

# CHHATTISGARH SWAMI VIVEKANAND TECHNICAL UNIVERSITY, BHILAI

## Diploma in Chemical Engineering

### SEMESTER-V

S No.	Board of study	Subject Code	Subject	Periods per week			Scheme of Examination					Total marks	Credit L+(T+P)/2
							Theory			Practical			
				L	T	P	ESE	CT	TA	ESE	TA		
1	Chemical Engg	219511 (19)	Chemical Process Tech – II	4	1	-	100	20	20	-	-	140	5
2	Chemical Engg	219512 (19)	Fluid Mechanics and Heat Transfer	4	1	-	100	20	20	-	-	140	5
3	Chemical Engg	219513 (19)	Mass Transfer Operation – I	4	1	-	100	20	20	-	-	140	5
4	Chemical Engg	219514 (19)	Reaction Engg and Thermodynamics	4	1	-	100	20	20	-	-	140	5
5	Chemical Engg	219515 (19)	Cement Technology	4	1	-	100	20	20	-	-	140	5
6	Chemical Engg	219521 (19)	Chemical Process Tech – II Lab	-	-	3				50	25	75	2
7	Chemical Engg	219522 (19)	Fluid Mechanics and Heat Transfer Lab	-	-	3				50	25	75	2
8	Chemical Engg	219523 (19)	Mass Transfer Operation – I Lab	-		3				50	25	75	2
9	Chemical Engg	219525 (19)	Industrial Training	-	-	2				50	25	75	1
Total				20	5	11	500	100	100	200	100	1000	32

L – Lecture

ESE – End Semester Examination

T – Tutorial

CT – Class Test

P – Practical

TA – Teacher's Assessment

**Note :** 1. Industrial Training will be carried out by the student after completion of IV semester examination.

2. Duration of training must be 4 weeks.

3. Training will be organized in IV semester and its evaluation will be done in V semester.

# CHHATTISHGARH SWAMI VIVEKANAND TECHNICAL UNIVERSITY, BHILAI

- (A) SEMESTER : V  
 (B) COURSE TITLE : CHEMICAL PROCESS TECHNOLOGY - II  
 (C) CODE (Theory) : 219511(19)  
 (D) BRANCH/DISCIPLINE : CHEMICAL ENGINEERING  
 (E) TEACHING AND EXAMINATION SCHEME :

Course code	Periods/Week (In Hours)			Scheme of Examination						Credit L+ (T+P)/2
	L	T	P	Theory			Practical		Total Marks	
				ESE	CT	TA	ESE	TA		
219511(19)	4	1		100	20	20	-	-	140	5
219521(19)	-	-	3	-	-	-	50	25	75	2

**(F) DISTRIBUTION OF MARKS AND HOURS :**

S. No.	CHAPTER No.	CHAPTER NAME	HOURS/PERIODS THEORY	MARKS
1	1	UNIT - I	16	20
2	2	UNIT - II	16	20
3	3	UNIT - III	15	20
4	4	UNIT -IV	17	20
5	5	UNIT - V	16	20

**(G) DETAILED COURSE CONTENTS :**

Study of the following industries, covering properties and uses of the product, manufacturing process, Chemical reactions, flow sheet, main features of the process and the product, major engineering problems and economics.

**UNIT - I**

- (a) Characteristics of oils, fats and waxes, extraction and refining of oil, hydrogenation of oil.
- (b) Manufacture of soap and glycerine recovery, cleaning action of soap, classification of detergents, manufacture of aryl alkyl sulfonate.
- (c) Manufacturing of cellulose, pulp, paper and viscose Rayon.
- (d) Manufacture of cane sugar and starch.

**UNIT - II**

- (a) Polymerization : Principles, Types of polymerization.
- (b) Processing of rubber latex, manufacturing of SBR and Neoprene rubber.
- (c) Resins : manufacture of phenal formaldehyde and urea formaldehyde resins.
- (d) Synthetic fibre : Manufacture of nylon and polyester.

**UNIT - III**

- (a) Industrial solvents : Manufacture of methanol, Acetone and normal Hexane.
- (b) Fermentation industries : Principles of fermentation, production of citric acid, penicillin and ethanol.

