Maharashtra State Board of Technical Education, Mumbai

Teaching and Examination Scheme for Post S.S.C. Diploma Courses

Program Name : Diploma in Chemical Engineering

Program Code : CH **With Effect From Academic Year: 2017 - 18**

Duration of Program : 6 Semesters **Duration : 16 Weeks**

Semester : Sixth **Scheme - I**

S. N.	Course Title	Course Abbreviation	Course Code	Teaching Scheme			Credit (L+T+P)	Examination Scheme												Grand Total
								Theory							Practical						
								Exam Duration in Hrs.	ESE		PA		Total		ESE		PA		Total		
				L	T	P			Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	
1	Chemical Engineering Drawing	CED	22608	3	-	4	7	3	70	28	30*	00	100	40	50#	20	50	20	100	40	200
2	Mass Transfer Operation	MTO	22609	3	-	4	7	3	70	28	30*	00	100	40	50#	20	50	20	100	40	200
	Elective – II (Any One)																				
3	Polymer Technology	PTE	22610	3	-	2	5	3	70	28	30*	00	100	40	25@	10	25	10	50	20	150
	Petroleum and Petrochemical Technology	PPT	22611	3	-	2	5	3	70	28	30*	00	100	40	25@	10	25	10	50	20	150
	Piping in Chemical Engineering	PCE	22612	3	-	2	5	3	70	28	30*	00	100	40	25@	10	25	10	50	20	150
	Elective – III (Any One)																				
4	Food and Beverages Technology	FBT	22613	3	-	2	5	3	70	28	30*	00	100	40	25@	10	25	10	50	20	150
	Pharmaceutical Technology	PTC	22614	3	-	2	5	3	70	28	30*	00	100	40	25@	10	25	10	50	20	150
	Fertilizer Technology	FTE	22615	3	-	2	5	3	70	28	30*	00	100	40	25@	10	25	10	50	20	150
5	Enterprenureship Development	EDE	22032	2	-	2	4	--	--	--	--	--	--	--	50@	20	50~	20	100	40	100
6	Capstone Project – Execution & Report Writing	CPE	22060	-	-	4	4	--	--	--	--	--	--	--	50#	20	50	20	100	40	100
			Total	**14**	**-**	**18**	**32**	--	**280**	--	**120**	--	**400**	--	**250**	--	**250**	--	**500**	--	**900**

Student Contact Hours Per Week: **32 Hrs.** Medium of Instruction: **English**

Theory and practical periods of 60 minutes each. Total Marks : **900**

Abbreviations: ESE- End Semester Exam, PA- Progressive Assessment, L - Lectures, T - Tutorial, P - Practical

@ Internal Assessment, # External Assessment, *# On Line Examination, ^ Computer Based Assessment

* Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of

2 tests to be taken during the semester for the assessment of the cognitive domain LOs required for the attainment of the COs.

~ For the courses having ONLY Practical Examination, the PA marks Practical Part - with 60% weightage and Micro-Project Part with 40% weightage

- **If Candidate not securing minimum marks for passing in the "PA" part of practical of any course of any semester then the candidate shall be declared as "Detained" for that semester.**

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.

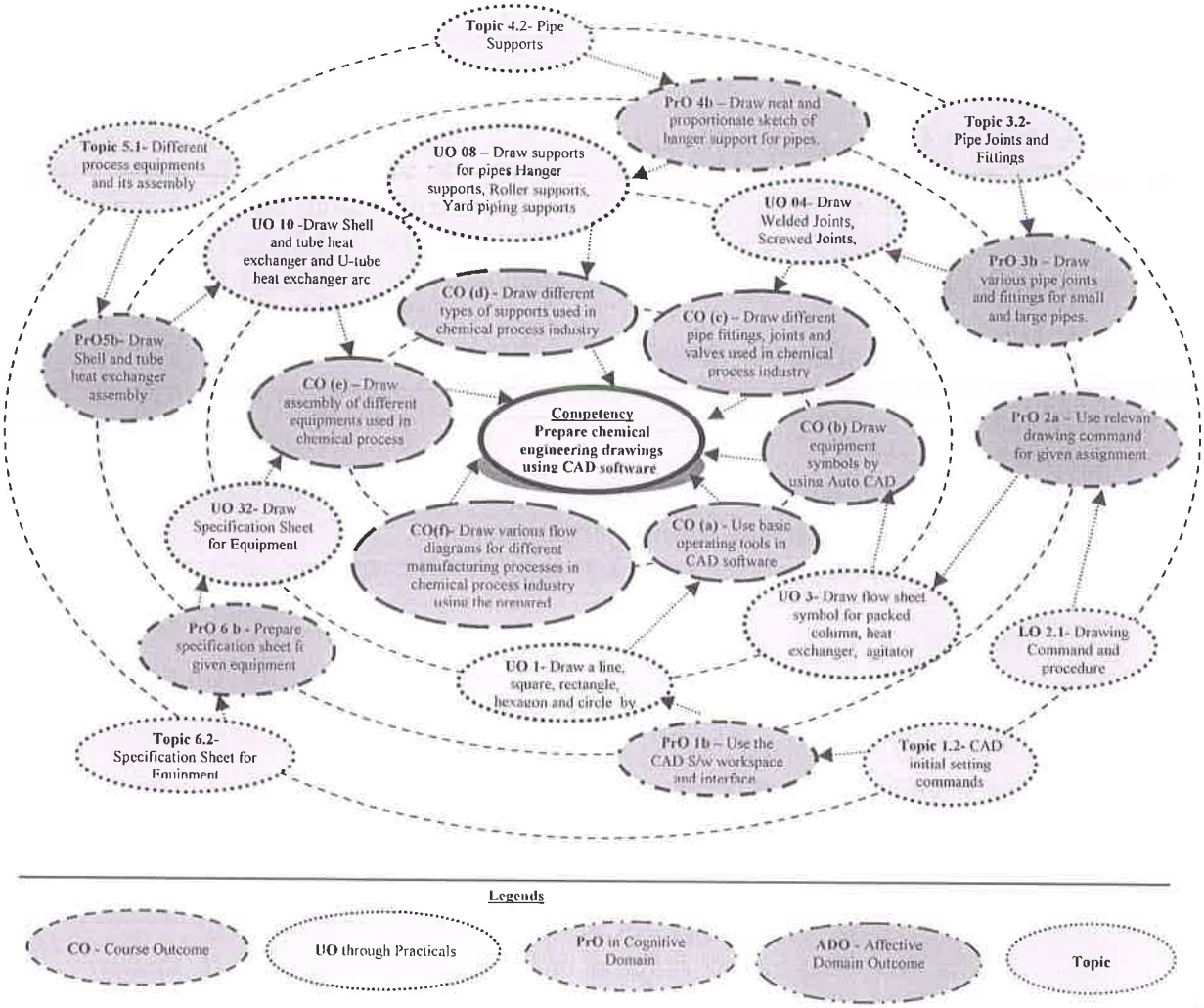

Figure 1 - Course Map

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.

Program Name : **Diploma in Chemical Engineering**

Program Code : **CH**

Semester : **Sixth**

Course Title : **Mass Transfer Operation**

Course Code : **22609**

1. RATIONALE

After studying this course the student will be able to operate and control various parameters related to mass transfer equipment. As Mass transfer operation is a core subject of chemical engineering, Diploma chemical engineer has to study the Mass Transfer Operations in the chemical process industry. They have to deal with the equipments related to Mass Transfer Operations like Distillation, Extraction, Absorption, Drying, Crystallisation. They have to handle various Mass Transfer Equipment like Distillation column, Dryer, Extractor, Crystalliser and Absorber and Extractor in safe and efficient manner.

2. COMPETENCY

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

- **Use chemical process plant equipment for mass-transfer operations safely.**

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 various distillation methods in chemical industry.
b) Use gas absorption operation and relevant equipment in chemical industries.
c) Select relevant solvent for extraction process.
d) Determine the time required for drying process.
e) Determine the yield of crystals obtained.

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 are for micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the cognitive domain UOs required for the attainment of the COs.

