6.1 EMPLOYABILITY SKILLS – II

L	T	P
-	-	2

RATIONALE

The present day world requires professionals who are not only well qualified and competent but also possess good communication skills. Our diploma students not only need to possess subject related knowledge but also soft skills to get good jobs or to rise steadily at their work place. The objective of this subject to prepare students for employability in job market and survive in cut throat competition among professionals.

DETAILED CONTENTS

1. Oral Practice

i)	Mock interview	(05 hrs)
ii)	Preparing for meeting	(05 hrs)
iii)	Group discussion	(05 hrs)
iv)	Seminar presentation	(05 hrs)
v)	Making a presentation	(12 hrs)

a) Elements of good presentation
b) Structure and tools of presentation
c) Paper reading
d) Power point presentation

6.2 ENTREPRENEURSHIP DEVELOPMENT AND MANAGEMENT

L	T	P
3	-	-

RATIONALE

In the present day scenario, it has become imperative to impart entrepreneurship and management concepts to students so that a significant percentage of them can be directed towards setting up and managing their own small enterprises. This subject focuses on imparting the necessary competencies and skills of enterprise set up and its management.

DETAILED CONTENTS

SECTION – A ENTREPRENEURSHIP

1. Introduction (14 hrs)

- Concept /Meaning and its need
- Qualities and functions of entrepreneur and barriers in entrepreneurship
- Sole proprietorship and partnership forms of business organisations
- Schemes of assistance by entrepreneurial support agencies at National, State, District level: NSIC, NRDC, DC:MSME, SIDBI, NABARD, Commercial Banks, SFC's TCO, KVIB, DIC, Technology Business Incubator (TBI) and Science and Technology Entrepreneur Parks (STEP).

2. Market Survey and Opportunity Identification (10 hrs)

- Scanning of business environment
- Salient features of National and State industrial policies and resultant business opportunities
- Types and conduct of market survey
- Assessment of demand and supply in potential areas of growth
- Identifying business opportunity
- Considerations in product selection

3. Project report Preparation (8 hrs)

- Preliminary project report
- Detailed project report including technical, economic and market feasibility
- Common errors in project report preparations
- Exercises on preparation of project report

SECTION –B MANAGEMENT

4. Introduction to Management (04 hrs)

- Definitions and importance of management
- Functions of management: Importance and Process of planning, organising, staffing, directing and controlling
- Principles of management (Henri Fayol, F.W. Taylor)
- Concept and structure of an organisation
- Types of industrial organisations
  a) Line organisation
  b) Line and staff organisation
  c) Functional Organisation

5. Leadership and Motivation (03 hrs)

a) Leadership

- Definition and Need
- Qualities and functions of a leader
- Manager Vs leader
- Types of leadership

b) Motivation

- Definitions and characteristics
- Factors affecting motivation
- Theories of motivation (Maslow, Herzberg, McGregor)

6. Management Scope in Different Areas (6 hrs)

a) Human Resource Management

- Introduction and objective
- Introduction to Man power planning, recruitment and selection
- Introduction to performance appraisal methods

b) Material and Store Management

- Introduction functions, and objectives
- ABC Analysis and EOQ

c) Marketing and sales

- Introduction, importance, and its functions
- Physical distribution
- Introduction to promotion mix
- Sales promotion

d) Financial Management

- Introductions, importance and its functions
- Elementary knowledge of income tax, sales tax, excise duty, custom duty and VAT

7. Miscellaneous Topics (03 hrs)

a) Customer Relation Management (CRM)

- Definition and need
- Types of CRM

b) Total Quality Management (TQM)

- Statistical process control
- Total employees Involvement
- Just in time (JIT)

c) Intellectual Property Right (IPR)

- Introductions, definition and its importance
- Infringement related to patents, copy right, trade mark

Note: In addition, different activities like conduct of entrepreneurship awareness camp extension lecturers by outside experts, interactions sessions with entrepreneurs and industrial visits may also be organised.

