DAV UNIVERSITY JALANDHAR

Course Scheme & Syllabus

For

B. Tech. in Chemical Engineering

1st TO 8th SEMESTER
Examinations 2015–2016 Session

Syllabi Applicable For Admissions in 2015

DAV UNIVERSITY, JALANDHAR

Scheme of Courses
B. Tech. in Chemical Engineering
Semerter-1

S.NO.	Paper Code	Course Title	L	T	P	Cr	Nature of Course
1	MTH151A	Engineering Mathematics-I	4	0	0	4	Core
2	CHE151A	Chemistry	4	0	0	4	Core
3	CSE101A	Computer Fundamentals and Programming	4	0	0	4	Core
4	EVS100	Environmental Studies	4	0	0	4	AECC
5	MEC101A	Engineering Drawing	2	0	4	4	Core
6	ENG151A	Basic Communication Skills	3	0	0	3	AECC
7	CHE152	Chemistry Lab	0	0	2	1	AECC
8	CSE103	Computer Fundamentals and Programming Lab	0	0	2	1	Core
9	ENG152	Basic Communication Skills Lab	0	0	2	1	Core

L: Lectures T: Tutorial P: Practical Cr: Credits

Scheme of Courses
B. Tech. in Chemical Engineering
Semerter-2

S.NO.	Paper Code	Course Title	L	T	P	Cr	Nature of Course
1	MTH152A	Engineering Mathematics-II	4	0	0	4	Core
2	PHY151A	Engineering Physics	4	0	0	4	Core
3	MEC103	Mechanical Engineering Fundamentals	4	0	0	4	Core
4	ELE101	Electrical and Electronics Technology	4	0	0	4	Core
5	SGS107	Human Values and General Studies	4	0	0	4	AECC
6	MEC104	Manufacturing Practice	0	0	4	2	Core
7	PHY152	Engineering Physics Lab	0	0	2	1	Core
8	ELE102	Electrical and Electronics Technology Lab	0	0	2	1	Core

L: Lectures T: Tutorial P: Practical Cr: Credits

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Scheme of Courses
B. Tech. in Chemical Engineering
Semerter-3

S.NO.	Paper Code	Course Title	L	T	P	Cr	Nature of Course
1	CHL211	Energy Engineering	3	0	0	3	Core
2	MTH252A	Engineering Mathematics-III	4	0	0	4	Core
3	CHL201	Mechanical Operations	4	0	0	4	Core
4	CHL202	Chemical Process Calculations	4	0	0	4	Core
5	CHL203	Fluid Flow	4	0	0	4	Core
6	CHL222	Mechanical Operations Lab	0	0	3	2	Core
7	CHL223	Fluid Flow Lab	0	0	3	2	Core

L: Lectures T: Tutorial P: Practical Cr: Credits

Scheme of Courses
B. Tech. in Chemical Engineering
Semester-4

S.NO.	Paper Code	Course Title	L	T	P	Cr	Nature of Course
1	CHL204	Chemical Technology-I (Inorganic)	4	0	0	4	Core
2	CHL205	Chemical Engineering Thermodynamics	4	0	0	4	Core
3	CHL206	Heat Transfer	4	0	0	4	Core
4	CHL207	Chemical Process Instrumentation	4	0	0	4	Core
5	CHL208	Material Science & Technology	3	0	0	3	Core
6	CHL225	Chemical Engineering Thermodynamics Lab	0	0	3	2	Core
7	CHL227	Heat Transfer Operations Lab	0	0	2	1	Core

L: Lectures T: Tutorial P: Practical Cr: Credits

Note: *At the end of the examination of 4^{th} Semester the students will undergo compulsory industrial training for a period of 4 weeks duration in reputed industries. Every student will submit the Training Report within two weeks from the start of teaching for 5^{th} Semester. The marks for this will be included in the 5^{th} Semester.*

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Scheme of Courses
B. Tech. in Chemical Engineering
Semerter-5

S.NO.	Paper Code	Course Title	L	T	P	Cr	Nature of Course
1	CHL301	Mass Transfer I	4	0	0	4	Core
2	CHL302	Chemical Reaction Engineering I	4	0	0	4	Core
3	CHL303	Chemical Technology-II (Organic)	4	0	0	4	Core
4	CHL304	Process Dynamics & controls	4	0	0	4	Core
5	MTH256A	Numerical Methods	3	0	0	3	Core
6	CHL323	Chemical Technology Laboratory	0	0	3	2	Core
7	CHL330	Instrumentation & Controls Laboratory	0	0	2	1	Core
8	MTH257A	Numerical Methods Lab with C/C++	0	0	2	1	Core
9	CHL300	Industrial Training	0	0	0	2	Training, D & P

L: Lectures T: Tutorial P: Practical Cr: Credits

Scheme of Courses
B. Tech. in Chemical Engineering
Semerter-6

S.NO.	Paper Code	Course Title	L	T	P	Cr	Nature of Course
1	CHL305	Mass Transfer II	4	0	0	4	Core
2	CHL306	Chemical Reaction Engineering II	4	0	0	4	Core
3	CHL308	Environmental Engineering	4	0	0	4	Core
4	CHL310	Process Engineering Economics	3	0	0	3	Core
5		Department Specific Elective-I	4	0	0	4	DSE-I
6	CHL325	Mass Transfer Lab	0	0	3	2	Core
7	CHL327	Reaction Engineering Lab	0	0	2	1	Core
8	CHL329	Environment Technology Lab	0	0	2	1	Core

L: Lectures T: Tutorial P: Practical Cr: Credits

Note:

- *Department specific elective-I should be from the basket of Department Specific Elective-I".*
- *At the end of the examination of 6th Semester the students will undergo compulsory industrial training for a period of 6 weeks duration in reputed industries. Every student will submit the training report within two weeks from the start of teaching of 7th Semester. The marks for this will be included in the 7th semester.*

Scheme of Courses
B. Tech. in Chemical Engineering
Semerter-7

S.NO.	Paper Code	Course Title	L	T	P	Cr	Nature of Course
1	CHL402	Transport Phenomenon	4	0	0	4	Core
2	CHL404	Process Engineering Design-I	3	0	2	4	Core
3	CHL406	Industrial Safety & Hazardous Management	4	0	0	4	Core
4		Department Specific Elective-II	4	0	0	4	DSE-II
5		Generic Elective-I	4	0	0	4	GE-I
6	CHL400	Industrial Training	0	0	0	2	Training, D & P
7	CHL499	Project	0	0	8	4	Core

L: Lectures T: Tutorial P: Practical Cr: Credit

Note:

- *Department specific elective-II should be from the basket of "Department specific Elective-II".*
- *Generic elective-I should be from the "Generic Elective Basket"*

Scheme of Courses
B. Tech. in Chemical Engineering
Semerter-8

S.NO.	Paper Code	Course Title	L	T	P	Cr	Nature of Course
1		Department Specific Elective-III	4	0	0	4	DSE-III
2		Department Specific Elective-IV	4	0	0	4	DSE-IV
3		Generic Elective-II	4	0	0	4	Generic Elective-II
4	CHL405	Process Modeling &Simulation	4	0	0	4	Core
5	CHL407	Process Engineering Design-II	3	0	2	4	Core
6	CHL425	Process Modeling &Simulation Lab	0	0	2	1	Core
6	CHL450	Seminar	0	0	4	2	Training, D & P
7	ENG351	Technical Communication	3	0	0	3	AECC

L: Lectures T: Tutorial P: Practical Cr: Credit

Note:

- *Department specific elective-III & IV should be from the basket of "Department Specific Elective-III & IV" respectively.*
- *Generic elective-II should be from the "Generic Elective Basket"*

Department Specific Elective-I

S.NO.	Paper Code	Course Title	L	T	P	Cr
1	CHL446	Optimization Techniques	4	0	0	4
2	CHL447	Electrochemical Technology	4	0	0	4
3	CHL448	Hazardous Waste Management	4	0	0	4

Department Specific Elective-II

S.NO.	Paper Code	Course Title	L	T	P	Cr
1	CHL451	Biochemical Engineering	4	0	0	4
2	CHL452	Membrane Separation	4	0	0	4
3	CHL453	Polymer Processing	4	0	0	4

Department Specific Elective-III

S.NO.	Paper Code	Course Title	L	T	P	Cr
1	CHL454	Fertilizer Technology	4	0	0	4
2	CHL455	Petrochemical Technology	4	0	0	4
3	CHL456	Corrosion Engineering	4	0	0	4

Department Specific Elective-IV

S.NO.	Paper Code	Course Title	L	T	P	Cr
1	CHL457	Alternate Energy Technology	4	0	0	4
2	CHL458	Application of Nano Technology in Chemical Engineering	4	0	0	4
3	CHL459	Paint Technology	4	0	0	4

Generic Elective Basket

S.NO.	Paper Code	Course Title	L	T	P	Cr
1	ELE801	Electro-Mechanical Energy Conversion	4	0	0	4
2	ELE802	Transducers and Signal Conditioning	4	0	0	4
3	CHL801	Industrial Pollution Control	4	0	0	4
4	CHL802	Fuel Cell Technology	4	0	0	4
5	MEC801	Industrial Engineering Techniques	4	0	0	4
6	MEC802	Energy Resources	4	0	0	4
7	CSE801	Software Engineering & Project Management	4	0	0	4
8	CSE802	Computer Networks	4	0	0	4
9	ECE801	Communication and Media Foundations	4	0	0	4
10	ECE802	Electronic Displays	4	0	0	4
11	ECE803	Everyday Electronics	4	0	0	4
12	CIV801	Construction Materials and Techniques	4	0	0	4
13	CIV802	Railway and Tunnel Engineering	4	0	0	4
14	MGT151A	Fundamentals of Management	4	0	0	4
15	MGT152	Fundamentals of Advertising	4	0	0	4
16	MGT153	Fundamentals of Stock Market	4	0	0	4
17	MGT154	Fundamentals of Research Methods	4	0	0	4
18	MGT155	Fundamentals of Accounting & Finance	4	0	0	4

DAV UNIVERSITY, JALANDHAR

B Tech Course Structure

CBCS	Nature of Courses	Core	Elective Courses			Ability Enhancement Courses		Total Credits
Year	Course Structure	Core	Dissertation/ Project	Generic Elective	Discipline Specific Elective	Ability Enhancement Compulsory Courses	Skill Enhancement Courses	
2015	Chemical	146	10	8	16	15	0	195

Core	Basic Sciences (BS) including Mathematics, Physics, Chemistry, Biology	Engineering Sciences (ES) including Materials, WS, ED, Basics of EE/ME/CSE	Interdisciplinary Core	Discipline Core	Total Credits
146	18-26	20	04-20	80-104	146
	22	20	04	100	146

Detailed

Syllabus

Course Title: Engineering Mathematics-I

Paper Code: MTH151A

L	T	P	Credits
4	0	0	4

Objective: The aim of this course is to familiarize the students with the theory of matrices which are used in solving equations in mechanics and the other streams. This course also provides a comprehensive understanding of the origin and development of ideas to exhibit the techniques origin and development of ideas to exhibit the techniques of solving ordinary differential equations.

Unit-A

Rank of matrices, Inverse of Matrices, Gauss Jordan Method, reduction to normal form, Consistency and solution of linear algebraic system of equations, Gauss Elimination Method, Eigen values and Eigen vectors, Diagonalisation of Matrix, Cayley Hamilton theorem. Orthogonal, Hermition and unitary matrices.

Unit-B

Concept of limit and continuity of a function of two variables, Partial derivatives, Homogenous Function , Euler's Theorem, Total Derivative, Differentiation of an implicit function, chain rule, Change of variables,Jacobian, Taylor's and McLaurin'sseries. Maxima and minima of a function of two and three variables: Lagrange's method of multipliers.

Unit-C

Formation of ordinary differential equations, solution of first order differential equations by separation of variables, Homogeneous equations, Reduce to Homogenous, exact differential equations, equations reducible to exact form by integrating factors, equations of the first order and higher degree, clairaut's equation.

Unit-D

Solution of differential equations with constant coefficients: method of differential operators. Non – homogeneous equations of second order with constant coefficients: Solution by method of variation of parameters, Simultaneously Linear differential equation.

References:

1. Grewal, B.S. *Higher Engineering Mathematics*. New Delhi: Khanna Publication, 2009.
2. Kreyszig, Erwin. *Advanced Engineering Mathematics*. New Delhi: Wiley Eastern Ltd., 2003.
3. Jain, R K, and K Iyengar S R. *Advanced Engineering Mathematics*, New Delhi: Narosa Publishing House, 2003.
4. Thomas, George B. and Finney Ross L. *Calculus and Analytic Geometry*. New Delhi Addison Wesley, 1995.

Course Title: Chemistry

Course Code: CHE151A

L	T	P	Credits
4	0	0	4

Course Objectives:

The objective of the Engineering Chemistry is to acquaint the student with the basic phenomenon/concepts of chemistry for the development of the right attitudes by the engineering students to cope up with the continuous flow of new technology. The student will able to understand the new developments and breakthroughs efficiently in engineering and technology.

Expected Prospective:

This course will equip students with the necessary chemical knowledge concerning the fundamentals as well as new technology in the field of chemistry.

Unit- A

Spectroscopy and its Applications

General Introduction: Introduction, electromagnetic spectrum, absorption and emission spectrum, atomic and molecular spectroscopy, types of molecular spectra, experimental techniques, selection rules, width and intensities of spectral lines.

UV/Visible Spectroscopy: types of electronic Transitions,Chromophores, Auxochromes, Effect of conjugation on Chromophores, Factors affecting λmax and intensity of spectral lines, effect of solvent onλmax, isobestic point, applications.

IR Spectroscopy: Infrared region, fundamental modes of vibrations and types, theory of infrared spectra, vibrational frequency and energy levels, anharmonic oscillator, modes of vibrations of polyatomic molecules, characteristic signals of IR spectrum, finger print region, factors affecting vibrational frequency; applications.

NMR Spectroscopy: Principle and instrumentation, relaxation processes, proton magnetic resonance spectroscopy, number of signals, Chemical shift, Spin-Spin Splitting, coupling constant, applications.

Unit- B

Water and its treatment

Introduction, hardness of water, degree of hardness, units of hardness, boiler feed water: specification, scales and sludge formation; priming& foaming, boiler corrosion, caustic embrittlement, treatment of boiler feed water, internal treatment of water; softening of water by lime-soda, zeolite and ion exchange methods, desalination of water; Water for domestic use: purification of water for domestic use.

Corrosion and its Prevention

Introduction; different types of corrosion - wet and dry corrosion; mechanism of wet corrosion; comparison of dry and wet corrosion, Types of electrochemical corrosion: galvanic corrosion, concentration cell corrosion or differential aeration corrosion, waterline corrosion, pitting corrosion, crevice corrosion, stress corrosion, intergranular corrosion; other forms of corrosion: atmospheric corrosion, soil corrosion, microbiological corrosion, erosion corrosion, Filliform corrosion, stray current corrosion, passivity, galvanic series, factors influencing corrosion, various methods of corrosion control.

Unit-C

Chemistry in Nanoscience and Technology

Introduction,Materials self-assembly, molecular vs. material self-assembly, hierarchical assembly, self-assembling materials, two dimensional assemblies, mesoscale self-assembly, coercing colloids, nanocrystals, supramolecular structures, nanoscale materials, future perspectives applications,nanocomposities and its applications.

Unit-D

Polymers and polymerization

Introduction, monomer and repeating unit, degree of polymerization, functionality, classification of polymers: based on origin, monomers, structure, method of synthesis, tacticity or configuration, action of heat, chemical composition, ultimate form; types of polymerization, specific features of polymers, regularity and irregularity, tacticity of polymers, average molecular weights and size, determination of molecular weight by number average methods, effect of molecular weight on the properties of polymers, introduction to polymer reinforced composites.

References:

1. William Kemp, *Organic Spectroscopy*, Palgrave Foundations, 1991.

2. D. A. Skoog, F. J. Holler and A. N. Timothy, *Principle of Instrumental Analysis*, 5th Edition., Saunders College Publishing, Philadelphia, 1998.

3. C. P. Poole, Jr., F. J. Owens, *Introduction to Nanotechnology*, WileyInterscience, 2003.

4. L.E. Foster, Nanotechnology, *Science Innovation & Opportunity*, Pearson Education, 2007.

5. P. Ghosh, *Polymer Science and technology*(2nd Edition), Tata McGraw Hill, 2008.

6. Wiley *Engineering Chemistry*, Second Edition, 2013.

DAV UNIVERSITY, JALANDHAR

Course Title: Computer Fundamentals and Programming

Course Code: CSE101A

L	T	P	Credits
4	0	0	4

Course Objective: To get basic knowledge of computers (hardware and software), its components and Operating systems. To acquire programming skills in C, basic knowledge of Internet

Unit-A

Introduction to Computers

Define a Computer System, Block diagram of a Computer System and its working, memories, Volatile and non-volatile memory, cache, virtual, secondary storage devices-Magnetic Tape, Hard Disk, CD-DVD, Magnetic Disk, Various input devices including keyboard, Mouse, Joystick, Scanners and Various output devices including Monitors, Printers, Plotters

Operating Systems

Computer Software and its types and Hardware, Operating Systems, their types and functions

Unit-B

Working Knowledge of Computer System

Introduction to word processors and its features, creating, editing, printing and saving documents, spell check, mail merge, creating power point presentations, creating spreadsheets and simple graphs.

Fundamentals of Internet Technology

Local area networks, MAN and wide area network, Internet, WWW, E-mail, Browsing and Search engines, Internet Connectivity, Network Topology, Hub, Switches, Router, Gateway.

Unit-C

Basic Constructs of C

Keywords, Identifiers, Variables, Data Types and their storage, Arithmetic Operators, Relational Operators, Logical Operators, Bitwise Operators, Increment & Decrement Operators, Expressions, Conditional Expressions, Assignment Operators and Expressions,

External Variables and Scope of Variables, Structure of C Program.

Control Structures

Decision making statements: if, nested if, if – else ladder, switch, Loops and iteration: while loop, for loop, do – while loop, break statement, continue statement, goto statement.

Unit-D

Functions

Advantages of functions, function prototype, declaring and defining functions, return statement, call by value and call by reference, recursion, and storage classes.

Arrays and Strings

Declaration of arrays, initialization of array, accessing elements of array, I/O of arrays, passing arrays as arguments to a function, strings, I / O of strings, string manipulation functions (strlen, strcat, strcpy, strcmp)

References:

1. V.K. Jain: "*Fundamentals of Information Technology and Computer Programming*", PHI. Latest Edition.
2. Anita Goel: "*Computers Fundamentals*", Pearson Publications
3. Brian Kernighan and Dennis M. Ritchie: "*The C Programming Language*", Prentice Hall, 2nd Edition 2007.
4. K.N.King : "*C Programming : A Modern Approach*", W.W. Norton Company 2nd edition (2008).
5. Herbert Schildt : "*C: The Complete Reference*", Tata Mcgraw Hill Publications 4th edition.
6. Gottfired : "*Programming in ANSI C, Schaum Series*", TMH publications, 2nd Edition (1996).

