Program Name : **Diploma in Chemical Engineering**

Program Code : **CH**

Semester : **Sixth**

Course Title : **Chemical Engineering Drawing**

Course Code : **22608**

1. RATIONALE

The awareness of different chemical equipments with its details and assembly is essential to diploma Chemical Engineer. Subject includes the drawings of various equipments like Heat exchangers, reactors, storage vessels, distillation columns, valves and fittings etc. and process flow sheet, utility line diagram, instrumentation diagram, various control schemes. As the drawing is a language of engineers, Diploma chemical engineer will be able to express their thoughts and ideas for arranging the various equipment in a particular pattern according to the requirement of process and prepare their drawings using CAD software.

2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Prepare chemical engineering drawings using CAD software.**

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a) Use basic operating tools in CAD software.
b) Use CAD software to draw equipment symbols used in chemical plants.
c) Draw different pipe fittings, joints and valves used in chemical process industry.
d) Draw different types of supports used in chemical process industry.
e) Draw assembly of different equipment used in chemical process industry.
f) Draw various flow diagrams for different manufacturing processes in chemical process industry using the prepared specifications.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme											
				Theory							Practical					
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
3	-	4	7	3	70	28	30*	00	100	40	50#	20	50	20	100	40

(*): Under the theory PA; Out of 30 marks, 10 marks of theory PA is for micro-project assessment to facilitate attainment of COs and the remaining 20 marks is for tests and assignments given by the teacher.

***Legends: L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** - Practical; **C** – Credit, **ESE** - End Semester Examination; **PA** - Progressive Assessment.*