INSTRUCTIONAL STRATEGY

Some of the topics may be taught using question/answer, assignment or seminar method. The teacher will discuss stories and case studies with students, which in turn will develop appropriate managerial and entrepreneurial qualities in the students. In addition, expert lecturers may also be arranged from outside experts and students may be taken to nearby industrial organisations on visit. Approach extracted reading and handouts may be provided.

RECOMMENDED BOOKS

1. A Handbook of Entrepreneurship, Edited by BS Rathore and Dr JS Saini; Aapga Publications, Panchkula (Haryana)
2. Entrepreneurship Development published by Tata McGraw Hill Publishing Company Ltd., New Delhi
3. Entrepreneurship Development in India by CB Gupta and P Srinivasan; Sultan Chand and Sons, New Delhi
4. Entrepreneurship Development - Small Business Enterprises by Poornima M Charantimath; Pearson Education, New Delhi

5. Entrepreneurship : New Venture Creation by David H Holt; Prentice Hall of India Pvt. Ltd., New Delhi
6. Handbook of Small Scale Industry by PM Bhandari
7. Principles and Practice of Management by L M Prasad; Sultan Chand & Sons, New Delhi.

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1	14	28
2	10	20
3	08	16
4	04	10
5	03	06
6	06	14
7	03	06
Total	**48**	**100**

6.3 PROCESS PLANT UTILITIES

L	T	P
4	-	-

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RATIONALE

This subject is introduced to give the student a thorough knowledge of process utilities such as demineralization of water, steam generation, steam distribution and cooling water, which is essentially required for working in any chemical or related industry.

DETAILED CONTENTS

1. Water (18 hrs)

Sources of water, Impurities in water, Define Hardness and its cause, types of hardness - Temporary Hardness, Permanent Hardness. Units of Hardness and their interrelation. Estimation of hardness by EDTA methods, Conditions for boilers feed, water boiler problems. Scale and sludge, Priming, Foaming, Carryover, Boiler Corrosion, Caustic Embrittlement, Water Softening, Internal Treatment, External Treatment, Colloidal Conditioning, Carbonate Conditioning, Phosphate Conditioning, Calgon Conditioning, External Treatment, Zeolite Process, Lime Soda Process, Ion Exchange Process, Mixed Bed Deionizer Process, Concept of soft, hard, de-ionized water and distilled water Resins used. Regeneration (Ion Exchange and Mixed Bed Deionizer).

2. Steam, Steam Generation and Steam Distribution (24 hrs)

Brief introduction of steam, Formation of steam at a constant pressure from water.

Temperature vs total heat graph during steam formation, important terms for steam (wet steam, dry saturated steam, superheated steam, dryness fraction or quality of wet steam, sensible heat of water, latent heat of vaporization, enthalpy or total heat of steam, specific volume of steam. Steam tables and simple numerical problems on them.

Enthalpy – Entropy (H-S) diagram for water and steam or Mollier Chart and simple numerical problems on them, specification of steam pipes, layout of piping, steam trap (Expansion and Bucket), Steam ejectors.

Boilers: Different types of boilers viz. Babcock Wilcox, Nestler, Cochran boiler. Boiler accessories like economizer, ID fan, FD fans, preheater, superheater, oil burner, soot blowers.

3. Refractories (08 hrs)

Definition, classification (acid, basis, neutral, insulating, special, cermets refractoriness), properties, characteristics, general method of manufacturing of refractories, selection of refractories, some important refractories (fire clay, silica, high alumina, bauxite, carbon/graphite). Failure of refractories.

4. Insulation (04 hrs)

Characteristics, properties, classification: cold insulation, low temperature insulation (high vacuum, multiple layer powder, rigid foam).

5. Refrigerants and Cooling Water (10 hrs)

Introduction, classification of refrigerants (primary, secondary) properties (thermodynamic, physical and safe working,), important refrigerants (ammonia, carbon dioxide, cryogeme, antifreeze). Selection of refrigerants. Construction and working of cooling towers (natural and forced draft).

INSTRUCTIONAL STRATEGY

Field visit is must to give idea about the various boilers and cooling towers. Students should be encouraged to make flow sheets for various processes.