DAV UNIVERSITY, JALANDHAR

Course Title: Environmental Studies

Paper Code: EVS100

L	T	P	Credits
4	0	0	4

Course Objective: This course aims at understanding the students in aspects of environmental problems, its potential impacts on global ecosystem and its inhabitants, solutions for these problems as well as environmental ethics which they should adopt to attain sustainable development.

Unit- A

The multidisciplinary nature of environmental studies

Definition, scope and importance, Need for public awareness

Natural Resources: Renewable and non-renewable resources:

Natural resources and associated problems

(a) **Forest resources:** Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forests and tribal people.

(b) **Water resources:** Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems.

(c) **Mineral resources:** Use and exploitation, environmental effects of extracting and using mineral resources, case studies.

(d) **Food resources:** World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.

(e) **Energy resources:** Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources, case studies.

(f) **Land resources:** Land as a resource, land degradation, man induced landslides, soil erosion and desertification.

- Role of an individual in conservation of natural resources.
- Equitable use of resources for sustainable lifestyles.

Ecosystem:

- Concept of an ecosystem
- Structure and function of an ecosystem

- Producers, consumers and decomposer.
- Energy flow in the ecosystem
- Ecological succession
- Food chains, food webs and ecological pyramids
- Introduction, types, characteristic features, structure and function of the following ecosystem:

a. Forest ecosystem

b. Grassland ecosystem

c. Desert ecosystem

d. Aquatic ecosystems (ponds, streams, lakes, rivers, ocean estuaries)

Unit -B

Biodiversity and its conservation

- Introduction – Definition: Genetic, Species and Ecosystem Diversity
- Bio-geographical classification of India
- Value of biodiversity: Consumptive use, Productive use, Social, Ethical, Aesthetic and Option values
- Biodiversity at global, national and local levels
- India as a mega-diversity nation
- Hot-spots of biodiversity
- Threats to biodiversity: habitat loss, poaching of wildlife, man wildlife conflicts
- Endangered and endemic species of India
- Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity, global and national efforts.

Environmental Pollution

- Definition, causes, effects and control measures of:

a. Air pollution

b. Water pollution

c. Soil pollution

d. Marine pollution

e. Noise pollution

f. Thermal pollution

g. Nuclear pollution

- Solid waste management: Causes, effects and control measures of urban and industrial wastes.
- Role of an individual in prevention of pollution
- Pollution case studies
- Disaster management: floods, earthquake, cyclone and landslides

Unit- C

Social Issues and the Environment

- Population growth, variation among nations, Population explosion – Family Welfare Programmes.
- Environment and human health,
- From unsustainable to sustainable development
- Urban problems and related to energy
- Water conservation, rain water harvesting, watershed management
- Resettlement and rehabilitation of people; its problems and concerns. Case studies.
- Environmental ethics: Issues and possible solutions
- Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case studies.
- Wasteland reclamation
- Consumerism and waste products
- Environmental Laws: The Environment Protection Act, 1986; The Air (Prevention and Control of Pollution) Act, 1981; The Water (Prevention and control of Pollution) Act 1974; The Wildlife Protection Act, 1972; Forest Conservation Act, 1980.
- Issues involved in enforcement of environmental legislation
- Public Awareness

Unit- D

Human Population and Environment

- Population Growth and Variations among Nations
- Population Explosion

- Human Rights
- Value Education
- HIV / AIDS
- Women and Child Welfare
- Role of Information Technology in Environment and Human Health
- Case Studies

Field Work

- Visit to a local area to document environmental assets river/ forest/ grassland/hill/mountain
- Visit to a local polluted site – Urban / Rural / Industrial / Agricultural
- Study of common plants, insects, birds
- Study of simple ecosystems-Pond, river, hill slopes, etc (Field work equal to 5 lecture hours)

Suggested Readings:

1. Odum, EP. *Basic Ecology*. Japan: Halt Saundurs, 1983.
2. Botkin, DB, and Kodler EA. *Environmental Studies: The Earth as a living planet.* New York: John Wiley and Sons Inc., 2000.
3. Singh, JS, Singh, SP, and Gupta SR. Ecology, *Environment and Resource Conservation.* New Delhi: Anamaya Publishers, 2006.
4. De, AK. *Environmental Chemistry*. New Delhi: Wiley Eastern Ltd., 1990.
5. Sharma, PD. *Ecology and Environment*. Meerut Rastogi Publications, 2004

DAV UNIVERSITY, JALANDHAR

Course Title: Engineering Drawing

Course Code: MEC101A

L	T	P	Credits
2	0	4	4

Course Objectives: Students will be able to use the techniques to interpret the drawings and to use it in the field work of engineering. They will learn various lines, planes, solids and their sectioning and to develop their lateral surfaces. Concepts of orthographic and isometric projections

Unit-A

Drawing Techniques

Introduction to drawing instruments, various types of lines and their convention, principles of dimensioning, Engineering symbols, Gothic lettering in single stroke as per SP-46 code (Vertical and inclined)

Scales

Concept of scaling, construction of plane and diagonal scales

Unit-B

Projection of Points

Concept of plane of projections (Principle planes), First and third angle projections; projection of points in all four quadrants, shortest distance problems

Projection of Lines and Planes

Projection of line parallel to both planes, perpendicular to one plane, inclined to one and both the reference planes and their traces. Plane perpendicular to one plane inclined to one and both the reference planes and their traces. Concept of profile plane and auxiliary planes, To find the true length, α, β, θ and Φ.

Unit-C

Projection of Solids

Right and oblique solids; solids of revolution and polyhedrons, projection of solid with axis perpendicular to one plane and parallel to one or both reference planes. Projection of solid with axis inclined to one or both reference planes.

Sectioning of Solids

Theory of sectioning, types of section planes, their practice on projection of solids, Sectioning by auxiliary planes,to find true section of truncated solids.

Unit-D

Development of Surfaces

Method of Development, Development of surfaces: Parallel line and Radial line method. Development of oblique solids, Development of curved surfaces.

Orthographic and Isometric Views

Draw orthographic views from isometric view or vice-a-versa, Missing line and missing view

References:

1. Jolhe, A.J., "*Engineering Drawing*", Tata McGraw-Hill, New Delhi.
2. Gill, P.S., *"Engineering Drawing",* S.K. Kataria and Sons, Ludhiana
3. French T.E. and Vierck, C.J., *"Graphic Science"*, McGraw-Hill, New York
4. Zozzora F., *"Engineering Drawing",* McGraw Hill, New York

Course Title: Basic Communication Skills

Course Code: ENG151A

L	T	P	Credits
3	0	0	3

Course Objective:

- To enhance students' vocabulary and comprehensive skills through prescribed texts.
- To hone students' writing skills.

Learning Outcomes: Students will be able to improve their writing skills as well as will enrich their word power.

Unit – A

Applied Grammar (Socio-Cultural Context)

1. Parts of Speech: Noun, Pronoun, Adjective, Verb, Adverb, Preposition, Conjunction, Interjection
2. Tenses (Rules and Usages in Socio-cultural contexts)
3. Modals: Can, Could, May, Might, Will, Would, Shall, Should, Must, Ought to
4. Passive/Active
5. Reported/Reporting Speech

Unit – B

Reading (Communicative Approach to be followed)

1. J M Synge: Riders to the Sea (One Act Play) 2.
Anton Chekhov : Joy (Short Story)
3. Swami Vivekanand : The Secret of Work (Prose)

Unit – C

Writing

1. Essay Writing and Letter Writing
2. Report Writing
3. Group Discussion & Facing an Interview

References

1. Kumar, Sanjay and PushpLata. *Communication Skills*. India: OUP, 2012. Print.
2. Vandana, R. Singh. *The Written Word* by. New Delhi: Oxford University Press, 2008. Print.

b. Websites

1. www.youtube.com (to download videos for panel discussions). Web.
2. www.letterwritingguide.com. Web.
3. www.teach-nology.com.Web.
4. www.englishforeveryone.org.Web.
5. www.dailywritingtips.com.Web.
6. www.englishwsheets.com.Web.
7. www.mindtools.com.Web.

Course Title: Chemistry Lab

Course Code: CHE152

L	T	P	Credits
0	0	2	1

Course Objectives:

This course is intended to learn the basic concepts of Engineering Chemistry Laboratory. The present syllabus has been framed as per the recent research trends in the subject. The various experiments have been designed to enhance laboratory skills of the undergraduate students.

Expected Prospective:

The students will be able to understand the basic objective of experiments in Engineering chemistry, properly carry out the experiments, and appropriately record and analyze the results through effective writing and oral communication skills. They will know and follow the proper procedures and regulations for safe handling and use of chemicals.

List of Practicals:

1. Verify Lambert Beer's law using spectrophotometer and $CoCl_2$ or $K_2Cr_2O_7$ solution.
2. Determine the strength of HCl solution by titrating against NaOHsolutionconductometerically.
3. Determination of the strength of HCl solution by titrating against NaOH using pH meter.
4. Determination of total hardness of water (tap) using standard EDTA solution and Eriochrome black T indicator.
5. Determination of alkalinity of water.
6. Determination of surface tension of given liquid by using Stalagmometer.
7. Determination of residual chlorine in a water sample.
8. Determination of Flash & Fire point of given a given lubricating oil by Pensky-Marten's apparatus.
9. Determination of the viscosity of given lubricating oil by using Redwood Viscometer.
10. Preparation of a polymer phenol/urea formaldehyde resin.
11. Determination of moisture, volatile matter and ash content in a given sample of coal by proximate analysis.
12. Determination of dissolved oxygen present in given sample of water.

References:

1. Levitt, B.P. Findlay's Practical Physical Chemistry, 9th edition, Longman Group Ltd., 1973.

2. Yadav, J.B. Advanced Practical Physical Chemistry.

3. Vogel, A. I. A textbook of Quantitative Inorganic Analysis, Longman Gp. Ltd, 4^{th} edition (2000).

DAV UNIVERSITY, JALANDHAR

Course Title: Computer Fundamentals and Programming Lab

Course Code: CSE103

L	T	P	Credits
0	0	2	1

Instruction for Students: The students will be attending a laboratory session of 2 hours weekly and they have to perform the practical related to the following list.

1. Practical know-how of various internal and external Hardware components of a computer (including basic working of peripheral devices).
2. Introduction to Operating Systems; installing Windows; basics of windows.
3. Working knowledge of Internet.
4. Introduction to word processor and mail merge.
5. Introduction to MS-Excel.
6. Working on MS-PowerPoint.
7. Introduction to basic structure of C program, utility of header and library files.
8. Implementation of program related to the basic constructs in C
9. Programs using different data types in C
10. Programs using Loops and Conditional Statements in C
11. Programs using functions by passing values using call by value method.
12. Programs using functions by passing values using call by reference method.
13. Programs using arrays single dimension in C.
14. Program to implement array using pointers
15. Programs related to string handling in C

Course Title: Basic Communication Skills Lab

Course Code: ENG152

L	T	P	Credits
0	0	2	1

Course Objective:

- To improve fluency in speaking English.
- To promote interactive skills through Group Discussions and role plays.

Learning Outcome: Students will get exposure to speaking through the above mentioned interactive exercises. In addition, they will develop a technical understanding of language learning software, which will further improve their communicative skills.

Unit – A Speaking/Listening

1. Movie-Clippings (10 Hrs)
2. Role Plays (10 Hrs)
3. Group Discussions (10 Hrs)

References:

1. Gangal, J. K. *A Practical Course in Spoken English.* India: Phi Private Limited, 2012. Print.
2. Kumar, Sanjay and PushpLata. *Communication Skills*. India: OUP, 2012. Print.

Websites

1. www.youtube.com (to download videos for panel discussions).Web.
2. www.englishforeveryone.org.Web.
3. www.talkenglish.com.Web.
4. www.mindtools.com.Web.

Course Title: Engineering Mathematics-II
Course Code: MTH152A

L	T	P	Credits
4	0	0	4

Objective:

The objective of the course is to equip the students with the knowledge of concepts of vectors and geometry and their applications. A flavour of pure mathematics is also given to the readers.

Unit-A

Functions of Complex Variables: Complex Numbers and elementary functions of complex variable De-Moivre's theorem and its applications. Real and imaginary parts of exponential, logarithmic, circular, inverse circular, hyperbolic, inverse hyperbolic functions of complex variables.Summation of trigonometric series. (C+iS method).

Unit-B

Integral Calculus: Rectification of standard curves; Areas bounded by standard curves; Volumes and surfaces of revolution of curves;

Multiple Integrals: Double and triple integral and their evaluation, change of order of integration, change of variable, Application of double and triple integration to find areas and volumes. Centre of gravity and Moment of inertia

Unit-C

Vector Calculus: Scalar and vector fields, differentiation of vectors, velocity and acceleration.
Vector differential operators: Del, Gradient, Divergence and Curl, their physical interpretations. Line, surface and volume integrals.

Application of Vector Calculus: Flux, Solenoidal and Irrotational vectors. Gauss Divergence theorem.Green's theorem in plane, Stoke's theorem (without proofs) and their applications

Unit-D

Infinite Series: Convergence and divergence of series, Tests of convergence (without proofs): Comparison test, Integral test, Ratio test, Raabe's test, Logarithmic test, Cauchy's root test and Gauss test. Convergence and absolute convergence of alternating series, Uniform Convergence and Power Series

References:

1. Grewal, B.S., *Higher Engineering Mathematics*. New Delhi: Khanna Publication, 2009
2. Kreyszig, Erwin, *Advanced Engineering Mathematics*. New Delhi: Wiley Eastern Ltd., 2003.
3. Jain, R K, and K Iyengar S R., *Advanced Engineering Mathematics*, New Delhi: Narosa Publishing House, 2003.
4. Thomas, George B. and Finney Ross L., *Calculus and Analytic Geometry*. New Delhi Addison Wesley, 1995

DAV UNIVERSITY, JALANDHAR

Course Title: Engineering Physics

Course Code: PHY151A

Total Lecture: 60

L	T	P	Credits
4	0	0	4

Course Objective: The aim of this course on physics is to make the student of engineering understand the basic concepts of physics which will form the basis of certain concept in their respective fields.

Unit-A

PHYSICAL OPTICS:

Interference: Division of wave front, Fresnel's biprism, division of amplitude, Newton's rings and applications.

Diffraction:

Difference between Fraunhofer and Fresnel diffraction, Fraunhofer diffraction through a slit, plane transmission diffraction grating, its dispersive and resolving power.

Polarization: Polarised and unpolarised light, double refraction, Nicol prism, quarter and half wave plates.

Unit-B

LASER: Spontaneous and stimulated emission, Laser action, Characteristics of laser beam, concept of coherence, HeNe laser, Semiconductor lasers and applications

FIBRE OPTICS: Propagation of light in fibres, numerical aperture, single mode and multimode fibres, applications

Unit-C

DIELECTRICS:

Molecular Theory, polarization, displacement, susceptibility, dielectric coefficient, permittivity, relations between electric vectors, Gauss's law in the presence of a dielectric, energy stored in an electric field, Behaviour of dielectric in alternating field and ClausiusMossotti equation.

Unit-D

QUANTUM MECHANICS:

Difficulties with Classical physics, Introduction to quantum mechanics simple concepts, Black Body radiation, Planck's Law of radiation and its limitations, Group velocity and phase velocity,

Schrodinger's wave equations and their applications.

SUPER CONDUCTIVITY:

Introduction (experimental survey), Meissner effect, Type I and type II superconductors, London equation, Elements of BCS theory, Applications of superconductors.

Reference Books:

1. Sear, F.W. *Electricity and Magnetism.* London: Addison-Wesley, 1962.
2. Resnick and Halliday. *Physics.*New York: Wiley, 2002.
3. Lal,B. and Subramanyam, N.*A Text Book of Optics.* New Delhi: S. Chand and Company Limited, 1982.
4. Jenkins, and White. *Fundamental of Physical Optics*. New York: Tata McGraw-Hill, 1937.
5. Griffiths,D*. Introduction to Electrodynamics,* New Delhi: Prentice Hall, 1998.
6. Beiser, A. *Perspective of Modern Physics.* New Delhi: McGraw Hill Ltd., 2002.

Course Title: **Mechanical Engineering Fundamentals**

Course Code: MEC103

L	T	P	Credits
4	0	0	4

Course Objectives:

To impart the basic knowledge of thermodynamic principles, design principles, power transmission devices, power producing and power absorbing devices.