5. COURSE MAP (with sample COs, PrOs, UOs, ADOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

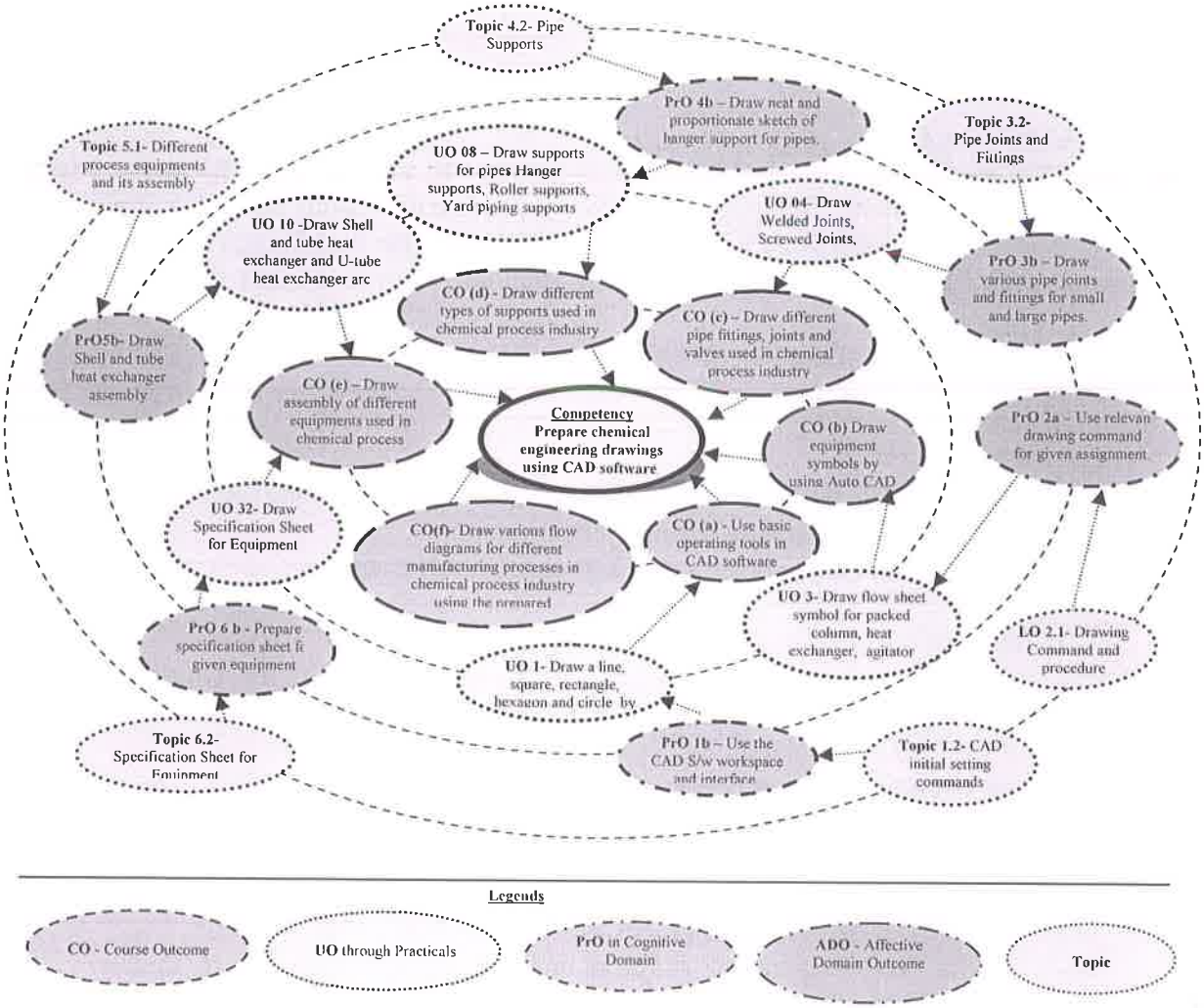

Figure 1 - Course Map

5. SUGGESTED PRACTICALS/ EXERCISES

The practicals in this section are PrOs (i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency.

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	**Sheet No.1 Basic Computer Aided Drafting Software**		
	Draw a line, square, rectangle, hexagon and circle by choose an object either from the draw menu or draw tool bar	I	02*
2	Draw an arc by specifying three point by choose an object either from the draw menu or draw tool bar	I	02
	Sheet No.2 CAD Software		
3	Draw flow sheet symbol for packed column, heat exchanger, agitator and centrifuge make use of draw tool bars	II	02*
	Sheet No.3 Pipe Joints, Fittings and valves		

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
4	Draw Welded Joints, Screwed Joints, bends, elbows, tee, nipple, Socket, Reducing socket(Reducer), plug	III	02*
5.	Draw Union joint, socket and spigot joint, Hydraulic joint, expansion joints and slip on flange, welded neck flanges.	III	02
6.	Draw Schematic View of Gate Valve, Globe Valve, Ball Valve, Diaphragm Valve, Butterfly Valve, Plug Valve , Check Valve, Control Valve	III	02*
7.	Draw Schematic View of Butterfly Valve, Plug Valve , Check Valve, Control Valve	III	02
	Sheet No.4 Supports		
8.	Draw supports for pipes Hanger supports, Roller supports, Yard piping supports	IV	02*
9.	Draw supports for Vessels Bracket support, leg support, Skirt Support, saddle support	IV	02
	Sheet No.5 Process Equipment Drawing		
10.	Draw Shell and tube heat exchanger and U-tube heat exchanger	V	02*
11.	Draw Kettle type reboiler, tube sheet, tube side passes, baffles & tie rods.	V	02
12.	Draw batch reactor assembly, Different types of heads(Minimum 8)	V	02*
13.	Draw Jackets and coils, agitators used for reactor.	V	02
	Sheet No.6 IS-3232 Equipment Symbols		
14.	Draw IS-3232 symbols for Reactors, Size reduction equipments, filters, Dryers, Different types of columns, storage vessels.	VI	02*
15.	Draw IS-3232 symbols for Heat exchangers, pumps and compressors, material handling devices, Strainers, Valves, Centrifuges.	VI	02
16.	Draw IS-3232 symbols for Controllers, Process variables symbols, instrument function symbols, process vessels, Furnaces & Boilers, separators, screens, mixers, pipe line symbols, evaporator, crystallizer, stirrer, sparger, rotameter, steam trap, vent, jacketed kettle, cooler, boiler, vaporizer, condenser, air cooler, decanter, .	VI	02*
	Sheet No.7 Block Diagram		
17.	Draw Block diagram for given manufacturing processes (Any 2)	V	02*
18.	Draw Block diagram for given manufacturing processes (Any 2)	V	02
	Sheet No.8 Process flow Diagram		
19.	Draw process flow diagram for practical no 17.	V	02*
20.	Draw process flow diagram for practical no 17.	V	02
21.	Draw process flow diagram for practical no 18.	V	02
22.	Draw process flow diagram for practical no 18.	V	02
	Sheet No.9 Utility Line Diagram		
23.	Draw Utility Line diagram for practical no 19.	V	02*
24.	Draw Utility Line diagram for practical no 20.	V	02
25.	Draw Utility Line diagram for practical no 21.	V	02
26.	Draw Utility Line diagram for practical no 22.	V	02
	Sheet No.10 Engineering Line diagram		
27.	Draw Engineering Line diagram (Instrumentation Diagram) for practical no 23.	V	02*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
28.	Draw Engineering Line diagram (Instrumentation Diagram) for practical no 24.	V	02
	Sheet No.11 Control schemes		
29.	Draw Control schemes(Flow, pressure, temperature) for - Heat Exchanger - Reactor - Distillation Column	V	02*
30.	Draw Control schemes(Flow, pressure, temperature - Dryers - Cooler/condenser/chiller - Evaporator - Vaporizer	V	02*
31.	Draw Equipment Layout and Tank Farm for given manufacturing processes for practical no.23	V	02*
	Sheet No.12 Specification Sheet		
32.	Draw Specification Sheet for Equipments (Any 1) - Heat Exchanger - Batch Reactor	V	02*
	Total		**64**