RECOMMENDED BOOKS

1. Industrial Chemistry by Shashi Chawla, Dhanpat Rai and Sons Publication
2. Plant Utilities by Dr. Mujawar, Nirali Prakashan Publication
3. Plant Economics by Peter Timmerhans, McGraw Hill
4. Heat Transfer by D.S. Kumar
5. Plant Utilities by D.B. Dhone, Nirali Prakshan Publication
6. Fuel Furances and Refractories by O.P. Gupta, Khanna Publishers

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted Hrs
1	18	30
2	24	35
3	8	15
4	4	5
5	10	15
Total	**64**	**100**

6.4 PROCESS INSTRUMENTATION AND CONTROL

L	T	P
4	-	3

RATIONALE

This subject gives the knowledge of various instruments used to measure various process parameters. This course will impart knowledge on working principle, construction, repair and use of these instruments.

DETAILED CONTENTS

1. Measurement Systems or Elements of Measurement Instruments (8 hrs)

   Measurement and its aim, primary and secondary element, manipulating and functioning elements, static characteristics, calibration, Accuracy, Precision, repeatability, drift, sensitivity, resolution, Dead Zone, Static Error.

2. Temperature Measurement (10 hrs)

   Temperature scales, methods of temperature Measurement: Expansion thermometers, filled system thermometer, electric temperature instruments, pyrometers.

3. Pressure Measurement (10 hrs)

   Units of pressure, methods of pressure measurement, manometers, elastic pressure transducers, force balance pressure gaugers, electrical pressure transducer, measurement of vacuum.

4. Level Measurement (10 hrs)

   Methods of Liquid level measurement, Direct Methods: Sight Glass, Float, Displacer, Indirect Methods: Pressure Gauge, Air Trap, Diaphragm box, Air Purge, Radioactive, Ultrasonic, Capacitive Solid level Measurement, Solid level Measurement.

5. Analyzers and Recorders (10 hrs)

   pH meter, viscosity measurement, various types of analyzers. Oxygen analyzer, Infrared Analyzer, Orsat Analyzer. Circular charts and strip chart recorders.

6. Introduction to Process Control (10 hrs)

   Definition and example of process control system. Block diagram representation of process control system, component of a process control system, Transfer function of a control system, types of process control system – open loop control system, closed loop control system, feed forward and feed backward control system, cascade control system (in brief). System Input-Step, Ramp, Sinusoidal, Pulse.

7. Control Valve (6 hrs)

Valve Characteristics, Valve Types, Valve Actuator and Valve Positioning.

LIST OF PRACTICALS

1. To calibrate pressure gauge with the help of dead weight pressure gauge
2. To calibrate bimetallic thermometer, resistance thermometer, thermocouple, energy meter and watt meter.
3. To measure pressure with the help of different types of manometers.
4. To determine the characteristics of a flapper nozzle system.
5. To study on-off controller for temperature control.
6. To study constructional details of strip chart recorder.
7. To study measurement of relative humidity and to compare the value with psychometric chart.
8. To study constructional details of circular chart recorder.
9. To plot the curve between flow rate and percent opening of control valve with the help of DCS (Distributed Control System)

INSTRUCTIONAL STRATEGY

The subject gives the knowledge of various process, instruments and controls to measure process parameters. 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 examples.

RECOMMENDED BOOKS

1. Industrial Instrumentation by Donald P. Eckman, Wiley Eastern publications.
2. Process System Analysis and Control by Cughnour, McGraw Hill publications.
3. Industrial Instrumentation by SK Singh, Tata McGraw Hill Publicaions.
4. Principles of Industrial Instrumentation by D. Patro Nalis, Tata McGraw Hill Publications

SUGGESTED DISTRIBUTION OF MARKS

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

6.5 POLLUTION CONTROL IN CHEMICAL PROCESS INDUSTRY

L	T	P
4	-	3

RATIONALE

The subject aims at providing students the knowledge of different types of pollutants, its harmful effects and mode of treatment and analysis techniques.