Unit-

A Fundamental Concepts of Thermodynamics

Introduction, Thermodynamic System and its types, Boundary and its types, Surroundings, Thermodynamic properties, State, Path, process and cycles, Thermodynamic Equilibrium, Working Substance, Microscopic and Macroscopic Analysis, Units and Dimensions, Quasi Static Process, Reversible and Irreversible processes, Point Function and Path Function, Mechanical and Thermodynamic work, P-dv Work (Displacement Work), Work is a Path Function, Equations for work done in various processes

Laws of Thermodynamics

Zeroth law of Thermodynamics, Temperature, Thermometry (Measurement of temperature), Temperature Scales, Energy, Potential and Kinetic Energies at Micro and Macro Level, Internal Energy, Law of conservation of energy, Joule's Experiment, First law of thermodynamics (Open and Closed System), Energy – A property of system, Enthalpy, Entropy, Heat, Heat vs Temperature, specific heat, Heat Capacity, Specific heat at constant volume, Specific heat at constant pressure, Adiabatic Index, Limitations of first law of thermodynamics

Unit-B

Pressure

Pressure Concept and Definition, Pressure conversion Table, Atmospheric pressure, Standard Atmospheric Pressure, Gauge Pressure, Vacuum Pressure, Absolute pressure, Properties of fluid, Pressure head of a Liquid, Pascal's Law, Pressure measurement: Mechanical Gauges and Manometers, Mechanical Gauges: (Bourdon tube pressure gauge, Diaphragm pressure gauge, Dead weight), Manometers: (Principle/Advantage/Limitation/ Classification), Piezometer,

Single U tube manometer (Numerical for Vacuum and Gauge pressure), [Simple problems on above topics]

Heat Transfer

Introduction, Heat Transfer vs Thermodynamics, Applications, Thermal Conductivity, Thermal Resistance, Modes of heat transfer, Spectrum of electromagnetic radiation, Surface emission properties, Absorptivity, Reflectivity and Transmissivity, Fourier law, Newton's law of cooling, Stefan Boltzmann's Law, Heat Exchangers (Applications, Selection, Classification), Thermal Insulation (Properties of insulation, Types of Insulations, Thermal Insulating Materials)

Power Absorbing Devices

Power Absorbing Devices, Difference between Hydraulic pump, Air compressor, Fan, Blower, Pump (Function, Selection, Applications), Classification of Pump, Positive displacement and Dynamic Pumps, Reciprocating Pumps and its types, Rotary Pumps and its types, Centrifugal Pump, Axial Pump

Unit-C

Power Producing Devices Boiler

States of matter, Changing State of Matter, Sublimation, Effect of temperature during change of Phase, Steam boiler, Application, Classification of boilers, Types of boilers (Brief Description), Essentials of a good boiler, Advantages of superheating the steam, Comparison between Water tube and Fire tube boilers, Function of boiler Mountings and Accessories

Turbines

Turbine, Classification based on working fluid, Classification of hydraulic turbines, Selection of hydraulic turbines, Impulse Turbines (Pelton Wheel/ Turgo/ Cross Flow), Reaction Turbines (Francis/ Kaplan/ Propeller)

Internal Combustion Engines

Heat Engine, Types of Heat Engine, Advantages, Disadvantages and Applications, Classification of IC Engine, Engine Components (Location, Function and Material), Basic Terminology used in IC engine, Four stroke Cycle Engines (SI and CI), Two stroke Cycle Engines (SI and CI)

Unit-D

Principles of Design

Need of design, Product Life Cycle, Material properties and selection, Factors affecting material selection, Stress and Strain and its types, Hooke's law, Modulus of Elasticity, Longitudinal and

Lateral Strain, Poisson's ratio, Stress- Strain Curve for ductile material and brittle material, Factor of Safety, Centre of Gravity, Centroid, Centroid of areas of plain, Figures (Without Derivation), Centroid of areas of composite sections (Without Derivation), Moment of Inertia, Radius of gyration, Theorem of perpendicular axis, Theorem of parallel axis, MI of L, I and T sections, [Simple problems on above topics]

Power Transmission Devices and Machine Elements

Individual and group drive system (advantages and Disadvantages), Belt drive (Types: V and Flat Belts and their Applications, Advantages and Disadvantages), Ropes drive (Types: Fiber and Wire Ropes and their Applications, Advantages and Disadvantages), Chain drive (Applications, advantages and Disadvantages, Sprockets), Gear drive (Types of Gears), Power transmission shafts, Types of shafts, Application of shafts, Axle, Keys (Function, Classification), Coupling (Function, Classification: Rigid and Flexible), Flanged coupling, Oldham's coupling, Universal coupling, Bearings and their types, Flywheel construction and types

References:

1. Rajan T.S. *Basic Mechanical Engineering*, New Delhi: New Age Publishers.
2. Singh Sadhu *Principles of Mechanical Engineering*, New Delhi: S Chand Publishers.
3. Shankar V.P., *Basic Mechanical Engineering*, New Delhi: Laxmi Publishers.
4. Phthak G. K., *Basic Mechanical Engineering*, New Delhi: Rajsons Publications.
5. Kumar Parveen, *Basic Mechanical Engineering*, New Delhi: Pearson Education

Course Title: Electrical and Electronics Technology

Course Code: ELE101

L	T	P	Credits
4	0	0	4

Unit-A

D.C Circuit Analysis:

Voltage source, current source, dependent and independent sources, analysis of D.C circuit by KCL and KVL , Nodal and Mesh analysis, The venin theorem , Norton theorem, superposition theorem, Maximum Power Transfer Theorem

Unit-B

A.C Circuit Analysis:

Review of single phase A.C. circuit under sinusoidal steady state, solution of R.L.C. Series circuit, the j operator, complex representation of impedance, solution of series and parallel circuit, series and parallel resonance, 3 phase A.C. Circuit, star and delta connections, line and phase quantities solution of 3 phase circuits, balance supply voltage and balanced supply voltage and balance load, phasor diagram, measurement of power and power factor by two wattmeter method.

Unit-C

Magnetic Circuit:

Review of laws of electromagnetism, Flux, MMF and their relation. Comparison of electrical and magnetic circuit, B-H Curve, saturation leakage and fringing.Analysis of series and parallel magnetic circuit, AC Excitation in magnetic circuits, Hysteresis and eddy currents.

Transformers:

Single phase transformer, basic concepts constructional detail, type, voltage current and impedance Transformation, phasor diagram, equivalent circuit, voltage regulation, oc/sc test, losses and efficiency concept of All day efficiency , autotransformer.

Unit-D

Rotating Electrical Machines:

Basic concepts, working principle and general construction of DC machines (motor/generators), torque and EMF expression

Basic Electronics:

P-Type and N-Type semiconductor, concept of diode, transistor and their application, introduction to OPAMP, application of op amp as a subtractor , summer, differentiator, integrator, logic gates AND ,OR, NOT, NOR, NAND etc.

References:

1. M.S. Sukhija, T.K. Nagsarkar, "Basic Electrical and Electronics Engineering", Oxford University Press, 2012.
2. Ashfaq Husain, HarsoonAshfaq, " Fundamentals of Electrical Engineering, 4th Edition, Dhanpat Rai and Co., 2013
3. V.N. Mittle, "Basic Electrical Engineering", 2nd Edition, Tata McGraw Hill Publication.
4. B.L. Theraja, A.K. Theraja, " A Text Book of Electrical Technology, Volume-1, S. Chand Publication
5. Debashisha Jena, "Basic Electrical Engineering", 1st edition, Wiley India Publication, 2012.
6. B.L. Theraja, R.S. Sedha, " Principles of Electric Devices and Circuits", S. Chand Publication, 1st edition, 2006

Course Title: Human Values and General Studies

Course Code: SGS107

L	T	P	Credits
4	0	0	4

Course Objectives

a) To sensitize students about the role and importance of human values and ethics in personal, social and professional life.

b) To enable students to understand and appreciate ethical concerns relevant to modern lives.

c) To prepare a foundation for appearing in various competitive examinations

d) To sensitize the students about the current issues and events of national and international importance

e) To provide opportunity to the students to study inter disciplinary subjects like Geography, Science, Economy, Polity, History, International Relations etc.

Unit-A

Human Values

1. **Concept of Human Values:** Meaning, Types and Importance of Values.
2. **Value Education :** Basic guidelines for value education
3. **Value crisis and its redressal**

Being Good and Responsible

1. Self Exploration and Self Evaluation
2. Acquiring Core Values for Self Development
3. Living in Harmony with Self, Family and Society
4. Values enshrined in the Constitution: Liberty, Equality
5. Fraternity and Fundamental Duties.

Unit-B

Value – based living

1. Vedic values of life
2. *Karma Yoga* and *Jnana Yoga*
3. *AshtaMarga* and *Tri-Ratna*

Ethical Living:

1. Personal Ethics
2. Professional Ethics
3. Ethics in Education

Unit-C

General Geography

World Geography

The Universe, The Solar System, The Earth, Atmosphere, The World we live in, Countries rich in Minerals, Wonders of the World, Biggest and Smallest.

Indian Geography

Location, Area and Dimensions, Physical Presence, Indian States and Union Territories, Important sites and Monuments, Largest-Longest and Highest in India.

General History

Glimpses of India History, Ancient Indian, Medieval India, Modern India, Various Phases of Indian National Movement, Prominent Personalities, Glimpses of Punjab history with special reference to period of Sikh Gurus

Glimpses of World History

Important Events of World History, Revolutions and Wars of Independence, Political Philosophies like Nazism, Fascism, Communism, Capitalism, Liberalism etc.

Indian Polity: Constitution of India

Important Provisions, Basic Structure, Union Government, Union Legislature and Executive, State Government: State Legislature and Executive, Indian Judiciary, The Election Commission, Panachayati Raj System, RTI etc.

General Economy

The process of liberalization, privatization, globalization and Major World Issues, Indian Economy, Indian Financial System, Major Economic Issues, Economic Terminology.

Unit-D

General Science

General appreciation and understandings of science including the matters of everyday observation and experience, Inventions and Discoveries

Sports and Recreation

The World of Sports and recreation, Who's Who is sports, Major Events, Awards and Honours.

Famous personalities, Festivals, Arts and Artists

Current Affairs

National and International Issues and Events in News, Governments Schemes and Policy Decisions

Miscellaneous

Information Who is who

Books and Authors, Persons in News, Awards and Honours, Abbreviations and Sports

References:

1. Human Values, A N Tripathi, New Age International Publishers, New Delhi, Third Edition, 2009
2. Professional Ethics, R. Surbiramanian, Oxford University Press, New Delhi, 2013.
3. Human Values and Professional Ethics, RishabhAnand, SatyaPrakashan, New Delhi, 2012
4. Human Values and Professional Ethics, Sanjeev Bhalla, SatyaPrakashan, New Delhi, 2012.
5. Human Values and Professional Ethics, RituSoryan Dhanpat Rai & Co. Pvt. Ltd., First Edition, 2010.
6. Human Values and Professional Ethics by Suresh Jayshree, Raghavan B S, S Chand & Co. Ltd. , 2007.
7. Human Values and Professional Ethics, Yogendra Singh, AnkurGarg, Aitbs publishers, 2011.
8. Human Values and Professional Ethics, Vrinder Kumar, Kalyani Publishers, Ludhiana, 2013.
9. Human Values and Professional Ethics, R R Gaur, R. Sangal, GP Bagaria, Excel Books, New Delhi 2010.
10. Values and Ethics, Dr.BramwellOsula, Dr.SarojUpadhyay, Asian Books Pvt. Ltd., 2011.
11. Indian Philosophy, S. Radhakrishnan, George Allen &Unwin Ltd., New York: Humanities Press INC, 1929.
12. Essentials of Hinduism, Jainism and Buddhism, A N Dwivedi, Books Today, New Delhi – 1979

13. Dayanand : His life and work, SurajBhan, DAVCMC, New Delhi – 2001.
14. Esence of Vedas, KapilDevDwivedi, Katyayan Vedic SahityaPrakashan, Hoshiarpur, 1990.
15. Vedic Concepts, Prof. B BChaubey, Katyayan Vedic SahityaPrakashan, Hoshiarpur, 1990.
16. Advance Objective General Knowledge, R. S. Aggarwal, S. Chand Publisher (2013)
17. Concise General Knowledge Manual 2013, S. Sen, Unique Publishers,2013
18. Encyclopedia of General Knowledge and General Awareness by R P Verma, Penguin Books Ltd (2010)
19. General Knowledge Manual 2013-14, Edgar Thorpe and Showick Thorpe, The Pearson, Delhi.
20. General Knowledge Manual 2013-14, MuktikantaMohanty, Macmillan Publishers India Ltd., Delhi.
21. India 2013, Government of India (Ministry of Information Broadcasting), Publication Division, 2013.
22. Manorama Year Book 2013-14, MammenMethew, Malayalam Manorama Publishers, Kottayam, 2013.
23. Spectrum's Handbook of General Studies – 2013-14, Spectrum Books (P) Ltd., New Delhi

CURRENT AFFAIRS

Magazines

Economic and Political Weekly, Yojna, the Week, India Today, Frontline, Spectrum. Competition Success Review, Competition Master, Civil Services Chronicle, Current Affairs, World Atlas Book

Newspapers

The Hindu, Times of India, The Hindustan Times, The Tribune

DAV UNIVERSITY, JALANDHAR

Course Title: **Manufacturing Practice**

Course Code: MEC104

L	T	P	Credits
0	0	4	2

Course Objective:

1. Know basic workshop processes, Read and interpret job drawing.
2. Identify, select and use various marking, measuring, holding, striking and cutting tools & equipment's
3. Operate and control different machines and equipment's.

CARPENTRY SHOP

a) Preparation of half lap joint

b) Preparation of Mortise and Tenon Joint

c) Preparation of a Dove & Tail joint

d) To prepare a White board duster

Welding Shop:

a) Preparation of Joint by Arc Welding

b) Preparation of Joint by using Gas Welding

c) Preparation of Joint by MIG/ TIG Welding

d) Preparation of Joint by Spot/ Seam Welding

Smithy Shop

a) To Forge the L – Hook

b) To Forge a Chisel

c) To Forge a Cube from a M.S Round

d) To forge a screw driver

Fitting Shop

a) Filing a dimensioned rectangular or square piece and prepare a sq. fitting

b) Preparation of T fitting male part

c) Preparation of U fitting Female part

d) Internal thread Cutting in Square piece and external thread cutting on a rod and assembling as a paper weight

Foundry Shop:

a) To make a Mould of solid pattern
b) To prepare a mould of sleeve fitting using gating system
c) To make a Mould of Split Pattern using Cope & Drag
d) To check the Hardness of the Mould

To check the Moisture Content in the Molding Sand

To check the Compressive Strength of Molding Sand

Sheet-Metal Shop

a) Preparation of a funnel from G.I. sheet
b) Preparation of a book rack stand from G.I. Sheet
c) Preparation of a leak proof tray with inclined edges from G.I. Sheet
d) Preparation of a square pen stand from G.I. Sheet with riveting at corners

Machine Shop

a) To make a job using step turning and grooving
b) To make a job using knurling and threading
c) To make a multi operation job on a Lathe machine
d) To make V – slot by using shaper machine

Electrical Shop

a) Layout of electrical tube light wiring
b) Layout of stair case wiring using two way switch
c) Testing and rectification of simulated faults in electrical appliances such as 'Electric Iron' Ceiling Fan. Electric kettle
d) To fabricate a circuit for the electrical wiring of, Fan with regulator and Bulb through a main switch and its testing using a series lamp

References:

1. Johl K. C., "Mechanical Workshop Practice", Prentice Hall India, 1st Edition.
2. Bawa H.S., "Workshop Technology", Tata McGraw Hill, 7th Edition.

Course Title: Engineering Physics Lab

Course Code: PHY152

L	T	P	Credits
0	0	2	1

Objective: The laboratory exercises have been so designed that the students learn to verify some of the concepts learnt in the theory courses. They are trained in carrying out precise measurements and handling sensitive equipments.

Note:

- Students are expected to perform at least eight-ten experiments out of following list. The experiments performed in first semester cannot be repeated in second Semester.
- The examination for both the courses will be of 3 hours duration

List of Experiments:

Experimental skills: General Precautions for measurements and handling of equipment, representation of measurements, Fitting of given data to a straight line, and Error analysis, Significant figures and interpretation of results.

1. To determine the Refractive Index of the Material of a given Prism using Sodium Light.
2. To determine the Dispersive Power and resolving power of the Material of a given Prism using Mercury Light.
2. To determine wavelength of sodium light using Fresnel Biprism.
3. To determine wavelength of sodium light using Newton's Rings.
4. To determination Wavelength of Sodium Light using Michelson's Interferometer.
5. To determine the wavelength of Laser light using Diffraction of Single Slit.
6. To determine the wavelength of (1) Sodium and (2) Mercury Light using Plane Diffraction Grating.
7. To determine the (1) Wavelength and (2) Angular Spread of HeNe Laser using Plane Diffraction Grating.
8. To study the wavelength of spectral lines of sodium light using plane transmission grating.
9. To study the specific rotation of sugar solution Laurent's half shade polarimeter method
10. To study the numerical aperture and propagation losses using HeNe laser Optical fibre set up.
11. To compare the focal length of two lenses by Nodal slide method.

12. To find the unknown low resistance by Carey Foster bridge.
13. To determine the beam divergence of the HeNe laser.
14. To study the Meissner's effect in superconducting sample.
15. To study the Faraday law of electromagnetic induction.
16. To study the capacitance by flashing/quenching of Neon bulb kit
17. To compare the two unknown capacitances of two capacitors by using DeSauty's bridge.
18. To find our out the unknown inductance by using the Anderson's bridge method.
19. To study the numerical aperture and propagation losses for He-Ne laser by using the optical fibre set up for
20. To study the Planck's constant by using photoelectric cell method.

Course Title: Electrical and Electronics Technology Lab

Course Code: ELE102

L	T	P	Credits
0	0	2	1

List of Experiments

1. To verify Ohm's Law, Kirchhoff's Current Law and Kirchhoff's Voltage Law.
2. To verify Thevenin's and Norton's theorems.
3. To verify Superposition theorem.
4. To verify Maximum Power Transfer theorem.
5. To study frequency response of a series R-L-C circuit and determine resonant frequency and Q-factor for various values of R, L and C
6. To study frequency response of a parallel R-L-C circuit and determine resonant frequency and Q-factor for various values of R, L and C.
7. To perform direct load test of a transformer and plot efficiency versus load characteristics.
8. To perform open circuit and short circuit test on transformer.
9. To perform speed control of DC motor.
10. Measurement of power in a three phase system by two wattmeter method.
11. To plot the V-I characterics of PN-junction diode.
12. To verify the truth table of logic gates.

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Course Title: Energy Engineering

Course Code: CHL211

L	T	P	Credits
4	0	0	4

Course Objectives: The student will study different types of fuels and their combustion.

UNIT-A **10 HOURS**

Introduction & Energy scenario : Concept of Energy, units of energy, conversion factors, general classifications of Energy, world energy resources and energy consumption, Indian energy resources and energy consumption, energy crisis, energy alternatives.

UNIT –B **14 HOURS**

Conventional Fuels

Solid fuels: Principal solid fuel-coal, origin, composition and classification of coal, origin, composition and classification of coals, analysis and properties of coal, characteristics and distribution of Indian coals, coal preparation, Storage of coal, coal carbonization, briquetting, gasification and liquefaction of solid fuels.

Liquid fuels: gasoline, Naphtha, Kerosene, diesel, storage and handling.

Gaseous fuel: Natural Gas, Producer Gas, Water Gas, LPG, LNG, storage and distribution of gaseous fuels

UNIT-C **14 HOURS**

Alternate sources of Energy

Solar energy: solar thermal systems, flat plate collectors, focusing collectors, solar water heating. Solar cooling, solar distillation, solar refrigeration, solar dryers, solar pond, solar thermal power generation, solar energy application in India, energy plantations.

Wind energy: types of windmills, types of wind rotors, wind electric power generation.

Other sources of Alternate Energy: Introduction to conversion of biomass technology, manufacturing and biodiesel and their application in chemical industries, tidal and geothermal energy, Ocean thermal energy conversion(OTEC)

UNIT –D **10 HOURS**

Energy conservation: Energy conservation in chemical process plants, energy audit, energy saving in heat exchangers, distillation columns, dryers, ovens and furnaces and boilers, steam economy in chemical plants. **Principles of combustion**: Combustion of fuels (solid, liquid and

gaseous), Combustion equipment, incomplete combustion, efficiency and heat recovery, calorific value, gas analysis.

Reference Books:

1. Rai, G.D. , *Non-conventional Energy Sources*, Khanna Publishers ,2011.
2. Sarkar Sameer, *Fuel and Combustion*, Orient Longman,3rd edition,2009.
3. Gupta. O.P, *Fuel Furnaces and Refractories,* Khanna Publishers,6th edition.
4. Haslam and Russel, *Fuels and their combustion* , McGraw Hill
5. Sukhatme S.P., *Thermal Collection and Storage*, Tata McGraw Hill

Title: Mechanical Operations

Course Code: CHL201

L	T	P	Credits
4	0	0	4

Course Objective: The objective of the course is to enable the students to understand the basic concepts of properties of particulate solids and mechanical separation aspect such as screening, filtration, sedimentation, transportation of solids etc.