**UNIT - IV**

Dyes and intermediates :

- (a) Classification of dyestuffs and intermediates, manufacture of B-naphthol, dimethyl aniline, H-acid, orange-II dye, methyl orange dye, Acid black, Lab dye.
- (b) Explosives : Classification and evaluation manufacture of TNT, Nitroglycerene and nitro cellulose.
- (c) Pesticides : Classifications, manufacture of melathion, BHC.

**UNIT - V**

- (a) Unit Processes : Elementry principle of Halogenations, Nitration, sulphonation and alkylation.
- (b) Manufacture of Monochlorobenzene, nitrobenzene. Benzene sulphonic acid and ethylbenzene.

Above mentioned all the processes from unit I to V should cover process description, reactions, flow sheet, main features about the process, major engineering problems and economics.

**COURSE TITLE : CHEMICAL PROCESS TECH - II LAB**

**PRACTICAL CODE : 219521(19)**

**TOTAL HOURSE : 48 hrs**

**LIST OF PRACTICAL**

**EXPERIMENTS :**

1. Extraction of groundnut oil.
2. Sulphonation of benzene.
3. Polymerisation of Acrylic acid.
4. Polymerisation of vinyl chloride.
5. Manufacture of Urea formaldehyde.
6. Manufacture of soap and detergents.
7. Analysis of Rubber.
- 8 Nitration of Benzene.

**TEXT/REFERENCE BOOKS :**

1. Chemical process technology Vol. II by Shukla and Pandey.
2. Outlines of Chemical technology - Dryden.
3. Chemical Process Industries by - Shreve.

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# CHHATTISHGARH SWAMI VIVEKANAND TECHNICAL UNIVERSITY, BHILAI

(A) SEMESTER : V

(B) COURSE TITLE : FLUID MECHANICS AND HEAT TRANSFER

(C) CODE (Theory) : 219512(19)

(D) BRANCH/DISCIPLINE : CHEMICAL ENGINEERING

(E) TEACHING AND EXAMINATION SCHEME :

Course code	Periods/Week (In Hours)			Scheme of Examination						Credit L+ (T+P)/2
	L	T	P	Theory			Practical		Total Marks	
				ESE	CT	TA	ESE	TA		
219512(19)	4	1	-	100	20	20	-	-	140	5
219522(19)	-	-	3	-	-	-	50	25	75	2

(F) DISTRIBUTION OF MARKS AND HOURS :

S. No.	CHAPTER No.	CHAPTER NAME	HOURS/PERIODS THEORY	MARKS
1	1	UNIT - I	16	20
2	2	UNIT - II	16	20
3	3	UNIT - III	16	20
4	4	UNIT -IV	16	20
5	5	UNIT - V	16	20

(G) DETAILED COURSE CONTENTS :

## UNIT - I

- (a) Nature of fluids : incompressible and compressible fluid, Hydrostatic Equilibrium, Equilibrium in a centrifugal field, Gravity and centrifugal decanters. Simple, differential and inclined manometers, definition of potential flow and one dimensional flow, relation between velocity gradient and rate of shear, viscosity and kinematic viscosity, Newtonian and non Newtonian fluids laminar and trubulent flow, transition from laminar to turbulent flow. Boundary layer, boundary layer separation and wake formation.
- (b) Continuity equation : Average velocity, mass velocity, Bernoulies theorem, kinetic energy correction factor, skin friction and form friction, shear stress distribution in a cylindrical tube. Relation between skin friction and wall shear, friction factor, relation between skin friction parameters. Hagen poisseullie eqn. Fanning eqn. Effect of roughness on friction factor hydraulically smooth tube, roughness parameter equivalent diameter, friction factor chart, losses due to enlargement, contraction, valves and fittings.

## UNIT - II

- (a) Measurement of flow of fluids; venturimeter orificemeter, pitot tube, Rotameter, weirs and notches.

- (b) Transportation and metering of fluids : pipe and tubing, connection of tubes and pipes by screwed fitting by welding, by flanges, by soldering, by compression and flare fittings, bell and spigot joint; Valves; gate valve, globe valve, butterfly valve, check valve, non return valve; Pumps : developed head, suction lift, cavitation, Classification of pumps : positive displacement and centrifugal pump, different types of reciprocating and rotary pumps, centrifugal pump priming, relation between developed head, capacity, power and speed of a centrifugal pump. Jet ejectors, elementary idea about fans, blowers and compressors.

