## 4.1 CHEMICAL ENGINEERING THERMODYNAMICS

| L | T | P |
|---|---|---|
| 5 | - | - |

**RATIONALE**

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

**DETAILED CONTENTS**

**1. Introduction:** **(10** Periods**)**

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

**2. Work and Heat Transfer:** **(10** Periods**)**

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

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

**3. First law of thermodynamics:** **(10** Periods**)**

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

**4. Second Law of Thermodynamics:** **(10** Periods**)**

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

**5. Thermodynamic Relations:** **(10** Periods**)**

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

Show that:

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

Maxwell Relations from first principle. Derive

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

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

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

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

**6. Entropy :** **(8** Periods**)**

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

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

**8. Refrigeration and Liquifaction:** **(10** Periods**)**

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

**9. Phase Equilibria** **(10** Periods**)**

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

## INSTRUCTIONAL STRATEGY

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

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

## RECOMMENDED BOOKS


1. Thermal Engineering by Balleny, Prentice Hall Publications
2. Chemical Engineering Thermodynamics by YUC Rao
3. Engineering Thermodynamics by PK Nag
4. Introduction to Chemical Engineering Thermodynamics by JL Smith and Vanners, McGraw Hill Publication

## SUGGESTED DISTRIBUTION OF MARKS

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

## 4.2 HEAT TRANSFER OPERATIONS

| L | T | P |
|---|---|---|
| 4 | 2 | 4 |

**RATIONALE**

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

**DETAILED CONTENTS**

**1. Modes of Heat transfer** **(04** Periods**)**

Conduction, convection & radiation

**2. Conduction** **(08** Periods**)**

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

**3. Convection.** **(08** Periods**)**

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

**4. Radiation** **(08** Periods**)**

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

**5. Heat Exchanger** **(10**Periods**)**

Log.-Mean-Temperature Difference (L.M.T.D.) for parallel or concurrent -flow, counter-current-flow, cross -flow, Construction and description of-

(i) Double pipe heat exchangers (ii) Shell & Tube heat exchanger (iii) Finned tube heat exchangers. Scale formulation and cleaning devices, Wilson's plot. (Simple Numerical Problems for heat exchangers).

**6. Condenser.** **(08** Periods**)**

Film-wise and Drop-wise condensation, Construction and description of contact condenser.

**7. Evaporators** **(10** Periods**)**

Construction and description of- (i) Kettle type boilers (ii) Horizontal tube types (iii) Standard vertical type or calendria type (iv) Natural and forced circulation type evaporators. Entrainment and foam formation, Method of feeding

evaporators –Forward feed, Backward feed and Mixed feed, Multi effect evaporation, Boiling : Nucleate boiling, Film boiling, Transition boiling, Maximum flux and critical temperature drop, Boiling Point rise (B.P.R) and its effect, steam economy for single effect evaporator (Simple Numerical Problem).

**8. Crystallizers** **(08** Periods**)**

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

**9. Insulation** **(06** Periods**)**

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

## LIST OF PRACTICALS

1. To determine the overall heat transfer coefficient for an open pan evaporator in steady and unsteady state conditions.
2. To determine the amount of steam required in evaporating the solution in open pan evaporator.
3. To determine overall heat transfer coefficient for a double pipe heat exchanger in steady state conditions and also to determine efficiency of heat utilization for parallel current.
4. To determine overall heat transfer coefficient for a double pipe heat exchanger in steady state conditions and also to determine efficiency of heat utilization for counter current.
5. To determine overall heat transfer coefficient for a shell and tube heat exchanger in steady state conditions and also to determine efficiency of heat utilization for parallel current.
6. To determine overall heat transfer coefficient for a shell and tube heat exchanger in steady state conditions and also to determine efficiency of heat utilization for counter current.
7. To determine steam economy of a single and double effect evaporator.
8. Measurement of emissivity of test surfaces.
9. To determine the rate of evaporation for a given sample.
10. To determine thermal conductivity of metal.
11. To determine the rate of evaporation in a jacket bottled (open pan evaporation).
12. Study a sketch of oil fired boiler.

