उत्तराखण्ड प्राविधिक शिक्षा परिषद् रुड़की (हरिद्वार)

पताः सुनेहरा रोड (निकट–के. एल. पालीटेक्निक छात्रावास), काशीपुरी –247 667
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सेवा में,

समस्त प्रधानाचार्य/निदेशक
परिषद् से सम्बद्ध समस्त
डिप्लोमा इंजीनियरिंग संस्थान।

पत्रांक 1311 /पाठ्यचर्या/आई.आर.डी.टी./2013–14दिनांक 12/07/2013

महोदय,

उत्तराखण्ड प्राविधिक शिक्षा परिषद् की दिनांक 24 जून 2013 को हुई शैक्षणिक समिति की बैठक में दिये गये सुझावों को समावेश करते हुए अध्यक्ष शैक्षणिक समिति द्वारा तृतीय/चतुर्थ सैमिस्टर हेतु अनुमोदित पाठ्यचर्या सत्र 2013–14 से लागू की जानी है।

परिषद् से सम्बद्ध समस्त संस्थान नवीन पाठ्यचर्या लागू करना सुनिश्चित करें, आगामी सैमिस्टर परीक्षाएं संशोधित नवीन पाठ्यचर्या से ही करायी जाएगीं।

संलग्नक – तृतीय/चतुर्थ सैमिस्टर इंजीनियरिंग ब्रान्चों की नवीन पाठ्यचर्या।

(हरि सिंह)
सचिव

सूचना

तृतीय एवं चतुर्थ सेमेस्टर के विभिन्न इंजीनियरिंग पाठ्यक्रमों की संशोधित पाठ्यचर्या सुझावों आमंत्रण हेतु परिषद् की वेबसाइट पर प्रसारित की गई थी। तद्नुसार प्राप्त उपयोगी सुझावों को विशेषज्ञ समूह के साथ मंथन के उपरान्त पाठ्यचर्या में समाहित कर दिया गया है। सत्र 2013–14 से लागू की जाने वाली इंजीनियरिंग पाठ्यक्रम हेतु तृतीय एवं चतुर्थ सेमेस्टर की पाठ्यचर्या परिषद् की वेबसाइट पर प्रसारित की जा रही है। पाठ्यचर्या में यदि कहीं पर spelling/ Evaluation sheet या अन्य कोई त्रुटि हों तो कृपया अधोहस्ताक्षरी की E-mail : rpgupta0106@gmail.com पर अवगत कराने का कष्ट करें।

(आर0पी0गुप्ता)
संयुक्त सचिव
आई0आर0डी0टी0

UTTARAKHAND BOARD OF TECHNICAL EDUCATION, ROORKEE

CURRICULUM

FOR

DIPLOMA PROGRAMME IN

CHEMICAL ENGG

FOR UTTARAKHAND

(Third & Fourth Semester Only)

Approved by:

UTTARAKHAND BOARD OF TECHNICAL EDUCATION
ROORKEE
247 667

THIRD SEMESTER (CHEMICAL ENGINEERING)

Sr. No	Subject	Hrs/week			EVALUATION SCHEME						Total Marks
					Internal Assessment		External Assessment (Examination)				
					Theory	Practical	Theory		Practical		
		L	T	P	Max. Marks	Max. Marks	Max. Marks	Hrs	Max. **Marks**	Hrs	
3.1	Fundamental of Electrical and Electronics Engineering **	4	-	4	30	20	70	2.5	50	3.0	170
3.2	Elements of Chemical Engg.	4	-	4	30	20	70	2.5	50	3.0	170
3.3	Fluid Mechanics **	4	-	4	30	20	70	2.5	50	3.0	170
3.4	Fuels and Material Science	4	-	0	30	-	70	2.5	-	-	100
3.5	Mechanical Operations**	4	-	4	30	20	70	2.5	50	3.0	170
3.6	Process Instrumentation **	4	-	4	30	20	70	2.5	50	3.0	170
General Proficiency#		-	-	4	-	25	-	-	-	-	25
Industrial Exposure (Assessment at Institute Level) ++		-	-	-	-	25	-	-	-	-	25
Total		**24**	**-**	**24**	**180**	**150**	**420**	**-**	**250**	**-**	**1000**

** Common with diploma programme in Chemical Technology (Paint) and Chemical Technology (Rubber & Plastic)

General Proficiency will comprise of various co-curricular activities like games, hobby clubs, seminars, declamation contests, extension lectures, field visits, NCC, NSS and cultural activities G.K., General Study, Elementary Math. And Discipline.

++ Industrial Visit compulsory at minimum two industries or department.

Note: 1- Each period will be of 50 Minute. 2- Each session will be of 16 weeks. 3- Effective teaching will be of at least 12.5 weeks.

FOURTH SEMESTER (CHEMICAL ENGINEERING)

Sr. No	Subject	Hrs/week			EVALUATION SCHEME						Total Marks
					Internal Assessment		External Assessment (Examination)				
					Theory	Practical	Theory		Practical		
		L	T	P	Max. Marks	Max. Marks	Max. Marks	Hrs	Max. **Marks**	Hrs	
4.1	Chemical Engineering Thermodynamics **	5	-	-	30	-	100	2.5	-	-	130
4.2	Chemical Technology-1	5	-	-	30	-	100	2.5	-	-	130
4.3	Heat Transfer Operations**	4	2	4	30	20	70	2.5	50	3.0	170
4.4	Material and Energy Balance**	4	2	-	30	-	100	2.5	-	-	130
4.5	Process Control**	4	-	4	30	20	70	2.5	50	3.0	170
4.6	Process Plant Utility	4	-	-	30	-	100	2.5	-	-	130
4.7	Minor Project	-	-	6	-	40	-	-	50	3.0	90
4.8	4 weeks Industrial Training after having appeared in the Fourth semester exam, during summer vacation and its evaluation will be done in Fifth semester exam.										
General Proficiency#		-	-	4	-	25	-	-	-	-	25
Industrial Exposure (Assessment at Institute Level) ++		-	-	-	-	25	-	-	-	-	25
Total		**26**	**4**	**18**	**180**	**130**	**540**	**-**	**150**	**-**	**1000**

** Common with diploma programme in Chemical Technology (Paint) and Chemical Technology (Rubber & Plastic)

General Proficiency will comprise of various co-curricular activities like games, hobby clubs, seminars, declamation contests, extension lectures, field visits, NCC, NSS and cultural activities G.K., General Study, Elementary Math. And Discipline.

++ Industrial Visit compulsory at minimum two industries or department.

Note: 1- Each period will be of 50 Minute. 2- Each session will be of 16 weeks. 3- Effective teaching will be of at least 12.5 weeks.

THIRD SEMESTER

3. DETAILED CONTENTS OF VARIOUS SUBJECTS

3.1 FUNDAMENTAL OF ELECTRICAL AND ELECTRONICS ENGINEERING

L	T	P
4	-	4

RATIONALE

The objective of the course is to impart basic knowledge and skills regarding electrical and electronics engineering, which diploma holders will come across in their professional life

DETAILED CONTENTS

1. Overview of Electricity:

General use and applications of electricity; Use and applications of electricity to chemical Engineering, Paint Technology and Rubber Technology Advantages of electrical energy over other forms of energy.