### **UNIT - III**

Nature of heat flow : conduction, convection and radiation, Fourier's law of heat conduction. Steady state conduction in one dimensional system with compound resistances in series, Heat flow through a cylinder. Heat transfer by radiation, Stefan Boltzman's Law, concept of emissivity, absorptivity, black body and gray body radiation.

### **UNIT - IV**

Convective heat transfer surface and overall heat transfer coefficients. Logarithmic mean temperature difference. Countercurrent and co current flow, Double pipe and shell and tube heat exchangers, multipass heat exchangers Dittus Boelter eqn and its application. Basic design concept and calculations for double pipe, 1-1 and 1-2 heat exchangers. Drop wise and film wise condensation.

### **UNIT - V**

Evaporation : heat transfer to boiling liquids, characteristics of liquids affecting design of an evaporator, single and multiple effect operation, characteristics and functioning of some important types of evaporators. Capacity and economy of an evaporator, Boiling point elevation, factors affecting the capacity and economy of an evaporator, single effect evaporator calculations, methods of feeding to a multiple effect evaporator, comparison of capacity of single effect evaporator, and multiple effect evaporator operating between same terminal temperature conditions.

### **COURSE TITLE : FLUID MECHANICS AND HEAT TRANSFER**

**PRACTICAL CODE : 219512(19)**

**TOTAL HOURS : 48 HRS.**

### **EXPERIMENTS :**

1. Flow measurement by venturimeter, orificemeter, rotameter, weir and notches.
2. Verification of Bernoulli's theorem.
3. Determination of friction factor for the given pipe under laminar flow conditions and to find out its relationship with Reynolds number there from.
4. Determination of the total thermal conductivity and thermal resistances of the given compound resistances in series.
5. Determination of overall heat transfer coefficient of the double pipe heat exchanger for both co-current and counter-current flows.
6. Verification of Stefan-Boltzman's law.

7. Heat transfer by natural convection.
8. Determination of the thermal conductivity of the given metal bar.
9. Determination of thermal conductivity of insulating powder.

**TEXT/REFERENCE BOOKS :**

1. Unit Operations of Chemical Engineering By – Mc Cabe and Smith.
2. Introduction to Chemical Engineering by - Badger and Bencharo.
3. Introduction to Chemical Engineering Vol I & II by - Richardson and Coulson.
4. Process Heat Transfer by - Donald Q. Kern.

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# CHHATTISHGARH SWAMI VIVEKANAND TECHNICAL UNIVERSITY, BHILAI

- (A) SEMESTER : V  
 (B) COURSE TITLE : MASS TRANSFER OPERATIONS - I  
 (C) CODE (Theory) : 219513(19)  
 (D) BRANCH/DISCIPLINE : CHEMICAL ENGINEERING  
 (E) TEACHING AND EXAMINATION SCHEME :

Course code	Periods/Week (In Hours)			Scheme of Examination						Credit L+ (T+P)/2
	L	T	P	Theory			Practical		Total Marks	
				ESE	CT	TA	ESE	TA		
219513(19)	4	1	-	100	20	20	-	-	140	5
219523(19)	-	-	3	-	-	-	50	25	75	2

**(F) DISTRIBUTION OF MARKS AND HOURS :**

S. No.	CHAPTER No.	CHAPTER NAME	HOURS/PERIODS THEORY	MARKS
1	1	UNIT - I	16	20
2	2	UNIT - II	16	20
3	3	UNIT - III	16	20
4	4	UNIT - IV	16	20
5	5	UNIT - V	16	20

**(G) DETAILED COURSE CONTENTS :**

**UNIT - I**

Significance of phase equilibrium in Mass transfer processes. Methods of conducting Mass Transfer operation -Steady state and unsteady state operations. Stagnant operations, concept of equilibrium stage, Vapour liquid equilibrium for bicomponent systems relevant to distillation. T-X-Y and P-X-Y diagrams. Computation of equilibrium data and plotting of equilibrium curve from vapour pressure data by application of Raoult law, Henry's law and Dalton's law Behaviour of constant boiling mixtures and their separation.

**UNIT - II**

Types of distillation : batch and continuous, differential and flash distillation, rectification of bi-component mixtures, steam distillation, construction and working details of continuous fractionating columns.

**UNIT - III**

Distillation column calculations - number of theoretical plates by McCabe-Thiele and Lewis-Sorel Methods, location of feed plate. Concept of minimum reflux, total reflux, operating reflux and optimum reflux.