## INSTRUCTIONAL STRATEGY

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

## RECOMMENDED BOOKS


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

## SUGGESTED DISTRIBUTION OF MARKS

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

## 4.3 MATERIAL AND ENERGY BALANCE

| L | T | P |
|---|---|---|
| 4 | 2 | - |

**RATIONALE**

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

**DETAILED CONTENTS**

**1. Introduction: (05 Periods)**

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

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

**2. Humidity and Saturation: (Definitions Only) (05 Periods)**

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

**3. Material Balance without Chemical Reactions: (15 Periods)**

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

**4. Material Balance with Chemical Reactions: (15 Periods)**

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

**5. Recycling Operations: (05 Periods)**

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

**6. Energy Balance: (10 Periods)**

General balance procedure, Sensible heat & Heat capacities, Heat capacities of gases at constant volume and pressure. Empirical equation for Heat capacities. Mean molal heat capacities of gases. Heat capacity of gaseous mixtures. Enthalpy Changes accompanying chemical reaction: Heat of reaction, Heat of formation, Standard heat of formation, Heat of combustion, Hess law of constant heat

summation. Standard heat of reaction from heats of formation, Standard heat of reaction from heats of combustion. Phase change operation: Latent heat of phase change, Latent heat of vaporization, Latent heat of fusion, Latent heat of sublimation. Energy balance during phase change operation. Heat of solution & mixing.

**7. Combustion Processes: (09** Periods**)**

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

## INSTRUCTIONAL STRATEGY

Emphasis should be laid on problem solving in all the area of material and energy balance. Simple practical relating to wet bulb temperature, dry bulb temperature and humidification chart, should be done students should be encouraged to make flow sheets for various processes. This will help the students to understand the subject better and solve intricate problems in various areas.

## RECOMMENDED BOOKS


1 Stoichiometry by Bhatt and Vohra, Tata McGraw Hill Publications

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

3 Industrial Stoichiometry by Lewis and Lewis, McGraw Hill Publications

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

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


## SUGGESTED DISTRIBUTION OF MARKS

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

## 4.4 PROCESS CONTROL

| L | T | P |
|---|---|---|
| 4 | - | 4 |

**RATIONALE**

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

## DETAILED CONTENTS

**1.0. Introduction** **(04** Periods**)**

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

**2.0. Control System Components** **(09** Periods**)**

2.0. Definition-Input means, controlling means, actuating means, measuring means, final control elements, feed forward and backward system.
2.1. Brief description and working of a potentiometer
2.2. Differential transformer servo motors
2.3. Tacho Generator
2.4. Eddy Current clutches, relay contractors, timing relay, temperature satiable core reactors & its use as magnetic amplifier
2.5. Constructional brief, operation, installation & application of Pneumatic control valve & solenoid valve.
2.6. DP transmitter.
2.7. Limit Switch.

**3.0. Process Characteristics** **(25** Periods**)**

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

(b) Second order system or oscillatory type element.
(i) Bulb in thermo well.
(ii) Mechanical damper.
(iii) Fluid manometer or U tubes.

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

**4. Types of Control Techniques** **(08** Periods**)**

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

**5. Controller** **(08** Periods**)**

**5.1.** Block Diagram & Circuits of pneumatic/Hydraulic proportional, PI,PD & PID controller, ON-OFF Controller
**5.2.** Electronic Controller/Automatic Controller

**6. Closed Loop in Automatic Control** **(06** Periods**)**

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

7. Programmable Logic Controller (PLC) (04Periods)

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

## PRACTICAL

1. Experiment of ON-OFF Controller
2. Experiment of PID Controller
3. Experiment of Elex Controller
   a. Heating Control
   b. Welding Control
   c. level Control
   d. Pressure Control
4. To calibrate & install a pneumatic control valve.
5. To study the response of two tank non interacting, liquid, level system and two tank interacting liquid system.
6. Experiment of solenoid valve.
7. To measure time constant of a single capacity thermal process (water bath & heater).
8. To study the transient response of first order system (thermo couple) and find out time constant.
9. To study the transient response of a simple R-C network plot Bodey's diagram.
10. To study the frequency response of a second order electrical circuit equipment. to a physical system (R-L-C network)

# List of Books

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

## SUGGESTED DISTRIBUTION OF MARKS

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

## 4.5 PAINT TECHNOLOGY - I

| L | T | P |
|---|---|---|
| 4 | - | 2 |

**RATIONALE**

Formulation of coatings is based on optimization and balancing of three major components; resin, pigments and solvents and their interactions . This subject imparts knowledge regarding paint formulation and manufacturing to the students.

**DETAILED CONTENTS**

1. **Principles of paint formulation**- formulation elements, mathematics and steps. PVC, P/B ratio, Sp gravity, etc. Typical formulations of primers, undercoats and finish coats, industrial and site applied coating for steelwork under mild, moderate and severe conditions, (10 Periods)

2: **.Steps in Paint manufacturing** - Phenomenon of wetting, grinding and dispersion, Important considerations in pigment dispersion, important considerations in rheology of pigment dispersion. (10 Periods)

3 Heavy duty mixtures, double blade mixture, sigma kneader's pug mills. Ball, pebble and bead mills, cascading & factors affecting effectiveness of milling such as size and speed of mill, volume,, composition, size and shape of grinding medium, mill base, attritors and vibration mill, Sand mill, type of grinding media sand grinding process efficiency of mill, Horizontal sand mills (30 Periods)