DETAILED CONTENTS

1. Air Pollution Source and Effects (8 hrs)

   Definition of air pollution, different scale for measurement of air pollution, sources of air pollutants (Natural and manmade or anthropogenic) classification of air pollution: according to origin (primary and secondary), state of matter (Gaseous and Particulate Matter), Gaseous (CO, CO_2, Oxides of nitrogen and oxides of sulphur, hydrocarbons), particulate (Dust, Fumes, Smoke, Mist, Fog and Fly ash); Effect of air pollution on human health, animals, plants, materials and climate.

2. Air Pollution Sampling and Measurement (10 hrs)

   Air sampling (ambient and stack, Grab sampling), collection of gaseous air pollutants (Absorption in liquid, Adsorption on solid), collection of particulate pollutants (Sedimentation, High Volume Filtration, Impingement, Electrostatic Precipitation, Thermal Precipitation), Analysis of air pollutions – SO_2 CO, Nitrogen oxides, Hydrocarbons.

3. Air pollution Control Methods and Equipments (10 hrs)

   Gases control equipment (absorption by liquid, adsorption by solid, combustion). Particulate control equipments (fabric filters, E.S.P., venturi scrubber, spray tower, centrifugal separator, control methods, substitution of raw materials, process modification, equipment modification of existing equipments, maintenance of equipment.

4. Control of Specific Gases Pollutants (10 hrs)

   Extraction of sulphur from fuel, desulphurization of fuel oil, sulphur reaction during combustion, desulphurization of fuel gases.

5. Water Pollution (18 hrs)

   Definition of water pollution, source of water pollution, type of water pollution, Health Hazards of water pollution, type of sampling (grab and composite), methods of analysis

(BOD, COD & TOC), Different treatment methods for effluent, primary treatment (pretreatment, flotation and sedimentation, secondary treatment (activated sludge process and trickling filter), Advanced waste water treatment, removal of suspended solid (membrane separation, coagulation and filtration), Removal of dissolved solids (adsorption on activated carbon, Ion Exchange.

6. Solid Waste Management (8 hrs)

Classification of solid waste, health hazards of solid waste pollution, disposal of solid waste methods (collection, disposal, waste utilization, incineration, compositing, dumping sanitary landfilling etc).

LIST OF PRACTICALS

1) Estimation of TS, TDS, SS, VSS
2) Estimation of Dissolved Oxygen
3) Estimation of BOD
4) Estimation of COD by titration method
5) Estimation of pH value
6) Estimation of carbonate, bicarbonate hydroxide and alkalinity of waste water sample
7) Estimation of acidity of waste water sample
8) To determine the turbidity of waste water sample
9) To determine the hardness of water
10) To determine SPM in Ambient Air by high volume sampler
11) Demonstration of isokinetic sampling of SPM in stack

INSTRUCTIONAL STRATEGY

In this subject, it is essential to give instructions to students about the environment and pollution due to industry and how it may be minimized. It is essential to take the students to industries for pollution related problems.

RECOMMENDED BOOKS

1. Environmental Engineering and Management by S.K. Dhameja, S.K. Kataria & Sons.
2. Environmental Engg., by CS Rao, Wiley Eastern Publication,.
3. Environmental Engg., by Heward Peavy, McGraw Hill Publiations.
4. Air Pollution by Perkins, McGraw Hill Publication
5. Waste Water Engineering by Metcalf and Eddy, McGraw Hill Publication
6. Environmental Sceince by S.C. Santra, New Central Book Agency, Kolkata
7. Environmental Engineering by Gerard Kiely, Tata McGraw Hill Publication

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1	8	10
2	10	15
3	10	15
4	10	15
5	18	30
6	8	15
Total	**64**	**100**

6.6 PAINT TECHNOLOGY

L	T	P
4	-	-

RATIONALE

This specialized subject will enable the students to study the paint technology in detail along with its applications and defects. This subject is of importance in view of the increasing job potential in paint industry.

DETAILED CONTENTS

1. Introduction to Paint (8 hrs)

Need of surface coating, common terms used in the paint industry. Enamel, Glaze Lake, Printing ink, Putty, Seller, Shellac, Stain, Thinner tinting strength, Toner Vehicle, primer undercoat and final coat.