Plate efficiency and overall efficiency of distillation columns and factors influencing efficiency of distillation columns.

#### **UNIT - IV**

Techniques and equipments of gas absorption, construction and working details of gas absorbers-packed bed and plate columns. Types of packing and packing Characteristics. Two phase flow through packed bed. Role of liquid and gas rates in the operation of packed towers, pressure drop in packed towers.

#### **UNIT - V**

Diffusional operations - steady state unicomponent and counter molecular diffusion in liquid and gases. Two film theory and mechanism of absorption. Concept of gas phase and liquid-phase transfer co-efficients, individual and overall co-efficients, Co-current and counter current processes of absorption, Concept of driving force and operating lines for absorber and strippers, counter-current state absorption for bicomponent dilute gas mixtures (when both the operation lined and equilibrium curve are straight). Capacity of packed towers for dilute gas mixtures. Concept of H.T.U, N.T.U. and H.E.T.P. Stage efficiency of plate towers.

### **COURSE TITLE : MASS TRANSFER OPERATION LAB**

**PRACTICAL CODE : 219523 (19)**

**TOTAL HOURS : 48 hrs.**

#### **EXPERIMENTS :**

1. To verify Rayleigh's equation by carrying differential distillation of ethanol and water mixture.
2. To determine the effective interfacial area as functions of the superficial liquid velocity in a packed column using the theory of gas absorption accompanied by a Chemical reaction.
3. Determination of diffusion Co-efficient for salt in water.
4. To determine the diffusivity of acetone in air.
5. Experiment on binary distillation of benzene toluene mixture.

#### **TEST/REFERENCE BOOKS :**

1. Unit operation of Chemical Engineering by - Mc. Cabe and Smith.
2. Introduction to Chemical Engineering by - Badger and Benchro.
3. Introduction to Chemical Engineering Vol. I & II by - Richardson and Coulson.

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# CHHATTISHGARH SWAMI VIVEKANAND TECHNICAL UNIVERSITY, BHILAI

- (A) SEMESTER : V  
 (B) COURSE TITLE : REACTION ENGINEERING AND THERMODYNAMICS  
 (C) CODE (Theory) : 219514(19)  
 (D) BRANCH/DISCIPLINE : CHEMICAL ENGINEERING  
 (E) TEACHING AND EXAMINATION SCHEME :

Course code	Periods/Week (In Hours)			Scheme of Examination						Credit L+ (T+P)/2
	L	T	P	Theory			Practical		Total Marks	
				ESE	CT	TA	ESE	TA		
219514(19)	4	1	-	100	20	20	-	-	140	5

**(F) DISTRIBUTION OF MARKS AND HOURS :**

S. No.	CHAPTER No.	CHAPTER NAME	HOURS / PERIODS THEORY	MARKS
1	1	UNIT - I	16	20
2	2	UNIT - II	16	20
3	3	UNIT - III	16	20
4	4	UNIT - IV	16	20
5	5	UNIT - V	16	20

**(G) DETAILED COURSE CONTENTS :**

**UNIT - I**

Basic concepts on Thermodynamics - scope of thermodynamics study, thermodynamic systems, states and process, system properties.

I & II laws of thermodynamics and their application to simple situations. Calculations of heat of reaction at different temperatures. Adiabatic flame temperature. Concept of entropy. Calculation of maximum work and lost work for a system. Outlines of refrigeration - Carnot refrigeration cycle.

**UNIT - II**

Free energy and work function - an elementary treatment. Elementary concept of fugacity and activity. Chemical reaction equilibrium for ideal gas reaction mixture. Temperature dependency of equilibrium constant.

**UNIT - III**

Chemical Kinetics : Types of reactions, Kinetics of homogeneous reactions, elementary concept of rate theories, formulation of rate equations. Molecularity and order of reactions. Analysis and interpretation of rate data in constant volume and variable volume non-complex irreversible and reversible isothermal reaction. Total pressure method of analysis of reactor data.

**UNIT - IV**

Elementary concept of batch, continuous stirred-tank and plug-flow reactors. Development of design expressions for ideal batch, continuous flow stirred tank and tubular flow isothermal reactors and their application in design calculations.

Combined reactor systems their advantages and limitations.