(04 hrs)

2. DC Circuits:

Introduction to basic terms: charge, current, voltage, power, and energy; Ohm's law; Power dissipation in resistors; Series and parallel combination of resistors; Kirchhoff's laws; Star-delta conversions; Ideal and practical voltage source; Current source.

(06 hrs)

3. AC Circuits:

Concept of alternating voltage and current; Introduction to basic terms: cycle, frequency, time period, amplitude, instantaneous value, rms value, peak value, phase difference, form factor, and peak factor; Concept of phasor; Phasor diagrams; Concepts of reactance, impedance, admittance, susceptance, and conductance; Concepts of instantaneous power, real power, reactive power, apparent power, complex power, and power factor; Analysis of simple AC circuits; Overview of three-phase AC circuits.

(10 hrs)

4. Batteries and Solar Cells:

Primary and secondary cells; Construction, working, and applications of Lead-Acid,; Charging methods for Lead-Acid batteries; Maintenance of Lead-Acid batteries; Series and parallel connection of batteries; Maintenance free batteries; General idea of solar cells, solar panels and their applications.

(06 hrs)

5. Electrical Machines:

Electromagnetic induction; Introduction to magnetic circuits; Principles of electromechanical energy conversion; Construction and operation of single phase transformers; Tests of transformers; Efficiency and regulation; Operation of autotransformers;. Types of three-phase induction motors; principle of operation,; Methods of starting and speed-control of three-phase induction motors; Overview of single-phase induction motors.; Construction and operation of synchronous machines; Construction and operation of stepper motors. Applications of single and three phase induction motors.

(10 hrs)

6. Semi Conductor Physics

Conductors, Insulators, Semiconductors, Idea of Energy Level, Energy Band Diagrams of Insulators, Conductors and Semiconductors, Effect of Temperature, Recombination of holes and electrons, n-type semiconductor, p-type semiconductor, Majority and Minority Carriers.

(04 hrs)

7. Semi Conductor Diode

Mechanism of current conduction and characteristics of ordinary diode, zener diode, LED

(06 hrs)

8. Transistor

Principle of operation characteristics and applications of BJT, JFET, MOSFET, UJT, Concept of configurations.

(06 hrs)

9. Electrical & Electronics Measuring Instruments

Construction and working Principle of PMMC and moving Iron voltmeter and ammeters, single phase dynamometer, wattmeter and induction type energy meter, operation and use of Analog, Digital multimeter, CRO and signal generators.

(06 hrs)

10. Electrical Installation and Safety:

Various accessories and parts of electrical installation; Overview of industrial and domestic wiring systems; Common electrical safety measures; Protection and precaution against electrical shock; Treatment of electrical shock; Basic protective devices like fuse, MCB, thermal overload relay, ELCB, and RCCB; Concepts and types of earthing; Protection against lightning.

(06 hrs)

LIST OF PRACTICALS

1. Verification of Ohm's Law.
2. Verification of KCL and KVL.
3. Test of charging and discharging of lead-acid battery using hydrometer.
4. Connection of a three-phase motor and starter with fuses and reversing of direction.
5. Study of a distribution board for domestic and industrial installation.
6. Open-circuit and short-circuit test on a single-phase transformer.
7. Star-delta starting of induction motors.
8. To draw V-I characteristics of PN-Junction diode and LED.
9. To draw input and output characteristics of a transistor in CB and CE configurations.
10. Use of analog & digital multimeter and measure resistance, voltage & current.
11. Use of CRO & measurement of frequency & voltage.
12. Use of Zener diode as a regulator.

RECOMMENDED BOOKS

1. Principle of Electrical Engineering by V.K. Mehta, S Chand Publication.
2. Basic Electrical Engineering by J.B. Gupta, S.K. Kataria & sons.
3. Basic Electrical Engineering by Sahdev & Sahdev, Uneek Publication.
4. Fundamental of Elex for polytechnics by Subhadeep Chaudhary, Paragon international Publication
5. Electrical machines by S.K. Bhattacharya Tata McGraw Hill Education Private Limited.

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	**Time Allotted (Hrs)**	**ks Allotted (%)**
1	04	05
2	06	10
3	10	15
4	06	15
5	10	05
6	04	10
7	06	10
8	06	10
9	06	10
10	06	10
TOTAL	**64**	**100**

3.2 ELEMENTS OF CHEMICAL ENGINEERING

L	T	P
4	-	4

RATIONALE

It is an introductory subject to be given to students opting for chemical engineering. It will expose the students to various areas to be covered in this course which have applications in field jobs where they can find employment. The course will also impart elementary knowledge, to the students regarding units and conversions.

DETAILED CONTENTS

1. Introduction: (05 Hrs)

Definition of chemical engineering, scope of chemical engineering with respect to new emerging areas in the field of chemical engineering like environmental engineering, bio-chemical and biomedical engineering, membrane techniques, polymer science engineering, factors to be taken in to account in the location of chemical industries.

2. Concept of unit operations and processes: (14 Hrs)

Unit Operations: Definitions, symbols and examples of unit operations like Distillation, Evaporation, Gas absorption, Extraction; size reduction, sedimentation, filtration; fluid handling, fluid solid contacting, fluid solid separation, fluid storage, mixing, solid handling, solid-solid separations, crystallization, drying, leaching, size separation and heat transfer.

Unit Processes**:** Introduction to unit processes with simple examples like sulphonation, polymerization, oxidation, reduction, hydrogenation, hydration, ammonolysis, chlorination, amination, calcination, and cracking/ pyrolysis.

3. Material and energy balance: (05 Hrs)

Scope of Material and Energy balance in process Industries.

4. Concept of dimensions & units: (10 Hrs)

Classification of system of units- Base units, Derived units and multiple units, Conversion of units.

Basic chemical Calculations: Atomic weight, Molecular weight, Basis of Calculation, Gram atom, Gram mole, Equivalent weight, Simple numerical Problems,

5. Methods of expressing the composition of mixtures and solutions: (10 Hrs)

Normality, Molarity, Molality, Weight Percent, Volume percent, Mole percent Mole fraction, Weight fraction, Simple numerical problems.

6. Behaviour of Ideal Gas Law: (20 Hrs)

Ideal gas law, PVT relationship, Normal temperature and pressure (NTP), Standard temperature and Pressure conditions (STP).Gaseous Mixtures: Partial Pressure, Pure component volume, Dalton's Law, Amagat's Law, Relation

between Partial pressure, Mole fraction of component gas to Total pressure. Average Molecular weight of gas mixture, Density of gas mixture, Simple numerical problems.

LIST OF PRACTICALS

1. To study and draw layout of chemical engineering laboratories.
2. To determine the heat load to be removed from the hot fluid by double pipe heat exchanger.
3. To determine the amount of heat required to evaporate per kg.
4. To find out the energy possess by liquid and solid fuels.
5. To study and calibrate the given manometer for level measurement.
6. To study centrifugal pump.
7. To study Reynolds's experiment.
8. To study and draw layout of chemical industry/ plant visited during two days per month also draw sketches of various chemical engineering equipment in the visited industry.

INSTRUCTIONAL STRATEGY

The teacher should make the students aware of the fundamentals of chemical engineering. Its scope with respect to the new emerging areas in the field of chemical engineering like Environmental Engineering , Polymer Science, Bio-Chemical etc.