UNIT-A **12 HOURS**

Characterization and Handling of Solids:
Characterization of solid particles: Shape, size, specific surface, Particle size distribution

Properties of particulate masses: Major distinctive properties, pressures in masses of particles, angle of internal friction, angle of repose.

Conveying of bulk solids: Basic idea of conveyor, conveyor selection, screw, belt, vibrating, continuous flow and pneumatic conveyors.
Storage and weighing: bulk storage, bin storage, feeders (vibrating hopper, screw feeder, belt feeder), batch and continuous weighing.

Solid –Solid Separation : Screening, Screen analysis, Screening equipment namely stationary Screens & Grizzles, Gyrating Screen, Vibrating Screens, material balance over screen, capacity & effectiveness of screen

UNIT-B **12 HOURS**

Size Reduction: Principles of Comminution: Criteria for comminution, characteristics of products, Energy and Power requirements, Bond's, Rittinger's and Kick's Law and Work Index.
Size Reduction Equipment: Crushers, Grinders, and ultrafine grinders cutting machines, equipment operation.

Agitation and Mixing: Agitation of low viscosity particle suspensions: axial flow impellers, radial flow impellers, close-clearance stirrer, unbaffled tanks, baffled tanks, basic idea for designing agitators. Power number, Froude number, power consumption in agitation
Mixing of Solids: Types of mixers, various mixers for cohesive solids, power requirements, mixing index, axial mixing. Mixers for free flowing solids: ribbon blenders, screw mixers, tumbling mixers import wheels, mixing index in blending granular solids, mixing index at zero time, rate of mixing.

UNIT-C

Mechanical separation **12 HOURS**

Solid-Liquid Separation: Concept of filtration, Plate & Frame filter press, Shell & Leaf filters, continuous Rotary Vacuum Filter, Principle of filtration, Centrifugal filtration,

Gas-Solid Separation: Cyclones, hydrocyclones, Gravity Settling chambers, Fabric filters, Wet scrubbers, electrostatic precipitators.,

UNIT-D **12 HOURS**

Settling:

Motion of particles through fluids: Terminal velocity, hindered settling, Stoke's law,

Centrifugal Settling processes: Decanters, tubular, disk and nozzle discharge centrifugal sludge separators, Centrifugal class filters, principles of centrifugal sedimentation.

Fluidization:

Fluidization and fluidized bed, conditions for fluidization, Ergun equation and Kozeny-Carman equation, minimum fluidization velocity, types of fluidization, expansion of fluidized beds and particulate fluidization, continuous fluidization; industrial applications.

Reference Books:

1. McCabe,W.L, Smith J .C. and Harriott P , *Unit operations of chemical Engineering,* McGraw-HILL, 7th edition,2005.
2. Richardson, J.F., Harker, J.H. and Backhurst, J.R., Coulson and Richardsons *Chemical Engineering,* Vol. 2, Butterworth-Heinemann., 2007.
3. Foust, A.S, Wenzel, L.A, Clump, C.W., Maus, L. and Anderson, L.B., *Principles of Unit Operations,* John Wiley.,2008.
4. Perry, R.H, and Green, D.W., *Perry's Chemical Engineers,* Handbook, McGraw Hill .2007.
5. Narayanan, C.M. and Bhattacharya, B.C., *Mechanical Operations for Chemical Engineers Incorporating Computer Aided Analysis,* Khanna Publishers.,2005.
6. K Swain Anup, Patra Hemlata, Roy G K, *Mechanical Operations,* McGraw Hill Education (India) Private Limited ,1st edition,

DAV UNIVERSITY, JALANDHAR

Course Title: Chemical Process Calculations

Course Code: CHL202

L	T	P	Credits
4	0	0	4

Course Objective: The objective of the course is to enable the students to understand the basic concepts of gases, liquids and solids and some basic mathematical tools. Learn what material balances energy balances are, and how to apply them and finally, to learn how to deal with the complexity of big problems.

UNIT-A **10 HOURS**

Introduction to Chemical Engineering Calculations

Units and dimensions, mole concept, conventions in methods of analysis and measurement, basis, temperature, pressure, the chemical equations and stoichiometry, limiting and excess reactant, conversion and yield. Gases Vapors, Liquids and Solids: Ideal gas law calculations, real gas relationships

UNIT -B **12 HOURS**

Material Balance without chemical reaction:

Material balance, program of analysis of material balance problems, solving material balance problems that do not involve chemical reactions, Absolute Humidity, Relative Humidity, Saturation, Dry bulb temperature, Wet bulb temperature, Adiabatic saturation temperature & use of psychometric Chart.

UNIT-C **12 HOURS**

Material Balance with chemical reaction:

Solving material balances problems involving chemical reactions, multiple subsystems, recycle, bypass, and purge calculations.,

UNIT -D **14 HOURS**

Energy Balance

Concepts and units, calculation of enthalpy changes, application of the general energy balance without reactions occurring energy balances that account for chemical reaction, reversible processes and the mechanical energy balances, heats of solution and mixing, Application of material and energy balance to the evaporators, reactors and other industrial processes (steady state operations), Basic calculations using chemical flow sheet simulator

Reference Books:

1. Himmelblau, D.M. and Riggs, J.M.,*Basic Principles and Calculations in Chemical Engineering,* Prentice Hall of India .,2003.

2. Bhatt, B.I. and Vora, S.M., *Stoichiometry*, Tata McGraw Hill .,2004.
3. Hougen, O.A., Watson, K.M. and Ragatz, R.S., *Chemical Process Principles,* Volume I, C.B.S. Publications .,2004.
4. Felder, R.M. & Rousseau, R.W., *Elementary Principles of Chemical Processes,* 2nd Edition, John Wiley & Sons.

DAV UNIVERSITY, JALANDHAR

Course Title: Fluid Flow

Course Code: CHL203

L	T	P	Credits
4	0	0	4

Course Objective: The course introduces the students to the principles of fluid mechanics that are of fundamental importance to chemical engineers i.e. fluid statics and dynamics, boundary layer, laminar and turbulent flows, fluid machinery etc. It is a prerequisite to Heat Transfer, Mass Transfer I & II.

UNIT-A

12HOURS

Introduction

Concept of fluid, difference between solids, liquids and gases; ideal and real fluids, Introduction to fluid statics and fluid flow

Fluid Statics

Normal forces in fluids, Manometers of different types, Forces on submerged bodies, Buoyancy and stability.

Fluid Properties

Concept of capillarity, vapour pressure, compressibility and bulk modulus, Newtonian and non- Newtonian Fluids, Nature of turbulence, Eddy Viscosity, Flow in Boundary Layers.

Basic Equation of Fluid Flow

Momentum Balance, Continuity equation, Bernoulli's Equations, Navier Stokes Equations, Derivation and Application

UNIT-B **14 HOURS**

Flow of Incompressible Fluids

Concept of boundary layer, Laminar and Turbulent flow in pipes, Velocity distribution in pipes, Frictional Losses in pipes and fittings, effect of roughness, Fanning Equation, Estimation of Economic Pipe Diameter, Derivation of Hagen Poiseuille's equation and $f = 16/Re$.

Dimensional Analysis of Fluid Flow Problems using Rayleigh method and Buckingham π method, Dimensionless numbers and their significance

UNIT-C **12HOURS**

Flow of compressible fluids

Compressible flow, basic equation, Mach number and its significance and isentropic flow through nozzles

Flow Measurement
In closed channels - Pitot tube, Orifice meter, venturimeter, Rotameter In open channels- Notches, Weirs

UNIT-D **10 HOURS**

Fluid Machinery
Classification and performance of Pumps, Positive displacement pumps and its types, Centrifugal pumps- characteristic curves, Net positive Suction Head and cavitation, Turbines, Compressors, Blowers, Selection and specification.

References Books:

1. Smith J. C., McCabe W. L., Harriot P. H., *Unit Operations of Chemical Engineering*, 7th Edition, Singapore, McGraw Hill., 2005.
2. Kumar D. S., *Fluid Mechanics & Fluid power engineering,* S. K. Kataria& Sons.,2003
3. Bansal, R.K., *Fluid Mechanics and Hydraulic Machines,* 7th Edition, Laxmi Publications., 2007.
4. Perry's, *Handbook of Chemical Engineering,* 7th Edition, New York, McGraw Hill., 1997.
5. Sekhar G. C., *Unit Operations in Chemical Engineering,* 7th Edition, Pearson Practice Series, 2005.

DAV UNIVERSITY, JALANDHAR

Course Title: Engineering Mathematics-III

Course Code: MTH252A

L	T	P	Credits
4	0	0	4

Objective:
The objective of the course is to enable the students to understand the basic concepts related to Laplace transforms, Fourier series, ordinary differential and partial differential equations and their applications.

Unit-A **14 HOURS**

Fourier series: Periodic functions, Euler's formula. Dirichlet's conditions. Fourier series of discontinuous functions. Fourier series of Even and Odd functions, half range expansions, Fourier series of different wave forms, Complex form of Fourier series. Fourier Transformation.

Unit-B **14 HOURS**

Laplace Transforms: Laplace transforms of various standard functions, Linear property of Laplace transforms, Shifting property and change of scale, inverse Laplace transforms, transform of derivatives and integrals, Laplace transform of unit step function, impulse function, periodic functions, applications to solution of ordinary linear differential equations with constant coefficients, and simultaneous differential equations.

Unit-C **14 HOURS**

Partial Differential Equations: Formulation of partial differential equations, Linear partial differential equations, homogeneous partial differential equations with constant coefficients.
Wave equation and Heat conduction equation in one dimension. Two dimensional Laplace equation and their applications, solution by the method of separation of variables.

Unit-D **15 HOURS**

Analytic Function: Limits, continuity and derivative of the function of complex variable, Analytic function, Cauchy-Riemann equations, conjugate functions, harmonic functions; **Complex Integration:** Line integrals in the complex plane, Cauchy's theorem, Cauchy's integral formula and derivatives of analytic function. Taylor's and Laurent's expansions (without proofs), singular points, poles, residue, Integration of function of complex variables using the method of residues.

Reference Books :

1. Grewal, B.S. *Higher Engineering Mathematics*. New Delhi: Khanna Publication, 2009
2. Kreyszig, Erwin. *Advanced Engineering Mathematics*. New Delhi: Wiley Eastern Ltd., 2003.
3. Jain, R K, and K Iyengar S R. *Advanced Engineering Mathematics*, New Delhi: Narosa Publishing House, 2003.
4. Thomas, George B. and Finney Ross L. *Calculus and Analytic Geometry*. New Delhi Addison Wesley, 1995

Course Title: Mechanical Operations Lab

Course Code: CHL222

L	T	P	Credits
0	0	3	2

List of Experiments

1. Analysis of various sizes of given material by sieve analysis and determination of cumulative and differential analysis.
2. Determination of specific cake resistance and medium resistance of a leaf filter.
3. Determination of the specific cake resistance and medium resistance in a vacuum filter.
4. To study the working of continuous type thickener.
5. Determination of screening efficiency in a vibrating screen.
6. Plate and frame filter press: determination of cake resistance and filter medium resistance.
7. Determination of power consumption and study of agitation and mixing characteristic of a fluid.
8. To plot Power number Vs Reynolds number for the given set of impeller with baffled/ unbaffled mixing.
9. To study effect of RPM on the power consumption of a Ball Mill.s
10. To determine the efficiency of a Ball Mill

Course Title: Fluid Flow Lab

Course Code: CHL223

L	T	P	Credits
0	0	3	2

List of Experiments

1. To find coefficient of friction in pipes of different materials.
2. To verify Bernoulli's equation using hydraulic bench.
3. To find losses due to sudden expansion and sudden contraction in pipes.
4. To calculate Reynold's number for laminar and turbulent flow.
5. To calculate metacentric height.
6. To determine volumetric and mass flow rates through the Venturi meter.
7. To determine volumetric and mass flow rates using Orifice meter.
8. To determine the efficiency of a pump.
9. To calibrate and to find mass flow rate through Rotameter.
10. To measure the velocity of flow at different points along the cross section in a pipe

Course Title: Chemical Technology -1(Inorganic)

Course Code: CHL204

L	T	P	Credits
4	0	0	4

Course Objectives:

The objective of the course is to enable the students to understand the basic flow chart symbols and flow charts for typical chemical processes

Unit-A **12 HOURS**

Sulphur and Chlor-alkali industry: Sulphur dioxide, sulphuric acid, oleum, Brine Electrolysis manufacture of caustic soda and chlorine, Solvey and modified solvey process, diaphragm cells, membrane cells, hydrochloric acid.

Unit-B **12 HOURS**

Cement & Glass: Cement- types and manufacture of Portland cement. Glass- manufacturing of glass, application of special glasses.
Ceramics- Refractories: Introduction, properties of ceramics, classification of refractories, important steps involved in the manufacture of refractories.

Unit-C **12 HOURS**

Industrial gases: Manufacture and uses of carbondioxide, oxygen, nitrogen and acetylene.
Paints: Introduction, classification of paints, manufacture of paints.
Dyes: Classification of dyes, manufacture of dyes, various physical and chemical properties of dyes and their industrial uses.

Unit-D **12 HOURS**

Fertilizers: Nitrogeneous fertilizers- Manufacture of Ammonia, Nitric acid, Urea, CAN, Ammonium Sulphate. Phosphatic fertilizers- superphosphate and tripl superphosphate. Potassic fertilizers- Potassium Chloride and Potassium Sulphate. Corrosion problems and materials of construction

Refrences Books:

1. M.Gopala Rao, Marshall Sitting, *Outlines of Chemical Technology*, East West Press, 3rd edition,2011.
2. Austin G. T., *Shreve's Chemical Process Industries*, 5th Edition, McGraw Hill Book Company, New Delhi, 2012.
3. Bose, P.K., *Chemical Engineering Technology*, Vol. 1,2, Books and Allied (Pvt) Ltd, 2011
4. Shukla S. D., Pandey G. N., *A text book of Chemical Technology, Vol. I, II*, Vikas Publishing House Pvt. Ltd., New Delhi, 2000

DAV UNIVERSITY, JALANDHAR

Course Title: Chemical Engineering Thermodynamics
Course Code: CHL205

L	T	P	Credits
4	0	0	4

Course Objective: This course covers the application of thermodynamic principles to chemical engineering problems. The concept of equations of state, phase and chemical equilibrium with emphasis on vapor/liquid systems and their applications to separation processes is included.

Unit-A **8 HOURS**

Basic Concepts and First Law: System, surrounding, processes, state and properties intensive and extensive properties, State and path functions, Reversible & irreversible processes, Zeroth law of thermodynamics. General statement of first law of thermodynamics, First law for cyclic process and non-flow processes, Heat capacity. Derivation for closed system and steady state flow process- flow calorimeter and heat capacity.

Unit-B **12 HOURS**

P-V-T Behavior: P-V-T behavior of pure fluids, Equations of state and ideal gas law, Processes involving ideal gas law: Constant volume, constant pressure, Constant temperature, adiabatic and polytropic processes, Equations of state for real gases: Van der Waals equation, Redlich – Kwong equation, Virial equation, Principles of corresponding states.

Second Law of Thermodynamics: General statements of the Second law, concept of Entropy, Carnot's principle, Calculations of entropy change, Clausius Inequality, Entropy and Irreversibility, Third law of thermodynamics.

Unit-C **14 HOURS**

Thermodynamic Properties of Pure Fluids: Work function, Gibbs free energy, Fundamental property relations, Maxwells equations, Residual properties, two phase system, Thermodynamic diagram Equations for U and H, Effect of temperature on U, G, H and S, Entropy heat capacity relations, Relationship between Cp, Cv, Clapeyron equation, Gibbs-Helmholtz equation, Fugacity and fugacity coefficient, determination of fugacity of pure fluids.

Properties of Solutions: Partial molar properties, estimation, Gibbs-Duhem equation, Chemical potential, Fugacity in solutions, Henry's law and dilute solutions, Activity in solutions, Activity coefficients, Property changes of mixing, excess properties (Qualitative treatment) Activity & Activity coefficients. Ideal and non-ideal solutions.

Unit -D **14 HOURS**

Phase Equilibria: Chemical potential, criterion for VLE for ideal solutions, Raoult's law, P-x,y and T-x,y diagrams, Non ideal solutions- Azeotropes types, VLE at low pressures, VLE correlations- van laar, Margules and Wilson equation. Gibbs-Duhem equation and its application to vapour- liquid equilibria, VLE at high pressures, Liquid-liquid equilibrium

Chemical Reaction Equilibrium: Reaction stoichiometry, Criteria of chemical reaction equilibrium, Equilibrium constant and standard free energy change, Effect of temperature, pressure on equilibrium constants and other factors affecting equilibrium conversion, Liquid phase reactions, Heterogeneous reaction equilibria, Phase rule for reacting system

Recommended Books

1. Smith J. M., Van Ness H. C., Abbott M. M., *Introduction to Chemical Engineering Thermodynamics,* 7th Edition, Tata McGraw Hill, 2005.
2. Rao Y. V. C., *Chemical Engineering Thermodynamics,* 7th Edition, Universities Press (India) Ltd., Hyderabad, 2005.
3. Kyle B. G., *Chemical and Process Thermodynamics*, Third Edition, Prentice Hall Inc., 1999.
4. Denbigh K. G., *Principles of Chemical Equilibrium,* 4th Edition, Cambridge University Press, 1981.
5. Halder G., *Introduction to Chemical Engineering Thermodynamics,* Prentice Hall Inc., 2009

DAV UNIVERSITY, JALANDHAR

Course Title: Heat Transfer
Course Code: CHL206

L	T	P	Credits
3	0	0	3

Course Objective: The objective of the course is to enable the students to understand the basic Heat transfer and their fundamental relations.

UNIT -A **12 HOURS**

Introduction to modes of heat transfer:

Conduction: Review of Fourier's Law, one-dimensional heat conduction through composites having plane wall, spherical & cylindrical geometry. Steady state heat flow with heat source through plane wall and cylindrical surface. Thermal conductivity of materials. Optimal thickness of insulation, Fins and their applications. Unsteady-state conduction; Lumped heat capacity system, semi-infinite solid.

UNIT-B **12 HOURS**

Convection: Free and forced convection, concept of heat transfer co-efficient, dimensionless numbers in free and forced convection, Dimensional analysis, Determination of Heat transfer coefficient using heat and momentum transfer analogies, experimental determination of heat transfer coefficient and common working correlations.