Note

i. Given in above tables is suggestive list of practical exercises. Teachers can design other similar exercises.

ii. To attain the COs and competency, a judicial mix of 10 or more practicals/exercises from the above listed PrOs need to be performed to achieve up to the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy'. Assessment of the 'Process' and 'Product' related skills in the laboratory/workshop/field work should be done as per suggested sample below:

S. No.	Performance Indicators	Weightage in %
1	Interpretation of given problem	20
2	Draw sheet using different drafting instruments and software	35
3	Follow line work for neat and accurate drafting	10
4	Neat proportionate the given drawing and writing text	10
5	Answers to sheet related questions	10
6	Submit the assigned sheet on time	5
7	Follow cleanliness and housekeeping in Drawing Hall	5
8	Attendance and punctuality	5
TOTAL		**100**

The above PrOs also comprise of the following social skills/ attitudes which are Affective Domain Outcomes (ADOs) that are best developed through the laboratory/ field based experiences:

a) Follow safety practices.
b) Practice good housekeeping.
c) Practice energy conservation.
d) Work as a leader/a team member.
e) Follow ethical Practices.

The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he undertakes a series of practical experiences over a period of time. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- 'Valuing Level' in 1st year
- 'Organisation Level' in 2nd year
- 'Characterisation Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specification mentioned here will usher in uniformity in conduct of experiments, as well as aid to procure equipment by authorities concerned.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1.	Drawing Table with Drawing Board of Half Imperial size	All
2.	Different types of pipe fittings	04 to 05
3.	Models of different valves	06 to 07
4.	Charts showing different types of supports for pipes and equipments	08 , 09
5.	Chart showing different parts of heat exchanger and batch reactor. Actual assembly of heat exchanger and batch reactor.	10 to 13
6.	IS-3232 unit operation symbols charts.	14 to 16
7.	IS-3232 Instrumentation and control symbols charts	29, 30
8.	Drawing equipment's and instruments for class room teaching-large size: a. T-square or drafter (Drafting Machine) b. Set squares (45^0 and 30^0- 60^0), Protractor Drawing instrument box (containing set of compasses and dividers)	All
9.	Specification sheets of equipments used in chemical industry in actual practice	32
10.	CAD Software (Freeware) or available on Open Source.	01 to 03
11.	Interactive board with LCD overhead projector	All

8. UNDERPINNING THEORY COMPONENTS

The following topics are to be taught and assessed in order to develop the sample UOs given below for achieving the COs to attain the identified competency. More UOs could be added.

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit-I Introduction to Computer Aided Drafting software	1a. Explain the use of Computer Aided Drafting (CAD) software in the given chemical engineering application. 1b. Explain the use CAD S/w for the specified workspace and interface. 1c. Apply different object selection methods in the given condition. 1d. Use Open, save and close new and existing file functions for the given	1.1 Fundamentals of Computer Aided Drafting (CAD) and applications in Chemical industries. 1.2 CAD initial setting commands- Snap, grid, Ortho, Osnap, Limits, Units, Ltscale, Object tracking. 1.3 Object Selection methods- picking, window, crossing, fence, last and previous. 1.4 Opening, saving and closing a new and existing drawing/template