RECOMMENDED BOOKS

1. Introduction to Chemical Engineering by Little John, CE and Meenaglum CM; McGraw Hill.
2. Introduction to Chemical Engineering by Anderson LB; McGraw Hill Publication.
3. Basic Principles of Chemical Engineering by Shaheen El; Joplin, Missouri, USA.
4. Elementary Principles of Chemical Processes Second Edition by Felder RM and Fouisseau RW; John Wiley and Sons.
5. Basic Principles and Calculations of Chemical Engineering by Himmelbleu DM; Prentice Hall.
6. Unit Operations of Chemical Engineering by McCabe and Smith, McGraw Hill Publication.
7. Elementary Chemical Engineering by Petu, McGraw Hill Publication
8. Introduction to Chemical Engineering by Shyamal K. Sanyal, Siddhartha Datta, Tata McGraw Hill Publication.

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1	4	10
2	4	10
3	12	20
4	10	10
5	15	20
6	15	20
7	04	10
Total	**64**	**100**

3.3 FLUID MECHANICS

L	T	P
4	-	4

RATIONALE

The knowledge of fluid flow is very essential because all chemical plants have fluid flow operations. The examples are flow of stream and gases in pipes, flow of liquid in pipes and open channels etc. This subject aims at the basic concepts of fluid flow, measurement techniques involved for the same and equipment used for the transportation of fluids. With this background, students will be able to find out quantitatively material and power requirements for a process.

DETAILED CONTENTS

1. Classification of fluids: (02 hrs)

Compressible fluids, incompressible fluids, Newtonian and Non-Newtonian fluids, Properties of fluids (only definitions), mass density, weight density, vapour pressure, specific gravity, viscosity, surface tension, compressibility, thermal conductivity, specific volume.

2. Various types of flow: (02 hrs)

Steady and unsteady flow, uniform and non-uniform flow, streamline flow, laminar and turbulent flow

3. Various types of manometer: (04 hrs)

U-tube manometer, inclined manometer, differential manometer / two liquid manometer / Multiplying gauge, simple numerical problems.

4. Basic equations of fluid flow: (18 hrs)

Stream line and stream tube, Average velocity, Mass velocity, Equation of continuity, derivation of continuity equation, Bernoulli's theorem, derivation of Bernoulli's equation, Hagen Poiseulli's equation, friction factor chart, Fanning equation, friction losses in pipes, friction loss from sudden enlargement and contraction, friction losses in various types of fittings and valves, effect of roughness, Equivalent length, Form fiction losses in Bernoulli's equation, Simple numerical problems related to above topics.

5. Flow measurements: (15 hrs)

Classification of flow meters, principle, construction, working, derivation of flow equation, advantages, disadvantages of (i) Venturimeter (ii) Orifice meter (iii) Pitot tube (iv) Rotameter, difference between Orifice meter and Venturimeter, Measurement of flow in open channels, classification of notches, derivation of total discharge equation of Rectangular notch and V-Notch, advantages of V-Notch over rectangular notch.

6. Transportation of fluids: (23 hrs)

Classification of pipes and fittings, different types of pipes, tubes and fittings, Schedule number, Birmingham wire gauge (BWG), internal diameter and outer diameter of pipes, difference between pipe and tube,

Classification of valves, gate valve, globe valve, ball valve, diaphragm valve, needle valve, butterfly valve,
Classification of pumps,
(i) Centrifugal pumps, principle, construction or components of centrifugal pumps, working, advantages and disadvantages, Head of a centrifugal pump, priming, cavitation and Net Positive Suction Head (NPSH), power requirement and efficiency of centrifugal pump, characteristics curves, centrifugal pump troubles and remedies.
(ii) Positive displacement pumps, positive displacement pumps classification, Reciprocating pump, classification of reciprocating pumps, piston pumps, plunger and diaphragm pumps, single acting and double acting, Rotary pumps.
Comparison of centrifugal and reciprocating pump, advantages of centrifugal pump over reciprocating pump.
Centrifugal blowers, compressors, vacuum pumps: rotary vacuum pump, steam jet ejectors, water ejectors.

LIST OF PRACTICALS

1. To determine the co-efficient of discharge of Orifice meter.
2. To determine the co-efficient of discharge of Venturi meter
3. To determine the co-efficient of discharge of V-Notches.
4. To determine the co-efficient of discharge of rectangular notches
5. To determine coefficient of velocity (Cv). coefficient of discharge (Cd), coefficient of contraction (Cc) and verify the relation between them.
6. To determine frictional losses in pipes and fittings.
7. To determine the equivalent length of pipes and fittings.
8. To verify Bernoulli's Theorem.
9. To determine the efficiency of a centrifugal pump.
10. To determine point velocity in a pipe by Pitot tube.

INSTRUCTIONAL STRATEGY

This syllabus is designed in such a way that the students get theoretical as well as practical knowledge about all the topics so that students should be first taught theoretical knowledge and then practical knowledge. The students may be asked to make files related to their experiments.

RECOMMENDED BOOKS

1. Unit Operation of Chemical Engineering by McCabe and Smith; McGraw Hill Publication

2. Chemical Engineering Vol. I and II by Coulson and Richardson; Pergamon Press Publication

3. Introduction to Chemical Engineering by Badger and Banchero; McGraw Hill Publication

4. Principles of Unit Operations by Foust John; Wiley Eastern Publication

5. Unit Operations by Brown, John Wiley Publications

6. Unit Operation – 1 (Fluid Flow and Mechanical Operations) by Gavhane KA; Nirali Prakashan

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1	02	05
2	02	05
3	04	10
4	18	25
5	15	20
6	23	35
Total	**64**	**100**

3.4 FUELS AND MATERIAL SCIENCE

L	T	P
4	-	-

RATIONALE

The students of chemical engineering has to deal with various types of fuels and materials. The fuels generally used are solid, liquid and gaseous. Their properties, advantages and disadvantages are included in the curriculum. Also a knowledge of non-conventional fuels will be imparted.

DETAILED CONTENTS

1. Introduction: (04 Hrs)

Types of conventional fuels, Characteristics of a good fuel, their merits and Demerits.

2. Solid fuels: (19 Hrs)

Classification of fuels- wood, charcoal, peat, coal, Indian classification of coal – rank of coal, caking and coking coal; Origin of coal, properties of coal. Testing/ Analysis- proximate and ultimate analysis, Methods of storage of coal; coal preparation. Washing methods of coal- objective of coal washing, advantages of coal washing. Various type of coal washing processes, (a) gravity separation- (i) wet process – lauder washer, jig washer (ii) dry process – jig washer (b) float and sink method- froth floatation. Pulverization of coal, various uses of coal.
Liquid Fuel: Advantages & disadvantages
Gaseous Fuels: Advantages & disadvantages

3. Furnaces: (08 Hrs)

Classification of furnaces, chimney gases and draught, furnace atmosphere, operation in different chemical and allied industries.

4. Atomic structure: (10 Hrs)

Different types of crystal structure, BCC, HCC, FCC, Melter indices of plans, structure of common metallic, polymeric, ceramic and amorphous materials.

5. Ferrous materials: (10 Hrs)

Cast Iron, plain carbon steel, low alloy steel, high alloy steel, types of stainless steel, effect of alloying elements on steel, iron carbon phase diagrams.