***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.

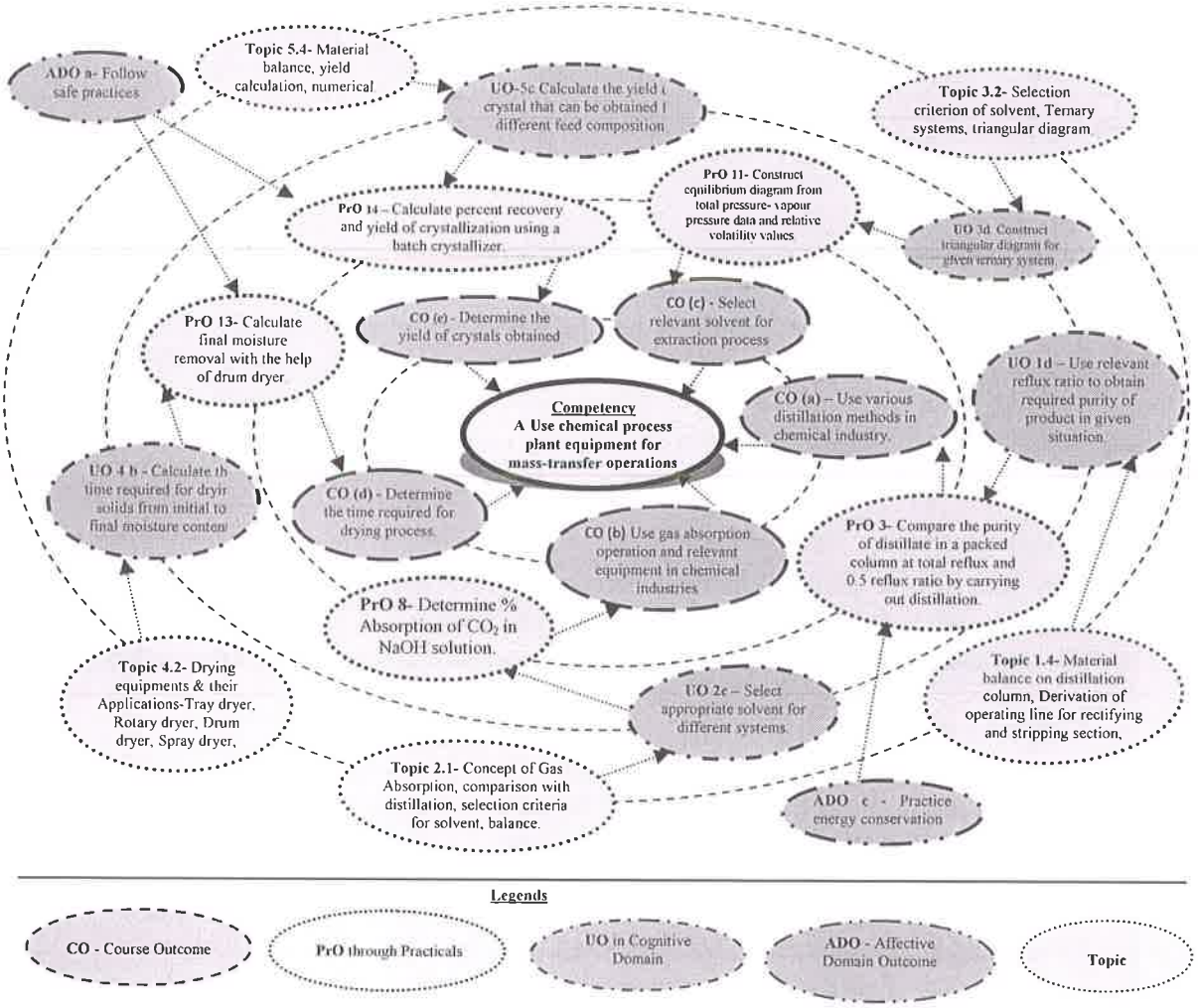

Figure 1 - Course Map

6. 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	Determine the diffusivity of given volatile liquids in air.	I	04*
2	Perform the simple distillation of methanol- water system.	I	04*
3	Measure purity of distillate in fractional distillation.	I	04
4	Determine Diffusivity of liquid in liquid mixture.	I	04*
5	Measure the purity of distillate by carrying out Steam Distillation.	I	04*
6	Carry out distillation to compare the purity of distillate in a packed column at total reflux and 0.5 reflux ratio	I	04
7	Construct equilibrium diagram from total pressure- vapour pressure data and relative volatility values.	I	04*
8	Determine % Absorption of CO_2 in NaOH solution.	II	04*
9	Calculate the pressure drop of a given packed column for wet and dry packing.	II	04*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
10	Determine distribution coefficient for toluene- acetic acid and chloroform- acetic acid mixture.	III	04*
11	Construct Ternary Diagram for system of three liquid, one pair partially soluble i.e. Acetic acid-Benzene-Water system.	III	04
12	Carry out drying of wet saw dust or sand in a batch dryer to obtain the drying rate curve.	IV	04*
13	Use the drum dryer to find the final moisture removal.	IV	04
14	Use a batch crystallizer to determine percent recovery and yield of crystallization.	V	04*
15	By heating or cooling method determine the solubility of a salt and obtain the solubility curve.	V	04*
16	Use the process simulator to analyze the parameters of distillation column or Crystalliser.	All	04
17	Use the process simulator to analyze the parameters of distillation column or Dryer.	All	04*
18	Use the process simulator to analyze the parameters of distillation column or Absorber.	All	04
	Total		**72**

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 12 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	Preparation of experimental set up	15
2	Setting and operation	20
3	Safety measures	10
4	Observations and recording	15
5	Interpretation of result and conclusion	20
6	Answer to sample questions	10
7	Submission of report in time	10
	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	Packed Distillation Column (Column with provisions for measuring pressure drop, flow rate and different reflux ratio)	06,09
2	Fractionation column with reflux provision.(Reboiler of capacity minimum 1000ml, Plate / packed column, condenser and receiver)	03
3	Tray Dryer.(Drying compartment with weight and temperature indicator and blower)	12
4	Drum Dryer (300mm Dia X 200mm long, coolant provision, Steam Provision, Feeding provision)	13
5	Simple Distillation Set up.(Reboiler of capacity minimum 1000ml, condenser and receiver)	02
6	Batch Crystalliser. (Cap. 2Ltrs. With (Jacketed) conical bottom, Stirrer-FHP, Heater, Cooling Water Tank-Capacity 30 liters-fitted with Pump, Rotameter for cooling water, Pump-FHP, Receiving Tank-Capacity 2 liters, Temp. Sensors-RTD PT-100 type, Control panel comprises of:Digital Temp. Indicator=0-199.9oC, RTD PT-100 Type with multi-channel switch)	14
7	Diffusivity apparatus.(Stefan Tube, hot plate, temperature indicator, blower)	01
8	Absorption column.(Column with provisions for measuring pressure drop and flow rate, compressor)	08
9	Process Simulator software setup.(Triangle Simulation Private Limited Software).	16
10	Steam Distillation set up.(Capacity-2000ml,Water Distiller, Purifier, Hot stove, Condenser)	05
11	Glass wares for titration.(Beaker, Separating funnel, measuring cylinder, conical flask, burette, pipette)	04,10, 15
12	Graph Paper	07,11,13

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	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit-I Distillation	1a. State the role of diffusion in the given mass transfer	1.1 Definition of diffusion, Ficks Law, Flux equation, Molecular diffusion in gases,