**UNIT - V**

(A) Elementary concept of fixed bed, moving bed, fluidized bed reactors, homogeneous, and heterogeneous reactors, catalytic and non-catalytic reactors, non-isothermal and adiabatic reactors.

(B) Catalysts - their nature, physical and Chemical properties, preparation, testing and use of catalysts, catalyst poisoning.

Kinetics of fluid-solid catalytic reactions an elementary treatment.

**TEXT/REFERENCE BOOKS :**

1. Chemical reaction Engineering by - Octave levenspiel.
2. Chemical Kinetics by - J.M. Smith.
3. Introduction o Chemical Engg. Thermodynamics. - J.M. Smith
4. Engineering Thermodynamics by - Nag.

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# CHHATTISHGARH SWAMI VIVEKANAND TECHNICAL UNIVERSITY, BHILAI

- (A) SEMESTER : V  
 (B) COURSE TITLE : CEMENT TECHNOLOGY  
 (C) CODE (Theory) : 219515(19)  
 (D) BRANCH/DISCIPLINE : CHEMICAL ENGINEERING  
 (E) TEACHING AND EXAMINATION SCHEME :

Course code	Periods/Week (In Hours)			Scheme of Examination						Credit L+ (T+P)/2
	L	T	P	Theory			Practical		Total Marks	
				ESE	CT	TA	ESE	TA		
219515(19)	4	1	-	100	20	20	-	-	140	5

**(F) DISTRIBUTION OF MARKS AND HOURS :**

S. No.	CHAPTER No.	CHAPTER NAME	HOURS/PERIODS THEORY	MARKS
1	Unit 1	Introduction, Mining, handling & Preparation of raw materials	16	20
2	Unit 2	Chemistry of Cement	16	20
3	Unit 3	Unit Operations, Pyroprocessing and Clinkerisation	16	20
4	Unit 4	Testing & Indian Standards of Cement	16	20
5	Unit 5	Environmental and Safety Aspect of Cement Industries	16	20

**(G) DETAILED COURSE CONTENTS :**

**Unit - 1. INTRODUCTION, MINING, HANDLING & PREPARATION OF RAW MATERIALS :** application of Cement as a building material, overviewing of Cement industries, Limestone, argalacious, laterite, bauxite, clay, silicious material, alumina, iron, gypsum and coal their availability and mining. Different types of refractories used in cement industries and their characteristics. Preparation of stock piles, types of reclamation, Feed hoppers. Raw mix proportioning, 2, 3 and 4 component mixes, concept of burnability, effect of minor constituents and minerals on raw mix burning and cement characteristics, corrective and additives materials, effect of coal ash.

**Unit – 2. CHEMISTRY OF CEMENT :** Study of phase diagram of cement and clinker, Pozzolanic reaction, hydration of cement, Physical and chemical aspect of setting. Strength development, shrinkage, creep, and expansion of cement, different types of cement, thermochemistry of clinker formation, sequence of reaction. Composition of clinker, C<sub>3</sub>S, C<sub>2</sub>S, C<sub>3</sub>A, C<sub>4</sub>AF, effects of chloride, alkalies. P<sub>2</sub>O<sub>5</sub> etc. on cement.

**Unit – 3. Unit Operations, Pyroprocessing and Clinkerisation. :** Review of Crushing, grinding, Conveying operations and equipments with respect to cement industries, grinding media, dry and wet grinding, control of specific surface, critical velolity of mill, Wear rate, Crusher efficiency. Rotary kiln, different zones of kiln, preheater, precalciner, grate & planetary coolers, cooling efficiency, air requirement for cooling, dry and wet process, themal heat calculation, sizing of kiln. Instrumentation like thermo couples, optical pyrometer, speed indicator, shell radiation scanner, parameter like O<sub>2</sub>, CO, CO<sub>2</sub>, Nox, Sox etc in Kiln efficiency.

**Unit – 4. TESTING & INDIAN STANDARDS OF CEMENT. :** Testing of physical properties of raw materials, clinker and cement like particle size analysis, specific area, chemical properties like pozolana & slag percentage in cement, other constituent like C<sub>3</sub>S, C<sub>2</sub>S, C<sub>3</sub>A, C<sub>4</sub>AF etc. Calcium and magnesium determination, residue determination. Concept of various standard for cement as per ISI, BIS, etc.