6. Other materials: (13 Hrs)

Introduction to non-ferrous material, copper, brass, bronze, aluminum, Non-metallic materials and their construction, Ceramic: types of specialty glasses, refractory, properties and application, Polymers: classification, comparison of properties of various polymers and their applications.

INSTRUCTIONAL STRATEGY

This specialized subject will enable the students to study the various conventional and non-conventional sources of energy. So the theoretical knowledge of this subject should be properly imparted to the students with the help of practical examples. Each topic should be supplemented with assignments.

RECOMMENDED BOOKS

1. Elements of Fuels, Furnaces and Refractories by OP Gupta,
2. Fuel – Solid, Liquid and Gaseous by Brame, JS and king JC, Students. Martin Press
3. Fuels and Fuel Technology, Vol I & II by Francis W, Pargamon Press
4. Coal, Coke and Coal Chemicals by Wilson, PJ Wells, GH, McGraw Hill
5. Introduction to Engineering Materials by Raghvan
6. Science and Engineering of Materials by Askelland. Donald R.
7. Introduction to Material Science for Engineers by Shacketford, Jaiw. F.

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1	04	05
2	19	30
3	08	15
4	10	15
5	10	15
6	13	20
Total	**64**	**100**

3.5 MECHANICAL OPERATIONS

L	T	P
4	-	4

RATIONALE

This subject gives the knowledge of working of individual mechanical operations and their significance in chemical industries. With this information, students, learn about the control of operation of equipment and regulate production.

DETAILED CONTENTS

1. Introduction: (04 Hrs)

Concept and role of unit operation in industries, force, pressure, work, power, heat.

2. Size Reduction (Communition): (15 Hrs)

Size reduction, necessity of size reduction, principles of size reduction, characteristics of size reduced/ comminuted product, expression for power required by machines, Rittinger's law, Kick's law, Bond's law and work index, simple numerical problems.

Size reduction equipment:

Classification of size reduction equipment, general description of crushers: Jaw crusher, Gyratory crusher, Roll crusher, Grinders: Hammer mill, Ball mill, critical speed of Ball mill, difference in crushing and grinding, Equipment operation: (i) Open circuit (ii) Closed circuit.

3. Characterization of solid particles: (15 Hrs)

Characterization of solid particles, particle shape, sphericity, particle size, particle size measurement by screen analysis, mesh, screen aperture or screen size opening, differential and cumulative methods of analysis of particle size, specific surface of mixture, average particle size, number of particles in a mixture.

Screen analysis: Tyler standard screen series (or US sieve series), screening, types of screening equipment their construction, working, vibrating screens, Grizzlies and Trommels, comparison of Grizzlies and Trommels.

4. Handling of solids: (10 Hrs)

Mechanical and pneumatic conveying equipment, classification of conveying equipment, general construction, working and industrial application of Belt conveyors, Chain conveyors, Bucket conveyors, Bucket elevators, Screw conveyors, Pneumatic conveyors.

5. Mechanical separations: (15 Hrs)

Filtration and sedimentation: define filtration, filter medium, characteristics of filter medium, filtrate, filter aids, characteristics of filter aids.

Types of filtration: (i) cake filtration (ii) deep bed filtration

Classification of filter equipment: (i) clarifying filter (ii) cake filter. Clarifying filter- principle, construction, working and industrial application of pressure filters: plate and frame filter press, rotary drum filter, leaf filter, sand filter.
Classifiers, thickeners, centrifugal filtration – centrifuge.

6. Mixing equipment: (05 Hrs)

Utility of mixing, mixing equipment used for liquid-liquid, liquid-solid, liquid-gas systems, impellers, propellers, turbines, flow pattern in agitated vessels, vortex formation and its prevention.

LIST OF PRACTICALS

1. To find the sieve analysis of a given sample of solid particles by sieve shaker.
2. To determine the grind ability of solids by ball mill.
3. To determine the effectiveness of disintegrator.
4. To find the rate of filtration with the help of filter press.
5. To determine the rate of settling of slurries of various concentration. Draw a height vs. time curve.
6. To determine the efficiency of jaw crusher.
7. To perform an experiment on rotary vacuum filter and find rate of filtration.

INSTRUCTIONAL STRATEGY

Mechanical operation has significant importance in the area of chemical engineering. Adequate competency needs to be developed by giving sufficient practical knowledge in mechanical operation (characterization of solid particles, size reduction, energy requirement and mechanical separations) A field visit may be conducted to expose the working of various conveyors and filtration equipment in industries.

RECOMMENDED BOOKS

1. Unit Operations of Chemical Engineering by McCabe and Smith, McGraw Hill Publications.
2. Chemical Engineering, Vol. I & II by Coulson and Richardson, Pergamon Press Publications.
3. Introduction to Chemical Engineering by Badger and Banchero, Tata McGraw Hill Publication.
4. Principles of Unit Operations by Allen Fourst, John Wiley Publication.
5. Unit Operations by Brown, C.G., John Wiley Publication.
6. Unit Operation – 1 (Fluid Flow and Mechanical Operations) by Gavhane KA; Nirali Prakashan.

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1	04	10
2	15	20
3	15	20
4	10	15
5	15	20
6	05	15
Total	**64**	**100**

3.6 PROCESS INSTRUMENTATION

L	T	P
4	-	4

RATIONALE

The subject will enable the student to gather the knowledge of different instruments used to measure different process parameters. This course will impart knowledge on working principle, construction, repair and use of these instruments.

DETAILED CONTENTS

1.0. Introduction (05 Periods)

1.0. Functional block diagram of instrumentation system.
1.1. Description of each block
1.2. Process
1.3. Process Characteristics
1.4. Process Variables

2.0. Pressure Measurement (08 Periods)

2.0. Types of Pressure
2.1. Measurement of Pressure by Manometers
2.2. Diaphragms
2.3. Bourdon Tube
2.4. Bellows
2.5. Differential Pressure Measurement
2.6. Vacuum Measurement
2.7. Dead wt Tester

3.0. Temperature Measurement (08 Periods)

3.0. General
3.1. Heat Transfer modes
3.2. Temperature Measuring Devices Like Thermocouples.
3.3. Pyrometer
3.4. Resistance Thermometer.
3.5. Thermister
3.6. Bimetallic Thermometer

4.0. Strain Measurement (06 Periods)

4.0. Requirements for strain measurement
4.1. Strain Gauges
4.2. Selection of Gauges
4.3. General Strain Measurement
4.4. Load Cell

5.0. Vibration and Angular Velocity Measurement (08 Periods)

5.0. Vibration Measurement Systems
5.1. Analysis of acceleration data.
5.2. Measurement of Angular Velocity
5.3. DC & AC Tachometer Generators
5.4. Digital Methods
5.5. Stroboscope

6.0. Flow Measurement (08 Periods)

6.0. General
6.1. Types of Flow
6.2. Flow Coefficient
6.3. Renolds No
6.4. Flow Meters
6.5. Venturi Meter
6.6. Orifice Plate
6.7. Pitot Tube
6.8. Rotameter
6.9. Turbine Meter
6.10. Electromagnetic Meter & mass flow measurement

7.0. Liquid Level Measurements (06 Periods)

Visual indicators, Float actuated level meters, static pressure type instruments. The bubbler system, diaphragm box and air trap system. Electrical contact type liquid level indicators.