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	operations. 1b. Explain with sketches the relevant distillation method for the given industrial applications. 1c. Calculate number of equilibrium stages in distillation column in the given situation. 1d. Use relevant reflux ratio to obtain required purity of product in the given situation.	Steady state diffusion of A through non diffusing B, Steady state equimolar counter diffusion and Role of Diffusion in Mass Transfer Operations. 1.2 Concept of distillation, Boiling point diagram, Vapour liquid equilibria, Henry's Law, Raoults Law, Computing x – y data, Volatility, relative volatility. 1.3 Methods of distillation, Simple or Differential distillation, Rayleigh's equation, Flash or Equilibrium distillation, Rectification or Fractionation, Azeotropic distillation, Steam distillation. 1.4 Material balance on distillation column, Derivation of operating line for rectifying and stripping section, McCabe – Thiele method, derivation of q line, effect of feed conditions on slope of q line, Reflux ratio – minimum, total and optimum. 1.5 Plate column, packed column, Bubble cap plate, Sieve plate, Valve plate, Down comers and weirs.
Unit– II Gas Absorption	2a. Explain with sketches the given process. 2b. State the relevant characteristics of the given material. 2c. Select relevant solvent for the specified system with justification. 2d. Identify the flooding and loading point in the given type of column.	2.1 Concept of Gas Absorption, comparison with distillation, selection criteria for solvent, Concept of equilibrium, minimum liquid-gas ratio, material balance. 2.2 Hydrodynamics of packed column. Loading and flooding of packed columns. 2.3 Gas absorption equipment- mechanically agitated vessel, packed columns, types of packings, Characteristics of packings, channeling in packed columns, 2.4 Concept of (Height Equivalent to Theoretical Plates)HETP
Unit– III Liquid-Liquid Extraction	3a. Explain with sketches the given process. 3b. State the applications of the give extraction equipment. 3c. Select relevant solvent for the given liquid-liquid mixture. 3d. Prepare the triangular diagram for the given ternary system.	3.1 Extraction and distillation 3.2 Concept of liquid-liquid extraction, comparison between distillation and extraction, distribution coefficient. 3.3 Selection criterion of solvent, Ternary systems, triangular diagram. 3.4 Extraction equipment- mixer settler, spray column, rotating disc contactor.
Unit –IV Drying	4a. State the relevant moisture contents for the specified	4.1 Moisture content on dry and wet basis, Bound, Unbound, Free, critical and

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	conditions. 4b. Calculate the time required for drying solids for the specified moisture content. 4c. Select relevant dryer for the given drying material(s). 4d. Determine the given parameters after plotting the rate of drying curve with the given data.	equilibrium moisture content. 4.2 Rate of drying-Constant and falling rate period, Time required for drying, rate of drying curve. 4.3 Material balance and Numericals based on Time of drying. 4.4 Drying equipments and their Applications- Tray dryer, Rotary dryer, Drum dryer, Spray dryer, Fluidized bed dryer.
Unit– V Crystallization	5a. Explain the mechanism of crystallization for the given materials. 5b. Plot solubility and super solubility curve with the given data. 5c. Calculate the yield of crystal that can be obtained for the given feed composition. 5d. Explain with sketches the construction and working of crystallizer.	5.1 Concept of crystallization, mechanism, saturation, super saturation, solubility curves. 5.2 Methods of super saturation, Mier's super saturation theory. 5.3 Crystallization equipments- Agitated tank crystalliser, vacuum crystalliser, Oslo (cooler and evaporative) crystallizer, Swenson-Walker crystallizer. 5.4 Material balance, numerical based on % yield and % recovery.

Note: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' and above 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	Distillation	20	04	12	12	28
II	Gas Absorption	06	02	06	00	08
III	Liquid -Liquid Extraction	06	02	06	00	08
IV	Drying	08	02	04	08	14
V	Crystallisation	08	00	04	08	12
Total		**48**	**10**	**32**	**28**	**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 UOs. 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: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a) Prepare practical journals based on practical performed in laboratory.
b) Attend NPTEL / MOOCS / SWAYAM platform for self learning.
c) Refer books available in department or Central library and prepare abstract of it.
d) Prepare power point presentation or animation for understanding different mass transfer operations.
e) See the video lectures and video practicals and make a report.
f) Prepare Technical Journal's abstract on latest mass transfer equipment.

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 are given here. Similar micro-projects could be added by the concerned faculty:

a) **Prepare report**: Prepare report of local industries where mass transfer operations are carried out.
b) **Prepare model**: Prepare working model / prototype model of equipments like rotary dryer / spray dryer / Swenson-Walker crystallizer etc.
c) **Prepare charts**: Prepare charts of different mass transfer operations and phases involved in it.
d) **Prepare List:** Prepare the list of different mass transfer operations and equipments with specific use in process industry which are not included in board curriculum.

e) **Visit of chemical process plant**: Visit nearby industry to observe mass transfer operations controlled by Simulator system / DCS /SCADA and prepare the report of it.
f) **Prepare Presentation:** Collect the data on recent equipments / technology to run the Mass Transfer Operations.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Introduction to Chemical Engineering	Badger, Walter L.; Banchero, Julius T.	Mc Graw Hill, New Delhi ISBN:978-0070850279
2	Unit Operations of Chemical Engineering.	Mc Cabe, W. L. Smith and Harriott.	Mc Graw Hill International, New York, ISBN-978-007284823
3	Mass Transfer Operations	Treybal, Robert E	Mc Graw Hill International, New York, ISBN978-00705170
4	Chemical Engineering Vol. 2	Coulson and Richardson's	Asian Books Pvt. Ltd., New Delhi ISBN: 978075044457

14. SOFTWARE/LEARNING WEBSITES

a) NPTEL – MTO FAQs - http://nptel.ac.in/Clarify_doubts.php?subjectId=103103035
b) 39Video Lectures on MTO-https://freevideolectures.com/course/3438/mass-transfer-operations-i
c) Virtual Laboratory - http://iitg.vlab.co.in/?sub=58andbrch=160
d) NPTEL Video Lecture 2-https://www.youtube.com/watch?v=EyREi7l5020
e) NPTEL Video Lecture by IIT Professor - https://www.youtube.com/watch?v=EyREi7l5020andlist=PLbMVogVj5nJSOgW8GYe_nJ3MYfnCQ3XXM
f) Introduction to Mass Transfer by IIT Professor - https://www.youtube.com/watch?v=5UT0eqHE578

Program Name : **Diploma in Chemical Engineering**

Program Code : **CH**

Semester : **Sixth**

Course Title : **Polymer Technology (Elective-II)**

Course Code : **22610**

1. RATIONALE

Diploma chemical engineers have to operate and monitor various chemical manufacturing processes. Polymer manufacturing is one of the important processes in chemical engineering world. They have to deal with various polymerization processes and operate various equipments related to it. They also deal with the safety aspects and environmental concerns related to polymerization process. This course is developed in the way by which the polymer manufacturing plant can be operated and related equipments can be handled in safe manner.

2. COMPETENCY

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

- **Use polymer manufacturing plant equipment efficiently.**

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) Select relevant type of polymerization to manufacture required polymer.
b) Use relevant process for manufacturing of polymers
c) Select relevant manufacturing process of resin and elastomers.
d) Use relevant operation for plastic processing.
e) Apply relevant treatment methods in fiber processing.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme											
				Theory							Practical				
				Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
L	T	P			Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
3	-	2	5	3	70	28	30*	00	100	40	25@	10	25	10	50	20

(*): Under the theory PA, Out of 30 marks, 10 marks are for micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the cognitive domain UOs required for the attainment of the COs.