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
	drawings/ templates	
Unit-II CAD for Chemical equipment symbols	2a. Use relevant drawing command for the given assignment. 2b. Identify Grips editing commands in the given situation with justification. 2c. Select relevant modify commands and procedure to use those in the given situation with justification. 2d. State the relevant formatting commands in the given situation.	2.1 Drawing Command and procedure: Line, arc, circle, rectangle, hexagon, polygon, ellipse, block, hatch 2.2 Grips editing and procedure- Move, Copy, Stretch 2.3 Modify Command and procedure - Erase, break, trim, copy, move, mirror, offset, fillet, extend, rotate, scale, stretch, measure, divide, explode, align 2.4 Formatting commands - Layers, block, linetype, lineweight, color. 2.5 Simple exercises related to distillation, heat exchanger, batch reactor etc.
Unit – III Pipe Joints, Fittings and Valves	3a. Describe the applications of pipe fittings and joints in the given type of chemical plant. 3b. Sketch the relevant pipe joints and fittings for the given pipes. 3c. Sketch the flange for the given application. 3d. Identify the relevant pipe joints and fittings for the given situation. 3e. Describe the applications of relevant type of valve for the given situation in the given Chemical process. 3f. Draw schematic view of the given valve.	3.1 Necessity of Pipe Joints and Fittings 3.2 Pipe Joints and Fittings - Welded Joints, Screwed /Threadcd Joints, Flanged Joints, Joints for Pipes (Bends, Elbows, Tee, Nipple, Socket, Cross, Plug, Union Joint, Socket and spigot joint, Hydraulic Joint, Expansion Joints. 3.3 Types of Flanges - Flange cast with pipe(Integral Flange), Slip on flanges, Welded neck flanges, Screwed flanges - Blind Flanges, Cast Iron Flange Joint. 3.4 Types of valves, Necessity of Valves in Chemical process industry. 3.5 Schematic View of different valves - Gate Valve, Globe Valve, Ball Valve, Diaphragm Valve, Butterfly Valve, Plug Valve, Check Valve, Control Valve
Unit– IV Supports for Pipe and Vessels	4a. Describe necessity of supports in the given chemical process industry. 4b. Draw neat and proportionate sketch of the given support for pipes. 4c. Draw neat and proportionate sketch of supports for the given vessels. 4d. Draw neat and proportionate sketch of support for the identified	4.1 Types of supports: - Pipe Supports, Vessel Supports 4.2 Pipe Supports - Single rod Hanger, Double rod hanger, Angle iron hanger, Structural bracket and Hanger, Roller Support, Yard piping support 4.3 Vessel Supports a. Vertical Vessel Supports - Bracket or lug support - Leg Support - Skirt (Angular and Straight) support b. Horizontal Vessel Supports - Saddle (Plate and Ring type) support

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
	distillation column.	- Wear Plate Support
Unit– V Process Equipment Drawing	5a. Describe components and assembly of the given heat exchanger. 5b. Draw Shell and tube of the given heat exchanger assembly 5c. Draw different tube pitch arrangements in the given heat exchanger. 5d. Draw internal and external coils used in the given reactor. 5e. Draw different types of heads used for the given chemical process equipment.	5.1 Different process equipments and its assembly a. Heat Exchanger - Shell and tube heat exchanger (Tube sheet- Triangular and square pitch, Method of fixing tube sheet, segmental baffle and tie rod, shell and tube side passes) - U-tube heat exchanger - Kettle type reboiler b. Batch Reactor: - Jacketed Batch Reactor - Different types of nozzles - Jackets and coils, Agitators. Types of Heads / covers
Unit –VI Specification sheet and Process Flow Diagrams	6a. Draw the given unit operation equipment and instrumentation symbols. 6b. Prepare specification sheet for the given equipment 6c. Draw the block diagram of the given manufacturing process. 6d. Draw utility and engineering line diagram for the given manufacturing process. 6e. Draw different control schemes for the given equipment. 6f. Draw equipment layout and tank farm of the given process.	6.1 Symbols for Unit operation equipments, instrumentation as per IS 3232. 6.2 Specification Sheet for Equipments - Heat exchanger, Batch Reactor Types of Flow sheets: Block diagram , Process Flow Sheet/ Diagram, Utility Block Diagram, Utility Line Diagram - Control schemes (Flow, pressure, temperature) for: - Heat Exchanger, Reactor, Distillation Column, Dryers, Cooler/condenser/ chiller, Evaporator, Vaporizer - Engineering Line diagram (Instrumentation Diagram) - Equipment Layout and Tank Farm.