8.0. Humidity, Moisture & Thickness Measurement (04 Periods)

9.0. Chemical & Analytical Instruments (06 Periods)

9.1. Spectrophotometer, Filters
9.2. Electrochemical Sensors
9.3. PH Meter
9.4. Analytical Sensor
9.5. Viscosity measurements by constant stress rational viscometer & falling ball type viscometer.

10.0. Plastic Testing Instruments (05 Periods)

Tensile testing machine, Melt flow index testing machine, Impact testing machine

INSTRUCTIONAL STRATEGY

The teacher should take the students to some industries and show them these instruments so that they get a better knowledge of every instrument.

LIST OF PRACTICALS

1. Experiment of Pressure Measurement
2. Experiment of Temperature Measurement
3. Experiment of Flow Measurement
4. Experiment of Humidity Measurement
5. To calibrate pressure gauge with the help of dead weight pressure gauge
6. Experiment of Strain Measurement
7. Experiment of Load Cell
8. Experiment on spectrophotometer and PH meter.

9. Measurement of Level
10. Measurement of angular velocity
11. To find out drying characteristics of given sample and drew drying rate curve by infrared moisture meter and rapid moisture meter.

RECOMMENDED BOOKS

1. Instrumentation Devices & Systems by S.Ranjan (Tata McGraw-Hill Publishing)
2. Electrical & Electronics Measurement by A.K.Sawhney (Danpat Rai & Co.)
3. Industrial Instrumentation by Tyson
4. Industrial Instrumentation by Donald P.Echman
5. Industrial Instrumentation by S.K.Singh
6. Instrumentation by Cirk & Rimboi
7. Instrumentation Measurement and Analysis by B.C.Nakra and KK Chaudhary (McGraw Hill Publication)
8. Electronics Instrumentation by H.S. Kalsi (McGraw Hill Publication)
9. Principles of Industrial Instrumentation by D. Patronalis (Tata McGraw Hill Publication)

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1	05	05
2	08	10
3	08	15
4	06	10
5	08	10
6	08	10
7	06	10
8	04	10
9	06	10
10	05	10
Total	**64**	**100**

FOURTH SEMESTER

4. DETAILED CONTENTS OF VARIOUS SUBJECTS

4.1 CHEMICAL ENGINEERING THERMODYNAMICS

L	T	P
5	-	-

RATIONALE

It is a core subject of chemical engineering and is essential for understanding basic concepts, thermodynamic properties of fluids and performance of thermal used in industry.

DETAILED CONTENTS

1. Introduction: (10 hrs)

Scope of Thermodynamics, Macroscopic and Microscopic view-point. Thermodynamic systems: open, closed & isolated systems. Thermodynamic properties: Temperature. State of a substance: Change of state,path,process-reversible & irreversible and cycle. Intensive & Extensive properties. Equality of temperature. Zeroth law of thermodynamics. Kinds of processes: Isobaric (constant-pressure process), Isochoric process (Constant Volume process), Isothermal process (Constant temperature process), Isentropic process, Isenthalpic process, Polytropic process. Pure substance.

2. Work and Heat Transfer: (10 hrs)

Work, Sign of work transfer, p-dv work or displacement work; Quasi-static processes, Calculation of work done in various Quasi-static Processes-Isobaric process (constant pressure process), Isochoric process (Constant Volume process), Isothermal process (Constant temperature process), Adiabatic process. Non-flow and Flow processes.

Heat &Transfer: Heat (Q), Sign of heat transfer, Heat transfer a path function. Specific heat& latent heat. Difference between heat and work.

3. First law of thermodynamics: (10 hrs)

Various forms of energy: Kinetic Energy, Potential Energy, Molecular Internal Energy, First law of thermodynamics, First applied for a closed system undergoing a cycle and a change of state, Joule Thomson coefficient J. Energy a property of the system. Specific heat at constant volume and pressure, Enthalpy, Calculation of U, ΔH, KE, PE, Q, W for reversible Non Flow processes Isobaric change(constant pressure process), Isochoric change (Constant Volume process), Isothermal change (Constant temperature process), Adiabatic change, Polytropic change.

4. Second Law of Thermodynamics: (10 hrs)

Second law of thermodynamics. Cyclic Heat Engine, Energy reservoirs, Kelvin Plank's statement of the second law, Reversibility & Irreversibility, Factors that render process of irreversibility, Carnot cycle, Two propositions regarding the efficiency of a Carnot cycle, Thermodynamic temperature scale and ideal gas temperature scale. Simple numerical problems.

5. Thermodynamic Relations: (10 hrs)

Significance of Thermodynamic Relations. Theorem of Exact Differentials, for a functional relationship among three coordinates x,y,z of the type f(x,y,z) = 0 ,
Show that:

$(\partial x/\partial y)_z = (\partial y/\partial x)_z^{-1}$ and $(\partial x/\partial y)_z\ (\partial y/\partial z)_x\ (\partial z/\partial x)_y = -1$

Maxwell Relations from first principle. Derive

(i) $dS = c_p(\ dT/T) - (\partial V/\partial T)_p\ dP$

(ii) $dS = c_v(\ dT/T) + (\partial P/\partial T)_v\ dV$

(iii) (a) $(\partial E/\partial V)_v = C_v$ and $(\partial H/\partial T)_p = C_p$

(b) $(\partial E/\partial V)_T = 0$ and $(\partial H/\partial P)_T = 0$

6. Entropy : (8 hrs)

Entropy- a property of a system. Inequality of Claussius, Temperature entropy plot, Entropy change in an irreversible process. Entropy principle: Entropy change for an open system, principle of change of entropy. Reversibility and availability, simple numerical problem for calculation of entropy change.

7. Third law of thermodynamics and its statement (2 hrs)

8. Refrigeration and Liquifaction: (10 hrs)

Refrigeration: Methods of achieving low temperature. Refrigeration cycle, Types of refrigeration cycles- Carnot-Air refrigeration and Vapour compression cycles. Capacity of refrigeration or Tons of refrigeration. Coefficient of Performance (COP), Characteristics of ideal refrigerants, Latest refrigerants and their qualities and application.

9. Phase Equilibria (10 hrs)

Roult's law, Gibbs' phase rule, vapour liquid equilibrium, dew point and bubble point calculations for binary system, Partial molar properties, definition of partial molar properties, Gibbs' Deuhem equation concept of fugacity and fugacity coefficient, , activity and activity coefficient

INSTRUCTIONAL STRATEGY

Lot of stress should be given to numerical aspect/problem solving to give indepth knowledge of the subject. This will make the subject interesting and improve students involvement in the subject.

Refrigeration and liquefaction cycles can be taught in a better way by field visits to industries having such units

RECOMMENDED BOOKS

1. Thermal Engineering by Balleny, Prentice Hall Publications
2. Chemical Engineering Thermodynamics by YUC Rao
3. Engineering Thermodynamics by PK Nag

4. Introduction to Chemical Engineering Thermodynamics by JL Smith and Vanners, McGraw Hill Publication

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1	10	10
2	10	10
3	10	15
4	10	15
5	10	15
6	08	10
7	02	05
8	10	10
9	10	10
Total	**80**	**100**

4.2 CHEMICAL TECHNOLOGY - I

L	T	P
5	-	-

RATIONALE

A comprehensive study of the following chemical industries involving manufacturing process availability of raw materials, production trend, preparation of flow sheet, engineering problems including materials of construction and uses.