***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.

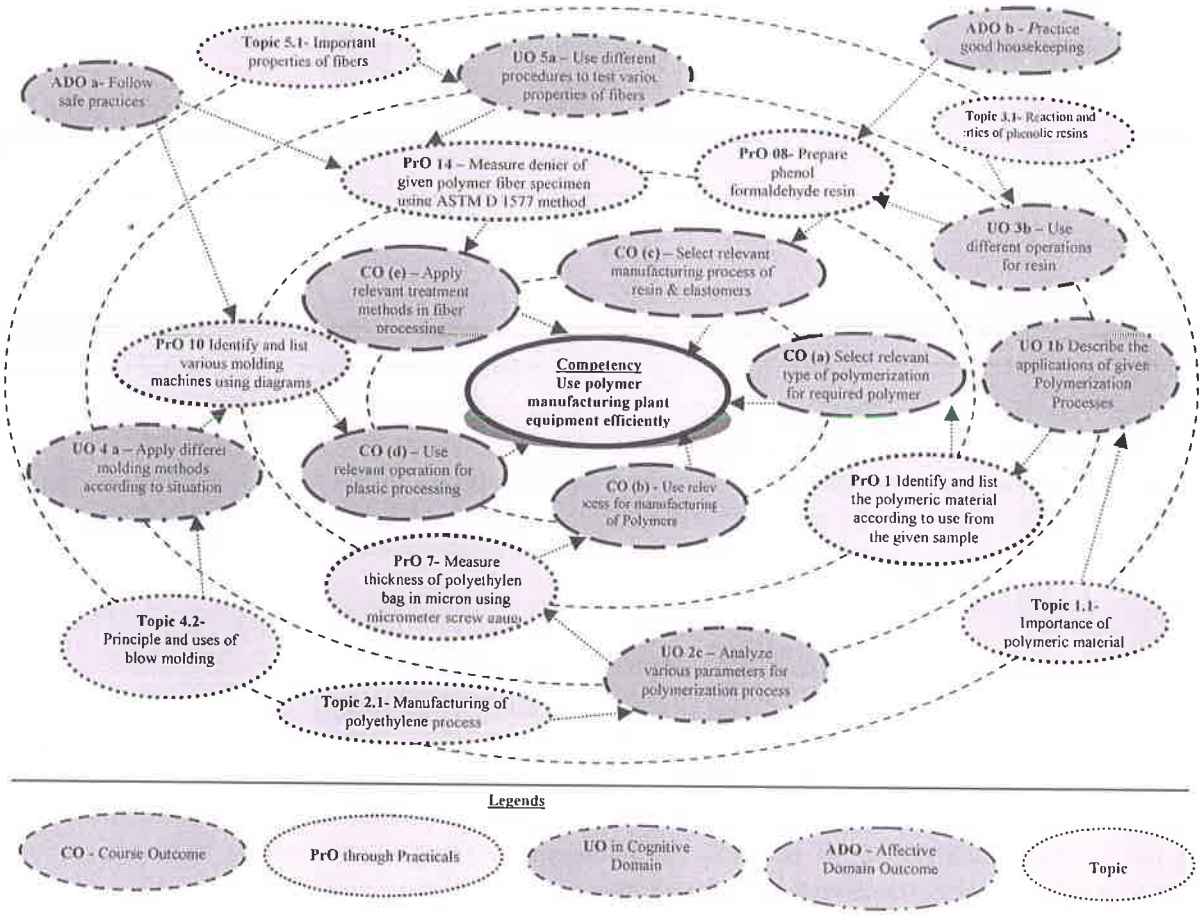

Figure 1 - Course Map

6. 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.	Identify the polymeric material according to use from the given sample.	I	02*
2.	Use the density gradient column to determine the density of given plastic specimen	I	02
3.	Use the displacement method to determine Specific Gravity (Relative Density) of Plastics	I	02*
4.	Use the bomb calorimeter to determine calorific value of plastic derived fuel.	I	02*
5.	Use the flame test Identify the polymeric material	I	02
6.	Identify the polyethylene material according to use from the given sample.	II	02*
7.	Use the micrometer screw gauge to measure thickness of polyethylene sheets in micron	II	02*
8.	Use the polymerization setup to prepare phenol formaldehyde resin	III	02*
9.	Use the polymerization setup to prepare urea formaldehyde resin	III	02*
10.	Identify various molding machines by interpreting the diagrams and charts.	IV	02*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
11.	View the injection molding and blow molding process animation videos to Compare their.	IV	02*
12.	Use the Universal Tensile Testing Machine to measure tensile strength of given plastic sample	IV	02*
13.	Identify the polymer yarn according to use from the given sample.	V	02*
14.	Use the ASTM D 1577 method to measure denier of given polymer fiber specimen.	V	02*
15.	Use the tensile strength tester to measure tenacity of given fiber yarn specimen.	V	02
16.	Use the magnifying glass to measure the numbers of fibers in given yarn samples.	V	02
	Total		**32**

Note

i. *A suggestive list of PrOs is given in the above table. More such PrOs can be added to attain the COs and competency. A judicial mix of minimum 12 or more practical need to be performed, out of which, the practicals marked as '*' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.*

ii. *The 'Process' and 'Product' related skills associated with each PrO is to be assessed according to a suggested sample given below:*

S. No.	Performance Indicators	Weightage in %
1	Preparation of experimental set up	20
2	Setting and operation	20
3	Safety measures	10
4	Observations and recording	20
5	Interpretation of result and conclusion	10
6	Answer to sample questions	10
7	Submission of report in time	10
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	Density gradient column (As per ASTM D1505) Resolution 0.0001 g/ml, Accuracy 0.0001 g/ml , with 7x optical microscope	02
2	Universal tensile testing machine (Crosshead Speed Range -10 to 500 mm/min, Maximum Travel Length -800 mm)	12,15, 16
3	Weighing balance (0.1 gm to 100 gm)	14
4	Bomb calorimeter (Combustion Bomb: Halogen and acid resistant stabilized stainless steel , Measurement range: up to 40,000 J/gm)	4
5	Screw Gauge / Micrometer	07

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	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Introduction to polymers	1a. Describe with sketches the relevant mechanism used for the given Polymer. 1b. Describe the applications of given Polymerization Processes. 1c. Select relevant building blocks for manufacturing of the given monomers with justification. 1d. State field applications of the given polymers	1.1 Importance of polymeric material in industry and applications of Polymers. 1.2 Polymerization Mechanism- Addition Polymerization and Condensation Polymerization. 1.3 Polymerization Processes- Bulk, Solution, Suspension, Slurry, Emulsion, Gas-Phase. 1.4 Monomers derived from Ethylene and Propylene. 1.5 Polymers and Environment – type of pollution, its effects and recycling
Unit-II Polymer manufacturing	2a. Select the relevant raw material for polymer manufacturing in the given situation with justification 2b. Draw labeled PFD of the given polymer processes 2c. Interpret the given parameters for polymerization process	2.1 Manufacturing of polyethylene by high pressure process-Raw material, catalyst, Process Flow Diagram (PFD) 2.2 Manufacturing of polyvinyl chloride - Raw material, catalyst, PFD of monomer and polymer from monomer 2.3 Manufacturing of Nylon 6-6 Raw material, catalyst, PFD of monomer and polymer from monomer
Unit– III Resins and Elastomers	3a. Classify the given types of resins. 3b. Explain with sketches different operations for the	3.1 Reaction , properties and uses of phenolic resins, amino resins and epoxy resins 3.2 Different types of elastomers,

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	given processing. 3c. Choose relevant type of elastomers in the given situation. 3d. Select the given types of fillers for the specified elastomer with justification	Principle of reinforcement and use in elastomers 3.3 Properties of elastomers- Weather resistance, Elongation , flame resistance, resistance to acid 3.4 Principle of Vulcanization and use in elastomers
Unit– IV Plastic processing	4a. Select the relevant molding method for the given situation. 4b. Select the relevant extrusion/ calendaring method for plastic processing in the given situation with justification 4c. Select the relevant operation for plastic processing for the given job requirement, with justification	4.1 Working principle of following plasing processing equipment: Compression and Injection molding, Blow molding and Reaction injection molding Extrusion and Calendaring, Foaming equipment.
Unit –V Fiber processing	5a. Select the relevant procedures to test the given properties of fibers, with justification. 5b. Explain with sketches the specified principle of spinning. 5c. Select the relevant spinning method for the given fiber production with justification 5d. Select the relevant treatment method for the given fiber processing with justification	5.1 Important properties of fibers in textile uses – Tenacity, Elasticity, Denier, acid resistance 5.2 Definition and applications of Yarn, fiber, denier, tenacity, elongation, stiffness, flex life 5.3 Principle of Wet and dry spinning 5.4 Principle and application of Fiber after treatments- scouring, lubrication, sizing, dyeing, finishing

***Note**: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' and above 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 polymers	06	02	04	04	10
II	Polymer manufacturing	10	02	04	06	12
III	Resins and Elastomers	06	02	04	06	12
IV	Plastic processing	14	04	04	12	20
V	Fiber processing	12	02	02	12	16
Total		**48**	**12**	**18**	**40**	**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 UOs. 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: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a) Prepare journals based on practical performed in laboratory.
b) Follow the safety precautions.
c) Use various instruments to measure various properties of polymers.
d) Library / Internet survey of various machines used in plastic processing
e) Prepare power point presentation for understanding different process used for manufacturing of polymers

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 are given here. Similar micro-projects could be added by the concerned faculty:

a) **Prepare report**: Prepare report on polymer processing industries in India , their products, raw material and applications
b) **Prepare charts**: Prepare charts displaying environmental effects of plastic its effects.
c) **Prepare flow chart:** Prepare flow chart of building blocks used for the production plastics
d) **Collect plastic specimen**: Collect different plastic specimen and write their industrial applications and molding process used for it.

