

Mgm-311 INDUSTRIAL MANAGEMENT AND HUMAN RELATIONS.

Total Contact Hours	T	P	C
Theory 32	1	0	1

AIMS The study of this subject will enable the student to develop the management skill, acquaint him with the principles of management and human relations and develop psychological approach to solve the labour problems.

COURSE CONTENTS

- 1. INDUSTRIAL PSYCHOLOGY. 2 Hours**
 - 1.1 History and definition.
 - 1.2 Nature and scope.

- 2. LEADERSHIP 1 Hour**
 - 2.1 Definition and types.
 - 2.3 Qualities of a good leader.

- 3. MOTIVATION 2 Hours**
 - 3.1 Definition.
 - 3.2 Types (Financial and non financial motives).
 - 3.3 Conflict of motives.

- 4. MORALE 1 Hour**
 - 4.1 Importance.
 - 4.2 Development.
 - 4.3 Measurement.

- 5. HUMAN ENGINEERING. 1 Hour**
 - 5.1 Importance of human factor in industry.
 - 5.2 Man-machine system.
 - 5.3 Strategy for making allocation decisions.

- 6. INDUSTRIAL FATIGUE AND BOREDOM. 2 Hours**
 - 6.1 Definition and distinction.
 - 6.2 Psychological causes.
 - 6.3 Objective causes.
 - 6.4 Prevention

- 7. INDUSTRIAL ACCIDENTS 2 Hours**
 - 7.1 Psychological causes.
 - 7.2 Objective causes.

7.3	Prevention	
8.	INDUSTRIAL PREJUDICE	2 Hours
8.1	Causes	
8.2	Remedies	
9.	PUBLIC RELATIONS.	2 Hours
9.1	Importance	
9.2	Functions	
10.	GUIDANCE AND COUNSELLING	2 Hours
10.1	Importance	
10.2	Choice of job.	
10.3	During service.	
11.	JOB EVALUATION	2 Hours
11.1	Importance	
11.2	Methods	
11.3	Job satisfaction	
11.4	Work simplification.	
12.	INDUSTRIAL MANAGEMENT	2 Hours
12.1	Introduction	
12.2	Functions of management.	
12.3	Subdivisions of management	
12.4	Objectives of industrial management.	
13.	PERSONNEL SELECTION.	2 Hours
13.1	Recruitment of employees.	
13.2	Training.	
13.3	Effects of training on production and product cost.	
14.	WORKING CONDITIONS.	2 Hours
14.1	Importance and consideration.	
14.2	Effects on efficiency and per unit cost.	
15.	TIME AND MOTION STUDY.	3 Hours
15.1	Concept and importance.	
15.2	Sequence of motion study.	
15.3	Principles of motion study.	
15.4	Steps to time study.	
15.5	Determination of operations time.	

- 16. QUALITY CONTROL.**
16.1 Concept and advantages
16.2 Methods.

2 Hours

17. ROLE OF FOREMAN IN MANAGEMENT.

2 Hours

- 17.1 Foreman's abilities.
- 17.2 Duties and functions.

BOOKS RECOMMENDED:

- 1 C.S. Meyers, Industrial Psychology, Oxford University Press, London.
- 2. Smith Wakley, Psychology of Industrial Behaviors, Mc-Graw Hill, New York.
- 3. Ghulam Hussain, Nizamat-e-Sanaat Aur Insani Rawabat, Ilmi Kitab Khana, Urdu Bazar, Lahore.
- 4. Andrew R. Megill, The Process of Management William M New Man.
- 5. Richard N Omen, Management of Industrial Enterprises.

INSTRUCTIONAL OBJECTIVES

At the completion of this course, the students will be able to:

- 1. KNOW INDUSTRIAL PSYCHOLOGY.**
 - 1.1 Describe brief history of industrial psychology.
 - 1.2 Describe in detail definition of industrial psychology.
 - 1.3 State nature and scope of industrial psychology.

- 2. KNOW LEADERSHIP.**
 - 2.1 Define leadership.
 - 2.2 Describe types of leadership.
 - 2.3 State qualities of a good leader.

- 3. UNDERSTAND MOTIVATION.**
 - 3.1 Define motivation.
 - 3.2 Describe financial and non financial motives.
 - 3.3 Explain conflict of motives.

- 4. KNOW MORALE.**
 - 4.1 State importance of morale.
 - 4.2 Describe development of morale.
 - 4.3 State the method of measurement of morale.

- 5. UNDERSTAND HUMAN ENGINEERING.**
 - 5.1 Explain importance of human engineering in the industry.
 - 5.2 Explain man-machine system.
 - 5.3 Explain strategy for making allocation decisions.

- 6. UNDERSTAND INDUSTRIAL FATIGUE AND BOREDOM.**
 - 6.1 Define fatigue and boredom.
 - 6.2 Describe psychological causes of fatigue and boredom.
 - 6.3 Describe objective causes of fatigue and boredom.
 - 6.4 Explain measures to prevent fatigue and boredom.

- 7. UNDERSTAND INDUSTRIAL ACCIDENTS.**
 - 7.1 Explain psychological causes of industrial accidents.
 - 7.2 Explain objective causes of industrial accidents.
 - 7.3 Explain measures to prevent industrial accidents.

- 8. UNDERSTAND INDUSTRIAL PREJUDICE.**

- 8.1 Define prejudice
- 8.2 Explain causes of industrial prejudice.
 - 8.3 Explain remedies of industrial prejudice.
- 9. **UNDERSTAND THE SIGNIFICANCE OF PUBLIC RELATIONS.**
 - 9.1 Explain importance of public relations.
 - 9.2 Explain functions of public relations.
- 10. **UNDERSTAND THE NEED FOR GUIDANCE AND COUNSELLING.**
 - 10.1 State importance of guidance and counselling.
 - 10.2 Explain the role of guidance and counselling in choosing the job.
 - 10.3 Describe help of guidance and counselling during service.
- 11. **UNDERSTAND JOB EVALUATION.**
 - 11.1 Explain importance of job evaluation.
 - 11.2 Explain methods of job evaluation.
 - 11.3 Explain job satisfaction.
 - 11.4 Explain work simplification.
- 12. **UNDERSTAND INDUSTRIAL MANAGEMENT.**
 - 12.1 Define management.
 - 12.2 State functions of management.
 - 12.3 Enlist subdivision of management.
 - 12.4 Explain objectives of industrial management.
- 13. **UNDERSTAND TRAINING AND ITS EFFECTS.**
 - 13.1 Describe the recruitment procedure of employees in an industrial concern.
 - 13.2 Explain training.
 - 13.3 Identify the kinds of training.
 - 13.4 Explain the effects of training on production and product cost.
- 14. **UNDERSTAND THE EFFECT OF WORKING CONDITION ON EFFICIENCY.**
 - 15.1 Explain importance of working condition.
 - 15.2 Describe air-conditioning, ventilation, lighting and noise.
 - 15.3 State the effects of good working conditions on efficiency and per unit cost.
- 15. **UNDERSTAND TIME AND MOTION STUDY.**
 - 15.1 Explain the concept.
 - 15.2 Describe the importance of work study.
 - 15.3 Explain the sequence of motion study.
 - 15.4 State the principles of motion study.
 - 15.5 Describe the steps for carrying out time study.

15.6 Explain the method of determination of operations time.

16. UNDERSTAND THE METHODS OF QUALITY CONTROL.

16.1 Define quality control

16.2 State the advantages of quality control.

16.2 Explain methods of quality control.

17. UNDERSTAND THE ROLE OF FOREMAN IN AN INDUSTRIAL UNDERTAKING.

17.1 Explain ability of the foreman.

17.2 Enlist duties of foreman.

17.3 Describe functions of foreman as middle management.

CHT 314 INSTRUMENTAL METHODS OF ANALYSIS.

T	P	C
2	6	4

COURSE CONTENTS.

1. INTRODUCTION. INSTRUMENTAL METHODS OF ANALYSIS.

- 1.1 Light and its properties.
- 1.2 Radiant energy.
- 1.3 Mathematical calculation by $E=Lc/t$
- 1.4 Numerical.

2. COLORIMETRY.

- 2.1 Fundamental law of colorimetry.
- 2.2 Bouger's Law , Bear's Law.
- 2.3 Failures of Bouger, Bear's Law.
- 2.4 Photo electric colorimetry.
- 2.5 Barrier layer cell construction and working.
- 2.6 Photo emissive tube construction and working.
- 2.7 Photo meter.
- 2.8 Single beam photo meter. Construction and working.
- 2.9 Double beam photo meter. Construction and working.
- 2.10 Bouger, Bear's law applied to photo electric calorimetry.

3. FLORESCENCE, PHOTO SCENES (DEFINITION, APPLICATION.)

- 3.1 Fluorescence methods for the Fluorescence development.
- 3.2 Relationship between florescent intensity and concentration.
- 3.3 Filter flourometer.
- 3.4 Construction, operating parts and working.

4. TURBIDIMETRY AND NEPHELOMETRY.

- 4.1 Application.
- 4.2 Nephelometer
- 4.3 Construction and working.
- 4.4 Tubidimeter, its construction and working.

5. SPECTOR PHOTO METRY.

- 5.1 Spectrum of light, visible spectra.
- 5.2 Ultra violet spectra.
- 5.3 Infrared spectra.
- 5.4 Absorption spectra, emission spectra.
- 5.5 Molecular structure, origin of spectra.
- 5.6 Specto photo meter.
- 5.7 Construction and working of a spectro photo meter.