DETAILED CONTENTS

1. Industrial Gases: (05 hrs)

1.1 Properties, uses & method of manufacture of nitrogen.
1.2 Properties, uses & method of manufacture of producer gas.
1.3 Properties, uses & method of manufacture of carbon dioxide.

2. Fertilizer Industries: (20 hrs)

2.1 Properties, uses & method of manufacture of Ammonia with flow-sheet.
2.2 Properties, uses & method of manufacture of Nitric acid with flow-sheet.
2.3 Properties, uses & method of manufacture of Ammonium sulphate with flow-sheet.
2.4 Properties, uses & method of manufacture of Urea with flow-sheet.
2.5 Properties, uses & method of manufacture of Ammonium nitrate with flow-sheet.
2.6 Properties, uses & method of manufacture of Phosphorus with flow-sheet.
2.7 Properties, uses & method of manufacture of Phosphoric acid with flow-sheet.
2.8 Properties, uses & method of manufacture of Calcium phosphates – super phosphate, nitro phosphate, NPK fertilizer with flow-sheet.

3. Chlor-Alkali Industries: (15 hrs)

3.1 Common salt: Process description, uses &Engineering problems
3.2 Manufacturing process of HCl & uses.
3.3 Properties, End uses, Raw Materials, Chemical reactions, Method of manufacture of caustic soda by diaphragm cell as well as by mercury cell with flow-sheet.
3.4 Properties, End uses, Raw Materials, Chemical reactions , Method of manufacture of (i)Soda ash by Solvay process (i.e. Ammonia-soda process) (ii) Dual process(Modified Solvay process)

4. Sulphur Industries: (10 hrs)

1.1 Sulphur: Properties, End uses, Raw Materials, Chemical reactions, Methods of production & classification of processes with flow-sheet:
(i) Elemental sulphur mining by Frasch Process.
(ii)Oxidation-Reduction of H_2S
(iii) Elemental sulphur from pyrites (Finish Process)

1.2 Properties, End uses, Raw Materials, Chemical reactions, Manufacture of sulphuric acid by Contact and Chamber process with flow-sheet.

5. Cement Industries: (10 hrs)

1.1 Definition of Portland cement, History of cement industries in India

1.2 Raw material for Portland cement, Properties & composition of Portland cement, End uses, and Method of manufacturing process of Portland cement by dry process and major engineering problems.

6. Glass Ceramic and Refractories: (10 hrs)

6.1 Definition of glass, general composition of glass, raw materials
6.2 Types of glass
6.3 Manufacturing of glass
6.4 Definition of ceramic refractories and their properties

7. Miscellaneous Inorganic Chemical Industries: (10 hrs)

1.1 Sodium hydrogen sulphate
1.2 Potassium permanganate
1.3 Sodium dichromate
1.4 Zinc chloride
1.5 Alum
1.6 Calcium hypo chloride (bleach liquor)
1.7 Hydrogen peroxide

INSTRUCTIONAL STRATEGY

As this subject involves study of lot of chemical industries, field vist is must to give details about the various unit operations and processes involved in chemical industries.

Small and simple experiments/practicals will give idea about operational aspect of the chemical industries.

RECOMMENDED BOOKS

1. Outlines of Chemical Technology by Dryden
2. A Text Book of Chemical Technology Vol. II
3. Chemical Process Industries by Shrieve, McGraw Hill Publication

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1	05	10
2	20	25
3	15	25
4	10	10
5	10	10
6	10	10
7	10	10
Total	**80**	**100**

4.3 HEAT TRANSFER OPERATIONS

L	T	P
4	2	4

RATIONALE

The subject enables the students to apply the understanding of heat transfer mechanisms such as conduction, convection and radiation for understanding the performance of various heat transfer equipment such as heat exchangers, condensers, boilers, evaporators etc. used in almost all chemical and related industries.

DETAILED CONTENTS

1. Modes of Heat transfer (04 hrs)
Conduction, convection & radiation

2. Conduction (08 hrs)
Fourier's law, Thermal conductivity, Conductance, flat Wall, Multilayer flat wall, Hollow cylinder, Multilayer cylinder, log mean area, geometric mean area and Arithmetic mean area, Introduction to unsteady state conduction, Simple numerical problems in S.I. Units.

3. Convection. (08 hrs)
Natural and forced convection, dimensional analysis, Pi-theorem, physical significance of dimension less number, Reynolds No, Prandlt No., Nusselt No., Stanton No., Peclet No., Grashoff No., Dittus-Boelter's equation, simple numerical problems using Dittus-Boelter equation, Fouling factor, Individual heat transfer coefficient and over all heat transfer coefficient.

4. Radiation (08 hrs)
Reflection, absorption and transmission of radiation, Kirchoff law, Emissive power, Wein's displacement law, Stefen Boltman law, heat transfered by radiation exchange of energy between two parallel planes of different emissivity, Radiant heat transfer coefficient, Solar radiation, grey surfaces or grey body.

5. Heat Exchanger (10hrs)
Log.-Mean-Temperature Difference (L.M.T.D.) for parallel or concurrent -flow, counter-current-flow, cross -flow, Construction and description of-
(i) Double pipe heat exchangers (ii) Shell & Tube heat exchanger (iii) Finned tube heat exchangers. Scale formulation and cleaning devices, Wilson's plot. (Simple Numerical Problems for heat exchangers).

6. Condenser. (08 hrs)
Film-wise and Drop-wise condensation, Construction and description of contact condenser.

7. Evaporators (10 hrs)

Construction and description of- (i) Kettle type boilers (ii) Horizontal tube types (iii) Standard vertical type or calendria type (iv) Natural and forced circulation type evaporators. Entrainment and foam formation, Method of feeding evaporators –Forward feed, Backward feed and Mixed feed, Multi effect evaporation, Boiling : Nucleate boiling, Film boiling, Transition boiling, Maximum flux and critical temperature drop, Boiling Point rise (B.P.R) and its effect, steam economy for single effect evaporator (Simple Numerical Problem).

8. Crystallizers (08 hrs)

Classification of crystallizers; construction and description of-
(i) Swensen Walker (ii)Vacuum crystallizer

9. Insulation (06 hrs)

Purpose of insulation, common insulators, critical thickness of insulation for cylinder and spheres, optimum thickness of insulation, Heat loss from a pipe.

LIST OF PRACTICALS

1. To determine the overall heat transfer coefficient for an open pan evaporator in steady and unsteady state conditions.

2. To determine the amount of steam required in evaporating the solution in open pan evaporator.

3. To determine overall heat transfer coefficient for a double pipe heat exchanger in steady state conditions and also to determine efficiency of heat utilization for parallel current.

4. To determine overall heat transfer coefficient for a double pipe heat exchanger in steady state conditions and also to determine efficiency of heat utilization for counter current.

5. To determine overall heat transfer coefficient for a shell and tube heat exchanger in steady state conditions and also to determine efficiency of heat utilization for parallel current.

6. To determine overall heat transfer coefficient for a shell and tube heat exchanger in steady state conditions and also to determine efficiency of heat utilization for counter current.