2. Constituents of Paints (12 hrs)

Definition and significance of pigment, properties (hiding power, tinting strength, refractive index, light fastness, bleeding, characteristics, particle size and shape).

Organic pigments (red, yellow, green, blue, black), Inorganic pigments white colored metallic extenders), Binders – types (alkyls, polyesters, acrylics, thermo set acrylics vinyl), Definition and significance of solvents, types (hydrocarbon solvents, oxygenated solvents water), Additives – types (thickening agents, surface active agents, surface modifiers, leveling agents and coalescing space agents, catalytically active additives), special effects additives, (skinning agents, light stabilizer, corrosion inhibitors, biocides, flame retardants).

3. Paint Manufacturing Process (12 hrs)

Flow sheet and process description, pigments dispersion equipments (roller mill, pug mill, attritions, extruders), classification and types of paint architectural coating (solvents based paint, water based paint) interior flat paints, Exterior flat paints, industrial coatingss, powder coatings, special purpose coatings. Varnishing, Lacquers.

4. Paint Formulation and Techniques for Paint Applications (12 hrs)

Pigments to binder ratio, solid contents, pigments volume concentration (PVC), cost, brush coating, roller coating, spray coating, deep coating, powder coating, electrode deposits.

5. Paint Failure (10 hrs)

Causes for paint failure, defects in paints, Aeration, Aging, Bleeding, Blooming, Blistering, Blushing, Chalking Cheeking, Coagulation, Coverage, Cracking, Embritllement, Erosion, Fading, Foaming, Hazing, Lifting, Opacity, Peeling, Pinholes, Sagging. Tackiness, Settling, Skinning, Thickening.

6. Electroplating (10 hrs)

Quantitative aspects of electrolysis, Faraday's first and second laws of electrolysis, difference between electrochemical and electrolytic cell, characteristics of electro deposit, methods of cleaning articles before electro deposition, electroplating methods, electroplating effects, uses of electroplating, difference between electroplating on metals and on plastics.

INSTRUCTIONAL STRATEGY

The students may be exposed to different types of paints formulation and application by field visits to understand the subject fully. Extension lectures by experts from paint industries can enrich the students with better inputs regarding formulation of paints and improving the quality of coatings.

RECOMMENDED BOOKS

1. A textbook of Engineering Chemistry by Shashi Chawla; Dhanpat Rai Publications.

2. Engineering Chemistry by Jain and Jain; Dhanpat Rai Publication.

3. Synthetic Resins Technology with Formulations, EIRI Board Publication.

4. Handbook of Industrial Chemistry of Organic Chemicals by Mohd. Farhat Ali, McGraw Hill Publication.

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1	8	10
2	12	20
3	12	20
4	12	20
5	10	15
6	10	15
Total	**64**	**100**

6.7 MAJOR PROJECT WORK

L	T	P
-	-	8

Project work aims at developing skills in the students whereby they apply the totality of knowledge and skills gained through the course in the solution of particular problem or undertaking a project. The students have various aptitudes and strengths. Project work, therefore, should match the strengths of students. For this purpose, students should be asked to identify the type of project work, they would like to execute. It is also essential that the faculty of the respective department may have a brainstorming session to identify suitable project assignments. The project assignment can be individual assignment or a group assignment. There should not be more than 3 students if the project work is given for a group. The students should identify or given project assignment at least two to three months in advance. The project work identified in collaboration with industry may be preferred.