- 5.8 Ultra violet spectro photo meter.
 - 5.9 Construction and working parts.
 - 5.10 Infrared spectro photo meter.
 - 5.11 Construction and working parts.
- 6. FLAME PHOTO METRY.**
- 6.1 Definition, application.
 - 6.2 Flame photo meter.
 - 6.3 Parts of flame photo meter.
 - 6.4 Flow meter.
 - 6.5 Atomise Burner.
 - 6.6 Parts of flame photo meter (continued).
 - 6.7 Optical system.
 - 6.8 Photo sensitive detector.
 - 6.9 Recording equipment.
 - 6.10 Commercial flame photo meter.
 - 6.11 Construction and working.
- 7. REFRACTIVE INDEX AND REFRACTOMETRY.**
- 7.1 Effect of temperature.
 - 7.2 Application.
 - 7.3 Refractometer.
 - 7.4 Abbe's refracto meter, construction and working.
 - 7.5 Fishen refractometer, construction and working.
- 8. POLARIMETRY.**
- 8.1 Optical active material, optical activity.
 - 8.2 Phase polarized light.
 - 8.3 Low rotatory dextro rotatory.
 - 8.4 Calculation of optical rotation.
 - 8.5 Specific rotation.
 - 8.6 Polarimeter, construction and working.
 - 8.7 Construction of analyzer and polarizer prisms.
- 9. ANEMOMETER: METHODOLOGY:**
- 9.1 Amperometer, construction and working.
 - 9.2 Metal Micro Electrode.
- 10. GAS CHROMATOGRAPHY.**
- 10.1 Definition.
 - 10.2 Principle of gas chromatography.
 - 10.3 Study of gas Ghromotography instrument (gas chromatography) essential parts.

11. POTENTIOMETRY: ELECTRODE POTENTIAL

- 11.1 E.M.F. of a cell.
- 11.2 Indicating electrodes, reference.
- 11.3 Electrode calomel, electrode.
- 11.4 Glass electrode, hydrogen electrode.

12. PH VALUE: P,OH VALUE.

- 12.1 Application of PH measurement
- 12.2 PH meter.
- 12.3 Construction working.
- 12.4 Buffer solution.
- 12.5 Properties of buffer solution.
- 12.6 Buffer capacity, Dilution value.
- 12.7 Standard Buffer solution.
- 12.8 Preparation of standard buffer solution.s
- 12.9 Measurement of PH value.
- 12.10 Colorimetric determination of PH value.
- 12.11 Ph paper methods, indicator method.
- 12.13 By direct reading PH meter.

13. ELECTROLYSIS, APPLICATIONS.

- 13.1 Equipment for electrolysis.
- 13.2 Electrolysis, analyzer and its parts.
- 13.3 Reactions on anode and cathode.
- 13.4 Separation of metals by electrolysis (Procedure).
- 13.5 Faraday's Laws of electrolysis.
- 13.6 Numericals.

14. CONDUCTIVITY AND CONDUCTOMETRY.

- 14.1 Conductivity cell, cell constant.
- 14.2 Conductivity bridge.
- 14.3 Measurement of sp.cond equivalent cond.
- 14.4 Mol. conductivity.

RECOMMENDED BOOK:

- 1. Instrumental Methods of Analysis by, Willand, H.N. Meritt and Dean J.A.

CHT 314 INSTRUMENTAL METHODS OF ANALYSIS

INSTRUCTIONAL OBJECTIVES.

1 INTRODUCTION

- 1.1 Student will be able to understand the instrumental method of analysis
 - 1.1.1 Define instrumental method of analysis
 - 1.1.2 give 4 merits of I.M.A.
 - 1.1.3 Enlist the demerits of I.M.A.
 - 1.1.4 Name different I.M.A.

2 LIGHT

- 2.1 Understand light
 - 2.1.1 Define light
 - 2.1.2 Enlist different properties of light
 - 2.1.3 Explain different properties of light
- 2.2 Understand radiant energy
 - 2.2.1 Define radiant energy
 - 2.2.2 Give different units for the measurement of wave length
 - 2.2.3 Calculate radiant energy by using the formula $E=hc$

3 COLORIMETRY

- 3.1 Understand colorimetry
 - 3.1.1 Define colorimetry
 - 3.1.2 Define transmittance and absorbance
 - Enlist photometric laws
 - Define bouge's law
 - Define beer's law
 - Give conditions for which bouger-Beer's law hold
- conditions in which bough beer's law fail
- 3.2 Understand photo electric coloumetry
 - 3.2.1 Define photo electric coloumetry
 - Enlist different photo dectectors
 - Explain the construction and working of photo call (Barrier layer cell)
 - Explain the construction and working of photo tube
 - 3.3 Understand photo meter
 - 3.3.1 Define photometer
 - Explain the working of single beam photometer
 - Explain the working of double beam photometer
 - Give compansion of the two photometers
- Calculate the concentration of sample sol from photometer readings by using bouger-Beer's law equation
- Give

4 PHOTO LUMINISEENCE

- 4.1 Understand photo lumini sence
 - 4.1.1 Define photo luminiseence
 - 4.1.2 Give examples of photo luminiscence

- 4.1.3 Differentiate between Fluorescence and luminescence.
- 4.1.4 Explain the methods of making Fluorescence spectrum
- 4.1.5 Develop a relationship between Fluorescence intensity and concentration
- 4.2 Understand Fluorometer
 - 4.2.1 Define Fluorometer
 - 4.2.2 Draw working diagram of filter Fluorometer
 - 4.2.3 Draw working diagram of spectro fluorometer
 - 4.2.4 Explain the function of operating parts of fluorometer
- 5 TURBIDIMETRY AND NEPHLOMETRY**
 - 5.1 Understand turbidimetry and Nephelometry
 - 5.1.1 Define turbidimetry
 - 5.1.2 Define Nephelometry
 - 5.1.3 Give industrial applications of turbidimetry
 - 5.1.4 Explain the construction and working of turbidimeter
 - 5.1.5 Explain the construction and working of Nephelometer
- 6 SPECTRO PHOTOMETRY**
 - 6.1 Understand spectro photometry
 - 6.1.1 Define spectrophotometry
 - 6.1.2 Define dispersion of light
 - 6.1.3 Explain spectrum of light
 - 6.1.4 Explain visible spectra UV-spectra IR-spectra
 - 6.1.5 Explain Absorption spectra, emission spectra, molecular spectra and origin of spectra
 - 6.2 Understand spectro photometer
 - 6.2.1 Enlist essential parts of spectro photometer
 - 6.2.2 Draw working diagram of spectro-photometer
 - 6.2.3 Explain the working of spectro-photometer
 - 6.2.4 Explain construction and working of UV-spectro photometer
 - 6.2.5 Explain construction and working of IR-spectro photometer
- 7 FLAME PHOTOMETRY**
 - 7.1 Understand flame photometry
 - 7.1.1 Define flame photometry
 - 7.1.2 Give applications of flame photometry
 - 7.1.3 Enlist essential parts of flame photometer
 - 7.1.4 Explain construction and working of a commercial flame photometer
- 8 REFRACTOMETRY**
 - 8.1 Understand refractometry
 - 8.1E.1 Explain refraction of light
 - Explain refractive index
 - Explain the effect of temperature on refractive index
 - Define refractometry
 - Give applications of refractometry
 - Explain the construction and working of Abbe's refractometer
 - Explain the construction and working of fisher refractometer
- 9 POLARIMETRY**

- 9.1 Understand polarimetry
- 9.1.1 define plane polarised light
 - 9.1.2 Define optical active material and optical activity
 - 9.1.3 Define levo rotatory material and dextro rotatory material
 - 9.1.4 Give examples of optical active materials
 - 9.1.5 Calculate specific rotation by using the formula $[\alpha] = 100x$
 - 9.1.6 Draw working diagram of polarimeter
 - 9.1.7 Enlist parts of a polarimeter
 - 9.1.8 Explain the function of different parts of polarimeter
- 10 AMPEROMETRY**
- 10.1 Understand amperometry
 - 10.1.1 Define amperometry
 - 10.1.2 Explain methodology of amperometry
 - 10.1.3 Explain the construction and working of amperometer
 - 10.1.4 Explain the construction and working of metal micro electrode
- 11 GAS CHROMATOGRAPHY**
- 11.1 Understand gas chromatography
 - 11.1.1 Define gas chromatography
 - 11.1.2 Explain principle of gas chromatography
 - 11.1.3 Draw working diagram of gas chromatograph
 - 11.1.4 Chromatograph
 - 11.1.5 Enlist essential parts of gas chromatograph
 - 11.1.6 Enlist different detectors used
 - 11.1.7 Explain the construction and working of detectors
 - (a) Conductivity detector
 - (b) Thermal conductivity detector
 - (c) Flame ionization detector
 - (d) Density box detector
- 12 POTENTIOMETRY**
- 12.1 Understand potentiometry
 - 12.1.1 Define potentiometry
 - Explain electrode potential
 - Explain e.m.f. of a cell
 - Calculate e.m.f. of a cell
 - Differentiate between indicating electrode and reference electrode
 - Enlist different reference electrodes
 - Explain the construction and working of
 - (a) hydrogen electrode
 - (b) Glass electrode
 - (c) Calomel electrode
 - (d) Antimony electrode
- 13 PH-VALUE AND BUFFER SOLUTION**
- 13.1 Understand PH-Value
 - 13.1.1 Define PH-Value
 - Define POH-Value
 - Enlist applications of PH-measurement

- 13.2 Understand Buffer solution
 - 13.2.1 Define Buffer solution
 - 13.2.2 Give properties of Buffer solution
 - 13.2.3 Explain Buffer capacity Buffering valve
 - 13.2.4 Explain dilution valve
 - 13.2.5 Explain the preparation of standard Buffer solution
- 13.3 Understand measurement of PH-Valve
 - 13.3.1 Explain colorimetric delamination of PH-Valve
 - (a) PH-paper method
 - (b) Indicator method
 - (c) Pocket comparator method
 - 13.3.2 Explain the construction and working of direct reading PH-metric

14 UNDERSTAND ELECTROLYSIS

- 14.1 Define electrobyte
Define Electrolysis
Give applications of electrolysis
Draw a sketch to show the essential parts of electrolytic analyzer
Explain the reaction at anode
Explain the reaction at cathode
Explain the procedure of separation of metals by electrolysis
Explain faradoys laws of electrolysis
Calculate the amount of material deposited by electrolysis(1st law based calculations)
Calculate the chemical equivalent of given material by electrolytic method(2nd law based calculations)

15 UNDERSTAND CONDUCTOMETRY

- 15.1.1 Define Resistance and conductivity
Define specific resistance
Define specific cond, equivalent cond and mobcular conductance
Give the units of resistance and of conductance
Explain the construction of conductivity cell
Calculate cell constent
Explain the construction and working of conductivity bridge
Describe the measurement of conductivity

CHT 314 INSTRUMENTAL METHODS OF ANALYSIS.