7. To determine steam economy of a single and double effect evaporator.

8. Measurement of emissivity of test surfaces.

9. To determine the rate of evaporation for a given sample.

10. To determine thermal conductivity of metal.

11. To determine the rate of evaporation in a jacket bottled (open pan evaporation).

12. Study a sketch of oil fired boiler.

INSTRUCTIONAL STRATEGY

Since this is an important subject, it is very essential for the teacher to make the students very clear about the fundamentals of heat transfer, numerical problems and various heat transfer equipment.

RECOMMENDED BOOKS

1. Unit Operation of Chemical Engineering by McCabe and Smith, McGraw Hill Publication
2. Heat Transfer by Chapman, McMillan Publication
3. Heat Transfer by NC Adams, McGraw Hill Publication
4. Process Heat Transfer by Kern, McGraw Hill Publication
5. Principles of Heat Transfer by Kreith, Harper and Raw Publication

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted Theory(Hrs)	Time Allotted Tutorials(Hrs)	Marks Allotted (%)
1	04	02	05
2	08	02	10
3	08	04	15
4	08	04	15
5	08	04	15
6	08	04	15
7	10	04	15
8	05	04	05
9	05	04	05
Total	**64**	**32**	**100**

4.4 MATERIAL AND ENERGY BALANCE

L	T	P
4	2	-

RATIONALE

The subject provides the knowledge of materials and energy requirements for a process and with this knowledge raw material requirements for a given process can be calculated.

DETAILED CONTENTS

1. Introduction: (5 hrs.)

1.1 Use of gravitational conversion factor. Problems relating conversion of one set of units in a function of equation into another equivalent set for mass, length, time, temperature, area, volume, pressure, energy and force of an expression for heat capacity from one set of units to another.

1.2 Conventions of Methods of Analysis and Measurement: Density & specific gravity, Transform a material from one measure of concentration to another, including mass/volume, moles/volume, PPM.

2. Humidity and Saturation: (Definitions Only) (5 hrs.)

Vapor pressure, Raoult's law, Saturation & partial saturation, relative saturation (humidity), absolute saturation (humidity) and percent saturation(humidity), humid volume, humid heat, dry bulb & wet bulb temperature, Dew point, Use of humidity chart, problems involving vaporization and condensation.

3. Material Balance without Chemical Reactions: (15 hrs.)

Significance of material balance, General methods for solving material balance problems involving no chemical Reaction, Outlines of a procedure for material Balance calculations. Various Important unit operations carried out in the chemical Industries. Tie substance. Bypass stream. Simple numerical problems.

4. Material Balance with Chemical Reactions: (15 hrs.)

Definition of terms involved: Stoichiometry, Stoichiometric equation, Stoichiometric coefficient, Stoichiometric ratio, Stoichiometric proportions. Limiting reactant, Excess reactant, Percent Excess. Conversion, Percent Conversion. Yield & Selectivity. Simple numerical problems.

5. Recycling Operations: (05 hrs.)

Importance of recycling operation. Recycle stream, Recycle ratio. Material balance for recycling operation. Purge, Purge stream, purge ratio. Simple problems relating various chemical reactions.

6. Energy Balance: (10 hrs.)

General balance procedure, Sensible heat & Heat capacities, Heat capacities of gases at constant volume and pressure. Empirical equation for Heat capacities. Mean molal heat capacities of gases. Heat capacity of gaseous mixtures. Enthalpy Changes accompanying chemical reaction: Heat of reaction, Heat of formation, Standard heat of formation, Heat of combustion, Hess law of constant heat summation. Standard heat of reaction from heats of formation, Standard heat of reaction from heats of combustion. Phase change operation: Latent heat of phase change, Latent heat of vaporization, Latent heat of fusion, Latent heat of sublimation. Energy balance during phase change operation. Heat of solution & mixing.

7. Combustion Processes: (09 hrs.)

Complete & incomplete combustion, Significance of combustion. Calorific values of fuels, Gross Calorific Value (GCV), Net Calorific Values (NCV). Air requirement, theoretical air, actual air, excess air, percent excess air. Oxygen requirement, theoretical Oxygen, actual Oxygen, excess Oxygen, percent excess Oxygen. Analysis of products of combustion, Proximate and Ultimate analysis. Oxidation of sulphur and its component. Problem on fuel gas analysis (i.e. calculation of net hydrogen carbon atomic ratio H/C).

INSTRUCTIONAL STRATEGY

Emphasis should be laid on problem solving in all the area of material and energy balance.

Simple practical relating to wet bulb temperature, dry bulb temperature and humidification chart, should be done

Students should be encouraged to make flow sheets for various processes. This will help the students to understand the subject better and solve intricate problems in various areas.

RECOMMENDED BOOKS

1 Stoichiometry by Bhatt and Vohra, Tata McGraw Hill Publications

2 Chemical Process Principles by Hougen and Watson, Wiley International Edition

3 Industrial Stoichiometry by Lewis and Lewis, McGraw Hill Publications

4 Solved Examples in Chemical Engineering by GK Ray, Khanna Publications

5 Basic Principles and calculations in Chemical Engineering by Himmelblau, Prentice Hall Publication International Series.

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs.)	Time Allotted for Tutorials (Hrs.)	Marks Allotted (%)
1	05	01	5
2	05	01	5
3	15	08	20
4	15	08	20
5	05	08	25
6	10	03	15
7	09	03	10
Total	**64**	**32**	**100**

4.5 PROCESS CONTROL

L	T	P
4	-	4

RATIONALE

The subject gives the knowledge of various process controls used to measure process parameters.

DETAILED CONTENTS

1 Introduction: (04 Hrs)

1.0. Block diagram of a general open and closed loop process
1.1. Control System & Application
1.2. Automatic Control

2 Control System Components: (09 Hrs)

1.3. Definition-Input means, controlling means, actuating means, measuring means, final control elements, feed forward and backward system .
1.4. Brief description and working of a potentiometer
1.5. Differential transformer servo motors
1.6. Tacho Generator
1.7. Eddy Current clutches, relay contractors, timing relay, temperature saturable core reactors & its use as magnetic amplifier
1.8. Constructional brief, operation, installation & application of Pneumatic control valve & solenoid valve.
1.9. DP transmitter.
1.10. Limit Switch.

3 Process Characteristics (25 Hrs)

3.1. Process variables, process degree of freedom, forcing function, step fn., ramp, impulse, sinusoidal function, Laplace transformation, introduction to first order and second order system.
3.2. Elements of process dynamics: - Proportional, Capacitance.
3.3. Time constant and oscillatory element, determination of system function or transfer function of the following: (Sketch physical diagram and block diagram)
3.4. (a) First order system or time constant element:-
(i) Naked bulb thermometer.
(ii) Stirred tank heater.
(iii) Mixing process.
(iv) R.C. Circuit.
(v) Liquid levels.
(vi) Two time constant type liquid vessel cascaded i.e. non interacting and non cascaded, i.e. interacting.
(vii) Continuous stirred tank chemical reactor with first order chemical reaction.
(b) Second order system or oscillatory type element.
(i) Bulb in thermo well.
(ii) Mechanical damper.

(iii) Fluid manometer or U tubes.

Response of first order system to step, ramp, impulse and sinusoidal inputs, Response of second order system to step change (Transient response).