**4 Mill base let down**
source of let down trouble, optimum let down condition (06 Periods)

**5 Safety measures protection-** factory layout principles and general considerations, typical flow diagram, single and multi storeyed building, sections of a paint factory and their location. (06 Periods)

**LIST OF PRACTICALS**

1. To check refractive index of oils (Drying, semidrying and non-drying)
2. To determine specific gravity of oils (Drying, semidrying and non-drying)
3. To check colour of oils (Drying, semidrying and non drying)
4. To determine acid value of oils
5. To determine acid value of resins
6. To prepare stand oil
7. To test the flash point of solvents
8. To test the aromatic content in the material

## INSTRUCTIONAL STRATEGY

Field visits to paint industry should be arranged so that the students can witness the making of various machines used in paint industry. Also they can see the process involved in paint, manufacturing. Students can also learn through simple and small experiments of paint formulations.

## RECOMMENDED BOOKS


1. Organic Coating Technology, Vol. I & II by H.F. Payne
2. Surfacing Coating Vol. I and II OGCA, Australia
3. Outlines of Paint Technology by W.M. Margans


## SUGGESTED DISTRIBUTION OF MARKS

| Topic No. | Time Allotted (Pds) | Marks Allotted (%) |
|---|---|---|
| 1 | 10 | 20 |
| 2 | 10 | 15 |
| 3 | 30 | 30 |
| 4 | 06 | 15 |
| 5 | 08 | 20 |
| **Total** | **64** | **100** |

## 4.6 NATURAL RESIN

| L | T | P |
|---|---|---|
| 4 | - | 2 |

**RATIONALE**

This subject is designed for students who will be involved in development of coatings in their daily professional life This involves the chemistry, raw materials, formulations and applications of various resins which are important component of the coatings.

**DETAILED CONTENTS**

1. **Fundamentals of film formers**- monomers, functionality and its determination, degree of polymerization, molecular weight, Convertible and non-convertible film former linear, branches and cross linked film former, natural and synthetic film former, homopolymers and copolymers. (12 Periods)

2. **Natural Resin** -Classification and properties of natural resins, processing of natural resins like copal Congo etc. Rosin sources, oleoresin and its composition. Recovery of resin and turpentine from oleoresin, properties and deficiencies rosin film, modification of rosin-calcium rosin ate, zinc and polymerized rosin, maleopimaric acid from rosin etc. Identification of rosin, Shellac origin, extraction of lac, Different kinds of lac and their props, Composition of Lac, Chemical modification of shellac for use in coatings, French polish, ,oleo resinous varnishes. (12 Periods)

3 **Bitumen**- pitches, gums and glues, natural bitumen's and petroleum in Bit Pitches, general properties and uses of gums and glues, (08 Periods)

4 **Cellulose**- source, properties, modification of cellulose for use in surface coatings like cellulose esters, ethers, water soluble cellulose derivatives, their properties, testing and uses in lacquers, putties etc. (12 Periods)

5 **Rubber resins-** sources of natural rubber, properties and modification of rubber like chlorinated rubber, cyclized rubber or isomerized rubber. Their properties and uses. (12 Periods)

**LIST OF PRACTICALS**

1. To test softening point of natural resins
2. To determine acid value of natural resins
3. To prepared limed rosin and test the acid value
4. To prepare ester gum and test the acid value and softening point
5. To prepare penta ester gum and test the acid value and softening point
6. To prepare long oil alkyd resin and test the acid value

## INSTRUCTIONAL STRATEGY

As the subject is completely theoretical, it involves synthesis of various resins used in paint industry. It can be made more interactive by showing various paint samples (automotive, wall coatings, high duty coatings etc). so that students can appreciate different types of resins and their properties.

## RECOMMENDED BOOKS


1. Organic Coating Technology, Vol. II by H.F. Payne
2. Surface Coating, Science and Technology, Ed. 2, Swarj Paul(john Wiley), 1997.
3. Outlines of Paint Technology by W.M. Morgans
4. Orgnic Coatings Wicks W; Jones FN.; Pappas S.P.; & Wicks D.A. (John Wiley 3rd Edn. 2007).


## SUGGESTED DISTRIBUTION OF MARKS

| Topic No. | Time Allotted (Pds) | Marks Allotted (%) |
|---|---|---|
| 1 | 12 | 20 |
| 2 | 20 | 20 |
| 3 | 8 | 20 |
| 4 | 12 | 20 |
| 5 | 12 | 20 |
| **Total** | **64** | **100** |

## 4.7 INDUSTRIAL TRAINING

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

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

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

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

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