Note: To attain the COs and competency, above listed Learning Outcomes (LOs) need to be undertaken to achieve the 'Application Level' of Bloom's 'Cognitive Domain Taxonomy'.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Introduction to computer Aided Drafting software	02	02	02	02	06
II	CAD for Chemical equipment symbols	04	02	02	02	06
III	Pipe Joints, Fittings and Valves	04	02	02	05	09

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
IV	Supports for Pipe and Vessels	04	02	02	05	09
V	Process Equipment Drawing	06	04	04	07	15
VI	Specification sheet and Process Flow Diagrams	28	05	05	15	25
Total		**48**	**17**	**17**	**36**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)*
Note*: This specification table provides general guidelines to assist students for their learning and to teachers to teach and assess students with respect to attainment of LOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.*

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course:

a) Student should maintain a separate A3 size sketch book which will be the part of term work and submit it along with drawing sheets. Assignment should be drawn in the sketch book as per the instruction given by subject teacher.
b) Students should collect various process flow diagrams from nearby chemical process industries.
c) Collect different samples of pipe fittings and joints.
d) Students should collect various specification sheets for equipments from nearby chemical process industries.
e) Prepare chart for instrumentation and control attached to various equipments in institute laboratories.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b) ***'L' in item No. 4*** does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
c) About ***15-20% of the topics/sub-topics*** which is relatively simpler or descriptive in nature is to be given to the students for ***self-directed learning*** and assess the development of the LOs/COs through classroom presentations (see implementation guideline for details).
d) With respect to item No.10, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
e) Use Flash/Animations to explain various instruments for measurement
f) Guide student(s) in undertaking micro-projects

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably be individually undertaken to build up the skill and confidence in every student to become problem solver so

that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should not exceed three.

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than 16 (sixteen) student engagement hours during the course. The student ought to submit micro-project by the end ***of the semester to develop the industry oriented cOs.***

A suggestive list of micro-projects is given here. Similar micro-projects could be added by the concerned faculty:

a) Collect information regarding different pipe fittings and valves used in nearby chemical industry and write report on the same.
b) Collect information regarding different supports used for equipments and pipes in nearby chemical industry and write report on the same.
c) Collect information on design of heat exchanger OR Batch Reactor and its assembly. Prepare the sample drawing and write report on the same.
d) Visit nearby chemical industry and draw block diagram, manufacturing process flow sheet for visited plant.
e) Visit any Chemical industry and draw equipment symbols by using CAD.
f) Any other micro-projects suggested by subject faculty on similar line.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Analysis, Synthesis and Design of Chemical Processes,	Richard Turton, Richard C. Bailie, Wallace B. Whiting, Joseph A. Shaeiwitz, Debangsu Bhattacharyya	Published Jun 22, 2012 by Prentice Hall. Part of the Prentice Hall International Series in the Physical and Chemical Engineering Sciences series. ISBN-13: 978-0-13-261812-0
2	Chemical Process Equipment Design	Richard Turton, Joseph A. Shaeiwitz	Published Feb 1, 2017 by Prentice Hall. ISBN-13: 978-0-13-380447-8
3	Chemical Engineering Drawing Symbols	D.G. Austin	George Godwin Ltd (April 1979) ISBN-13: 978-0711433182
4	Introduction to Chemical Equipment Design: Mechanical Aspects	Bhattacharyya	CBS; 1 edition edition (1 December 2008)ISBN-13: 978-8123909455
5	Chemical Process Equipment: Selection and Design	James R. Couper W. Roy Penney Dr.	Butterworth-Heinemann; November 2012) ISBN-13: 978-0123969590
6	Process Equipment Design (3 Edition)	M. V. Joshi V. V. Mahajani	Macmillan India Limited, 2000 ISBN: 0333924185, 9780333924181
7	Dryden's Outlines Of Chemical Technology	M. Gopala Rao Marshal Sittig	Affilated East-West Press Pvt Ltd. (1997) ISBN-13: 978-8185938790

S. No.	Title of Book	Author	Publication
8	IS 3232: Recommendations on Graphical Symbols for Process Flow Diagrams, Piping and Instrumentation Diagrams	Bureau of Indian Standards	Chemical Engineering Plants and Related Equipment (MED 17)
9	Engineering Autocad	AP.Gautam , Pradeep Jain	Khanna Publishers ISBN-13: 978-9381068946

14. SOFTWARE/LEARNING WEBSITES

a) **For pipe fitting-** https://hardhatengineer.com/pipe-fittings/
b) **For pipe fitting** https://www.plumbingsupply.com/pipe-fittings.html
c) **For Valve-** https://globalvalveandcontrols.com/blog/tag/types-of-valve-used-in-chemical-industries/
d) **For Valve-** http://empoweringvalves.com/control-valves-used-in-the-chemical-industry/
e) **For Valve-** http://www.valvias.com/types-of-valves.php
f) **For fabrication drawing** http://www.ddpsinc.com/blog-0/glass-lined-reactor-jacket-selection
g) **For process flow diagram-** https://chemengineering.wikispaces.com/Process+flow+diagrams
h) **For cad-** https://www.autodesk.com/education/free-software/autocad.