UNIT-C **12 HOURS**

Radiation Heat Transfer: Radiation: Distribution of radiant energy, Definition of emissivity, absorpitivity, Reflectivity and Transmissivity, concept of Black and Grey bodies, Planck's Law of monochromatic radiation, Kirchhoff's Law, Wein's displacement law, Stefan-Boltzmann law, definition of intensity of radiation. Radiation formula for radiation exchange between simple bodies, two parallel surfaces and between any source and receiver.

Condensation and Boiling: Condensation heat transfer phenomenon, film condensation on vertical plates and cylinders as well as on horizontal cylinders. Effects of non-condensable gases and vapor velocity on condensation, pool boiling, forced convection boiling, working correlations for pool boiling.

UNIT -D **12 HOURS**

Evaporation: Types of Evaporators, single and multiple effects, single and multiple effects calculations, evaporator capacity, economy, effect of liquid head and boiling point elevation, methods of feeding

Heat Exchangers: Various types of heat exchangers, overall heat transfer coefficients, and heat exchanger mean temperature differences, heat exchanger effectiveness and the number of transfer units

Reference Books:

1. McCabe, W.L, Smith J .C. and Harriott P, *Unit Operations of Chemical Engineering,* McGraw-HILL, 7th edition, 2005.
2. Holman, J.P., *Heat Transfer,* McGraw Hill, 9th edition, 2004.
3. Rao, Y.V.C., *Heat Transfer,* University Press (India) Ltd, New Delhi, Ist edition, 2000.
4. Kern, D. Q., *Process Heat Transfer,* McGraw Hill, Tata McGraw Hill, 2004.
5. Foust, A.S., Wenzel, L.A, Clump, C.W., Maus, L. and Anderson, L.B., *Principles of Unit Operations*, John Wiley, 2th edition 2008.

DAV UNIVERSITY, JALANDHAR

Course Title: Chemical Process Instrumentation

Course Code: CHL207

L	T	P	Credits
4	0	0	4

Course Objective: The objective of the course is to enable the students to understand the basic concepts related to instruments used in chemical process industry.

UNIT -A

INTRODUCTION **10 HOURS**

Process instrumentation diagrams for some typical units like reactors and evaporators. Importance of instruments in chemical process industries, general principles of measurement, static and dynamic characteristics of instruments, sensors and transducers.

PROCESS INSTRUMENTS

Recording instruments, indicator and signaling instruments, transmission of instrument reading control centre, instrumentation diagram, on line instrumentation in modern plants.

UNIT-B **12 HOURS**

TEMPERATURE MEASUREMENT

Thermocouple resistance thermometers, bimetallic thermistors, optical and radiation pyrometer.

LIQUID LEVEL MEASUREMENT

Direct and indirect method for the measurement in open pressure vessels.

UNIT-C **14 HOURS**

FLOW MEASUREMENTS

Use of obstruction type meters, variable area pressure probe, positive displacement type meters, electromagnetic flowmeters and mass flow meters.

PRESSURE MEASUREMENT

Use of manometer, bourdon and bellow, type gauge, measurement of vacuum, pressure transducers.

UNIT-D **12 HOURS**

MISCELLANEOUS MEASUREMENTS

lnstruments for gas analysis. Gas chromatography, mass spectroscopy. Measurement of nuclear radiation, instruments of gas analysis, viscosity, conductivity, humidity and pH value, industrial weighing and feeding systems, amplification, automatic gain amplifiers, UV Spectrophotometer.

Controls:
Introduction to the concept of Automatic process control and Process and Instrumentation diagrams of typical units like Reactors and Evaporators.

BOOKS RECOMMENDED:

1. Eckman, D.P. *lndustrial lnstrumentation,* Wiley Eastern Ltd, 2004
2. Krishnaswamy, K. *Industrial Instrumentation,* Volume 1, New Age International P Limited, 2003.
3. Singh, S.K, *Industrial Instrumentation and Control*, 3rd Edition, McGraw Hill Education (India) Pvt Ltd, 2008.
4. Coughanour, D.R., *Process Systems Analysis and Control,* Indian Edition (3e) McGraw Hill, 2013.

DAV UNIVERSITY, JALANDHAR

Course Title: Material Science and Technology

Course Code: CHL208

L	T	P	Credits
3	0	0	3

Course Objective: The objective of the course is to enable the students to understand the basic concepts of Microstructure and information on selection of materials for design and manufacturing.

UNIT-A **14 Hours**

Crystal Structure: Review of bonding in solids, structure –property-processing relationship. Space lattice, FCC, HCC, crystal systems, Miller indices, effect of radius ratio on coordination, structures of common metallic, polymeric, ceramic, amorphous and partly crystalline materials.

Crystal Imperfection: Point imperfections, Frenkel, and Schottky defects and their equilibrium concentration determination, Color centres, types of color centres, generation of color centres, Edge and screw dislocation, Burger vector, Surface defects

Mechanical, Thermal and Electrical Properties:

Methods of improving strength- reinforcement, additives. specific heat, glass transition temperature, crystalline melting temperature, thermal conductivity; dielectric strength, dielectric constant, power loss and electrical diffusivity.

UNIT-B **12Hours**

Ferrous Metals:

Important varieties of iron ores. Cast iron: types, properties and uses of cast iron; Pig iron: Types of pig iron. Wrought iron: properties and uses of wrought iron. Steel: factors affecting physical properties of steel and uses of steel.

Non Ferrous Metals: Aluminium, cobalt, copper, lead, magnesium, nickel, tin and zinc their properties and uses.

Alloys: Introduction to Phase-Diagrams of metals and its alloys; Fe-Fe3C; Cu-Ni, Cu-Zn, Al-Cu equilibrium diagrams, methods of improving strength, and applications of metals and alloys.

UNIT –C **12 Hours**

Ceramics: Definition of ceramic, clay: properties of clay, earthen wares and stonewares, uses of stonewares.

Glass: Definition, classification, composition, types and properties of glass.

Refractories: Definition of refractory, classification of refractories, properties of refractories. Common refractory bricks like silica bricks, fire clay bricks, dolomite bricks, high alumina bricks and carbon bricks.

Polymers & Composites: Classification of polymers, Properties and Engineering Usage of Nylon-66, nylon-6, polyesters, polycarbonates, polyurethanes, PVC, polypropylene, rubber, polymer composite blends

UNIT-D **8 Hours**

Novel Materials:
Introduction to nano materials and biomaterials and their uses

Corrosion And its Prevention: Electro-chemical corrosion, Galvanic cells, Passivity, Corrosion rate and its prediction, Prevention of corrosion.

Reference Books:

1. Khanna, O. P. *Material Science*, Dhanpat Rai Publications, New Delhi, 2010.
2. VanVlack, H.L.,*Elements of Materials Science*, 6th Edition, Addision-Wesly Publishing Company, NY, 1989.
3. Raghavan V., *Material Science and Engineering***,** A First Course, 5th Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2004.
4. William D. Callister, *Materials Science and Engineering: An Introduction,* 6th Edition, Wiley, 2006.
5. Hajra Choudhary S. K**.,** *Material Science and Processes,* Indian Book Distributing Co., 1982.

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Course Title: : Chemical Engineering Thermodynamics Lab

Course Code: CHL225

L	T	P	Credits
0	0	3	2

List of Experiments:

1. To study the constructional details & working principles of two-stroke/ four stroke petrol engine.
2. To study the constructional detail & working of two-stroke/ four stroke diesel engine.
3. Study of locomotive boiler (Model).
4. To study the Red wood viscometer and measure the viscosity of fluid.
5. To measure the flash point of the given fuel.
6. To study various parts of the vertical steam engine.
7. To Study the Vapour liquid Equilibria
8. To Study the Heat of solution mixing
9. To Study the Elevation in boiling point
10. To Study the Depression in freezing point
11. To Study the Determination of specific heat.
12. To determine the heat of reaction between acid & base.

Course Title: : Heat Transfer Lab
Course Code: CHL226

L	T	P	Credits
0	0	3	2

List of Experiments

1. Determination of emmissivity of the given test plate.
2. Determination of thermal conductivity of the given liquid..
3. Determination of thermal conductivity of insulating powder.
4. Determination of heat transfer coefficient by forced convection.
5. Determination of heat transfer coefficient for pin fin by natural convection.
6. Determination of heat transfer coefficient for pin fin by forced convection.
7. Determination of overall heat transfer for parallel flow in double pipe heat exchange.
8. Determination of overall heat transfer coefficient for counter flow in double pipe heat exchanger
9. To conduct test on heat pipe and comparison of the temperature distribution.
10. Determination of heat transfer coefficient in shell & tube heat exchanger.
11. Determination of overall heat transfer coefficient in an open pan evaporator.
12. Determination of heat transfer coefficient by dropwise and filmwise condensation.

DAV UNIVERSITY, JALANDHAR

Course Title: Mass Transfer-I

Course Code: CHL301

L	T	P	Credits
4	0	0	4

Course Objectives: The objective of this course is to present the principles of mass transfer and their application to separation and purification processes. The concept of mass transfer coefficients, rate expressions and some mass transfer operations is developed.

UNIT-A **12 HOURS**

Introduction: Importance and classification of mass transfer operations in Chemical Engineering.

Diffusion: Diffusion in gases and liquids, Fick's First law of diffusion, Mass balance in simple situations - with and without chemical reaction.

Diffusion in solids, diffusion through porous solids and polymers, unsteady state diffusion

Eddy diffusion: Mass transfer coefficients and their correlations. Theories of mass transfer, Interphase mass transfer, problems on mass transfer resistance. J_d factor, Analogies in mass, heat and momentum transfer processes.

Interphase Mass transfer:

Theories of Mass transfer, Individual and overall mass transfer coefficients, Convective mass transfer. Mass balance in concurrent and counter-current continuous contact equipment, Concept of operating line, Multi-stage counter current operations, Concept of ideal stage, Stage efficiencies, Design of continuous contact equipments, HTU and NTU concepts.

UNIT-B **14 HOURS**

Gas-Liquid Contacting Equipments: Equipments for gas-liquid operations: general characteristics and operational features of tray towers and packed towers, tray design, flow through a packed towers, spray towers, venture-scrubbers

Gas Absorption: Equilibrium in gas-liquid systems: Two components and multicomponent systems, ideal and non-ideal solutions, Selection of suitable solvent, Counter-current multistage operations- one component transferred, Real trays and tray efficiencies. **Gas Absorption Equipments**: Continuous contact equipments: Packed towers, HETP & NTU, Overall transfer coefficients and transfer units

UNIT-C **10 HOURS**

Humidification: VLE & Enthalpy, Reference substance plots, vapour gas mixtures, concept of adiabatic saturation, psychometric charts, adiabatic operations-humidification operations and water cooling operations. Dehumidification Equipments: water cooling towers & spray chambers

UNIT-D **12 HOURS**

Adsorption & Ion-Exchange Operations: Adsorption and adsorbents-Type and nature, Adsorption equilibria and various popular mathematical models, Selecti adsorbents, Adsorption hysteresis, Batch adsorption, Stagewise adsorption-single stage and multiple stage, Ion-Exchange, Equilibrium distribution of ions.

Adsorption & Ion-Exchange Operations' Equipments: Adsorption in a fixed bed. Adsorption equipments-agitated vessels for liquid-solid contact, fluidized and teeter beds, slurry adsorption of gases and vapours, steady-state-moving-bed adsorbers, Unsteady state-Fixed Bed Adsorbers, Concept of Chromatography, Elution, Percolation etc and equipments concerning these concepts.

Reference Books:

1. Treybal, R.E., *Mass Transfer Operations*, 3rd Edition, McGraw Hill, 2012.
2. Dutta, B.K, *Principles of Mass Transfer and Separation Processes,*PHI Learning Pvt. Ltd, 2007 Coulson JM, Richardson JF and Sinnott RK, *Chemical Engineering*, Vol I, II, IV and V, 5th Edition, Pergmen Press, 2002.
3. Badger & Banchero, *Introduction to Chemical Engineering,* TMH, 6th Reprint, 1998.
4. Geankoplis, C. J., *Transport Processes and Unit Operation,* Prentice Hall (I), 2000.

Course Title: Chemical Reaction Engineering-I
Course Code: CHL302

L	T	P	Credits
4	0	0	4

Course Objectives: The students will study design of various types of reactors for the application to chemical industry and learn the fundamentals related to homogeneous chemical reactions and their kinetics

UNIT-A

Introduction **12 HOURS**

Introduction & Importance of Chemical Reaction Engineering, Kinetics of homogeneous reactions, Concepts of reaction rates, rate equation, rate constant, order & molecularity, Mechanism for Elementary & Non-elementary reaction., single and multiple reactions, order & molecularity, rate constant, temperature dependent term of rate equation.

Interpretation of Batch Reactor

Constant volume batch reactor, integral method of analysis of data, series and parallel reactions, reversible reactions, variable volume batch reactor, differential methods of analysis, temperature and reactions rate.

UNIT-B **12 HOURS**

Introduction to Reactor Design

Ideal batch reactor, mixed flow reactor, plug flow reactor, holding and space time, design for single reactions, size comparison analytical and graphical method, plug flow reactors in series & parallel, mixed reactor in series, recycle reactors.

UNIT –C **12 HOURS**

Design for Multiple Reactions

Reactions in parallel and series in CSTR, reactions in parallel and series in Plug flow reactor, autocatalytic reactions, choice of reactors for simple and complex reactions, yield & selectivity.

UNIT-D **12 HOURS**

Temperature and Pressure Effects

Concept of adiabatic & non-isothermal operations, Energy balance equation for Batch, CSTR & PFR and their application to design of reactors, optimal temperature progression, multiple steady states in CSTR.

Basics of Non Ideal flow: Importance & interpretation of RTD, C, E & F curves & Statistical interpretation. Dispersion model. Tanks in series model. Conversion in non- ideal flow reactors for simple systems.

Recommended Books:

1. Levenspiel O., *Chemical Reaction Engineering*, 3rd Edition, John Wiley & Sons, Singapore, 2010
2. Fogler H. S., *Elements of Chemical Reaction Engineering,* 4th Edition, Prentice Hall Inc.,2009
3. Smith J. M., *Chemical Engineering Kinetics,* 3rd Edition, McGraw Hill, 1981.
4. Hill C. G., *Chemical Engineering Kinetics and Reactor Design,* John Wiley, 1977.
5. Coulson J. M., Richardson J. F., *Chemical Engineering Volume 3***,** Pergamon Press, 1999.

Course Title: **Chemical Technology-II (Organic)**

Course Code: CHL303

L	T	P	Credits
4	0	0	4

Course Objectives: The students will
1. Study the Organic, Petroleum Process industries.
2. Learn to write flow chart symbols and flow charts for typical chemical processes

UNIT-A **12HOURS**

Oils and fats: Major oil seeds, solvent process, hydrogenation of oils. Soaps and Detergents: Raw material, manufacturing of detergents, biodegradability, and glycerin manufacture, fat splitting, purification of fatty acids,

UNIT-B **12HOURS**

Sugar Industry: Cane production and varieties, manufacturing equipment and technology, cane sugar refining, Bagasse utilization,
Fermentation: Production of ethyl alcohol from molasses, citric acid and antibiotics like penicillin.

UNIT-C **14HOURS**

Petroleum refining: General composition of crude oil, typical refinery operations for obtaining useful products, their utilization for manufacture of ethylene glycol, acrylonitile, styrene, and butadiene. Polymer: classification of polymers, degree of polymerization, modes of polymerization synthetic fibers (Nylon, terylene) synthetic & natural rubbers.

UNIT –D **10 HOURS**
Pulp and paper: pulping processes, recovery of chemicals, stock preparation and paper making, recovery, of chemicals, viscose rayon. Surface-coating Industries: paints, pigments, varnishes, Lacquers.

Reference Books:

1. Dryden C. E., *Outlines of Chemical Technology,* 2nd Edition, East–West Press Pvt. Ltd., New Delhi, 1999.
2. Austin G. T., *Shreve's Chemical Process Industries*, 5th Edition, McGraw Hill Book Company, New Delhi, 2012.
3. Groggins, P.H., *Unit Processes in Organic Synthesis,* 5th Edition Tata McGraw Hill ,2003
4. Garry, James H., Handwerk, G. E. and Kaiser, M.J., *Petroleum Refining Technology and Economics,* Taylor & Francis ,2007

DAV UNIVERSITY, JALANDHAR

Course Title: **Process Dynamics and Controls**

Course Code: CHL304

L	T	P	Credits
4	0	0	4

Course Objectives: The student will
1. Understand a control system with various input functions, characteristics and transfer functions
2. Know the behaviour of a control system for I and II order type
3. Understand different closed loop systems and Controllers (P, I, D and On – Off modes)

UNIT-A **12HOURS**

Laplace Transformation. Inversion by partial fractions. Properties of transform. Linear Open-loop System. Response of first-order systems, physical examples of first order system, response of first order systems and Transportation Lag.

UNIT-B **12 HOURS**

Linear closed-loop systems, control systems, Controllers and Final control elements, closed-loop Transfer functions. Transient response of Simple control Systems Control valve, Construction, valve sizing and characteristics.

UNIT-C **12 HOURS**

Stability, Routh Test of stability, Root Lacus. Introduction to Frequency Response, Bode diagram, Gain Margins and Phase Margins.

UNIT-D **12 HOURS**

Controller tuning (Ziegler- Nichols Controller settings), Process identification, Identification methods: Step test data, Sine Wave testing, Pulse testing, Introduction to advanced control technique, cascade control, ratio control, overwrite control, feed forward control.

Reference Books:

1. Coughanour, D.R., *Process Systems Analysis and Control,* 3rd edition, McGraw Hill 2013.
2. Stephanopoulous, G., *Chemical Process Control: An introduction to Theory and Practice*, Prentice Hall of India, 1990.
3. Peacock D.G., Richardson J.F., *Chemical Engineering,* Volume 3, 3rd Ed., Butterworth Heinemann, 1994.
4. Harriott, P., *Process Control,* Tata McGraw Hill,2001
5. Eckman, D.P., *Industrial instrumentation***,** John Wiley & Sons ,2004

DAV UNIVERSITY, JALANDHAR

Course Title: Numerical Methods

Paper Code: MTH256A

L	T	P	Credits
3	0	0	3

Course Objectives

The aim of this course is to teach the applications of various numerical techniques for a variety of problems occurring in daily life. At the end of the course, the students will be able to understand the basic concepts in Numerical Analysis of differential equations.

Unit-A

Approximate numbers, Significant figures, rounding off numbers, Error Absolute, Relative and percentage

Non-Linear Equations: Bisection, Regula-Falsi, Secant, Newton-Raphson, General Iteration Method. Rate of convergence

Unit-B

Systems of Simultaneous Linear Equations: Direct methods: Gauss elimination method, Gauss Jordon method, Matrix inversion method; Iterative methods: Jacobi method and Gauss-Seidel method, Power method for finding largest Eigen value.