**Unit – 5. ENVIRONMENTAL AND SAFETY ASPECT OF CEMENT INDUSTRIES. :** Control of particulate emissions, cyclone separators, bag filter, ESPs, pulse jet cleaner, GCT, noise abatement,. Safety in mines and inside

plants. Pollution measuring equipments, & instruments, different measures taken by cement industries to control pollution, compensatory afforestation

**REFERENCE BOOKS :**

Textbook of Cement & Concrete - Lee  
Advances in cement Technology - S. N. Ghosh  
Cement Engineer's handbook - Van Otto Labalin, McGraw Hill  
The Rotary Cement Kiln - Edward Arnold.  
Cement Data Book, All volumes, Verlag GmbH, Berlin - W.H. Duda  
Process Technology of Cement Manufacturing - Zementwerke.  
Cement Data Book, Process Engineering in the Cement Industry - Macdonald and Evans, London.  
NCB Norms for Cement Plant Operations, Fifth Editions, 2005, NCB, New Delhi.  
Quality Control in Cement Manufacture, NCB publication, 1995, New Delhi.

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## CHHATTISGARH SWAMI VIVEKANAND TECHNICAL UNIVERSITY, BHILAI

- A) SEMESTER : V
- B) COURSE TITLE : INDUSTRIAL TRAINING
- C) CODE : 219525 (19)
- D) BRANCH/DISCIPLINE : CHEMICAL ENGINEERING
- E) RATIONALE :

The purpose of industrial training is to offer wide range of practical exposures to latest practices, equipments, machines used in Govt. industries, Semi Govt. Industries, private industries, workshops and ancillary units. Industrial training also helps the students in acquiring hands-on-experience of various practices and events required to perform in different job situations. Through the industrial training the students try to integrate all that they have learnt and put that into practice.

The duration of four weeks is kept for compulsory industrial training for all students of the programme. It has been suggested that industrial training must be offered only after completion of fourth semester examination.

### F) TEACHING AND EXMINATION SCHEME:

Course Code	Periods/Week (In Hours)			Scheme of Examination						Credit L+(T+P)/2
	L	T	P	Theory			Practical		Total Marks	
				ESE	CT	TA	ESE	TA		
219525 (19)	-	-	2	-	-	-	50	25	75	1

### Objectives of Industrial Training :-

The objective of the industrial training is to correlate theory and practice. Through industrial training students will be able to :-

1. Acquaint themselves to industrial environments
2. Follow industry work discipline
3. Understand the psychology of the workers, their habits, attitudes and approach to problems.
4. Familiarize with various materials, processes, products and their applications along with relevant aspects of shop floor management.
5. Realize the size and scale of operations in the industries
6. Get opportunities to use their knowledge in problem solving and in project assignments
7. Understand various constraints of time and cost, within which goods/parts are produced and services rendered in specified quantum
8. Understand the scope, function and job responsibilities in various departments of organizations.

## **Components of Industrial Training :-**

The industrial Training has basically the following three components: -

1. Orientation Programme
2. Industrial Training in the Industry
3. Report Writing and Evaluation

During the orientation programme complete guidelines will be provided to the students regarding planning, implementation and evaluation of industrial training.

During the training student will have to maintain a daily diary to record his observations and experiences at field and on the basis of daily diary, student has to prepare and submit Industrial Training Report.

For evaluation each student has to prepare and present a seminar paper related to experience gained during the industrial training. Each student will be evaluated on the following criteria as mentioned in the evaluation.

### **Expected outcome :-**

Expected outcome of industrial training is the work done by the student or a group of students during the industrial training. Proper recording of events and work done shall be recorded and assessed in the requisite format. The student shall be assessed on the basis of work done during industrial training and report submitted and also by way of oral/ viva voce examination/presentation after completion of the training.

### **Evaluation :-**

The industrial training work of the student or a group of students will be evaluated jointly by faculty member and an expert from industry/field. The basis of evaluation will cover following criteria:

- Nature and extent of technical skills learnt
- Innovative skills/problem solving skills.
- Coordination and integration between theory and practice.
- Planning and decision making skills.
- Organization of work.
- Assemble the component/materials being used in given task.
- Work in group or independently and confidently.
- Submission of report.
- Skills and attitudes necessary in a technician.

**Note:** To assess the student performance, general guidance will be provided by the teacher.

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