LIST OF PRACTICALS.

1. Study of reflection, refraction, dispersion of light.
2. Determination of Ammonia in water by Nessler reagent in colorimetry.
3. Determination of chlorine in water by visual colorimeter.
4. Determination of concentration of CuSO_4 sample by visual colorimeter.
5. Determination the absorbance of transmittance for different concentration of coloured solution.
6. Study the effect of wave length on the absorption of light by coloured solution.
7. Draw a concentration and absorption curve for colored solutions.
8. Colorimetric determination of Nickel with Dimethyloxime (Nephelometry).
9. Determination of PO_4 and SO_4 contents by using Nephelometer.
10. Determination of Manganese in steel by using spectronic 21 (auto-recording).
11. Study and operation of flame photometer.
12. Setting of flame by using controlling instruments.
13. Measurement of refractive index of various liquid by using Abbe Refractometer and Fisher Refractometer.
14. Determination of calcium, sodium Potassium by using Photometer.
16. Determination of specific rotation of optical active materials.
17. Determination of concentration of source solution by using polarimeter.
18. Determination of Ph value of industrial samples by:
 - i. Indicating method.
 - ii. PH paper method.
 - iii. Pocket comparator method.
 - iv. PH meter (Direct reading).
19. Electroplating.
20. Verification of faraday law.
21. Measurement of cell constant, sp. conductivity, equivalent conductivity, molecular conductivity by using conductivity bridge.
22. Analysis of flue gases by using orset apparatus.
23. Study of gas chromatography.
24. Study of U-V spectro photometer.

Note: Class teacher can change the Practicals in accordance with the National and Industrial need and the availability of instruments . In this connection he will get guidance from head of department.

CHT 324 INDUSTRIAL CHEMICAL PROCESS II

T	P	C
3	3	4

OBJECTIVES

1. Understand important manufacturing procedure employed by modern chemical Industries.
2. Use the equipments necessary to carry out chemical reaction on industrial scale.
3. To give to the students of the flow sheet diagram.
4. Understanding Chemical industry from the viewpoint of statistics of production consumption and location in Pakistan

COURSE CONTENTS.

1. OILS FATS AND WAXAS.

- 1.1 Vegetable oils. (name orign and uses)
- 1.2 Linseed oil, coconut oil, corn oil, palm oil, Peanut oil, tung oil, castor oil, sunflower oil, colton seed oil, soybean oil.
- 1.3 Extraction of oils.
- 1.4 Compression method for colton seed oil. (Introduction only)
- 1.5 solvent extraction method for soybeen oil/sun flower oil
- 1.6 Flow sheet. unit operations involved
- 1.7 Energy requirements by products of solvent extraction. their uses.
- 1.8 Processing of vegetable oils
- 1.9 Refining, Bleaching.
- 1.10 Hydrogenation
- 1.11 Deodarization, Vitaminization.
- 1.12 Flowsheet
- 1.13 Unit operations and unit process involved

2. WAXES NAME, ORIGIN AND USES.

- 2.1 Bees wax, carnaube wax, spermacet.
- 2.2 Ozocerite, Paraffin wax, mortion wax. condellilla wax, synthetic wax.

3. SOAP.

- 3.1 Soap chemical formul. raw materials.
- 3.2 Manufacture of soap by kettle process.
- 3.3 Manufacture of soap and fatty acid by continuous process.
- 3.4 Flow sheets.
- 3.5 unit operations and unit processes by products.
- 3.6 By products.
- 3.7 Typical soaps.

- 3.8 Toilet soap industrial soap.
- 3.9 shaving soap millad toilet soap.
- 3.10 Medicated soap transparent soap.

4. GLYCERIN USES FORMULA.

- 4.1 Manufacture of glycerine as by product of soap plant.
- 4.2 Flowsheet.
- 4.3. Unit operations and unit process involved.
- 4.4 Energy requirements
- 4.5 synthetic glycerine.
- 4.6 Raw materials.
- 4.7 Chemical reaction.
- 4.8 Manufacture of glycerine by the Hydrolysis of oil/fat.
- 4.9 Flow sheet
- 4.10 Unit operations and unit process.

5. DETERGEN, SURFACTANTS.

- 5.1 Classification of detergent.
- 5.2 Anionics, Cationics, Non ionic, Amphoteric.
- 5.3 suds regulators.
- 5.4 Builders and Additives.
- 5.5 Biodegradability.
- 5.6 Manufacture of detergent (ABS)
- 5.7 Flow sheet.
- 5.8 Unit operations and unit processes.
- 5.9 Detergent action.

6. PULP AND PAPER INDUSTRIAL

- 6.1 Raw materials. Preparation of Raw materials (cleancing)
- 6.2 Types of pulps (mechanical, semi chemical, chemical pulp)
- 6.3 kraft pulping
- 6.4 Flow sheet
- 6.5 Unit operations and energy requirements.
- 6.6 Recovery of Black liquor (kraft Pulping)
- 6.7 Soda pulping.
- 6.8 Sulphite pulping.
- 6.9 Flow sheet.
- 6.10 unit operations and energy requirements.
- 6.11 Recovery of Black liquor.
- 6.12 comparison of the three pulps.
- 6.13 Manufacture of paper.
- 6.14 Beating and refining of pulp. fillers.
- 6.15 Conical refiner of a Jordan engine.

- 6.16 Emerson claffin refiner.
 - 6.17 Fourdinier machine for paper manufacture.
 - 6.18 Cylinder machine for heavy paper/card board manufacture
 - 6.19 Structural Boards.
- 7. SUGAR INDUSTRY.**
- 7.1 Raw materials.
 - 7.2 Manufacture of cane sugar.
 - 7.3 flow sheet.
 - 7.4 unit operations and unit processes.
 - 7.5 Manufacture of Beet suger
 - 7.6 unitoperationsandunit processes.
 - 7.7 By products of suger industries/their uses.
- 8. FERMENTALTION INDUSTRIES.**
- 8.1 Industrial Alcohol uses.
 - 8.2 Manufacture of industrial alcohohal by fermentation.
 - 8.3 Flow sheet.
 - 8.4 unit operations and unit processes involved.
 - 8.5 Preparation of Absolute alcohol from industrial alcohol.
 - 8.6 Preparation of Acetone and Butanol from molasses/corn.
 - 8.7 Flow sheet unit operations and unit processes.
 - 8.8 Preparation of citric acid from molasses.
- 9. SYNTHATIC FIBER.**
- 9.1 Classification, uses.
 - 9.2 Manufacture of polyester fiber. Flow sheet.
 - 9.3 Chemical process and unit operations.
 - 9.4 Manufacture of Nylon-6 fiber. Flow sheet.
 - 9.5 Unit operations
 - 9.6 Unit processes.
- 10. Nuclear industries**
- 10.1 Introdouction,nuclear reactions (Fusion and Fission)
 - 10.2 Uranium and thorium fission
 - 10.3 Uranium as enagy source.
 - 10.4 Sources and reserves of nuclear fuels in Pakistan
 - 10.5 Mining and milling.ore
 - 10.6 Refining of ore.
 - 10.7 Refining of ore.
 - 10.8 flow sheet.
 - 10.9 Iso tops enrichment.
 - 10.10 Conversion of UF_6 to UO_2 flow sheet.
 - 10.11 Unit operations and unit processes.

- 10.12 Nuclear fuels selection.
- 10.13 Isotopes and isotope separation.
- 10.14 Protection from radioactivity.
- 10.15 Waste disposal of nuclear waste.

TEXT BOOK

Shreve's chemical process industries fifth edition George T. Austia

CHT-324 INDUSTRIAL CHEMICAL PROCESS - II

INSTRUCTIONAL OBJECTIVES.

1. UNDERSTAND OILS AND FATS.

- 1.1 Define oils and Fats.
- 1.2 Enlist various types of oils.
- 1.3 Distinguish between oils and fats.
- 1.4 Explain solvent extraction method for cotton seed, and soy-been.
- 1.5 Describe expression method for cotton seed.
- 1.6 Explain refining, Bleaching and hydrogenation.
- 1.7 Name catalyst and explain its validity.
- 1.8 Draw a neat flowsheet diagram for solvent extraction method.