Unit-C

Operators: Forward, Backward and Shift (Definitions and some relations among them). Newton forward and backward, Gauss backward and forward interpolation, Stirling formula, Bessel formula, Lagrange's interpolation, Hermite Interpolation, Newton divided difference Interpolation. Numerical Differentiation, Maximum and Minimum values of a tabulated function.

Unit-D

Numerical Integration: General Quadrature formula, Trapezoidal Rule, Simpson's 1/3-Rule, Simpson's 3/8-Rule, Boole's rule, Weddle's Rule.

Numerical solutions to first order ordinary differential equations: Taylor's Series method, Picard's Method, Euler's and modified Euler's methods, Runge-Kutta methods.

References:

1. Jain, M.K. *Numerical Analysis for Scientists and Engineers*. New Delhi: S.B.W. Publishers, 1971.
2. Grewal B.S. *Numerical Methods in Engineering & Science With Programs In C& C++.* New Delhi: Khanna Publishers, 2012.
3. Golub G.H. and Ortega, J.M. *Scientific Computing and Differential Equations: An Introduction to Numerical Methods*. London: Academic Press, 1992.
4. John H. Mathews and Kurtis D. Fink, *Numerical Methods using Matlab*, 4th Ed., PHI Learning Private Limited, 2012.

Course Title: Chemical Technology Lab

Course Code: CHL323

L	T	P	Credits
0	0	3	2

List of Experiments:

1. To find Acid value of vegetable oil
2. To find Iodine value of vegetable oil
3. To Saponification of polymer
4. Determination of NPK value
5. Preparation of soap
6. Preparation of polymer(Preparation of Urea Formaldehyde)
7. To determine the Moisture, Volatile and Ash content in a given coal sample by Proximate Analysis
8. Determination of viscosity of Ostwald Viscometer

Course Title: Instrumentation & Controls Lab

Course Code: CHL330

L	T	P	Credits
0	0	2	1

List of Experiments

1. Determination the time constant of a given Mercury Thermometer.
2. Determination of time constant in a liquid level tank
3. Determination of time constant in interacting and non-interacting tank
4. Determination of time constant in a heated tank
5. To study the effect of proportional controller in a liquid level tank
6. To study the effect of proportional Integral controller in a liquid level tank

Course Title: Numerical Methods Lab

Paper Code: MTH257A

L	T	P	Credits
0	0	2	1

List of Programs:

1. Write a program to solve a polynomial equation.
2. Write a program to find C (n, r).
3. Write a program to write a tridiagonal matrix.
4. Write a program to solve the system of linear equations
   a) Using Gauss Elimination (b) using LU Decomposition.
5. Write a program in Matlab to find the characteristic roots and the characteristic functions
6. WAP on Bisection and False Position Method.
7. WAP on polynomial interpolation.
8. WAP on Taylor Series method.
9. WAP on Runge-Kutta Methods
10. WAP on Finite Difference Methods
11. WAP on Numerical Integration.
12. WAP on Trapezoidal and Simpson's rule.
13. WAP on Gaussian Quadrature.
14. WAP on Lagrange's Interpolation.
15. WAP on Hermite Interpolation.

Reference Books:

1. Atkinson, K.E. *An Introduction to Numerical Analysis.* Wiley. 1989.
2. Eriksson K.,Estep D., Hansbo, P., and Johnson C. *Computational Differential Equations.*Cambridge: Cambridge Univ. Press. 1996.
3. Golub, G.H., and Ortega, J.M. *Scientific Computing and Differential Equations: An Introduction to Numerical Methods.*Academic Press. 1992.
4. Conte, S.D., and Boor, Carl De.*Elementary Numerical Analysis-An Algorithmic Approach.*New Delhi: Tata McGraw Hill. 1981.
5. Jain, M.K. *Numerical Analysis for Scientists and Engineers.* Delhi: S.B.W. Publishers. 1971
6. K.E. Atkinson, An Introduction to Numerical Analysis, Wiley, 1989.

DAV UNIVERSITY, JALANDHAR

Course Title: Mass Transfer II

Course Code: CHL305

L	T	P	Credits
4	0	0	4

Course Objectives: The objective of this course is to present the principles of mass transfer and their application to separation and purification processes. The concept of various mass transfer operations is developed which are extensively used.

UNIT-A **12HOURS**

Distillation: Limitations and applications, prediction of VLE using thermodynamic & experimental techniques. Dew point & bubble point estimations for binary & multicomponent mixtures. Distillation methods – flash distillation, differential distillation for binary systems, steam distillation, optimum reflux ratio. Fractionation of binary mixtures using McCabe – Thiele method and enthalpy concentration method (Ponchon and Savarit method). Packed distillation columns. Azeotropic & extractive distillation preliminaries and molecular distillation.

UNIT-B **12HOURS**

Liquid-Liquid Extraction Operations: Liquid-Liquid Equilibria, Equilateral triangle coordinate systems, Suitable solvent selection, Design calculations for single stage and multiple extraction, Multistage extraction using partially miscible & immiscible solvents.

Liquid-Liquid Extraction Operation's Equipments: Liquid-Liquid Extraction Equipments-Spray Towers, Packed Towers, Mechanically Agitated Countercurrent Extractors, Rotating Disc Extractor.

UNIT-C **12HOURS**

Leaching Operations: Liquid-Solid Equilibria, Design calculations for single stage and multiple stage leaching.

Leaching Opeartions' Equipments: Unsteady State leaching systems: Percolation tank, batch settling, Steady state continuous operations- Agitated vessels, thickeners, continuous countercurrent decantation, classifiers, method of calculations related to single stage and multistage leaching

UNIT-D **10HOURS**

Drying Operation and Equipments: Drying equilibria, Physical mechanism of drying, batch drying rate of dying curve, time of drying drying rate data, Drying equipments-Batch and continuous dryers.

Crystallization Operations' and Equipments: Solid-liquid phase equilibria, nucleation and crystal growth, crystal size distribution, batch crystallization, crystallization equipments

Reference Books:

1. Treybal, R.E., *Mass Transfer Operations,* McGraw Hill, 3rd Edition (Indian), 2012.
2. Dutta, B.K, *Principles of Mass Transfer and Separation Processes,* PHI Learning Pvt. Ltd, 2007.
3. Coulson JM, Richardson JF and Sinnott RK, *Chemical Engineering,* Vol I, II, IV and V, 4th Edition, Pergmen Press, 1998.
4. Geankoplis, *Transport Processes and Unit Operations*, Prentice-Hall of India, 1993.
5. McCabe, W.L., and Smith, J.C., *Unit Operations of Chemical Engineering,* McGraw Hill, 7th Edition, 2005.

DAV UNIVERSITY, JALANDHAR

Course Title: Chemical Reaction Engineering-II

Course Code: CHL306

L	T	P	Credits
4	0	0	4

Course Objectives: The students will
1. Learn heterogeneous reaction systems.
2. Study the design and analyze performance of non-ideal reactors.
3. Study catalytic systems and its deactivation studies for students to handle such process systems.

UNIT-A **10HOURS**

Kinetics of heterogeneous reactions: Introduction to catalysts & their classification, Concepts of physical adsorption and Chemisorption, Preparation of solid catalysts, Deactivation of Catalysts, Synthesis of rate law, mechanism & rate limiting step for catalytic reactions, Langmuir Hinshelwood rate equations and parameter estimation

UNIT-B **10HOURS**

Diffusion through porous catalyst particles:

Effectiveness factor for pore diffusion resistance through a single cylindrical pore, Significance of Thiele modulus, Heat effects during reaction, Performance equations for solid- gas reactions for different reactor types & determination of controlling resistance.

UNIT-C

Kinetics and design of Fluid-Particle Reactions: **14HOURS**

Modelling ofgas-solid non-catalytic reactions and determination of parameters, Combination of resistances & determination of rate controlling step. Analysis of rate data design outline and selection of fixed bed, fluid bed and slurry reactors

UNIT-D

Kinetics & Design of Fluid-Fluid Reactions: **14HOURS**

Interface behavior for liquid-phase reaction, Regimes for different reaction kinetics for liquid-liquid reactions, Determination of reaction rate & tower height based on film and penetration theories, Concept of Enhancement factor & Hatta number. Reactor systems and design for gas-liquid-solid non-catalytic system

Reference Books:

1. Levenspiel O., *Chemical Reaction Engineering,* 3rd Edition, John Wiley & Sons Singapore, 2010.
2. Fogler H. S., *Elements of Chemical Reaction Engineering,* 4th Edition, Prentice Hall Inc., 2009.

3. Smith J. M., *Chemical Engineering Kinetics,* 3rd Edition, McGraw Hill, 1981.
4. Hill C. G., *Chemical Engineering Kinetics and Reactor Design,* John Wiley, 1977.
5. Coulson J. M., Richardson J. F., *Chemical Engineering,* Volume 6", 3rd Edition Pergamon Press,

DAV UNIVERSITY, JALANDHAR

Course Title: Environmental Engineering

Course Code: CHL308

L	T	P	Credits
4	0	0	4

Course Objectives: The main objective of this course is to understand the various types of industrial pollution and their control methods

UNIT-A **12HOURS**

Air Pollution Control Engineering

Introduction, Definition, Sources, Characteristics and Perspective of Air Pollutants, Effects of Air Pollution on Biodiversity, Economic Effects of Air Pollution, Air Quality and Emission Standards, Engineering Systems of Control of Air Pollution by Equipment and by Process Changes.

UNIT-B **14HOURS**

Water Pollution Control Engineering

Introduction, Definition, Sources, Characteristics and Perspective of Water and Wastewater Pollutants, Effects of Water Pollution on Biodiversity, Economic Effects of Water Pollution, Water Quality and Emission Standards, Physical, Chemical and Biological Parameters(BOD and COD). Waste water treatment techniques, primary treatment involving removal of suspended particles through flocculation, settling, skimming and friction. Secondary treatment: biological treatment, aerobic and anaerobic digestion, activated sludge processes, trickling filters and oxidation periods and Advance Treatment.

UNIT-C **10 HOURS**

Solid Waste Management

Introduction, Definition, Sources, Characteristics and Perspective of Solid Waste, Generation, Separation, Handling, Storage and Transportation of Solid Waste, Chemical and Biological Treatment of Solid Waste.

UNIT-D **12HOURS**

Biomedical and Hazardous Waste Management

Introduction, Definition, Sources, Characteristics and Perspective of Biomedical and Hazardous Waste, Handling, Storage, Transportation of Biomedical and Hazardous Waste, Physical, Chemical and Biological Treatment of Biomedical and Hazardous Wastes.

Recommended Books:

1. Rao , C.S, *Environmental Pollution Control Engineering*, New Age Publication,3rd Edition ,2013.
2. Rao M. N., Rao H. V. N.*, Air Pollution,* Tata McGraw Hill Publishing Company Ltd.,2005.
3. Dhameja, S. K. *Environmental Science,* S. K. Kataria & Sons, 2010.
4. Metcalf and Eddy, Inc., *Wastewater Engineering-Treatment and Reuse,* Tata McGraw Hill Publishing Company Ltd., Fourth Edition, 2004.
5. Rittmann BE., McCarty P. L., *Environmental Biotechnology: Principles and Application,* McGraw Hill International Editions, First Edition, 2001.
6. Kiely G., *Environmental Engineering,* Tata McGraw Hill, Special Indian Edition, 2007.

DAV UNIVERSITY, JALANDHAR

Course Title: Process Engineering Economics

Course Code: CHL310

L	T	P	Credits
4	0	0	4

Course Objectives: The student will
1. Learn basics of Cost estimation, Working Capital and Capital Investment and understand the time value of money
2. Study depreciation methods and learn tax calculation methods
3. Learn the methods of estimation of profitability of an industry

UNIT-A **12 HOURS**

Cost Estimation
Factors affecting investment and production costs, capital investment-fixed investments and working capital. Cost indices. Estimating equipment costs by scaling 6/10 factor rule. Methods for estimating capital investment. Estimations of total product cost. Different cost involved in the total product for a typical chemical process plant.

UNIT-B **12 HOURS**

lnterest and lnsurance costs
Simple and compound interest. Nominal and effective rates of interest. continuous interest. ordinary annuity. Perpetuities and capitalized costs.

UNIT-C **12 HOURS**

Taxes and lnsurance
Type of taxes and tax returns, type of insurance and returns, types of insurance of legal responsibility.

Depreciation:
Types of depreciation, service life, salvage value, present value and methods of determining depreciation single unit and group depreciation, single unit and group depreciation.

UNIT-D **12 HOURS**

Profitability Alternative lnvestment and Replacements :
Methods for profitability evaluation, cash flow diagram, Determination of acceptable investment, Alternatives when an investment must be made and analysis with a small increment investment, replacement, break even analysis, Balance sheet and income statement.

Optimum design :
Procedure with one variable optimum reflex ratio in distillation and other examples.

BOOKS RECOMMENDED:

1. Peters, M.S. Timmerhaus, K.D, *Plant Design and Economics of Chemical Engineers,* 5th Edition , MC Graw Hill,New York, 2011 **.**
2. Desai, V., *Dynamics of Entrepreneurial Development & Management,* Himalaya Publishing House.
3. Schweyer, H. E., *Process Engineering Economics*, McGraw Hill, NY.
4. Gupta, C.B., Kanka, S.S., Entrepreneurship *& Small Business Management,* S Chand & Sons, 2007.
5. Ulrich G.D. *A Guide to chemical Engineering process Design and Economics,* John Wiley, 1984.

Course Title: Mass Transfer Lab

Course Code: CHL325

L	T	P	Credits
0	0	3	2

List of Experiments

1. To plot the ternary phase diagram for acetic-acid–water Toluene.
2. To draw the tie line and to determine plait point for ternary system.
3. To determine the diffusivity of acetone in air.
4. To study the drying characteristics of the given wet material (Natural Convection).
5. To determine the Mass Transfer Coefficient for vaporization of naphthalene in air.
6. To verify Rayleigh's Equation for Batch distillation.
7. To find HETP and HTU for packed distillation column.
8. To purify turpentine oil having high boiling point using steam distillation.
9. To determine VLE data for methanol–water and to compare it with literature data.
10. To determine the mass transfer coefficient by carrying out liquid-liquid extraction in a packed column using acetic acid- toluene-water system.
11. To study the drying characteristics of the given wet material (forced convection).
12. To study the process of crystallization in an agitated batch crystallizer and to plot a graph between weight of crystals vs. temp.
13. To find out mass transfer coefficient in a drop wise liquid–liquid extraction. To Study the Heat and Mass Balance in Cooling Tower.

DAV UNIVERSITY, JALANDHAR

Course Title: Reaction Engineering Lab

Course Code: CHL327

L	T	P	Credits
0	0	2	1

List of Experiments:

1. Determination of rate constant for saponification reaction in a batch reactor
2. Determination of porosity and sphericity of the given catalyst.
3. RTD study in a Packed bed reactor
4. To study the adsorption of acetic acid on charcoal and prove the validity of Freundlich and Langmuir adsorption isotherm
5. To study the adsorption of oxalic acid on charcoal and prove the validity of Freundlich and Langmuir adsorption isotherm

Course Name: Environment Technology Lab
Course Code: CHL329

L	T	P	Credits
0	0	2	1

List of Experiments:

1. To determine the Total Solids of a given sample.
2. To find out Total Dissolved Solids of a given sample.
3. To find out Fixed and Volatile solids of the given sample.
4. To determine Acidity of the given sample.
5. To determine the Alkalinity of the given sample.
6. To determine the Total Hardness of the given sample.
7. To find out amount of Sulphates in a given sample.
8. To estimate the content of Chlorides in the given water sample
9. To find the quantity of the Dissolved Oxygen present in the given sample.
10. To determine the BOD of a given wastewater sample.
11. To determine the COD of a given wastewater sample.

DAV UNIVERSITY, JALANDHAR

Course Title: Transport Phenomenon

Course Code: CHL402

L	T	P	Credits
4	0	4	4

Course Objectives: The student will
1. Learn the mechanisms and Laws transport phenomena, Effect of temperature and pressure on transport properties
2. Study velocity distributions in laminar flow for simple fluid flow situations by shell balances

UNIT-A **10 HOURS**

Introduction: Transport Phenomena and Unit Operation, Equilibrium and Rate Processes, Fundamental variables and units, The analogy between Heat, Mass & Momentum Transfer, Concept of Thermal Conductivity, Diffusion Coefficient & Viscosity, Newtonian and non-Newtonian fluids; Newton's law of viscosity, Fourier's law of heat conduction and Fick's law of diffusion.

UNIT-B **14 HOURS**

Momentum Transport: Velocity Distribution, Equation of continuity in Cartesian, polar and spherical coordinates, Laminar flow of Newtonian fluid over an inclined plate, through circular tube and through annulus, Bingham flow in a circular tube, Equation of Change: Partial, total and substantial times derivatives, Equation of motion and Navier's-Stokes equation and their applications to solve problems of different geometries.

Flow with More Than One Independent Variable: Unsteady-state Newtonian fluid flow, Stream function, Potential function and two-dimensional viscous flow, Boundary layer theory.

UNIT-C **10 HOURS**

Energy Transport: Temperature Distribution: Heat conduction with an electrical, viscous, chemical and nuclear heat source, Heat conduction in a cooling fin, Equation of Change, Equation of energy in rectangular, spherical and cylindrical geometries, Equations of energy for convection in non-isothermal flow, Forced convection, Free convection.

UNIT-D **14HOURS**

Mass Transfer: Concentration distribution with shell mass balances, Diffusion through stagnant gas film, Diffusion with moving interface, Diffusion through a non-isothermal spherical film, Gas absorption with chemical reaction in an agitated tank, Diffusion with heterogeneous and homogeneous chemical reaction, Diffusion and chemical reaction inside porous catalyst, Equation of Change, Equation of component continuity for binary and ternary mixtures and various simplifying assumptions.

Reference Books

1. Bird, R. B., Stewart, W. E., and Lightfoot, E. N., *Transport Phenomena,* 2nd Edition, Wiley, 2006.
2. Raj, B., *Introduction to Transport Phenomena*, PHI Learning, 2012.
3. Geankoplis, C. J., Transport *Processes and Unit Operations,* Prentice-Hall 1993.
4. Bennett, C.O., and Myers, J.E., *Momentum, Heat, and Mass Transfer*, 3rd Edition, McGraw-Hill, 1983.
5. Welty, J. R., Wicks, C. E., and Wilson, R. E., *"Fundamentals of Momentum, Heat, and Mass Transfer,* John Wiley and Sons, 1984.
6. William J. T., *Introduction to Transport Phenomena*, Prentice Hall 1999.