4 Types of Control Techniques (08 Hrs)

4.1 ON-OFF Control
4.2 Proportional
4.3 Integral
4.4 Derivative
4.5 PI
4.6 PD
4.7 PID

5 Controller (08 Hrs)

5.1 Block Diagram & Circuits of pneumatic/Hydraulic proportional, PI, PD & PID controller, ON-OFF Controller
5.2 Electronic Controller/Automatic Controller
5.3 Simple Example Of
- 5.3.1 Heating Control using SCR
- 5.3.2 Welding Control using SCR
- 5.3.3 Level Control
- 5.3.4 Pressure Control

6 Closed Loop in Automatic Control (06 Hrs)

6.1. Overall transfer function for a single loop system,
6.2. Overall transfer function for change in set point and for change in load,
6.3. Overall transfer function for multi loop control system,
6.4. Unit step response.

7 Programmable Logic Controller (PLC) (04 Hrs)

7.1. Introduction of PLC,
7.2. Block Diagram of PLC
7.3. Characteristics function of PLC
7.4. Use of PLC in Chemical Industry

LIST OF PRACTICAL

1. Experiment of ON-OFF Controller
2. Experiment of PID Controller
3. Experiment of Electronics Controller
   a. Heating Control
   b. Welding Control
   c. Level Control
   d. Pressure Control
4. To calibrate & install a pneumatic control valve.
5. To study the response of two tank non interacting, liquid, level system and two tanks interacting liquid system.

6. Experiment of solenoid valve.
7. To measure time constant of a single capacity thermal process (water bath & heater).
8. To study the transient response of first order system (thermo couple) and find out time constant.
9. To study the transient response of a simple R-C network plot Bodey's diagram.
10. To study the frequency response of a second order electrical circuit equipment. to a physical system (R-L-C network)

INSTRUCTIONAL STRATEGY

Field visits to new and developing industries with automatic controls will give in-depth knowledge of different types of controllers used in chemical industry. If possible small simple experiments can be designed to give practical information about first order and second order systems.

RECOMMENDED BOOKS

1. Instrumentation Devices & Systems by S Ranjan (Tata McGraw-Hill Publishing)
2. Electrical & Electronics Measurement by A.K. Sawhney (Danpat Rai & Co.)
3. Process Instrumentation by Donald P. Echman
4. Process Control by Donald P. Echman
5. Instrumentation by Cirk & Rimboi
6. Instrumentation Measurement and Analysis by B.C. Nakra and KK Chaudhary (McGraw Hill Publication)
7. Process System Analysis and Control by Cough Snowr D.R. & Koppel L.B.
8. Chemical Process Control by Stephanopolous
9. Chemical Process Control by Kulkarni

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1	04	05
2	09	20
3	25	35
4	08	15
5	08	10
6	06	10
7	04	05
Total	**64**	**100**

4.6 PROCESS PLANT UTILITIES

L	T	P
4	-	-

RATIONALE

Air, water and steam are principle plant utilities in many chemical processes. Detailed knowledge concerning these utilities will enable the students to act as a supervisor on chemical shop floor to run the various process equipment efficiently.

DETAILED CONTENTS

1. Generation, Process & Steam Properties: (10 hrs)

Generation of steam at constant pressure, phases of transformation. Pressure-temperature, curve for steam. Latent Heat-external work of evaporation, Sensible heat of water, dry and saturated steam. Dryness fraction, Latent heat of wet steam, detail of wet steam, total heat of super-heated steam, specific volume of wet & super-heated steam. Simple problems using steam-table,

2. Types of fuels used in boilers: (06 hrs)

Types of fuels used in boilers, Coal, Oil, Rice husk, Natural gas, etc. Produced/ forced draught concept.

3. Steam Generator (10 hrs)

Type of steam generators (boilers) - Fire tube & water tube and their principles. Elementary concept and principles of modern water tube boilers. Boiler mountings and accessories. Quantity of heat spent in generation. Ideal cycle of a steam plant. Ways of increasing the efficiency to steam. Details of problems like scaling, refrigeration, absorption, and compression and vapour compression

4. Steam Distribution (06 hrs)

Pipe quality, lay out of piping, steam trap, pressure reducing station: Steam ejectors.

5. Water (06 hrs)

Different water resources, storage, quality parameters like hardness, suspended solids, turbidity, etc.

6. Water Treatment Techniques (08 hrs)

Water treatments techniques, Flow diagram, Coagulation by Iron compounds like Alum, sedimentation, filtration, softened by Sodium Carbonate and Bi-carbonate.

7. Demineralization (06 hrs)

Demineralization flow diagram, Cation and Anion exchangers, Regeneration of Cation and Anion exchangers and degasser.

8. Cooling Water (06 hrs)

Recycling of water, Cooling towers, Principals, details and problems like sealing use of inhibitors, like sodium and chromates.

INSTRUCTIONAL STRATEGY

Field visit to various chemical industries to gain knowledge about various types of boilers, water treatment facilities and cooling towers and pipe line accessories. Small and simple equipments to be conducted on water demineralization.

RECOMMENDED BOOKS

1. Plant Economics by Peter Timmerhaus, McGraw Hill Publication
2. Applied Process Design for Chemical and Petrochemical Plants by E Ludwig, Gulf Publishing, Houston, Texas
3. Unit Operation of Chemical Engineering by McCabe and Smith, McGraw Hill Publication
4. Industrial Boilers by Advance Training Institute, Ludhiana
5. Engineering Chemistry by PC Jain

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1	10	15
2	06	10
3	10	20
4	06	10
5	06	05
6	08	10
7	06	10
8	06	10
9	06	10
Total	**64**	**100**

4.8 INDUSTRIAL TRAINING

Industrial training provides an opportunity to students to experience the environment and culture of industrial production units and commercial activities undertaken in field organizations. It prepares student for their future role as diploma engineers in the world of work and enables them to integrate theory with practice.

For this purpose, students at the end of fourth semester need to be sent for industrial training for a minimum of 4 weeks duration to be organised during the semester break starting after IV Semester examinations. The concerned HODs along with other teachers will guide and help students in arranging appropriate training places relevant to their specific branch. It is suggested that a training schedule may be drawn for each student before starting of the training in consultation with the training providers. Students should also be briefed in advance about the organizational setup, product range, manufacturing process, important machines and materials used in the training organization.

Equally important with the guidance is supervision of students training in the industry/organization by the teachers. A teacher may guide a group of 4-5 students. A minimum of one visit by the teacher is recommended. Students should be encouraged to write daily report in their diary to enable them to write final report and its presentation later on.

Internal assessment and external assessment have been provided in the study and evaluation scheme of V Semester. Evaluation of professional industrial training report through viva-voce/presentation aims at assessing students understanding of materials, industrial process, practices in industry/field organization and their ability to engage in activities related to problem solving in industrial setup as well as understanding of application of knowledge and skills learnt in real life situations. The formative and summative evaluation may comprise of weightage to performance in testing, general behaviour, quality of report and presentation during viva-voce examination. It is recommended that such evaluations may be carried out by a team comprising of concerned HOD, teachers and representative from industry, if any. The components of evaluation will include the following.

a) Punctuality and regularity 15%
b) Initiative in learning new things 15%
c) Relationship with workers 15%
d) Industrial training report 55%