2. UNDERSTAND WAXES.

- 2.1 Define waxes.
- 2.2 Enlist various types of waxes.
- 2.3 Differentiate between natural and synthetic waxes with examples.
- 2.4 Explain uses of both types of waxes.

3. UNDERSTAND SOAPS

- 3.1 Define soaps.
- 3.2 Name Raw-materials
- 3.3 Write formula.
- 3.4 Explain continuous process for soap manufacturing.
- 3.5 Draw a neat and labelled diagram of continuous process.
- 3.6 Explain unit process and operations involved in soap manufacturing.
- 3.7 Describe typical soaps and their By-products.
- 3.8 Explain energy requirements.

4. UNDERSTAND GLYCERIN.

- 4.1 Define Glycerin.
- 4.2 Name Raw materials.
- 4.3 Differentiate between synthetic and natural glycerin.
- 4.4 Write chemical reaction.
- 4.5 Explain manufacture of glycerin by the hydrolysis of oil and fats.
- 4.6 Draw a neat flow diagram.
- 4.7 Explain unit operation and unit process
- 4.8 Enlist uses.

5. UNDERSTAND DETERGENTS/SURFACTANTS.

- 5.1 Define detergent.
- 5.2 Identify soaps and detergents.

- 5.3 Explain manufacture of different (Alkyl - Benzene) sulphates.
 - 5.4 Draw a neat flow sheet diagram.
 - 5.5 Explain detergents action.
 - 5.6 Enlist various types of detergents.
 - 5.7 Name Builders and additives.
 - 5.8 Enlist uses.
- 6. UNDERSTAND PULP AND PAPER.**
- 6.1 Enlist Raw material
 - 6.2 Name various types of pulps.
 - 6.3 Explain the manufacture of Mechanical, pulp, kraft and chemical pulp, sulphate/sulphite pulp.
 - 6.4 Draw flow sheet diagram for each of above types.
 - 6.5 Explain manufacture of paper by jordan engine.
 - 6.6 Enlist fillers and sizing elements.
 - 6.7 Explain manufacturing methods for heavy paper/cor-board and structural boards.
- 7. UNDERSTAND SUGAR INDUSTRY.**
- 7.1 Name Raw materials.
 - 7.2 Explain the manufacture of sugar from cane.
 - 7.3 Explain the Unit process and operation involved i sugar manufacturing.
 - 7.4 Explain manufacture of sugar from beet.
 - 7.5 Enlist by-products of sugar industry.
 - 7.6 Describe the uses of By-products of sugar industry.
- 8. UNDERSTAND FERMENTATION.**
- 8.1 Define fermentation.
 - 8.2 Enlist fermenting agents.
 - 8.3 Name the products of "Mollasses" after fermentation.
 - 8.4 Explain the manufacture of industrial alcohol by fermentation.
 - 8.5 Describe the manufacture of absolute alcohol from industrial alcohol
 - 8.6 Explain the manufacture of acetic acid, citric acid and acetone.
 - 8.7 Draw a flow sheet diagram for each one of the above.
 - 8.8 Enlist the unit operation and process involved in the manufacture of acetic acid, citric acid.
 - 8.9 Explain the energy requirement for 8.8
 - 8.10 Explain the uses of industrial alcohol, acetic and citric acid.
- 9. UNDERSTAND SYNTHATIC FIBER.**
- 9.1 Define synthatic fiber.
 - 9.2 Enlist various types of fibre.
 - 9.3 Explain the manufacture of polyester fiber with flow sheet diagram.
 - 9.4 Explain the manufacturing procedures of Nylon-6

- 9.5 Draw a neat flow diagram for 9.4
- 9.6 Explain the unit process and operation involved in nylon-6
- 9.7 Name the uses of polyester.

10. NUCLEAR INDUSTRIES.

- 10.1 Define nuclear and fission reaction.
- 10.2 Enlist various radio active elements.
- 10.3 Explain the characteristic of alpha, beta and gama rays.
- 10.4 Distiguish between nuclear and fission reaction.
- 10.5 Locate the position of nuclear fuels and sourse in Pakistan.
- 10.6 Describe mining operations of the Uranium ore.
- 10.7 Explain the refining of Uranium ore.
- 10.8 Draw a flowsheet diagram for 10.7
- 10.9 Enlsit uses of radio-active elements.
- 10.10 Explain enrichment techniques of radio-active elements.
- 10.11 Identify nuclear fuels according to their uses.
- 10.12 Describe isotope seperation techniques.
- 10.13 Name protective devices from radio active elements.
- 10.14 Explain the use of waste disposal of nuclear waste.

CHT 324 INDUSTRIAL CHEMICAL PROCESS - II

LIST OF PRACTICALS

(One Practical Period Per Week)

1.	Determination of F.F.A of vegetable oils/Fats.	3	
2.	Determination of colour index of oil/fats by tintometer.	3	
3.	Determination of Acid-value of oil/Fats.	2	
4.	Determination of iodine-value of oil/Fats.	2	
5.	Determination of melting point of Fats. (ghee)	4	
6.	Determination of saponification value of oil/Fat.	2	
7.	Vitamin test for ghee.		2
8.	Extraction of oil by Soxhlet apparatus.	4	
9.	Preparation of soyabean oil in the laboratory.		2
	Preparation of soap from Acid (stearic Acid) in the laboratory.	2	
10.	Preparation of Medicated Soap. F.F.A= Free fatty acids.		2

**CHT 335 CHEMICAL ENGINEERING -II
(UNIT OPERATION-II)**

T	P	C
3	6	5

OBJECTIVES

1. To apply principles of unit operations in the laboratory work
2. Chemical production equipment related to these operations.

CONTENTS.

- 1. CRYSTALLIZATION, IMPORTANCE, TYPES OF CRYSTALS, CRYSTAL, FORMS**
 - 1.1 Principle of crystallization
 - 1.2 Supersaturation, Nucleation
 - 1.3 Miscellaneous crystallization techniques
 - 1.4 Classification of crystallization
 - 1.5 Crystallization, Agitated batch crystallization
 - 1.6 Swenson walker crystallizer
 - 1.7 Vacuum crystallizer, vacuum crystallizer with recirculation, crystal crystallizer
 - 1.8 Crystallizer produce large crystals
- 2. FILTRATION, CLASSIFICATION OF FILTERS**
 - 2.1 Filter media, filter aids
 - 2.2 sand filter, chamber press
 - 2.3 Plate and frame press, leaf filter, pressure filter
 - 2.4 Rotary drum filter
 - 2.5 washing of filter cakes
- 3. CENTRIFUGES**
 - 3.1 Batch top driven centrifuges
 - 3.2 Batch under driven centrifuges
- 4. INTRODUCTION TO DRYING**
 - 4.1 Bound unbound and free water, equilibrium moisture content
 - 4.2 Classification of dryers
 - 4.3 Compartment and tunnel dryers
 - 4.4 Rotary dryer (construction and working)
 - 4.5 Feston dryer
 - 4.6 Factors affecting rate of drying
 - 4.7 Drying rate curve
- 5. SIZE REDUCTION**
 - 5.1 Classification of crushing and grinding machinery
 - 5.2 Jaw crusher
 - 5.3 Gyratory crusher
 - 5.4 Roll crushers
 - 5.5 Single roll crusher

- 5.6 Fine grinders
- 5.7 Roller mills
- 5.8 Ball and tube mill
- 5.9 ultra fine grinders
- 5.10 Closed circuit grinder

6. **DISTILLATION**

- 6.1 Theory of Distillation
- 6.2 Raoult's Law, Relative volatility
- 6.3 Henry's Law, constant boiling mixtures
- 6.4 Differential distillation
- 6.5 Equilibrium distillation
- 6.6 Rectification and vacuum distillation
- 6.7 Construction of rectifying columns
- 6.8 Sieve plate and packed columns
- 6.9 Bubble cap fractionating columns
- 6.10 Fractionating column calculations
- 6.11 Heat and material balances
- 6.12 Plate to plate calculations
- 6.13 McCabe Thiele method
- 6.14 Types of trays Bubble cap
- 6.15 Sieve trays, flexitrays, disc and daughtnut trays
- 6.16 Types of down comers
- 6.17 Towers operating conditions
- 6.18 Pressure vacuum tower top temperature reboiler temperature temperature gradient
- 6.19 Types of feed effect of feed temperature, reflux ratio
- 6.20 Tower operating troubles
- 6.21 Overloading, flooding, entrainment
- 6.22 Coring, weeping, improper reflux rate
- 6.23 Steam distillation, extractive distillation
- 6.24 Azeotropic distillation, petroleum distillation

7. **EXTRACTION**

- 7.1 Extraction, classification of extraction equipments
- 7.2 Oil seed extraction plant
- 7.3 Continuous diffusion batteries
- 7.4 the Dorr agitator, dorr thickner
- 7.5 Counter current decantation system
- 7.6 Counter current extraction with filters
- 7.7 Liquid liquid extraction towers
- 7.8 Baffle plate towers spray towers, pulse towers Agitated operation towers
- 7.9 Centrifugal type extractors

8. **ABSORPTION**

- 8.1 Theory of Gas absorption
- 8.2 Construction and working of Gas absorber
- 8.3 Types and properties of packings

9. **HUMIDITY**

- 9.1 Air water vapour contact theory

- 9.2 Humidity, Relative and % age humidity
- 9.3 Humid heat, saturated of humid volume
- 9.4 Dew point, wet bulb temperature
- 9.5 Use of humidity chart
- 9.6 Humidification methods
- 9.7 Construction and operating principles of cooling towers
- 9.8 Atmospheric draft cooling towers
- 9.9 Mechanical draft cooling towers