DAV UNIVERSITY, JALANDHAR

Course Title: Process Engineering Design-I

Course Code: CHL404

L	T	P	Credits
4	0	0	4

Course Objectives: The students will
1. Study design safe process and design appropriate equipment like reactors, mass transfer heat transfer equipment, pipelines storage tanks etc.
2. Study relevant codes for design of chemical plant equipment as per the standard procedures specified by design code books

Unit-A **10 HOURS**

Design preliminaries: Introduction, nature of design, codes and standards, equipment selection and specification. Piping design: Piping classification, important fittings and their use, symbols, layouts and color codes for pipe lines, process piping design and pipe size selection

Unit-B **14 HOURS**

Design of process vessels under internal pressure: Thin wall vessels, Cylindrical vessels, Tubes, Pipes, Spherical vessels, Design of heads and closures such as different heads, Nozzle, Flange joints, Gaskets, Types & design of non- standard flanges and Bolts. Design of process vessels under external pressures : Introduction, Determination of safe pressure against elastic failure, Circumferential stiffeners, Spherical shells, Pipes and tubes under external pressure

Unit-C **12 HOURS**

Design of tall vessels : Introduction, Equivalent stress under combined loadings and Longitudinal stresses. Design of support for process vessels: Introduction, Different types of supports, Design of supports. Equipment fabrication and testing : Welding joints, Inspection and Non-destructive testing of equipment.

Unit-D **12 HOURS**

Design of some special parts : Introduction, Expansion joints and its design, Expansion loop in piping system, Design equations for expansive forces in pipe lines, Shafts and Keys. Storage tanks: Introduction, Classification of storage tanks, Filling & breathing looses, Design of liquid and gas storage tanks

Recommended Books:

1. Bhattacharya B. C., *Chemical Equipment Design*, CBS Publisher, 2011.
2. Coulson, Richardson &Sinnott, R.K., *An Introduction to Chemical Engineering Design*, Chemical Engineering, Volume 6 , 4th Edition, Pergamon Press, 2007.
3. Joshi , M.V., *Process Equipment Design*, 3rd Edition, Macmillan India,2007.
4. Perry's, *Handbook of Chemical Engineering*, 7th Edition, McGraw Hill, 1997

DAV UNIVERSITY, JALANDHAR

Course Title: Industrial Safety & Hazardous Management

Paper Code: CHL406

L	T	P	Credits
4	0	0	4

Course objectives: The student will learn classification of hazards and their identifications. Awareness of different hazards in process, risk analysis techniques.

UNIT-A **12 HOURS**

Definition, identification, classification and assessment of various types of industrial hazards. General principles of industrial safety, importance of safety in chemical industrial. Protective and preventive measures in hazard control.

UNIT-B **12HOURS**

Standard safety procedures for disaster control, Indian legislation on safety and prevention of hazards and safety code. Environmental Protection Act (1986).

UNIT-C **12HOURS**

Toxic chemicals, Maximum allowable concentration and other standards biological threshold limit values, toxicity and radioactivity. Regulations for storage and handling of hazardous substances and labelling

UNIT-D **12HOURS**

Hazards, hazards classification, hazard due to the explosion' Dow's fire and explosion index,HMOP, : Hazard & Operability (HAZOP) studies ,guide words and their meaning, application of guide words to hazardous operation deviation, possible causes, Consequences and actions required, event trees and fault trees.

Refrences Books:

1. Raghavan K. V. and Khan AA., *Methodologies in Hazard Identification and Risk Assessment*, Manual by CLRI, 1990.
2. Marshal V. C., *Major Chemical Hazards,* Ellis Horwood Ltd., Chichester, 1987.
3. Sam Mannan, Lees, *Loss Prevention in the Process Industries, Hazard Identification, Assessment and Control,* 4th Edition, Butterworth Heineman, 2012.
4. Wells, G. L., *Safety in process plant design,* New York, J. Wiley, 1980.

Course Title: Process Modeling & Simulation

Paper Code: CHL405

L	T	P	Credits
4	0	0	4

Course Objective: The student will
1. Study the principles of model building and precautions
2. Learn the approach to solution by the method of shell balances and a review of continuity equation, energy equation, equation of motion, transport equation of state equilibrium and Kinetics.
3. Learn the classification of mathematical models

UNIT-A **12 HOURS**

Introduction: Uses of mathematical models. Scope of coverage, Principles of formulations Fundamental Laws: Continuity equations, energy equations, equations of motion, Transport equations, equation of state, equilibrium, Chemical kinetics.

UNIT-B **12 HOURS**

Mathematical Models: Series of isothermal CSTR & constant hold-up CSTR's, CSTR's With variable hold ups two heated tanks, gas phase pressurized CSTR' Non isothermal CSTR & single component vaporizer, multicomponent flash drum, batch, reactor with Mass transfer.

UNIT –C **12 HOURS**

Mathematical Modeling of Mass Transfer and Heat transfer Processes: Ideal binary distillation column multi component non ideal distillation column, batch distillation with hold up, liquid extraction, absorption, adsorption, heat exchanger.

UNIT-D **12 HOURS**

Interacting and Non-Interacting Systems: Real CSTR modeled with and exchange volume Real CSTR modeled using by passing and dead space. Two CSTR's with interchange.

Reference Books:

1. Luyben W.L., *Process Modeling, Simulation and Control for Chemical Engineering,* McGraw-Hill, 1998.
2. Denn, M. M., *Process Modeling, Longman Sc & Tech*, 1987.
3. Himmelblau, D.M and Bischoff, K.B., *Process Analysis and Simulation: Deterministic Systems,* John Wiley, 1968.
4. Holland, C. D., *Fundamentals and Modeling of Separation Processes: Absorption, Distillation, Evaporation and Extraction,* Englewood Cliffs, Prentice-Hall ,1974.

Course Title: Process Engineering Design II

Course Code: CHL407

L	T	P	Credits
3	0	2	4

Course Objectives: The students will study design safe process and design appropriate equipment like reactors, mass transfer heat transfer equipment, pipelines storage tanks etc.

UNIT-A **12HOURS**

Process design and specifications of double pipe heat exchanger, shell and tube heat exchanger, plate type heat exchanger, condensor and reboiler.

UNIT-B **14HOURS**

Equilibrium procurement techniques – experimental and use of thermodynamics or its evaluation and then use in design height of distillation column. Calculations using McCabe Thiele, Plate-to-Plate calculation methods for fractionators, design of batch fractionating columns, design of fractionator internals for sieve-tray**.**

UNIT-C **12HOURS**

Absorber/Stripper design of stage-wise and continuous contact equipment (packed column), height of column and diameter calculation, design of various internals of absorber/stripper.

UNIT-D **10HOURS**

Process flow sheets, material and energy balance flow sheeting analysis.

Reference Books

1. Coulson, Richardson & Sinnott, R.K, Chemical Engineering, *An Introduction to Chemical Engineering Design,* 4the Edition, Volume 6 Pergamon Press, 2007.
2. Kern, D.Q., *Process Heat Transfer,* International Student Edition, McGraw Hill , 2002.
3. Ludwig E.E., *Applied Process Design in Chemical and Petrochemical Plants Vol I, II, III,*Gulf PublishingCo.,1995
4. Brownell, L.E. and Young, E.H., *Process Equipment Design,* Wiley Eastern India Limited, 1991.
5. Perry, R.H. and Green, D*, Chemical Engineer's Handbook,* 8th Edition, McGraw Hill, New York. 2008.
6. Seader, J. D., Henley, E.t6 J., *Separation Process Principles,* Wiley 2001.

Course Title: Process Modeling & Simulation Lab

Course Code: CHL425

L	T	P	Credits
0	0	2	1

LIST OF EXPERIMENTS

1. Model and simulate a gravity flow tank.
2. Simulate the non-isothermal CSTR
3. Simulate three CSTR's arranged in series.
4. Simulate ideal binary distillation column.
5. Model and simulate a batch reactor.
6. Simulate two interacting tank system in series.
7. Simulate two non-interacting tank system in series.
8. Simulate a heat exchanger.
9. Simulate a real CSTR modeled using by passing and dead space.
10. Simulate an extrusion column.

DAV UNIVERSITY, JALANDHAR

Course Title: Technical Communication Skills

Course Code: ENG351

L	T	P	Credits
3	0	0	3

Course Objective: This paper, with a practice-oriented approach, aims to hone students' skills in all the dimensions of technical communication.

Learning

Outcomes: Students will show adequate understanding of technical communication skills.

Unit-A

- Nature of Technical Communication
- Verbal and Non-Verbal Communication
- Barriers to Communication

Unit-B

- Conversation: Formal and Informal
- Sounds of English (Speech Skills)
- Panel Discussion and Group Discussion
- Oral Presentation

Unit-C

- Report Writing
- Business and Technical Proposals
- Memos

Unit-D

- C.V. and Resume
- Business Letters and Application Letters
- Interview

Suggested Readings

Koneru, Aruna. *Professional Communication*. Delhi: McGraw, 2008. Print.

Rizvi, M. Ashraf. *Effective Technical Communication*. Delhi: McGraw, 2005. Print.

Sharma, R.C. and Krishna Mohan. *Business Correspondence and Report Writing*. Delhi: McGraw, 2013. Print.

Tyagi, Kavita and Padma Misra. *Basic Technical Communication*. Delhi: PHI Learning, 2013. Print.

DAV UNIVERSITY, JALANDHAR

Course Title: Optimization Techniques

Course Code: CHL446

L	T	P	Credits
4	0	0	4

Course Objectives: Students will learn about the basic concepts of optimization techniques and to use them for optimum utilization of resources.

UNIT– A **10 Hour**

Introduction:
Origin of OR and its role in solving industrial problems. General approach for solving OR problems. Classification of mathematical models, various decision making environments.

Linear Programming:
Formulation of linear mathematical models: Graphical and simplex techniques for solution of linear programming problems, Big M method and two phase method, Introduction to duality theory and sensitivity analysis.

12 Hour

UNIT – B

Transportation and Assignment Models:
Various initial basic feasible solutions methods, Optimization of transportation and assignment using different methods considering the concept of time and cost function.

Dynamic Programming:
Introduction to deterministic and probabilistic dynamic programming.

UNIT – C **12 Hour**

Network models:
Shortest route and traveling sales - man problems, PERT &CPM introduction, analysis of time bound project situations, construction of networks, identification of critical path, slack and float, crashing of network for cost reduction.

Queuing Theory:
Types of queuing situation: Queuing models with Poisson's input and exponential service, their application to simple situations.

UNIT – D **14 Hour**

Replacement Models: Replacement of items that deteriorate, Replacement of items whose maintenance and repair costs increase with time, replacement of items that fail suddenly; replacement of items whose maintenance costs increase with time and value of money also changes, individual replacement policy, group replacement policy.

Optimization Techniques: Introduction, Theory and algorithms, classical method, non-linear optimization-Unconstrained optimization, constrained optimization: Langrangian multiplier method.

References:

1. Swarup K, Gupta P. K., "Operations Research", 18th Edition, Jain Book Agency, 2015.
2. Gupta P. K., Hira D.S., "Operations Research", S. Chand & Co, 2013.
3. Hillier, F.S. and G.J. Lieberman, G. J., "Introduction to Operation Research", 8th edition, Mc Graw Hills, 2005.

Course Title: Electrochemical Technology

Course Code:CHL447

L	T	P	Credits
4	0	0	4

Course Objectives: Students will learn about the Electrochemistry and its industrial applications.

Unit-A **12 Hour**

Introduction: Electrochemistry basics; Thermodynamics of ideally polarizable and non-polarizable interfaces. Electrochemical cells; reversible and irreversible cells, EMF

Electrode kinetics: Equilibrium potential, Nernst equation, overpotential and its different types. Equilibrium exchange current density; Butler-Volmer equation; high field and low field approximations; charge transfer resistance and polarizability of the interface. Rate determining step, stoichiometric number, reaction order. Determination of kinetic parameters

Unit-B **12 Hour**

Electro-analyticaltechniques: Potentiometry and amperometry. Linear sweep voltammetry and cyclic voltammetry. Analysis of cyclic voltammograms. Potential steps under mass transfer control; Cottrell equation for a planar and spherical electrode. Faradaic impedance

Unit-C **12 Hour**

Electrodes and electrolytic membranes: Electrodes for the electrochemical reactors. Preparation, characteristics and applications of graphite, magnetite, lead dioxide coated anodes, noble metal coated anodes, noble metal oxide coated anodes, steel cathodes, coated cathodes, diaphragms and ion exchange membranes.

Unit-D **12 Hour**

Industrial applications: Chlor alkali industry. Manufacture of potassium and ammonium persulphates, hydrogen peroxide, potassium permanganate. Production of hydrogen by water electrolysis. Electrodialysis and electrochemical incineration. Batteries and fuel cells. Electrometallurgy

Recommended Books:

1. Bockris, J.O.M., & Reddy, A.K.N., *Modern Electrochemistry, Vol.1 & 2*, Plenum, New York 1970.
2. Hartmut Wendt, & Gerhard Kreysa, *Electrochemical Engineering: Science and Technology in Chemical and Other Industries*, Springer, 1999.
3. Linden, D. and Reddy T. B. , *Hand Book on Batteries and Fuel Cell*, McGraw Hill Book Co., 2002

DAV UNIVERSITY, JALANDHAR

Course Title: Hazardous Waste Management

Course Code: CHL448

L	T	P	Credits
4	0	0	4

Course Objectives: Students will learn about various Hazardous waste and their management.

Unit-A **12 Hour**

Introduction: Need for hazardous waste management – Sources of hazardous wastes – Effects on community – terminology and classification – Storage and collection of hazardous wastes – Problems in developing countries – Protection of public health and the environment.

Nuclear wastes and e-waste: Characteristics – Types – Nuclear waste – Uranium mining and processing – Power reactors – Refinery and fuel fabrication wastes – spent fuel – Management of nuclear wastes – Decommissioning of Nuclear power reactors – Health and environmental effects

Unit-B **12 Hour**

Biomedical and chemical wastes: Biomedical wastes – Types – Management and handling – control of biomedical wastes Chemical wastes – Sources – Domestic and Industrial - Inorganic pollutants – Environmental effects – Need for control – Treatment and disposal techniques – Physical, chemical and biological processes – Health and environmental effects

Unit-C **12 Hour**

The scientific landfill: Concept – function – site selection and approval – acceptable wastes – Design and construction – Liners: clay, geomembrane, HDPE, geonet, geotextile – Treatment and disposal of leachate – Combined and separate treatment. Site remediation – Remedial techniques.

Unit-D **12 Hour**

Management of hazardous wastes: Identifying a hazardous waste – methods – Quantities of hazardous waste generated – Components of a hazardous waste management plan – Hazardous waste minimization – Disposal practices tin Indian Industries – Future challenges

Recommended Books:

1. J. Glynn Henry and Gary. W. Heinke, *Environmental Science and Engineering,* Pretice Hall of India, 2004.
2. A. D.Bhide and B.B.Sundaresan, *Solid Waste Management – Collection, Processing and disposal,* Mudrashilpa Offset Printers, Nagpur, 2001.
3. Biomedical waste (Management and Handling) Rules, 1998.

DAV UNIVERSITY, JALANDHAR

Course Title: Biochemical Engineering

Course Code: CHL451

L	T	P	Credits
4	0	0	4

Course Objectives: The students will
1. Study introduction to the application of chemical engineering principles in biochemical systems.
2. Be enabled to understand the biological systems and kinetics of enzymatic reactions.
3. Learn the kinetics of growth of microorganisms, hence be able to control the process

UNIT-A **14 HOURS**

Introduction
Bioprocess engineering and technology. Role of a Chemical engineer in bioprocess industry. An introduction to basic biological sciences.Microbiology: Structure of cells: Prokaryotes and Eukaryotes. Classification of micro-organisms.Taxonomy, Whitaker's 5-kingdom concept. Characteristics and control of microorganisms. Environmental and Industrial microbiology.
Biochemistry: Chemicals of Life: Lipids, Sugars, Polysaccharides, Amino acids and proteins, Vitamins, Biopolymers, Nucleic Acids: RNA, DNA and their derivatives (Structure, Biological function and Importance for life only to be studied).

UNIT-B **14 HOURS**

Enzymes and Proteins: Detailed structure of proteins and enzymes: Primary, Secondary, Tertiary and quaternary. Functions. Production and purification of Enzymes (Methods only). Nomenclature and Classification of enzymes. Mechanism and Kinetics using various models. Kinetics of Enzyme action: Michaelis–Menten rate equation. Derivation with Equilibrium and Pseudo- (quasi-) steady state approximations. Experimental determination of rate parameters: Batch and continuous flow experiments.

UNIT-C **12 HOURS**

Enzyme Inhibition: Effect of Inhibitors (Competitive, noncompetitive, uncompetitive, substrate and product inhibitions), Temperature and pH on the rates enzyme catalyzed reactions.
Fermentation Technology: Ideal reactors: A review of Batch and Continuous flow reactors for bio kinetic measurements. Microbiological reactors: Operation and maintenance of typical aseptic aerobic fermentation processes. Formulation of medium: Sources of nutrients. Alternate bioreactor configurations. Introduction to sterilization of bioprocess equipment. Design of batch & continuous sterilization equipment

UNIT-D **12 HOURS**

Growth Kinetics of Microorganisms: Transient growth kinetics (Different phases of batch cultivation). Quantification of growth kinetics: Substrate limited growth, Models with growth inhibitors, Logistic equation, Filamentous cell growth model. Continuous culture: Optimum Dilution rate, Critical Dilution rate in Ideal Chemostat. Introduction to Fed-batch reactors. Strategies and Steps involved in product purification.

Reference Books:

1. Bailey and Ollis, *Biochemical Engineering Fundamentals*, 2nd Edition, McGraw Hill, 1986.
2. Shuler, M. L. and Kargi, F., *Bioprocess Engineering,* 2nd Edition, Prentice Hall, 2002.
3. Pelczer, *Microbiology Concept and Application,* 5th Edition, McGraw Hill, 2001 Reprint.
4. Stanbury and Whittaker, *Principles of Fermentation Technology*, 2nd Edition.

DAV UNIVERSITY, JALANDHAR

Course Title: Membrane Separation

Course Code: CHL452

L	T	P	Credits
4	0	0	4

Course Objective: The student will learn different membrane separation technological processes and their design

UNIT-A **12HOURS**

Fundamental, mechanisms of membrane transport. Gaseous diffusion. Membrane, osmosis and reverse osmosis, porosity, permeability, salt rejection, different membrane processes.

UNIT-B **12HOURS**

Physical and chemical properties of membranes, cellulosic and non cellulosic membrane

UNIT-C **12HOURS**

Techniques of membrane formation, membrane characteristics, type of membrane modules, liquid membranes.

UNIT-D **12HOURS**

Separation processes: Design, operation, maintenance and industrial applications of different membrane separation processes such as Reverse Osmosis, Ultra filtration, Electro Dialysis, nanofiltration pervaporation dialysis.