e) **Collect polymer fiber cloths:** Collect polymer cloths and observe types of polymer used in it. Make a flow chart of polymer used in cloths, raw material and process used in it.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Polymer Science and Technology	Ebewele, Robert	CRC Press, New York (2000) ISBN - 0-8493-8939-9
2	Text book of Polymer Science	Billmeyer, Fred	Wiley India, New Delhi 3ed (2007) ISBN - 9788126511105
3	Polymer Science and Technology	Fried, Joel R.	Prentice Hall Professional Technical Reference 3 ed (2014) ISBN- 978-0-13-703955-5
4	Polymer Science and Technology: Plastics, Rubber, Blends and Composites	Ghosh, Premamoy	McGraw Hill Education; 3 edition (2011); ISBN- 9780070707047
5	Modern Technology of Plastic & Polymer Processing industries	NIIR Board	Asia Pacific Business Press Inc 1 ed ISBN: 8178330776
6	Plastics Technology Handbook	Chanda, Manas Roy, Salil K.	CRC Press, New York 4 ed (2007) ISBN -10:0-8493-7039-6

14. SOFTWARE/LEARNING WEBSITES

a. Test for identification of fiber http://content.inflibnet.ac.in/data-server/eacharya-documents/53e0c6cbe413016f234436ed_INFIEP_8/3/ET/8_ENG-3-ET-V1-S1__lesson.pdf
b. Types of polymers http://www.materials.unsw.edu.au/tutorials/online-tutorials/8-polymer-types
c. Textile technology https://textechdip.wordpress.com/contents/textile-fiber/
d. Plastic molding http://www.plasticmoulding.ca/
e. Elastomer https://www.britannica.com/science/elastomer
f. Testing of Polymer https://insights.globalspec.com/article/7810/how-to-perform-tensile-testing-on-polymers
g. Fiber testing https://www.youtube.com/watch?v=9ClNtwHt58A
h. Molding machine http://www.injectionmoldingmachine.in/
i. Injection molding https://www.youtube.com/watch?v=b1U9W4iNDiQ
j. Blow molding https://www.youtube.com/watch?v=8W6P5KU5ONQ

Program Name : **Diploma in Chemical Engineering**

Program Code : **CH**

Semester : **Sixth**

Course Title : **Petroleum and Petrochemical Technology (Elective-II)**

Course Code : **22611**

1. RATIONALE

To operate a plant efficiently, safely and economically every chemical engineering technologist gets acquainted with knowledge of petroleum refining and petrochemical technology. Proper selection of equipment and process improves efficiency of the plant. By learning this subject they can measure performance of various refinery products and select relevant process with safe handling of equipment to obtain desired petrochemical.

2. COMPETENCY

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

- **Use petroleum and petrochemical plant equipment efficiently.**

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) Identify class of given petroleum sample.
b) Use relevant distillation of crude oil to obtain required fraction.
c) Apply relevant process to upgrade refinery product.
d) Select proper process to manufacture petrochemicals.
e) Use Udex process to manufacture aromatics.

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	-	2	5	3	70	28	30*	00	100	40	25@	10	25	10	50	20

(*): *Under the theory PA; Out of 30 marks, 10 marks of theory PA are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the UOs required for the attainment of the COs.*

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.

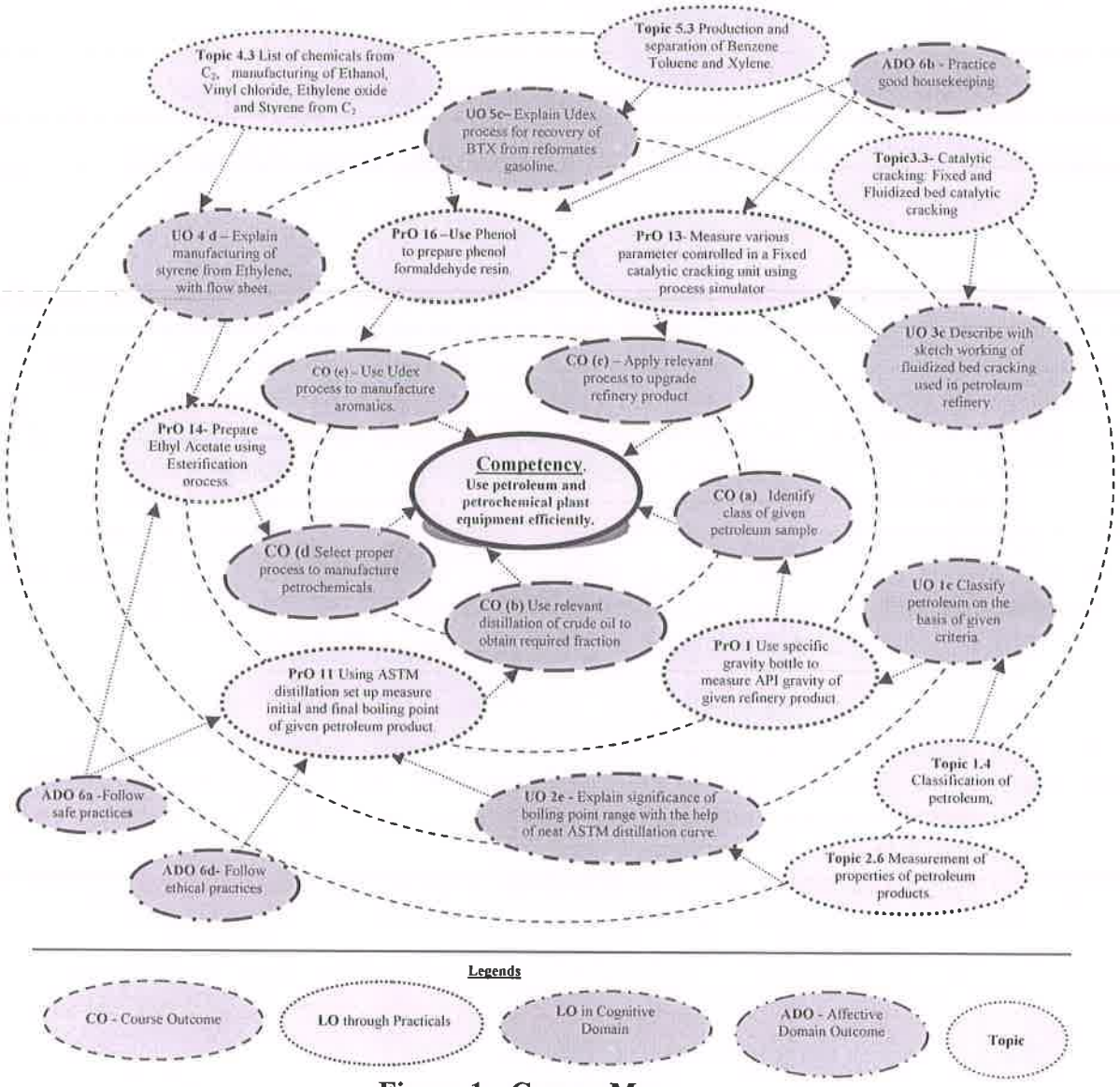

Figure 1 - Course Map

6. 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	Use the specific gravity bottle to measure API gravity of given refinery product.	I	02*
2	Use the Pensky Marten's apparatus to determine flash point of kerosene	II	02*
3	Use the Pensky Marten's apparatus to measure fire point of kerosene.	II	02*
4	Use the Abel's apparatus to measure flash and fire point of petrol.	II	02
5	Use the cloud and pour point apparatus to determine cloud and pour point of given oil.	II	02*
6	Use the drop point apparatus to measure drop point of given	II	02*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	sample.		
7	Use the smoke point apparatus to measure smoke point of kerosene.	II	02*
8	Use the aniline point apparatus to determine aniline point of given sample	II	02*
9	Use aniline point apparatus and gravity bottle to measure diesel index of given sample.	II	02*
10	Use the Conradson apparatus to determine carbon residue of given oil sample.	II	02
11	Use the ASTM distillation set up to measure initial and final boiling point of given petroleum product.	II	02*
12	Use the Draw distillation characteristic curve for given sample using ASTM distillation setup.	II	02
13	Use the process simulator to measure various parameters controlled in a Fixed or Fluidized bed catalytic cracking unit.	III	02*
14	Use the Esterification process to prepare Ethyl Acetate.	IV	02*
15	Use the ransesterification process to prepare biodiesel from used oil.	IV	02
16	Prepare Phenol formaldehyde resin using Phenol.	V	02*
	Total		**32**