TEXT AND REFERENCE BOOKS:

1. Introduction to chemical engineering By Wall.L.Badger & Julius T.Banchero Mc Graw Hill book co New york
2. Chemical Engineering Hand Book By J.H Perry (Editor) Mc Graw Hill Book co. in New York

LIST OF PRACTICALS

1. Study the working and construction of bubble cap fractionating column.
2. Separation of binary mixture by fractional distillation in a bubble cap distillation tower
3. To study the principle of extraction by using solvent extractor
4. Determination of Humidity of air water vapour system by using dew point method
5. To determine the humidity, % age humidity humid heat specific and saturated volume of an air water vapour system by psychometric method
6. To study the Construction and working principle of an air conditioner
7. To study the construction and working principle of an absorption column
8. To study the effect of the rate of distillation
9. The practicals in unit operation should include a considerable amount of installing and dismantling the equipments whichever is feasible

LIST OF PRACTICALS
UNIT OPERATION-11

1. Study the effect of temperature, concentration and agitation on crystallization
2. Study the theory and operation of filter press, filtering, washing, cleaning of press, by filtering various industrially important slurries
3. Study the effect of flow rate on the efficiency of a filter press
4. Study the operation of a portable mixer by use of various industrially important materials
5. Determination of horse power required and rate of mixing for the mixing of definite quantities, of materials (such as salt and sand) in dry and wet states
6. Determination of the number of revolutions and time required for mixing of two materials per unit weight and calculation of the efficiency of the mixer
7. Determination of rate of drying for a fibrous, and granular material.
8. Study the operation of a sieve shaker through the use of a variety of crushed solids (Alternately, a manual sieve screen analysis may be carried out)
9. Study the operation of a pulverizer by using a variety of materials analyse the efficiency and purpose of the machine by sieve screen analysis
10. Study the operation of various mills by grinding several materials analysis of efficiency and purpose of the machines by sieve screen analysis
11. Study the operation of jaw crusher
12. Determine the horse power required for crushing a definite material e.g red bricks
13. Determine the horse power required for grinding a definite quantity of a material to 100 mesh in a mill. Also calculate the work index for such a grinding operation.
14. Prepare a graph relating particle diameter to time in sample grinder

**CHT 335:- CHEMICAL ENGINEERING-II
(UNIT OPERATION-II)**

INSTRUCTIONAL OBJECTIVES.

1 CRYSTALLIZATION

- 1.1 Understand crystallization
 - 1.1.1 Define crystallization
 - 1.1.2 Give the importance of crystallization
 - 1.1.3 Enlist the types of crystals
 - 1.1.4 Give the crystal forms
 - 1.1.5 Explain the principle of crystallization
 - 1.1.6 Explain super-saturation
 - 1.1.7 Explain Nucleation
 - 1.1.8 Enlist crystallization techniques
 - 1.1.9 Explain different crystallization techniques
- 1.2 Understand crystallizers
 - 1.2.1 Give classification of crystallizers
 - 1.2.2 Explain construction and working of
 - (a) Tank crystallizer
 - (b) Agitated batch crystallizer
 - (c) Swenson walker crystallizer
 - (d) Vacuum crystallizer
 - (e) Vacuum crystallizer with recirculation
 - (f) Krystal crystallizer
 - (g) Crystallizer to produce large crystal

2 FILTRATION

- 2.1 Understand filtration
 - 2.1.1 Define filtration
 - 2.1.2 Enlist filter medias
 - 2.1.3 Define filter aid
 - 2.1.4 Give examples of filter aid
- 2.2 Understand filters
 - 2.2.1 Give classification of filters
 - 2.2.2 Explain construction and working of
 - (a) Sand filter
 - (b) Chamber filter
 - (c) Plate and frame filter
 - (d) Leaf filter
 - (e) Pressure filter
 - (f) Rotary drum filter
 - 2.2.3 Explain the washing of filter cake

3 CENTRIFUGE

- 3.1 Understand centrifuge
 - 3.1.1 Explain the working principle of centrifuge
 - 3.1.2 Give types of centrifuges
 - 3.1.3 Explain the working of batch type top driven centrifuge

3.1.4 Explain the working of batch under driven centrifuge

4 DRYING

- 4.1 Understand drying
 - 4.1.1 define drying
 - 4.1.2 Define bound, unbound and free water
 - 4.1.3 Explain equilibrium moisture content
 - 4.1.4 Explain drying rate
 - 4.1.5 Enlist factors affecting rate of drying
 - 4.1.6 Draw drying rate curve
- 4.2 Understand dryers
 - 4.2.1 Define dryer
 - 4.2.2. Give the classification of dryers
 - 4.2.3 Explain the construction and working of
 - (a) Compartment dryer
 - (b) Tunnel dryer
 - (c) Rotary dryer
 - (d) Festoon dryer

5 SIZE REDUCTION

- 5.1 Understand size reduction
 - 5.1.1 Define size reduction(crushing and grinding)
 - 5.1.2 Give classification of crushing and grinding machinery
 - 5.1.3 Differentiate between inter mediate grinding, fine grinding and ultra fine grinding.
 - 5.1.4 Explain construction and working of
 - (a) Jaw crusher
 - Gyratory crusher
 - Roll crusher
 - Ball mill
 - Tube mill
 - 5.1.5 Explain the construction and working of ultrafine grinder(pulvenizer)
Explain closed circuit grinding

6 DISTILLATION

- 6.1 Understand distillation
 - 6.1.1 Define distillation
 - 6.1.2 Explain theory of distillation
 - 6.1.3 Explain Raoult's law
 - 6.1.4 Explain Henry's law
 - 6.1.5 Explain relative volatility
 - 6.1.6 Give examples of constant boiling mixtures
- 6.2 Understand types of distillation
 - 6.2.1 Enlist types of distillation
 - 6.2.2 Define differential distillation
 - 6.2.3 Define equilibrium distillation
 - 6.2.4 Define rectification
 - 6.2.5 Define vacuum distillation

- 6.2.6 Explain steam distillation
- 6.2.7 Explain extractive distillation
- 6.2.8 Explain Azeotropic distillation
- 6.2.9 Explain petroleum distillation
- 6.3 Understand the Rectifying Columns
 - 6.3.1 Explain the construction and working of
 - (a) Packed column
 - (b) Sieve plate column
 - (c) Bubble cap column
 - 6.3.2 Enlist the types of trays
 - Explain the merits of each type of tray
 - Explain the types of down comers
- 6.4 Understand fractionating column calculation
 - 6.4.1 Make heat balance
 - Make material balance
 - Make plate to plate calculations by using McCabe-Thiele method
- 6.5 Understand tower's operating conditions
 - 6.5.1 Enlist the factors which affect the tower's operating conditions
 - 6.5.2 Explain the effect of pressure and vacuum
 - 6.5.3 Explain the effect of tower top temp
 - 6.5.4 Explain the effect of reboiler temp
 - 6.5.5 Explain the effect of feed temp
 - 6.5.6 Explain the effect of reflux ratio
- 6.6 Understand tower operating troubles
 - 6.6.1 Explain over loading and flooding
 - Explain entrainment coning
 - Explain weeping
 - Explain the effect of improper reflux rate

7 EXTRACTION

- 7.1 Understand extraction
 - 7.1.1 Define extraction
 - 7.1.2 Give the examples of solid liquid extraction
 - 7.1.3 Give the examples of liquid-liquid extraction
- 7.2 Understand the extraction equipments
 - 7.2.1 Give the classification of extraction equipments
 - 7.2.2 Explain the oil seed extraction plant
 - 7.2.3 Explain the construction and working of
 - (a) Continuous diffusion batteries.
 - (b) Dorr agitator
 - (c) Dorr thickener
 - 7.2.4 Explain counter current decantation system
 - 7.2.5 Explain counter current extraction with filters
 - 7.2.6 Explain the construction and working of liquid liquid extraction towers like:
 - (a) Baffle plate tower
 - (b) Spray tower
 - (c) Pulse tower

- (d) Agitated extraction tower
- 7.2.7 Explain the construction and working of the centrifuge type extractor

8 **ABSORPTION**

- 8.1 Understand absorption
 - 8.1.1 Explain theory of gas absorption
 - 8.1.2 Explain the construction and working of gas absorber
 - 8.1.3 Give the types of packing materials
 - 8.1.4 Enlist the properties of packing materials

9 **HUMIDITY**

- 9.1 Understand humidity
 - 9.1.1 State air-water vapour contact theory
 - Define humidity
 - Give mathematical form of relative humidity
 - Give formula for percentage humidity
 - Define humid heat and humid volume
 - Explain dew point
 - Differentiate between dry bulb and wet bulb temperature
 - Use humidity chart to calculate different terms
- 9.2 Understand humidification methods
 - 9.2.1 Define humidification
 - 9.2.2 Enlist humidification methods
 - 9.2.3 Explain humidification methods
- 9.3 Understand cooling towers
 - 9.3.1 Enlist types of cooling towers
 - Explain construction and working of atmospheric draft cooling tower
 - Explain construction and working of mechanical draft cooling towers

OBJECTIVES:-

- 1 Understand the mechanism of various control instruments used in various chemical industries.
- 2 Explain the function and working of control instruments used for different process variables. after going through the curriculum.

1. INTRODUCTION.

- 1.1 Importance of process instrumentation in Chemical industry.
- 1.2 How measurement are made.
- 1.3 Introduction to important process variables.
- 1.4 Temperature : Pressure
- 1.5 Flow : Level

2 BASIC PRINCIPLES INVOLVED IN PROCESS INSTRUMENTATION.

- 2.1 Pascal's law.
- 2.2 Bernaulli's theorem.
- 2.3 Hook's law.
- 2.4 Thermoelectric effects.
- 2.5 Whetstone Bridge circuit
- 2.6 Capacitance, Resistance, Inductance imperence.