Each teacher is expected to guide the project work of 5-6 students. The project assignments may consist of:

- Development of prototypes
- Study of different types of :
    - heat exchangers
    - distillation columns
    - evaporators
    - reactors
    - drying unit etc.
- Study of different types of vessels, heads and joints (can be done through factory visit)
- Study of pumps and valves used in process industries
- Fabrication of components/equipments
- Fault diagnosis and rectification experiences
- Bringing improvements in the existing system/equipment
- Audits of industry- energy audit, water audit, material audit etc.
- Case Studies

A suggestive criteria for assessing student performance by the external (personnel from industry) and internal (teacher) examiner is given in table below:

Sr. No.	Performance criteria	Max. marks	Rating Scale				
			Excellent	Very good	Good	Fair	Poor
1.	Selection of project assignment	10	10	8	6	4	2
2.	Planning and execution of considerations	10	10	8	6	4	2
3.	Quality of performance	20	20	16	12	8	4
4.	Sense of responsibility	10	10	8	6	4	2
5.	Self expression/communication skills	10	10	8	6	4	2
6.	Interpersonal skills/human relations	10	10	8	6	4	2
7.	Report writing skills	20	20	16	12	8	4
8.	Viva voce	10	10	8	6	4	2
Total marks		**100**	**100**	**80**	**60**	**40**	**20**

The overall grading of the practical training shall be made as per following table

	Range of maximum marks	Overall grade
i)	More than 80	Excellent
ii)	79 <> 65	Very good
iii)	64 <> 50	Good
iv)	49 <> 40	Fair
v)	Less than 40	Poor

In order to qualify for the diploma, students must get “Overall Good grade” failing which the students may be given one more chance of undergoing 8 -10 weeks of project oriented

professional training in the same industry and re-evaluated before being disqualified and declared “not eligible to receive diploma ”. It is also important to note that the students must get more than six “goods” or above “good” grade in different performance criteria items in order to get “Overall Good” grade.

Important Notes

1. This criteria must be followed by the internal and external examiner and they should see the daily, weekly and monthly reports while awarding marks as per the above criteria.

2. The criteria for evaluation of the students have been worked out for 100 maximum marks. The internal and external examiners will evaluate students separately and give marks as per the study and evaluation scheme of examination.

3. The external examiner, preferably, a person from industry/organization, who has been associated with the project-oriented professional training of the students, should evaluate the students performance as per the above criteria.

4. It is also proposed that two students or two projects which are rated best be given merit certificate at the time of annual day of the institute. It would be better if specific nearby industries are approached for instituting such awards.

The teachers are free to evolve another criteria of assessment, depending upon the type of project work.

It is proposed that the institute may organize an annual exhibition of the project work done by the students and invite leading Industrial organisations in such an exhibition. It is also proposed that two students or two projects which are rated best be given merit certificate at the time of annual day of the institute. It would be better if specific industries are approached for instituting such awards.

10. RESOURCE REQUIREMENTS

10.1 Physical Resources

10.1.1 Space requirement

Norms and standards laid down by All India council for Technical Education (AICTE) may be followed to work out space requirement in respect of class rooms, tutorial rooms, drawing halls, laboratories, space required for faculty, student amenities and residential area for staff and students.

10.1.2 Equipment requirement

For three year diploma programme in Chemical Engineering for student intake of 30, following laboratories and workshops are required corresponding to the curriculum structure suggested by the expert group:

i) Physics Laboratory

ii) Chemistry Laboratory

iii) Mechanical Engineering Laboratory

iv) Unit Operation and Fluid Mechanics Laboratory

v) Electrical and Electronics Laboratory

vi) Heat and Mass Transfer Laboratory

vii) Environment Engineering Laboratory

viii) Instrumentation and Process Control

ix) Computer Laboratory

x) Petroleum Processing Laboratory

xi) Chemical Technology Laboratory

xii) Basic Workshops; Forging; Fitting and Assembly; Carpentry; Welding; Electrical Shop; Molding; Turning, Milling; Advanced Fitting; Grinding Advanced Machine Shop

The equipment required for laboratories/workshops for (i), (ii), (iii), (v), (ix) and (xii) will be as per the standard list approved by All India Council for Technical Education (AICTE). Equipment/Machinery requirement for laboratories/ workshops needed for Chemical Engineering course is given in the following pages.