Note

i. *A suggestive list of practical Los are given in the above table, more such practical Los can be added to attain the COs and competency. A judicial mix of minimum 12 or more practical/tutorials need to be performed, out of which, the practical marked as '*' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.*

ii. *The 'Process' and 'Product' related skills associated with each PrO are to be assessed according to a suggested sample given below:*

S. No.	Performance Indicators	Weightage in %
1	Preparation of experimental set up	20
2	Setting and operation	20
3	Safety measures	10
4	Observations and recording	10
5	Interpretation of result and conclusion	20
6	Answer to sample questions	10
7	Submission of report in time	10
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	Specific gravity bottle , capacity =10ml/25ml.	1
2	Pensky Marten Flash Point Apparatus: electric heater with temp. regulator. Suitable for operation on 220 Volts 50 cycles AC Circuits.	2,3
3	Abels Flash Point Apparatus: It is supplied with oil cup, cover fitted with stirrer, thermometer socket S.S.Water Bath, Stand. An electric heater is fitted at bottom for range -18°C to +70°C with Refrigeration System	4
4	Cloud & Pour Point Apparatus: glass bath jar, polished brass cylinder mounted on metal tripod base, glass test cylinder, cork bottom disc and top rings, thermometer (H-2600.5F -36° to 120°F) fitted into cork for sealing test cylinder.	5
5	Drop point apparatus: Drop Point apparatus as per IP-132 and ASTM-D-566 20 to 120 Deg, C x 1 Deg, C Or 100 to 230 Deg., C x 1 Deg,	6
6	Smoke point apparatus: as per ASTM /IP standard.	7
7	Aniline Point Apparatus: Power: 10W, Supply Voltage: 220V/50Hz, 01 no. Transformer Unit Electrical heater with variable heat control, Multi-test Verification Material. Spares Kit, glassware. electrically heated with motorized stirrer	8,9
8	Conradson Carbon Residue Apparatus: The apparatus consists of spun sheet iron crucible 25cc Capacity, Sheet Iron hood and sheet iron block on a stand with triangular wire, and gas Burner. Elect heating with separate regulator control.	10
9	ASTM distillation set up as per ASTM standard.	11,12
10	PC with simulation software.	13

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	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I	1a. State the composition of the	1.1 Petroleum: occurrence and history

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Petroleum and Refinery	specified petroleum product. 1b. Classify petroleum on the basis of given criteria. 1c. Describe with sketches the function of the specified petroleum refinery equipment/ Component. 1d. State the properties of the specified refinery products.	Crude oil reserves in India 1.2 Composition of petroleum and petroleum products 1.3 Classification of petroleum. 1.4 Indian petroleum refinery and the different sections and equipment 1.5 Refinery products.
Unit– II Distillation of crude oil	2a Describe specified treatment of the specified type of crude. 2b Describe with sketches the procedure to measure the specified property (flash point, fire point, cloud and pour point, drop point, smoke point or aniline point) of the specified petroleum product. 2c Explain with sketches the specified type of distillation of crude oil. 2d State major properties of the specified petroleum product. 2e Explain significance of boiling point range for the specified material.	2.1 Primary treatment of crude: Dehydration and desalting of crude. 2.2 Atmospheric distillation of crude. 2.3 Vacuum distillation of crude 2.4 Fractions obtained from crude oil with their boiling range and uses. 2.5 Properties of petroleum products: octane number, cetane number, flash point, fire point, aniline point, pour point, cloud point, drop point, calorific value, carbon residue. 2.6 Pensky Marten's apparatus, Abel's apparatus, cloud and pour point apparatus, drop point apparatus, smoke point apparatus, aniline point apparatus, Conradson apparatus 2.7 Measurement of properties of petroleum products :Gasoline(ASTM distillation set up, specific gravity) Kerosene(flash and fire point , smoke point, aniline point) Diesel(cloud and pour point, aniline point, flash point, viscosity) wax(drop point) Lubricating oil.
Unit III- Processes in Refinery	3a. Explain with sketches the specified type of cracking process 3b. Compare the specified refinery processes based on the given criteria. 3c. Suggest up gradation process for the petroleum product with justification. 3d. Describe with sketches the specified treatment of the waste water from oil refinery.	3.1 Cracking: Definition, types of cracking (thermal and catalytic). 3.2 Thermal cracking: Visbreaking and delayed coking.(Flow sheet and reaction of following) 3.3 Catalytic cracking: Fixed and Fluidized bed catalytic cracking. 3.4 Reforming: catalytic reforming (platforming). 3.5 Hydrogenation, Hydrocracking and Isomerization. 3.6 Alkylation : sulfuric acid and (Hydro floric acid) HF alkylation process 3.7 Esterification and Hydration 3.8 Waste treatment: oil removal, organic

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
		content removal, solid and hazardous waste treatment.
Unit-IV Petrochemicals (from C_1 to C_3)	4a. Explain the manufacturing of the specified petrochemical of C_1/ C_2 or $C_3$with process flow diagram. 4b. State the reaction of the specified petrochemical of C_1 / C_2 or $C_3$for its production.. 4c. Draw the flow sheet for manufacturing of specified of C_1 /C_2 or C_3 petrochemical.	4.1 Petrochemical industries in India, List of chemicals from C_1, manufacturing of Methanol and Formaldehyde. 4.2 Esterification process 4.3 List of chemicals from C_2, manufacturing of Ethanol, Vinyl chloride , Ethylene oxide and Styrene from C_2 4.4 List of chemicals from C_3, manufacturing of Propylene Oxide and Acetaldehyde.
Unit –V Petrochemicals from C_4 and aromatics	5a. State the chemical obtained from specified fraction of petrochemical C_4 or aromatics. 5b. Describe with flow sheet the manufacturing of specified of petrochemical C_4 or aromatics. 5c. Explain with sketch manufacturing of specified petrochemical C_4 or aromatics. 5d. Explain Udex process for recovery of BTX from the specified reformates gasoline.	5.1 Chemicals from $C_4$and manufacturing of Butadiene and Methyl Tertiary Butyl Ether 5.2 List of chemicals from aromatics 5.3 Production and separation of Benzene Toluene and Xylene. 5.4 Manufacture of aniline from phenol 5.5 Manufacture of benzoic acid from toluene.

***Note**: To attain the COs and competency, above listed UOs 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	Petroleum and Refinery	6	02	02	04	8
II	Distillation of crude oil	12	06	04	08	18
III	Processes in Refinery	12	02	04	12	18
IV	Petrochemicals (from C_1 to C_3)	10	02	04	10	16
V	Petrochemicals from C_4 and aromatics	8	02	02	06	10
Total		**48**	**14**	**16**	**40**	**70**

***Legends:** R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)*
***Note**: This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of UOs. 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: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a) Download the videos related to the Petroleum refinery/ petrochemical industry hazards and safety.
b) Conduct/ participate in MCQ/Quiz
c) Give seminar on relevant topic.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various learning 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 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) Guide student(s) in undertaking micro-projects.
f) Demonstrate students thoroughly before they start doing the practice.
g) Encourage students to refer different websites to have deeper understanding of the subject.
h) Observe continuously and monitor the performance of students in Lab.
i) Demonstrate students thoroughly before they start doing the practice.
j) Encourage students to refer different websites to have deeper understanding of the subject.