3 TEMPERATURE MEASURING INSTRUMENTS

- 3.1 Thermometers.
- 3.2 Liquid-filled thermometer.
- 3.3 Hg-filled thermometer.
- 3.4 Bi-metallic thermometers.
- 3.5 Pressure spring thermometers.
- 3.6 Thermocouples.
- 3.7 Resistance thermometers
- 3.8 Pyrometers (Optical radiation)
- 3.9 Pneumatic Temperature transmitters.

4 PRESSURE MEASURING INSTRUMENTS

- 4.1 U -tube manometer.
- 4.2 Inclined manometer
- 4.3 Well type manometer
- 4.4 Inverted bell type manometer
- 4.5 Bourdon tube
- 4.6 (a) Spiral
- 4.7 (b) Helix
- 4.8 Bellows
- 4.9 Pneumatic Pressure transmitters.
- 4.10 Transducer
- 4.11 Definition of transducer

- 4.12 Electrical transducer
- 4.13 Mechanical transducer
- 4.14 The Pirani gage.

5 INTRODUCTION TO DIFFERENTIAL PRESSURE

- 5.1 Differential pressure measuring instruments.
- 5.2 U-tube manometer
- 5.3 Well-type manometer
- 5.4 Inclined tube manometer
- 5.5 Differential pressure bellows
- 5.6 Bell differential pressure gauge
- 5.7 Differential pressure transmitter

6 FLOW MEASURING INSTRUMENTS

- 6.1 Head meters
- 6.2 (a) Orifice meter
- 6.3 (b) Venturi meter
- 6.4 (c) Flow nozzles
- 6.5 Variable area meters (Rotameters)
- 6.6 Magnetic flow meters
- 6.7 Open channel flow measuring instruments

7 LIQUID LEVEL MEASURING INSTRUMENTS

- 7.1 Direct liquid level measuring instruments.
- 7.2 Bob and tape
- 7.3 Sight glass
- 7.4 Floats
- 7.5 Probe type level detector.
- 7.6 Indirect liquid level measuring instruments
- 7.7 Pressure gage.
- 7.8 Purge or bubbler systems.
- 7.9 Control loop
- 7.10 Pneumatic control valve
- 7.11 On-Off control.
- 7.12 Proportional control.
- 7.13 Proportional derivative control
- 7.14 Proportional integral derivative control.

REFERENCES

- 1Industrial Instrumentation fundamentals by Austin E Fribance McGraw-Hill Book company
- 2Instrumentation by Franklyn .W Kirk and Nicholas.Rinbo American Technical society Chicago, Illinois

INSTRUCTIONAL OBJECTIVES.

1. UNDERSTAND IMPORTANCE OF CONTROL INSTRUMENTS

- 1.1 Name various process variable used in chemical industry
- 1.2 Explain each variable
 - a-Temperature
 - b-Pressure
 - c-Flow
 - d-Level
- 1.3 Explain the basic principles involved in process instrumentation
- 1.4 Define pascal's Law
- 1.5 Explain pascal law with examples
- 1.6 Explain Bernoulli's theorem
- 1.7 Enlist uses of Bernoulli's theorem
- 1.8 Define thermoelectric effect
- 1.9 Draw neat sketch of Wheatstone bridge circuit and explain it
- 1.10 Define each one of the followings
 - a-Capacitance
 - b-Resistance
 - c-Inductance
 - d-Impedance
- 1.11 Explain each one of no 10

2. KNOW TEMPERATURE

- 2.1 Define temperature
- 2.2 Distinguish between heat and temperature
- 2.3 Enlist various temperature scale
- 2.4 Read temperature on Celsius scale
- 2.5 Read temperature on Fahrenheit scale

3. KNOWS THERMOMETRY

- 3.1 Describes liquid filled thermo-meter
- 3.2 Explain mercury filled thermometer (with diagram)
- 3.3 Explain bimetallic thermometer.
- 3.4 Explain pressure spring thermometer

4. UNDERSTAND THERMOCOUPLES

- 4.1 Define thermocouple
- 4.2 Explain the principle of thermocouple
- 4.3 Enlist various types of thermocouples
- 4.4 Explain iron constantan thermocouple
- 4.5 Explain chromel/Al thermocouples
- 4.6 Describe Pt/Rh-Pt thermocouple
- 4.7 Identify the use of each thermocouples for different temperature ranges

5. UNDERSTAND RESISTANCE THERMOMETER

- 5.1 Define resistance thermometer
- 5.2 Explain the principle of resistance thermometer

5.3 Draw the diagram of wheat stone bridge circuit and label its parts.

5.4 Describe the operation of the resistance thermometer

6 UNDERSTAND PYROMETRY AND PYROMETERS

6.1 Define pyrometer.

6.2 Enlist types of pyrometers

6.3 Draw a neat sketch of the radiation pyrometer

6.4 Describe the functioning of radiation pyrometer.

6.5 Draw the diagram of optical pyrometer

6.6 Explain the function and operation of the pyrometers

6.7 Identify the pyrometer on the basis of temperature range and electrical circuit

7 UNDERSTAND TEMPERATURE TRANSMITTER

7.1 Define temperature transmitter

7.2 Enlist types of temperature transmitters

7.3 Explain the principle of temperature transmitter.

7.4 Draw the diagram

7.5 Explain the electrical operation of the transmitter

7.6 Identify the transmitters electronic on the bases of their operation and temperature change

8 UNDERSTAND PRESSURE

8.1 Define pressure

8.2 Enlist various pressure measuring instrument

8.3 Describe U-tube manometer

8.4 Explain well type manometer

8.5 Explain well type meter

8.6 Draw the neat sketch of a
a-Bourdon gauge
b-bellows

8.7 Explain bourdon gauge

8.8 Explain the principle of differential pressure instruments

8.9 Describe differential pressure instruments

8.10 Differentiate between differential pressure and direct pressure measuring instruments

8.11 List the uses of d/p measuring instrument

8.12 Differentiate between pneumatic and electronic pressure transmitters

9 UNDERSTAND TRANSDUCERS

9.1 Define transducers

9.2 Enlist types of transducers

9.3 Draw diagrams of transducers.

9.4 Explain the mechanical/electrical transducer

9.5 Differentiate between mechanical and electrical transducer

9.6 Enlist five advantages of electrical transducer and their disadvantages of mechanical transducer

9.7 Explain piezoelectric gauge

10 UNDERSTAND FLOW MEASURING INSTRUMENTS

10.1 Describe flow of the fluid

- 10.2 Name type of flow
- 10.3 Enlist flow measuring instruments
- 10.4 Describe orifice meter
- 10.5 Explain venturi-meter
- 10.6 Explain flow nozzle
- 10.7 Explain Rota meter
- 10.8 Explain magnatic flow meter
- 10.9 Explain pitot tube
- 10.10 Draw diagram of flow meter
- 10.11 Differentiate between
 - a-orifice meter & venturimeter
 - b-Rotameter and pitot tube
- 10.12 Enlist characteristics of each flow meter

11 UNDERSTAND LEVEL MEASSURING INSTRUMENTS

- 11.1 Define level of the fluids
- 11.2 Name type of level meter.
- 11.3 Enlist level mearuring instruments
- 11.4 Explain the principle of electrical level measuring instruments
- 11.5 Draw diagram of the level measuring instrument
- 11.6 Describe sight glass
- 11.7 Describe flood method
- 11.8 Explain the use of pressure gauge for in direct level measuremnts
- 11.9 Explain radio active system of level measurement
- 11.10 Explain the sonic principle
- 11.11 Explain the ultra sonic method for liquid level measurement
- 11.12 Explain liquid level measurement by load cell
- 11.13 Enlist four uses of electrical level measuring instrument

12 UNDERSTAND CONTROL SYSTEM

- 12.1 Define control system
- 12.2 Explain control loop with its working principle
- 12.3 Names various type of controllers
- 12.4 Explain proportional controller
- 12.5 Describe propertional derivative controller
- 12.6 Explain propertial integral derivative controller
- 12.7 Explain pnevmatic control valve
- 12.8 Explain on-off control system
- 12.9 List uses of each controller

CH. 352 C	CHEMICAL TECHNOLOGY PRACTICE.	T	P
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Total contact hours:

Theory:-	Nil.
Practical	192

OBJECTIVES

1. To acquaint the students with all the practicals skill, they need to develop/use in heavy light chemical Industries.
2. A project to a group of students will be allocated which will be completely the co-ordination of industry.
3. A close liaison will be established between the institution and industry to achieve the institutional objectives.
4. Objective No. 3 will help in facilitating the placement of the students in industries.

The time allocation will depend on the Project assigned, by the working teacher and the Industrial Management.

CONTENTS

1. INTRODUCTION, SIGNIFICANCE IN INDUSTRIES

- 1.1 Preparation of flow diagram of typical chemical industries showing process conditions and products at different sections e.g Fertilizers, Sugar, Cement, Petroleum and petrochemicals, acid alkali industries
- 1.2 Preparation of standard solutions of various normalities of different chemicals.
- 1.3 Sampling, precipitation, digestion, ignition, filtration and distillation techniques

2. VOLUMETIC ANALYSIS

- 2.1 Neutralization titration, Redox titration
- 2.2 Iodometry, Iodimetry and argentometry

3. GRAVIMETRIC ANALYSIS

- 3.1 Use of oven, furnaces, dissectors etc.

