods: Exhaustive search, Bounding phase, Region elimination methods- Interval halving, Fibonacci search, Golden section search, PointEstimation, Successive quadratic estimation methods. **(10 hrs)**

Unit III

Indirect First Order and Second Order Methods: Gradient-based methods-NewtonRaphson, Bisection, Secant, Cubic spline, Root-finding using optimization Techniques. Multivariable Optimization Algorithms: Optimality criteria, Unidirectional search, Direct search Methods- Evolutionary optimization, Simplex search, Powell's conjugate direction, Gradient-based methods- Cauchy's (steepest yvinab70.emctsea8415(.)-6.1.142(B)13.321(i)-16.7.48415(t.2

b) They will be able to describe the concepts of lattice dynamics and crystal binding forces and correlate the same with thermal properties.

Syllabus Details

Unit I

CRYSTAL STRUCTURES

Unit III

Natural radioactivity, successive radioactive transformations, radioactive equilibrium, radioactive series, radiometric dating.

Nuclear force and its characteristics, Elementary description of shell model, explanation of magic numbers, liquid drop model and semi-empirical binding energy formula. Nuclear fission, fission products, mass and energy distribution of fission products, neutron emission and energy distribution of neutrons emitted in fission, theory of fission process, nuclear reactors - class

Introduction to different types of energy storage and conversion devices and technologies. Synthesis and characterization of materials used for these technologies, Properties desired in the materials,

Unit IV

Techniques to evaluate the properties and performance, failure modes and analysis, environmental impact of the following technologies:
Fuel cells (10 Hours)
Batteries (10 hours)
Super-capacitors (3 hours)
Solar energy conversion devices (7 Hours)
Wind (3 Hours)
Mechanical Energy storage (2 Hours)

Suggested books

1. Renewable Energy: Power for a Sustainable Future, Godfrey Boyle, Oxford University Press, 2004

Course Outcomes

After completing this course the student should be able to:

1) Evaluate an energy technology for environmental friendliness
2) Explain the operating principle of several energy technologies
3) Indicate the material requirements for these energy technologies
4) Demonstrate the ability to understand the characterization, performance, and failure data related to these technologies

Materials Characterization

Note for the Examiner Question No. 1, which is comp

Teaching Scheme and Syllabi of B.E. (Chemical Engineering)
(2023-2027)

1.

6) Indicate how specific synthesis techniques can result in nanomaterials
7)

Unit-II

Z-Transforms: Introduction, Some standard Z-transforms, Linearity property, Damping rule, Some standard results, Shiftingrules, Initial and Final value theorems, Evaluation of inverse transforms: Power series method, Partial fractions method, Inversionintegral method, Applications in the solution of difference equations.

Unit-III

Teaching Scheme and Syllabi of B.E. (Chemical Engineering) (2023-2027)

Paper Title: Departmental Elective (Theory)

Course Duration: 60 Lectures of one hour each.

Title	**NUMERICAL METHODS IN CHEMICAL ENGINEERING**		
THEORY			
Note for the Examiner	**Question No. 1, which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of the Questions (2 to 9) will be divided into FOUR Units having TWO questions each and candidate is required to attempt at least ONE question from each Unit. The duration of End Term exam will be 3 hrs.**		
Course Objectives	**To learn students:** **1. Solve algebraic and transcendental equations, apply Least Square Curve Fitting Procedures to fit various curves and understand the concept of Finite differences.** **2. Apply the concept of Finite differences to carry out Forward, Backward and Central Interpolation and Inverse Interpolation with equispaced and unequispaced data.Use suitable methods to perform numerical differentiation.** **3. Use various methods to carry out numerical integration. Solve numerically ordinary differential equations of First order, higher order and Simultaneous differentialequations.** **4. Solve linear system of equations by Direct and Iterative methods. Further, apply Finite Difference Approximation method to solve Partial differential equations.**		
Course Outcomes	**Upon successful completion of the course, the students will be able to:** **CO 1:Apply numerical methods for solving algebraic and transcendental equations,apply Least Square Curve Fitting Procedures to fit various curves and understand the concept of Finite differences.** **CO 2:Apply the concept of Finite Differences to carry out Forward, Backward and Central Interpolation and Inverse Interpolation with equispaced and unequispaced data. Also, apply suitable methods to perform numerical differentiation.** **CO 3: Use various methods to carry out numerical integration.Solve, numerically, ordinary differential equations of First order, higher order and Simultaneous differentialequations.**		

	CO 4: Solve linear system of equations by Direct and Iterative methods. Further, apply Finite Difference Approximation method to solve Partial differential equations.

Unit I

Solution of Algebraic and Transcendental Equations:
Bisection Method, Method of False Position, Iteration Method / Fixed Point Iteration Method, Newton-Raphson Method.**06 hrs**.

Curve Fitting: Least-Squares Curve Fitting Procedures for Fitting

Teaching Scheme and Syllabi of B.E. (Chemical Engineering)
(2023-2027)

Title	PROJECT MANAGEMENT	Credits	04

Course Objectives

1. This course is aimed at introducing the primary important concepts of project management, project life cycle, scheduling, evaluation, analysis and reporting.
2. To identify the resources needed for each stage, including involved stakeholders, tools and supplementary materials
3. To develop a detailed implementation plan that will allow to monitor project progress and

2. Waddane, A.L. : Chemicals from Petroleum, John Murry.
3. Topchiev, A.V. : Synthetic Materials from Petroleum, Pergamon Press.
4. Astle, M.J. : The Chemistry of Petrochemicals, R

Unit II

Principles of Refrigeration. Calculation of refrigeration load. Natural refrigeration, Vapour compression refrigeration. Mollier Chart, Rating of Systems, Compressors, evaporators, Condensers, Expansion valve. Pump, Absorption refrigeration.

Unit III

Thermal Processing of foods. Pasteurization and sterilization, D value, F value, Z value. Process time calculation. Cook value and quality retention. Time temperature integrators (TTI).

Unit IV