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 are given here. Similar micro-projects could be added by the concerned faculty:

a) **Industry visit:** Visit nearby petroleum refinery/ petrochemical industry and prepare the report on manufacturing processes used.
b) **Collection of sample:** Collect samples of different refinery product and prepare a report based on composition & cost.
c) **Prepare model**: Prepare a model of crude oil distillation unit using waste material.
d) **Prepare charts**: Prepare charts showing list of petrochemicals from C_1 to C_2 fraction along with reaction and process.
e) **Prepare charts**: Prepare charts showing list of petrochemicals from C_3 to C_4 fraction along with reaction and process.
f) **Chemical Engineering aspects in Petroleum refinery/Petrochemical Industry**
g) **(Internet based assignment):** Identify a Petroleum refinery/Petrochemical Industry, make the list of product manufactured and make the list of unit operations and unit processes and safety precautions. Identify the job role for a chemical engineer in Petroleum refinery/Petrochemical Industry.
h) **Preparation of list of fractions obtained from crude oil and their uses:** Prepare list of fractions obtained from crude oil with their boiling point range and uses
i) Any other micro-projects suggested by course faculty on similar line.

13. SUGGESTED LEARNING RESOURCES :

S. No.	Title of Book	Author	Publication
1	Modern Petrochemical Refining processes	Rao, B. K. Bhaskara	Oxford – IBH Publications, Delhi ISBN:9788120417115
2	Petroleum Refinery Engineering	Nelson, W. L.	McGraw Hill, Newyork ISBN: 9780070855366
3	A Text on Petrochemicals	B. K. Bhaskara Rao	Khanna Publishers, Delhi ISBN- 9788174090444
4	Petroleum Refining Technology and Economics	Gary, James H Glenn E Handwork Mark J Kaisen	CRC Press,USA ISBN -9780849370380
5	Dryden's Outlines of chemical Technology	Rao, M. Gopal. & Sitting, Marshal	East-West Press Pvt. Ltd., Delhi ISBN- 9788185938790
6	Shreve's Chemical Process Industries	Austin G.T.	McGraw Hill India, Pune ISBN - 9781259029455
7	Petroleum Refining Technology	Prasad, Ram	Khanna Publishers, Delhi ISBN- 9788174090645

14. SOFTWARE/LEARNING WEBSITES

a) **Petroleum Refining Overview:** http://nptel.ac.in/courses/103103029/pdf/mod2.pdf
b) **Composition of crude oil:** http://www.kau.edu.sa/Files/0053956/Subjects/Chapter%201%20petro.pdf
c) **Petrochemical from C1to C4:**http://nptel.ac.in/courses/103103029/pdf/mod3.pdf

Program Name : **Diploma in Chemical Engineering**

Program Code : **CH**

Semester : **Sixth**

Course Title : **Piping in Chemical Engineering (Elective-II)**

Course Code : **22612**

1. RATIONALE

Piping in chemical industries focuses on piping materials, color coding, piping insulation, installation, leak testing and others. This course also helps student to become conversant with related manufacturing codes and standards of process piping e.g. ASME, API, BS, IS and others. This course has been so designed that the chemical engineering technologists will be able to maintain piping systems for various chemical engineering processes.

2. COMPETENCY

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

- **Maintain piping system for trouble free functioning in chemical plants.**

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) Select the relevant pipes for various chemical processes as per standards.
b) Identify significant material of pipe for various chemical processes.
c) Choose relevant insulation material and accessory for piping system.
d) Identify relevant leak testing and heat tracing methods for various chemical processes.
e) Interpret piping drawings for maintenance.

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	-	2	5	3	70	28	30*	00	100	40	25@	10	25	10	50	20

(*): 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, Learning Outcomes i.e. LOs 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.

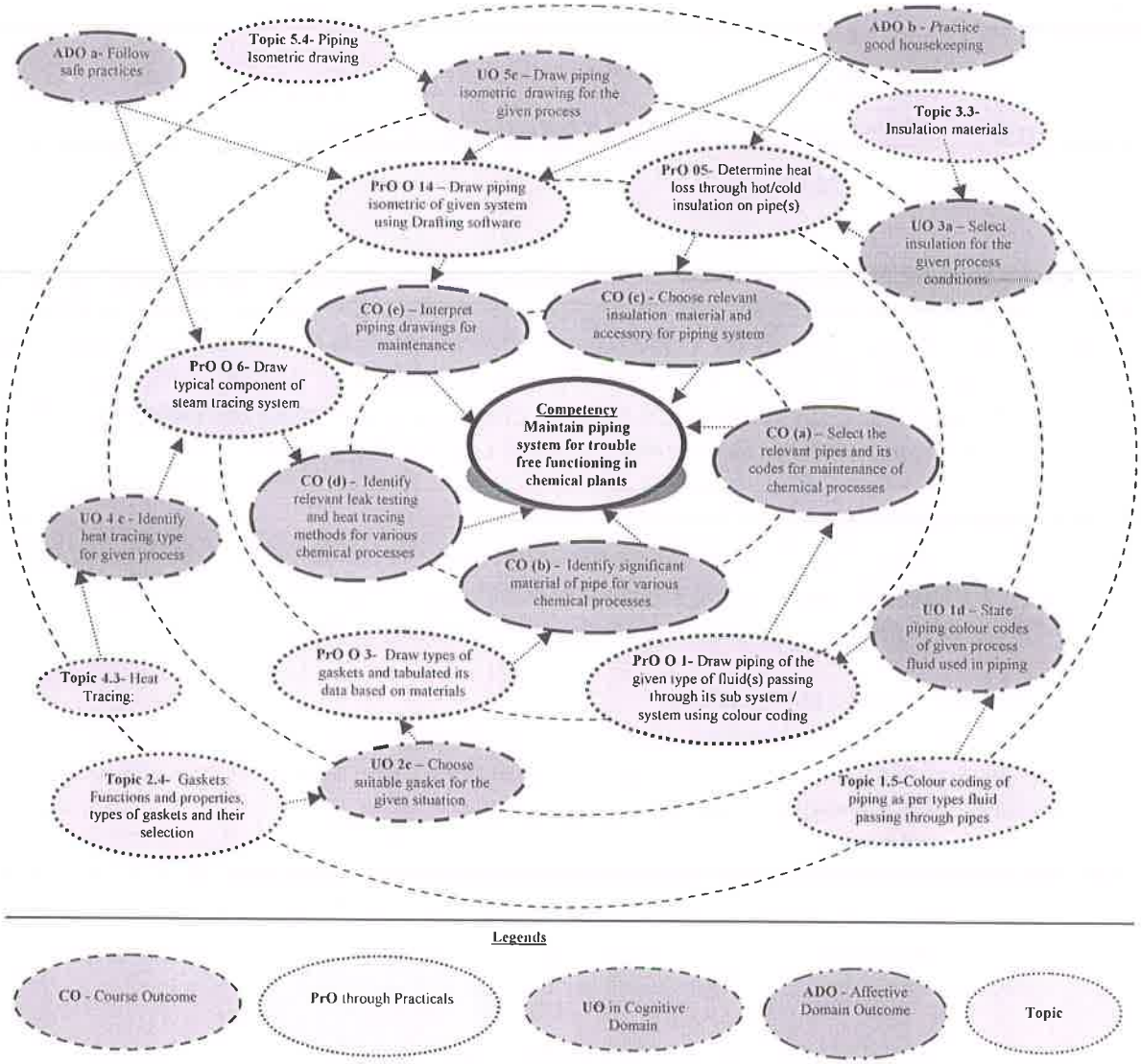

Figure 1 - Course Map

6. 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	Identify the different types of pipes, joints, washers and related accessories used in chemical engineering plants.	I	02*
2	Describe the condition of the given type of pipes and joints	I	02
3	Determine fluid velocity for given pipe size for different flowrates.	I	02*
4	Describe with sketches the condition of the given gaskets.	II	02*
5	Use the drafting software to draw sectional view of the given pipes with insulation	III	02
6	Determine heat loss through hot/cold insulation on pipe(s)	III	02*
7	Describe with sketches the condition of the given steam tracing system.	IV	02*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
8	Describe with sketches the condition of the given self-regulating parallel resistance heat tracer.	IV	02
9	Perform pneumatic leak test for joints/connections to check the leakage by soap bubble method.	IV	02*
10	Perform leak test by determination of pressure drop in straight pipe.	IV	02
11	Use the drafting software to draw the given piping line symbols.	V	02*
12	Use the drafting software to draw pipe rack column spacing.	V	02
13	Use the drafting software to draw the components of the given pump suction and discharge piping system	V	02*
14	Use the drafting software to draw the piping isometric symbols	V	02*
15	Use the drafting software to draw the piping isometric of given system	V	02*
16	Use the drafting software to draw the plant layout of given system	V	02*
17	Use the drafting software to draw the Piping General Arrangement of the given system.	V	02
18	Use the drafting software to draw the single line drawing for given system	V	02
19	Use the drafting software to draw the double line drawing for given system.	V	02*
	Total		**38**