4. DETAILED DESCRIPTION REPORT ABOUT THE FOLLOWING CHEMICAL INDUSTRIES, BY DEPUTING DIFFERENT GROUPS OF STUDENTS (6 NO) AT DIFFERENT SECTIONS OF INDUSTRIAL UNITS. THE STUDENTS WILL GET TRAINING AT THEIR RESPECTIVE SECTIONS ONCE A WEEK.

FERTILIZER INDUSTRIES

- 4.1 Reforming Section

- 4.2 NH₃ Synthesis
- 4.3 Compressor Section
- 4.4 NH₃ Storage
- 4.5 HNO₃ manufacturing unit
- 4.6 Urea plant
- 4.7 Utility section
- 4.8 Laboratory

- 5. VEGETABLE GHEE INDUSTRIES**
 - 5.1 H₂ gas plant
 - 5.2 Refining Section
 - 5.3 Hardening and Filling Section
 - 5.4 Laboratory/lab techniques

- 6. SOAP AND SODIUM**
 - 6.1 Soap and Silicate manufacturing units
 - 6.2 Solvent extraction plant

- 7. INDUSTRIAL GASES**
 - 7.1 CO₂ plants
 - 7.2 O₂ plants

- 8. BEVERAGES**
 - 8.1 Water Softening and water treatment
 - 8.2 Beverage manufacturing unit
 - 8.3 Laboratory

- 9. CERAMICS AND BLUE POTTERY**
 - 9.1 Raw materials and flow diagram

- 10. LABORATORY TESTS PERTAINING TO DIFFERENT CHEMICAL INDUSTRIES.**
 - 10.1 Water Analysis (Municipal and Boiler water)
 - 10.2 Vegetable Ghee analysis
 - 10.3 Sugar tests
 - i) Sucrose percentage test using a) Indicator
b) Polarimeter
 - ii) Determination of specific gravity by Hydrometer
 - 10.4 Ferrous, non ferrous alloys analysis

CHT 362 ENERGY CONSERVATION & ENVIRONMENTAL POLLUTION.

T	P	C
1	3	2

OBJECTIVES

1. Know about energy and energy conservation in industry.
2. Know the uses of basic instruments to measure Energy
3. To apply his knowledge to conserve energy in chemical industries. Calculate energy losses.

CONTENTS.

ENERGY CONSERVATION.

1. Introduction to energy & energy conservation, sources of energy
 - 1.1 Types of energy

Heat energy.	Mechanical energy
Potential energy	Kinetic energy
Electrical energy	Chemical energy.
2. First and 2nd Laws of thermodynamics and application
3. Heat recovery in internal combustion engines and steam turbines
4. Types of fuels, primary fuels
 - 4.1 (solid fuels) Secondary fuels
 - 4.2 (liquid fuels) Tertiary fuels
 - 4.3 (Gaseous fuels) Incomplete combustion and its effects on energy recovery
5. Selection of equipment for process energy recovery such as. Hydraulic Turbines, wheel or runner gas expansion units etc
6. Energy Management systems
 - 6.1 energy monitoring
 - 6.2 Measuring instruments and techniques
7. Heat recovery in process plants
 - 7.1 Steam generation
 - 7.2 Pre-heating boiler's feed water
 - 7.3 Application for heat recovery, economics of heat recovery
8. Energy recovery in petro-chemical industry
 - 8.1 Process and equipments
 - 8.2 Steam and electric energy generation
 - 8.3 Refrigeration, heat gain.
9. Emerging energy saving trends in sugar industry

Reference:

1. Process energy conservation by Richard Green & Staff of chemical Engineering Published by Mc Graw Hill publishing co, New York
2. Energy education for Pakistan enercon 86-11 Ministry of planning and development Govt of Pakistan March 1987

ENVIRONMENTAL POLLUTION.**1. INTRODUCTION.**

Definition, types of pollution, atmospheric pollution, land pollution, noise pollution, and waste water pollution.

2 ATMOSPHERIC POLLUTION.

- 2.1 Definition.
- 2.2 Methods of control
- 2.3 Its effects on human health.

3. WATER POLLUTION

- 3.1 Definition, methods of control.

4. NOISE POLLUTION.

- 4.1 Definition, sources of pollution, sound characteristics, controlling measures.

5. LAND POLLUTION.

- 5.1 Types, controlling techniques.

6. POLLUTION CONTROL IN FERTILIZERS.

- 6.1 Ammonia, Urea pollution, bllled gases, effect on human health, use of gas masks, controlling techniques.

7 PAPER AND PULP POLLUTION.

- 7.1 Chemicals used, elimination of poisonous gases, controlling methods.

8. A PETROLEUM POLLUTION.**B SUGAR POLLUTION.**

- 8.1 Poisonous chemicals in petroleum
- 8.2 Their effects upon human health.
- 8.3 Bleaching chemicals used in sugar industry.
- 8.4 Pollution controlling techniques.

REFERENCES BOOKS.

1. Environmental pollution Atmosphere, Land, Water and Noise by H.M. Dix published by John Wiley and Sons.
2. Pollution control in process industries by S.P. Mahajan Tata Mc Graw Hill publishing company.

CHT 362- ENERGY CONSERVATION & ENVIRONMENTAL POLLUTION.

INSTRUCTIONAL OBJECTIVES.

ENERGY CONSERVATION.

1. UNDERSTAND ENERGY AND ENERGY CONSERVATION.

- 1.1 Define Energy and Energy conservation.
- 1.2 Enlist sources of Energy.
- 1.3 Name various types of Energy.
- 1.4 Explain all types of Energy.
- 1.5 Differentiate different Energy on the basis of their heat contents.

2. UNDERSTAND LAWS OF THERMODYNAMICS.

- 2.1 Define first-Law of thermodynamics.
- 2.2 Define second Law of thermodynamics.
- 2.3 Derive relationships for kinetic and potential Energy.
- 2.4 Prove $K.E = 1/2 MV^2$.
- 2.5 Prove $P.E. = mZ$.
- 2.6 Explain their application in conserving Energy.

3. UNDERSTAND INTERNAL COMBUSTION ENGINES AND TURBINES.

- 3.1 Define internal combustion engines.
- 3.2 Name various types of turbines.
- 3.3 Explain the merits of rotary turbine over reciprocating Engines.
- 3.4 Explain methods of heat recovery from internal combustion Engine and rotary turbines.

4 UNDERSTAND FUELS AND COMBUSTION PROCESS.

- 4.1 Define solid Liquid and gaseous Fuels.
- 4.2 Enlist types of solid Fuels.
- 4.3 Enlist types of Liquid and gaseous Fuels.
- 4.4 Explain merits of gaseous Fuels over solid and Liquid Fuels.
- 4.5 Define combustion.
- 4.6 Explain the methods of heat recovery by the combustion of Liquid and gaseous Fuels.
- 4.7 Calculate waste heat.
- 4.8 Describe an effective and efficient method of heat recovery and its re-cycle.

5. SELECTION OF EQUIPMENT FOR PROCESS ENERGY RECOVERY.

- 5.1 Enlist equipment
- 5.2 Describe working and use of equipment for energy recovery.

6. ENERGY MANAGEMENT SYSTEMS.

- 6.1 Definition

- 6.2 List of types of systems.
- 6.3 Explain different energy management systems.

7 HEAT RECOVERY IN PROCESS PLANTS.

- 7.1 Steam turbine
- 7.2 Gas Expansion unit.
- 7.3 Explain managing energy techniques.
- 7.4 Describe Energy monitoring system.
- 7.5 Name the process variables required for energy measurement and control.
- 7.6 Explain the process variable relevant for energy conservation.

8 UNDERSTAND PETRO-CHEMICAL PROCESS PLANTS.

- 8.1 Define process plants.
- 8.2 Enlist various process plants such as glass-plastics, petroleum-sugar etc.
- 8.3 Name methods for heat recovery from such plants.
- 8.4 Describe pre-heating system in steam power plant.
- 8.5 Explain the method of steam production.
- 8.6 Describe per-heating system in steam power plant.
- 8.7 Describe method how heats conserved in such a plant.
- 8.8 Explain the use of heat recovered in others as an energy sources.
- 8.9 Explain economic impact, of heat recovery in terms of saving money
- 8.10 Explain the heat recovery system in petrochemical plant.
- 8.11 Describe fractianating column and recovery of heat as waste heat from the vapour-Liquid phase.
- 8.12 Calculate heat recovered mathematically and the amount saved in Pakistani Rupees.
- 8.13 Name the equipment used for heat recovery in the plant.
- 8.14 Describe heat generation system from water, both as a steam power plant and Electricity generation plant.
- 8.15 Explain the use of low pressure and light pressure steam in refrigeration system thought sudden enlargement and T.

9: UNDERSTAND SUGAR MANUFACTURING TRENDS .

- 9.1 Explain cane crushing process
- 9.2 Name the tallest type of sharp knife edge crushers.
- 9.3 Calculate energy used and conserve in the above system
- 9.4 Define evaporation.
- 9.5 Enlist various types of evaporators.
- 9.6 Explain the use of multiple effect eveporator and heat saved.
- 9.7 Calculate the energy saved in terms of money.

- of 9.8 Identify between various types of evaporators on the basis
- 9.8.1 Heat conserved
 - 9.8.2 Re-use both from cane sugar and beet sugar juice.