Reference Books:

1. Wilson, Sirkar, *Membrane Handbook*, McGraw Hill, London, 2001.
2. Nune, Peinemann, *Membrane Technology in Chemical Industries*, Wiley, New York, 2000.
3. Cheryan M., *Ultra filtration Handbook*, Technomic, New York, 1985.
4. Noble, Stern, *Membrane Separation and Technology, Principles and Applications*, Elsevier, 1995.
5. Baker R. W., *Membrane Technology and Applications*, Wiley, New York, 2000.

DAV UNIVERSITY, JALANDHAR

Course Title: Polymer Processing

Course Code: CHL453

L	T	P	Credits
4	0	0	4

Course Objectives: The student will learn about the different classification of polymer and rubbers and their strength properties

UNIT-A **12 HOURS**

Definition, types of polymers, functionality, polymerization reactions, polycondensation. Addition-free radical and chain polymerization. Co-polymerization kinetics of radical chain and tonic polymerization. Gelation phenomena.

UNIT-B **12 HOURS**

Molecular weight estimation: Average molecular weight, number average and weight average molecular weight. polydispersity, degree of polymerization.Methods of determination of molecular weight.
Polymerization Processes: Bulk, solution, suspension and emulsion polymerization. Thermoplastic composites, fiber reinforcement fillers.

UNIT-C **12 HOURS**

Polymer Processing: Thermoforming, injection moulding, extrusion moulding, calendaring rotational casting, film casting, blow moulding, foaming' Fiber spinning wet dry and melt.

UNIT-D **12 HOURS**

Polymerization Kinetics
Chemistry of step reaction polymerization, Mechanism and kinetics of poly condensation reactions, Relationship between average functionality, extent of reaction and degree of polymerisation. Mechanism and kinetics of free- radical chain polymerization, kinetic chain length, chain transfer reactions, Inhibition and retardation

Refrences BOOKS :

1. Gowarikar, V.R., Viswanathan, Sreedhar, J., *Polymer science*, Wiley eastern Limited,1993.
2. Ghosh, P., *Polymer Science and Technology: Plastics, Rubber, Blends and Composites* ,McGrraw Hill, 2010.
3. Billmeyer, F. W., *Textbook of polymer science,* John Wiley, 1984.

DAV UNIVERSITY, JALANDHAR

Course Title: Fertilizer Technology

Course Code: CHL454

L	T	P	Credits
4	0	0	4

Objective: The main objective of this courts is to study the various manufacturing processes , uses and application of different fertilizer

UNIT-A **12 HOURS**

Micro and macro nutrients fertilizer grades, different types of fertilizer, fertilizer storage and handling. Nitrogenous fertilizers

Synthesis gas: various feed stocks, merits/demerits. Synthesis gas production by stem reforming and partial oxidation, purification methods, shift convertors, carbon dioxide removal systems, final gas purification.

UNIT-B **12 HOURS**

Ammonia synthesis: Different types of reactors, their design considerations and operations. Urea: Physiochemical consideration. Various processes: Calcium ammonium nitrate sulphate, methods of production.

UNIT-C **12 HOURS**

Phosphatic fertilizer: Raw materials, triple super phosphate, phosphoric acid, processes of manufacture and their limitations.

UNIT-D **12 HOURS**

Potash fertilizer: Methods of production of potassium chloride and potassium sulphate. Complex NPK fertilizer: mono and di ammonium phosphates, urea ammonium phosphate, mixed fertilizer, granulation techniques.

Reference Books:

1. A.V. Slack, *Chemistry and Technology of fertilizer*, Interscience Publishers, 1966.
2. Dryden C. E., *Outlines of Chemical Technology*, 2nd Edition, East–West Press Pvt. Ltd., New Delhi, 1999.
3. Austin G. T., *Shreve's Chemical Process Industries,* 5th Edition, McGraw Hill Book Company, New Delhi, 2012

DAV UNIVERSITY, JALANDHAR

Course Title: Petrochemical Technology

Course Code: CHL455

L	T	P	Credits
4	0	0	4

Course Objective: The students will study about the petroleum industries and the operations that is carried out in them.

UNIT –A **10 HOURS**

An overview

Introduction to petroleum industry, world petroleum resources, petroleum industry in India. Origin, exploration & drilling of petroleum crude. Transportation of crude and products. Sources of petrochemicals-Natural gas and petroleum, classification of petrochemicals.

UNIT –B **14 HOURS**

Crude pretreatment: Refining and distillation of petroleum crude, composition and classification of petroleum crude, methods of evaluation: ASTM, TBP and EFV distillation. Properties and specifications of petroleum products such as LPG, gasoline, naphtha, kerosene, diesel, lubricating oils and waxes.

UNIT –C **12HOURS**

Separation Processes: Design and operation of topping and vacuum distillation units and tube still furnaces. Solvent extraction processes for lube oil base stock and for aromatics from naphtha and kerosene steams, solvent dewaxing.

UNIT –D **12 HOURS**

Conversion Processes: Thermal cracking: visbreaking and coking processes, catalytic cracking, thermal reforming and catalytic reforming, alkylation, polymerization, isomerization and hydroprocessing, Safety and pollution considerations in refineries.

References Books:

1. Rao, B.K., *Modern Petroleum Refining Processes*, 5th Edition, Oxford & IBH Publishing Co., 2009.
2. Nelson, *Petroleum Refinery Engineering,* 4th Edition, McGraw Hill, 1987.
3. Guthrie, V. B., *Petroleum Products Handbook,* McGraw Hill, 1960.

DAV UNIVERSITY, JALANDHAR

Course Title: Corrosion Engineering

Course Code: CHL456

L	T	P	Credits
4	0	0	4

Course Objective: The main objective of this course is to study the different types of corrosion and their prevention methods.

UNIT –A **12HOURS**

Basic concepts: Definition and importance, Electrochemical nature and forms of corrosion, Corrosion rate and its determination.

Electrochemical thermodynamics and kinetics: Electrode potentials, Potential-pH (Pourbiax) diagrams, Reference electrodes and experimental measurements, Faraday's laws, Electrochemical polarization, Mixed potential theory, Experimental polarization curves, Instrumentation and experimental procedure.

UNIT –B **12HOURS**

Galvanic and concentration cell corrosion: Basic concepts, Experimental measurements, and determination of rates of galvanic corrosion, Concentration cells.

Corrosion measurement through polarization techniques: Tafel extrapolation plots, Polarization resistance method, Instrumental methods and Errors in measurement of polarization resistance, Commercial corrosion probes, Other methods of determining polarization curves.

UNIT –C **12HOURS**

Passivity: Basic concepts of passivity, Properties of passive films, Experimental measurement, Applications of Potentiostatic Anodic Polarization, Anodic protection.

Pitting and crevice corrosion: Basic concepts, Mechanisms of pitting and crevice corrosion, Secondary forms of crevice corrosion, Localized pitting, Metallurgical features and corrosion: Inter-granular corrosion, Weldment corrosion, De-alloying and dezincification.

Environmental induced cracking: Stress corrosion cracking, Corrosion fatigue cracking, Hydrogen induced cracking, Some case studies, Methods of prevention and testing, Erosion, Fretting and Wear.

UNIT–D **12HOURS**

Environmental factors and corrosion: Corrosion in water and Aaqueous Ssolutions, Corrosion in sulphur bearing solutions, Microbiologically induced corrosion, Corrosion in soil, Corrosion of concrete, Corrosion in acidic and alkaline process streams.

Atmospheric and elevated temperature corrosion: Atmospheric corrosion and its prevention, Oxidation at elevated temperatures, Alloying, Oxidising environments.
Prevention and control of corrosion: Cathodic protection, Coatings and inhibitors, Material selection and design.

References Books:

1. Fontana, M.G., *Corrosion Engineering,* Tata McGraw-Hill , 2005.
2. Jones, D.A., *Principal and Protection of Corrosion,* Prentice-Hall ,1995.
3. Pierre R. Roberge, *Corrosion engineering: principles and practice,* McGraw-Hill , 2008.
4. Mantell, C.L., *Electrochemical Engineering*, McGraw-Hill, New York, 1960.
5. Sastri, V.S., Ghali, E. and Elboujdaïni, M.,*Corrosion prevention and protection: practical solutions*, John Wiley and Sons, 2007

DAV UNIVERSITY, JALANDHAR

Course Title: Alternate Energy Technology

Paper Code: CHL457

L	T	P	Credits
4	0	0	4

Course Objective: The students will study the non-conventional sources of energy which has higher priority with reference to national needs. It deals with the different non-conventional energy systems such as solar energy, wind energy, energy from biomass and biogas, geothermal energy, energy from oceans, chemical energy sources.

Unit-A **12 HOURS**

Introduction: Energy, Present and future trends of energy consumption, Resources in India and worldwide, Introduction to different non-conventional energy sources, Detailed study of following sources with particular reference to India.

Solar energy: Solar radiation and its measurement, Limitation in application of solar energy, Solar collectorstypes and constructional details, Solar water heating, Application of solar energy for residential and industrial heating, Drying, Space cooling, Water desalination, Photovoltaic power generation using silicon cells.

UNIT-B **12 HOURS**

Bio-Fuels: Importance, Combustion, Pyrolysis and other thermo chemical processes for biomass utilization bperformance analysis, Alcoholic fermentation, Anaerobic digestion for biogas production

Wind Power: Principle of energy from wind, Windmill construction, Operational details, Electricity generation, Mechanical power production.

UNIT-C **12 HOURS**

Tidal Power: Introduction, Causes of tides and their energy potential, Enhancement of tides, Power generation from tides and problems, Principles of ocean thermal energy conversion (OTEC) analysis.

Geothermal Energy: Geo thermal wells and other resources dry rock and hot aquifer analysis, harnessing geothermal energy resources.

UNIT-D **12 HOURS**

Energy Storage and Distribution: Importance, Biochemical, Chemical, Thermal, Electrical storage, Fuel cells, distribution of energy.

Scope and Economics: Calculation of energy cost from renewable, Comparison with conventional fuel driven systems, Calculation of CO reduction, Incremental costs for renewable options.

Reference Books:

1. Rai, G.D., *Non-Conventional Energy Sources*, Khanna Publishers ,2001.
2. Twiddle, J. Weir, T., *Renewable Energy Resources,* Cambridge University Press, 1986.
3. Duffie, J. A., Beckman, W. A., *Solar Engineering of Thermal Processes,* John Wiley, 1980.
4. Sukhatme, S. P., *Solar Energy: Principles of Thermal Collection and Storage,* Tata McGraw-Hill, 2001.
5. Garg, H.P. and Prakash, J., *Solar Energy: Fundamentals and Applications*, Tata McGraw-Hill .2001.

DAV UNIVERSITY, JALANDHAR

Course Title: Paint Technology

Paper Code: CHL459

L	T	P	Credits
4	0	0	4

Course Objectives: The student will learn basics of paint manufacturing process, Paint applications, Quality control of paints Safety and Hazards in paint industry

UNIT-A **12 HOURS**

Introduction: Paints and their general ingredients, function of ingredients and classification of paints. Decorative and industrial coating: latest types of surface coating and their advantages. Raw materials of Paints like drying oil boiled oils, natural and synthetic resins. Extends and prime pigments and additives, Varnishes and Lacquers: Classification of varnishes and lacquers. Formulation and manufacture of varnishes and lacquers

UNIT-B **12 HOURS**

Paint Manufacturing: Formulation and manufacture of paints and machinery used in paint manufacture.

Paint Applications: Surface Preparation Selection of industrial paints for different end uses. Practical aspects for use & application of paints. Type of surfaces and paint, application techniques for large surfaces.

UNIT-C **12 HOURS**

Surface preparation and treatments: Surface Preparation : (a) Mechanical - Hard cleaning, power tool cleaning, flame cleaning, Blast cleaning, cleaning & welds (b) Chemical - Solvent wiping & degreasing, alkali cleaning emulsification. Application techniques: Paint application techniques. Paint defects: Classification, causes & remedies

UNIT-D **12 HOURS**

Quality control of paints, various tests of paints, Quality control and management of paints, Safety and Hazards: Safety practices and devices used in paint industries. Health hazards and prevention in paint industries, Case studies.

Reference Books:

1. Morgan W.M., *Outlines of Paint Technology.*, 3rd ed, CBS Publishers & Distributors, 2003
2. Paul S., *Surface coating*, 2nd ed., John Wiley & Sons Ltd, 1996
3. Dryden C. E., *Outlines of Chemical Technology*, 2nd Edition, East–West Press Pvt. Ltd., New Delhi, 1999.
4. Austin G. T., *Shreve's Chemical Process Industries*, 5th Edition, McGraw Hill Book Company, New Delhi, 201

DAV UNIVERSITY, JALANDHAR

Course Title: Application of Nano Technology in Chemical Engineering

Paper Code: CHL460

L	T	P	Credits
4	0	0	4

Course Objectives: The student will learn Application of Nano Technology in Chemical Engineering

Unit-1 **10 HOURS**

Introduction : Background and Definition of Nanotechnology. Applications in Different Fields, Chemical Approaches to Nanostructured Materials, Solid State Devices.

Microscopy :Microscopy - Scanning Tunneling Microscope, Atomic Force Microscope, Scanning Electron Microscopy, Principles of Noncontact Atomic Force Microscope (NCAFM)

Unit-2 **12 HOURS**

Carbon Nanotubes: Carbon Nanotubes - Structure of Carbon Nanotubes, Synthesis of Carbon Nanotubes, Growth Mechanisms of Carbon Nanotubes, Properties of Carbon Nanotubes, Carbon Nanotube-Based Nano-Objects, Applications of Carbon Nanotubes, Nanowires–Synthesis, Characterization and Physical Properties of Nanowires,Applications.

Unit-3 **14 HOURS**

Fabrication Techniques: Basic Microfabrication Techniques, MEMS Fabrication Techniques, Nanofabrication Techniques, Stamping techniques - High Resolution Stamps, Microcontact Printing, Nanotransfer Printing, Applications.

Applications: Material aspects of NEMS and MEMS–Silicon, Germanium-Based Materials, Metals, GaAs, InP, and Related III-V Materials, MEMS Devices and Applications - Pressure Sensor, Inertial Sensor, Optical MEMS, RF MEMS, NEMS Devices and Applications, Current Challenges and Future Trends

Unit-4 **12 HOURS**

Nano Composites: Introduction, Polymer as Matrix, Nylons, Polyolefins, Polystyrene, Epoxy resins, Nano Materials as a Filler, Nano fibre, Nano clay, Fabrication and Processing of Composites, Benefits to Ultimate Physical, Mechanical and Thermal Properties, Nano structured Materials,

Reference Books:

1. B. Bhushan, (in Eds.) ,*Springer handbook of nanotechnology.*
2. , Springer – Verlag, 2004
3. Elnashaie, S. E., *Nanotechnology for Chemical Engineers*, Springer-2015.
4. Poole, C.P., Frank K. , *Introduction to Nanotechnology,* A John Wiley and Sons, Inc, Publication, 2003.

DAV UNIVERSITY, JALANDHAR

Course Title: Industrial pollution control

Course Code: CHL801

L	T	P	Credits
4	0	0	4

Course Objectives: The main objective of this course is to understand the various types of industrial pollution and their control methods

UNIT-A **10 Hours**

Introduction: Pollution due to industries with special reference to chemical process industries.

Wastewater characterization: Solids analysis of wastewater, Physical characteristics of wastewater, Chemical characteristics of wastewater; inorganic pollutants, organic pollutants; their harmful effects. Wastewater discharge standards and regulations.

UNIT-B **12 Hours**

Wastewater treatment: Primary treatment of wastewater; Flow equalization, Primary clarifiers, construction and working. Secondary treatment of wastewater; biological treatment methods; aerobic suspended growth processes, attached growth processes. Working of aerobic lagoons, activated sludge process, trickling filters. Wastewater treatment by adsorption, membrane separation.

UNIT-C **14 Hours**

Air pollutants: Natural and anthropogenic sources of air pollutants such as particulates, oxides of sulphur, oxides of nitrogen, carbon monoxide, hydrocarbons etc. Secondary air pollutants. Environmental impacts of air pollutants. Ambient and emission standards for air pollutants.

Meteorological factors in Air pollution: Atmospheric turbulence. Lapse rate and atmospheric stability. Wind velocity and distribution, windrose diagram. Plume behaviour.

UNIT-D **12 Hours**

Air pollution control: Air pollution control devices; settling chambers, cyclone separators, bag filters, electrostatic precipitators; construction and working. Control of gaseous pollutants.

Solid waste management: Biochemical treatment, Thermochemical treatment, landfilling

References:

1. Metcalf & Eddy, *Wastewater Engg. Treatment, Disposal, Reuse*; Tata McGraw Hill
2. Dhameja, S. K . *Environmental Science*, S. K. Kataria & Sons, 2010.
3. Rao , C.S, *Environmental Pollution Control Engineering,* New Age Publication,3rd Edition ,2013.
4. Rao M. N., Rao H. V. N., *Air Pollution,"*Tata McGraw Hill Publishing Company Ltd.,2005.

DAV UNIVERSITY, JALANDHAR

Title: Fuel Cell Technology

Course Code: CHL802

L	T	P	Credits
4	0	0	4

Course Objectives: The course is aimed at providing the information about fuel cells, their types, fundamentals, technology and the problems associated with fuel cell technology.

UNIT-A **10 Hours**

Introduction:

Fuel Cell definition and basics- cathode, anode, electrolyte, Difference between a fuel cell and a battery, Advantages and disadvantages, Basic fuel cell operation

UNIT-B **14 Hours**

Fuel Cell Fundamentals Relationship between Gibb's free energy and electric work/ electric voltage, Reversible Voltage/ potential of fuel cell using standard electrode potentials, Effect of temperature and pressure on fuel cell potential, Nernst equation, Fuel cell efficiency, concept of OCV Current density, Losses in fuel cell- activation loss, ohmic loss and concentration loss,

UNIT-C **14 Hours**

Fuel cell performance curve 1-D model for a fuel cell, application of model to SOFC and PEMFC Types of Fuel Cells Construction, fuels and usage of Phosphoric Acid Fuel Cell, Polymer Electrolyte Membrane Fuel Cell, Alkaline fuel cell, Molten Carbonate Fuel Cell, Solid Oxide Fuel cell Relative advantages and disadvantages of the various types of fuel cells

UNIT-D **10 Hours**

Fuel Cell Systems Fuel cell stack, engineering issues related to Fuel Cell Technology Hydrogen as a fuel, availability and engineering issues

References:

1. Hayre R.O., Cha S., Colella W., Prinz F. B., *Fuel Cell Fundamentals***,** John Wiley and Sons, 2006
2. Berger E. D., *Handbook of Fuel Cell Technology*, Prentice-Hall, 1968
3. Vielstich W., Lamm A., Gasteiger H. A*., Handbook of Fuel Cells*, Vol. 2, Wiley, 2003