Sr. No.	Particulars	Unit 1 each
UNIT OPERATIONS AND FLUID MECHANICS LABORATORY		
1.	Centrifuge	01
2.	Ball Mill	01
3.	Mixer – Liquid Liquid Mixer and Solid Liquid Mixer	02
4.	Roller mill	01
5.	Compressor, Wet Gas Meter, Blower	01
6.	Jaw Crusher	01
7.	Cyclone Separator	01
8.	Plate and frame filter press	01
9.	Sieve shaker	01
10.	Vacuum pumps	01
11.	Packed column (Randomly packed with Raschig Rings) and fluidized column	02
12.	Agitating equipment	01
13.	Particle settling in fluids (Drag coefficient)	01
14.	Sedimentation apparatus (Measuring Cylinder, 1 lt)	01
15.	Determination of Friction loss through pipe	01
16.	Weirs, v-notch	01
17	Centrifugal pumps, reciprocating pump	01
18.	Redwood Viscometer	01
19.	Rotameter, Venturimeter, Orificemeter, pitot tube	01
20.	Globe valve, check valves	01
21.	Gatevalve	01

22.	Reynolds number determination apparatus	01
23.	Rotary Disc Filter, Vacuum Rotary Drum Filter	01
HEAT AND MASS TRANSFER LABORATORY		
24.	Double Pipe Heat Exchanger	01
25.	Shell and Tube Heat Exchanger	01
26.	Coiled Evaporator	01
27.	Single Effect Evaporator	01
28.	Boiler House	01
29.	Condenser	01
30.	Open Pan Evaporator	01
31.	Batch Distillation Apparatus	01
32.	Oven	01
33.	Liquid – Liquid Extractor setup	01
34.	Packed Column	01
35.	Dryer (Tray)	01
36.	Bubble cap distillation column	01
37.	Refractrometer	01
38.	Composite wall	01
39.	Thermal conductivity apparatus for insulating powder	01
40.	Natural convection apparatus	01
41.	Forced convection apparatus	01
42.	Drop wise and film wise condensation apparatus	01
43.	Stefan’s Boltzman apparatus	01
44.	Liquid diffusion apparatus	01
45.	Solid diffusion apparatus	01
46.	Welted wall column apparatus	01
47.	Cooling tower	01
48.	Finned tube heat exchanger	01

49.	Crystallizer	01
50.	Reverse osmosis set up	01
	ENVIRONMENT ENGINEERING LABORATORY	
51.	pH Meter	01
52.	Turbidity Meter	01
53.	Oven with Temperature Controller and Forced Air Circulation Type	01
54.	B.O.D. Incubator	01
55	Water Analysis Kit	01
56.	High Volume Sampler	01
57.	Electrical Balance for weighing upto 1/10 of milligram (capacity)	01
INSTRUMENTATION AND PROCESS CONTROL LABORATORY		
58.	Apparatus for calibration of pressure gauge	01
59.	Energy Meter	01
60.	Watt Meter	01
61.	Manometers	01
62.	Flapper Nozzle system apparatus	01
63.	On-off controller	01
64.	Thermopiles	01
65.	Resistance thermometer	01
66.	Bimetallic thermometer	01
67.	Strip chart recorder	01
68.	Wet bulb – dry bulb temperature thermometer	01
69.	Circular chart recorder	01
70.	PID, PD and P Controller	01

PETROLEUM PROCESSING LABORATORY		
71.	Pour Point Apparatus	01
72.	Cloud Point Apparatus	01
73.	Smoke Point Apparatus	01
74.	Flash Point Apparatus	01
75.	ASTM distillation Apparatus	01
76.	Redwood Viscometer	01
77.	Penetratometer	01
78.	Bomb Calonimeter	01
79.	Softening Point determination apparatus	01
CHEMICAL TECHNOLOGY LABORATORY		
80.	Refractometer	01
81.	Muffel Furnace	01
82.	Electrical Oven	01

10.1.3 Furniture Requirement

Norms and standards laid down by AICTE be followed for working out furniture requirement for this course.

10.2 Human Resources Development:

Weekly work schedule, annual work schedule, student teacher ratio for various group and class size, staffing pattern, work load norms, qualifications, experience and job description of teaching staff workshop staff and other administrative and supporting staff be worked out as per norms and standards laid down by the AICTE.