POLLUTION

1 UNDERSTAND POLLUTION.

- 1.1 Define pollution
- 1.2 Enlist types of pollution such as atmospheric pollution, land pollution, land pollution, noise and waste water pollution.
- 1.3 Define noise pollution.
- 1.4 Describes its effect upon human health.
- 1.5 Explain damages caused by above types of pollution.
- 1.6 Identify various types of pollution on the basis of their damages caused, effect on environment and human health.
- 1.7 Explain control methods.

2. UNDERSTAND AIR/ATMOSPHERIC POLLUTION

- 2.1 Define atmospheric pollution
- 2.2 Enlist various types of gases present in atmosphere.
- 2.3 Explain methods to control air pollution.
- 2.4 Explain the effects of atmospheric pollution on human health.
- 2.5 Explain physical and chemical treatment to control.
- 2.6 Explain neutralisation and precipitation, oxidation-reduction method to control.

3 UNDERSTAND WATER POLLUTION

- 3.1 Define water pollution.
- 3.2 Name water pollutants.
- 3.3 Explain the oxidation effect on bacteria's present in water.
- 3.4 Define chemical nutrients.
- 3.5 Explain ion exchange method to control waste water disposal.
- 3.6 Explain filtration techniques to control and check water affluent in sewage and industrial waste water.

4 UNDERSTAND NOISE POLLUTION

- 4.1 Define noise pollution.
- 4.2 Name sources of noise pollution.
- 4.3 Define sound characteristics of high pitch which affects worker health and public health.
- 4.4 Name units of intensity of sound.
- 4.5 Explain the effect of sound of 80-150 db on human ear.
- 4.6 Explain ear plug system to control.

5 UNDERSTAND LAND POLLUTION.

- 5.1 Define land pollution.
- 5.2 Enlist types of land pollution.
- 5.3 Explain control methods
 - (i) Precipitation
 - (ii) adsorption
 - (iii) Ion exchange

6 UNDERSTAND AMMONIA/UREA MANUFACTURING

- 6.1 Define ammonia equilibrium.
- 6.2 Define equilibrium Constant
- 6.3 Enlist bleed gases
- 6.4 Explain the effect of gases upon human health
- 6.5 Name quality catalyst
- 6.6 Explain the absorption system of gases.
- 6.7 Explain the use of gas mask on ammonia plant/urea plant
- 6.8 Explain reaction between CO_2 & NH_3
- 6.9 Explain the damage caused by bi-uret on the plant
- 6.10 Explain how pollution can be controlled by latest stripping techniques.

7 UNDERSTAND PULP AND PAPER MANUFACTURING TECHNIQUES.

- 7.1 Enlist chemicals used
- 7.1 Explain the toxicity of chemicals
- 7.2 Describe the elimination techniques of SO_2 and NO_2 's by chemical methods
- 7.3 Name method of removal by ordination
- 7.4 Explain the meeting process for the removal of organic compound which produce harmful gases.

**8 UNDERSTAND PETROLEUM REFINING
UNDERSTAND SUGAR MANUFACTURING**

- 8.1 Enlist various abnoscious chemicals present in petroleum
- 8.2 Explain tetra-ethyle lead use and its effect upon engine and human healths
- 8.3 Explain the method of removal of sulphur from gasoline
- 8.4 Explain the use of additives in petroleum product
- 8.5 Explain the formation of alkylates and re-formations to overcome pollution.
- 8.6 Enlist various refining and decolourising agents
- 8.7 Explain the use of SO_2 in bleaching
- 8.8 Describe method to eleminate sulphur
- 8.9 Explain the use of diocta-decyl dimethyle ammonium chloride
- 8.10 Name in-organic salt which are problomatic for environment
- 8.11 Explain Ion-exchange method to overcome encironmental pollution
- 8.12 Explain method to eleminate fromation of CO_2 during burning of baggasse as a fuel.

CHT. 372 INDUSTRIAL STOICHIOMETRY

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COURSE CONTENTS.

1. UNITS AND DIMENSIONS

- 1.1 Definition
- 1.2 Conversion of units in English/metric system
- 1.3 Calculation based on unit conversion

2. BEHAVIOUR OF GAS

- 2.1 Ideal gas laws
- 2.2 Boyle's law
- 2.3 Charles's law
- 2.4 Gas equation
- 2.5 Absolute Temperature
- 2.6 Absolute Zero
- 2.7 Absolute temperature scales
- 2.8 Standard conditions
- 2.9 Value of gas constant 'R' in different systems
- 2.10 Calculation based on gas equation
- 2.11 Dalton's law of partial pressure
- 2.12 Amagats law of partial volume
- 2.13 Avogadro's number
- 2.14 Mole fraction and percent
- 2.15 Pressure fraction and percent
- 2.16 Mass fraction and percent
- 2.17 Volume fraction and percent
- 2.18 Mole percent and percent
- 2.19 Prove Mole percent = volume percent = pressure percent
- 2.20 Calculation based on percentage and fractions for gaseous mixtures
- 2.21 Vander Waal's equation

3. CHEMICAL EQUATION

- 3.1 Limiting reactant
- 3.2 Excess reactant
- 3.3 Theoretically required amount of reactant
- 3.4 Percent excess of reactant
- 3.5 Degree of completion of reaction
- 3.6 Percent conversion of reactant
- 3.7 Percent yield
- 3.8 Calculation based on chemical equation

4. MATERIAL BALANCE

- 4.1 Law of material balance
- 4.2 Steps involved in making material balance calculation
- 4.3 Tie component
- 4.4 Material balance without chemical change

- 4.5 Material balance involving chemical change
- 4.6 Calculation based on simultaneous equation
- 4.7 Calculation based on combustion problems

5. ENERGY BALANCE

- 5.1 Energy unit
- 5.2 Law of Energy Balance
- 5.3 Specific heat at constant volume
- 5.4 Specific heat at constant pressure
- 5.5 Latent heat
- 5.6 Enthalpy

6. THERMO CHEMISTRY

- 6.1 Heat of Reaction
- 6.2 Heat of Formation
- 6.3 Heat of Combustion
- 6.4 Hesis law of Heat Submission

7. THERMODYNAMICS

- 7.1 First law of Thermodynamics
- 7.2 Heating at constant volume
- 7.3 Heating at constant pressure

TEXT BOOKS

- 1. Manual on Stoichiometry (Chemical Technology) Polytechnic Manual pens
- 2. An Introduction to Chemical Engg. by Charles E. Little

John

CHT 372 INDUSTRIAL STOICHIOMETRY

INSTRUCTIONAL OBJECTIVES.

1 UNIT AND DIMENSION

- 1.1 Understand unit and dimension
 - 1.1.1 Explain unit and dimension
 - 1.1.2 Enumerate the system of units
 - 1.1.3 Define English system, metric system and S.I system
 - 1.1.4 Explain derived units

2 BEHAVIOUR OF GAS

- 2.1 Understand behaviour of gases
 - 2.1.1 Explain facts and observation about gases
 - 2.1.2 Enlist the gas laws
 - 2.1.3 Define ideal gas law
 - 2.1.4 State boyle's law
 - 2.1.5 State charle's law
 - 2.1.6 Derive general gas equation
 - 2.1.7 Describe Absolute temperature
 - 2.1.8 Define Absolute Zero
 - 2.1.9 Define Absolute temperature scale
 - 2.1.10 Define the standard conditions of temp pressure (STP or NTP)
 - 2.1.11 Calculate value of R in different system
 - 2.1.12 Solve problems based on gas equation
 - 2.1.13 Explain dalton's law of partial pressure
 - 2.1.14 Define amagats law
 - 2.1.15 Explain the Application of problems
 - 2.1.16 Describe avogadro's number
 - 2.1.17 Explain mole fraction and percent
 - 2.1.18 Illustrate pressure fraction, mass fraction, volume fraction
 - 2.1.19 Prove mole percent=volume percent=pressure percent
 - 2.1.20 Solve problems of gaseous mixture based on %age and fraction
 - 2.1.21 Derive vander wall's equation
 - 2.1.22 Solve problems based on vanders wall's equation

3 CHEMICAL EQUATION

- 3.1 Understand chemical equation
 - 3.1.1 Define limiting reactant
 - 3.1.2 Define excess reactant
 - 3.1.3 Calculate theoretical required amount of reactant
 - 3.1.4 Calculate excess of reactant
 - 3.1.5 Define degree of competition reaction
 - 3.1.6 Describe percent conversion of reaction

- 3.1.7 Describe percent field
- 3.1.8 Solve problems based on chemical equation

4 MATERIAL BALANCE

- 4.1 Understand material balance
 - 4.1.1 Enlist the steps involved in making material balance calculation
 - 4.1.2 Define the components
 - 4.1.3 Describe material balance with out chemical change
 - 4.1.4 Explain material balance involving chemical change
 - 4.1.5 Solve problems based on simultaneous equation
 - 4.1.6 Solve problems based on combustion process

5 ENERGY BALANCE

- 5.1 Understand energy balance
 - 5.1.1 Define energy unit
 - 5.1.2 State law of energy balance
 - 5.1.3 Explain specific heat at constant volume and constant pressure
 - 5.1.4 Define latent heat
 - 5.1.5 Explain enthalpy

6 THERMO CHEMISTRY

- 6.1 Understand thermo chemistry
 - 6.1.1 Define heat of reaction, heat of formation and heat of combustion
 - 6.1.2 State Hess's law of heat summation
 - 6.1.3 Calculate heat of combustion of gases/ fuels
 - 6.1.4 Calculate heat of reaction applying Hess's law

7 THERMODYNAMICS

- 7.1 Understand thermodynamics
 - 7.1.1 State first law of thermodynamics
 - 7.1.2 Calculate specific heat at constant volume and at constant pressure