Note

i. *A suggestive list of PrOs is given in the above table. More such PrOs can be added to attain the COs and competency. A judicial mix of minimum 12 or more practical need to be performed, out of which, the practicals marked as '*' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.*

ii. *The 'Process' and 'Product' related skills associated with each PrO is to be assessed according to a suggested sample given below:*

S. No.	Performance Indicators	Weightage in %
1	Preparation of experimental set up	10
2	Setting and operation	20
3	Safety measures	20
4	Observations and recording	10
5	Interpretation of result and conclusion	20
6	Answer to sample questions	10
7	Submission of report in time	10
	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	Exp. No.
1	Drawing Table	1, 3, 6, 7, 16, 18
2	Computers – Processor: Intel i5 / i7, Memory 32 GB, Graphics card :NVIDIA Quadro, Hard disk – 1 TB, Operating system: Windows 8 64- bit	4, 10, 11, 12, 13, 14, 15, 17
3	Freeware / Open source Drafting software	4, 10, 11, 12, 13, 14, 15, 17
4	Laser Printer (Black) – Print/Copy/Scan/Fax multitasking, memory 256MB	4, 10, 11, 12, 13, 14, 15, 17
5	Experimental setup of different pipe size with flowmeter and pump	2
6	Experimental setup of pipe with hot/cold insulation, thermocouples with digital indicators, tank with heat arrangement, flowmeter, pump	5

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 Piping Fundamentals	1a. Choose relevant piping for the given process of chemical industries. 1b. Select pipe size for the given process system with justification 1c. Identify the piping Standards as per given application with justification 1d. State piping colour codes	1.1 Introduction to Piping: Pipe, classification of pipe 1.2 Pipe Size, Pipe wall thickness, Schedule number 1.3 Standards referred by piping engineer: API, ASME, BS, IS 1.4 Fundamentals of Design Codes and selection criteria for piping. 1.5 Colour coding of piping as per types of fluid passing through pipes (IS 2379:1990)

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
	of the given process fluid used in piping	
Unit-II Piping Material, Properties and Gasket	2a. Describe material properties of the given piping in chemical industries 2b. Select relevant metallic material for the given process application with justification 2c. Choose relevant gasket for the given situation with justification.	2.1 Selection of material for piping 2.2 Material properties of piping: - Chemical Properties - Mechanical Properties: Modulus of elasticity, yield strength, elongation and reduction of area, hardness, toughness - Physical Properties: density, thermal conductivity, thermal expansion, specific heat 2.3 Metallic Material: Ferrous metals, Cast Iron, Steel, Copper and alloys, Aluminum and alloys 2.4 Gaskets: Functions and properties, types of gaskets and their selection
Unit– III Piping Insulation	3a. Select insulation for the given process conditions with justification. 3b. Calculate insulation thickness for the given pipe size and situation 3c. Identify Accessory materials for insulation with justification 3d. Calculate heat loss through insulation for given condition	3.1 Design parameters of insulation system design for piping, Service types for insulation design. 3.2 Critical thickness of insulation, estimating thickness of insulation, optimum thickness of insulation 3.3 Insulation materials: Calcium silicate, Cellular glass, Fiberglass and Mineral wool, Phenolic foam, Polyurethane foam 3.4 Accessory materials for Insulation: Acrylic latex mastic, Aluminum banding, Aluminum jacketing, FRP jacketing, Stainless steel jacketing, Mesh fabric 3.5 Heat loss through insulation
Unit– IV Piping Installation, Leak Testing and Heat Tracing	4a. Describe the given piping installation for chemical industries 4b. Describe the use of relevant leak testing method in the given system 4c. Identify relevant heat tracing type for the given process with justification	4.1 Piping Installation: Installation Drawings, Erection Planning, Cold spring, Joint alignment 4.2 Leak testing: Methods of leak testing, Hydrostatic, Pneumatic, vacuum and static head testing 4.3 Heat Tracing: Types of heat tracing system, Steam tracing, Self-regulating heater, Skin effect, Impendance heat tracing and Induction heating. Selection criteria for tracing systems

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit –V Piping Drawings	5a. Suggest the sources for piping drawing and layout with justification 5b. Describe the given pipe rack spacing and rack drawing for the given process. 5c. Draw piping isometric drawing for the given process.	5.1 Information sources for piping arrangement drawings, layout procedure 5.2 Pipe rack spacing and rack drawing organization 5.3 Drawing formats - Single line drawings - Double line drawings 5.4 Piping Isometric drawing: - Isometric piping symbols - Isometric dimension and text callouts - Isometric offset

***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	Piping Fundamentals	08	04	04	04	12
II	Piping Material, Properties and Gasket	08	04	04	04	12
III	Piping insulation	08	02	06	04	12
IV	Piping Installation, Leak Testing and Heat Tracing	10	02	02	10	14
V	Piping Drawings	14	04	06	10	20
Total		**48**	**16**	**22**	**32**	**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: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a) Prepare journals based on practical performed.
b) Follow the safety precautions.
c) Use software for understanding piping systems.
d) Library / Internet survey of piping used for various parameters
e) Prepare power point presentation or animation for understanding different piping systems

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 are given here. Similar micro-projects could be added by the concerned faculty:

a) Prepare report on different insulation used for piping in nearby industries.
b) Prepare model of pipe rack.
c) Prepare charts for displaying Pipe supports.
d) Prepare the list of piping size and its material used in chemical industries.
e) Collect different gasket samples from market and prepare report.
f) Visit nearby fabrication unit to collect information of piping joints and fittings.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Piping Handbook	Mohinder L. Nayyar	McGraw Hill; Seventh Edition 2000, ISBN-10: 0070471061
2	Process Plant Layout and Piping Design	Ed Bausbacher; Roger Hunt	PTR Prentice Hall Inc,1993 ISBN: 0131386298
3	Pipe Drafting and Design	Roy A. Parisher, Robert A. Rhea	Gulf Professional Publishing, ISBN: 0-7506-7439-3
4	Indian Standard 2379:1990	Indian Standard	Bureau of Indian Standards , 1991

S. No.	Title of Book	Author	Publication
5	ASME code for Power Piping, B31.1	ASME	ASME B31.1, 2004
6	ASME code for Process Piping, B31.3	ASME	ASME B31.3, 2004

14. SOFTWARE/LEARNING WEBSITES

a) Codes and Standards, https://www.scribd.com/document/235892891/TN-Gopinath
b) Thermal Insulation Handbook, https://www.aaamsa.co.za/images/Technical%20Publications/TIASA/Handbook%20Chapter1.pdf
c) Piping and Equipment Insulation, http://www.standard.no/pagefiles/1094/r-004.pdf
d) Single line and Double line diagram, https://www.standards.doe.gov/standards-documents/1000/1016-bhdbk-1993-v1/@@images/file

Program Name : **Diploma in Chemical Engineering**

Program Code : **CH**

Semester : **Sixth**

Course Title : **Food and Beverages Technology (Elective-III)**

Course Code : **22613**

1. RATIONALE

This course deals with the equipment which are generally employed for sorting, grading and processing of the food raw materials. It includes cleaning, grinding, pulping, drying, filling, sealing of raw material and processed foods. Even it also deals with material handling, distillation, crystallization and storage of food. This course is designed so that the technologists is able to use the separation processes of foods, fruit and vegetable processing, oil seeds processing, beverage processing and food additives.

2. COMPETENCY

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

- **Use different equipment in food and beverage industries.**

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 the cleaning, sorting and grading process.
b) Use the equipment for Fruit and Vegetable Processing.
c) Use the equipment for different types of Oil Seeds Processing.
d) Apply the process parameters for Brewing different types of Beverages.
e) Apply the blending process technology for food additives.

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	-	2	5	3	70	28	30*	00	100	40	25@	10	25	10	50	20

(*): Under the theory PA, Out of 30 marks, 10 marks are for micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the cognitive domain UOs required for the attainment of the COs.

***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.

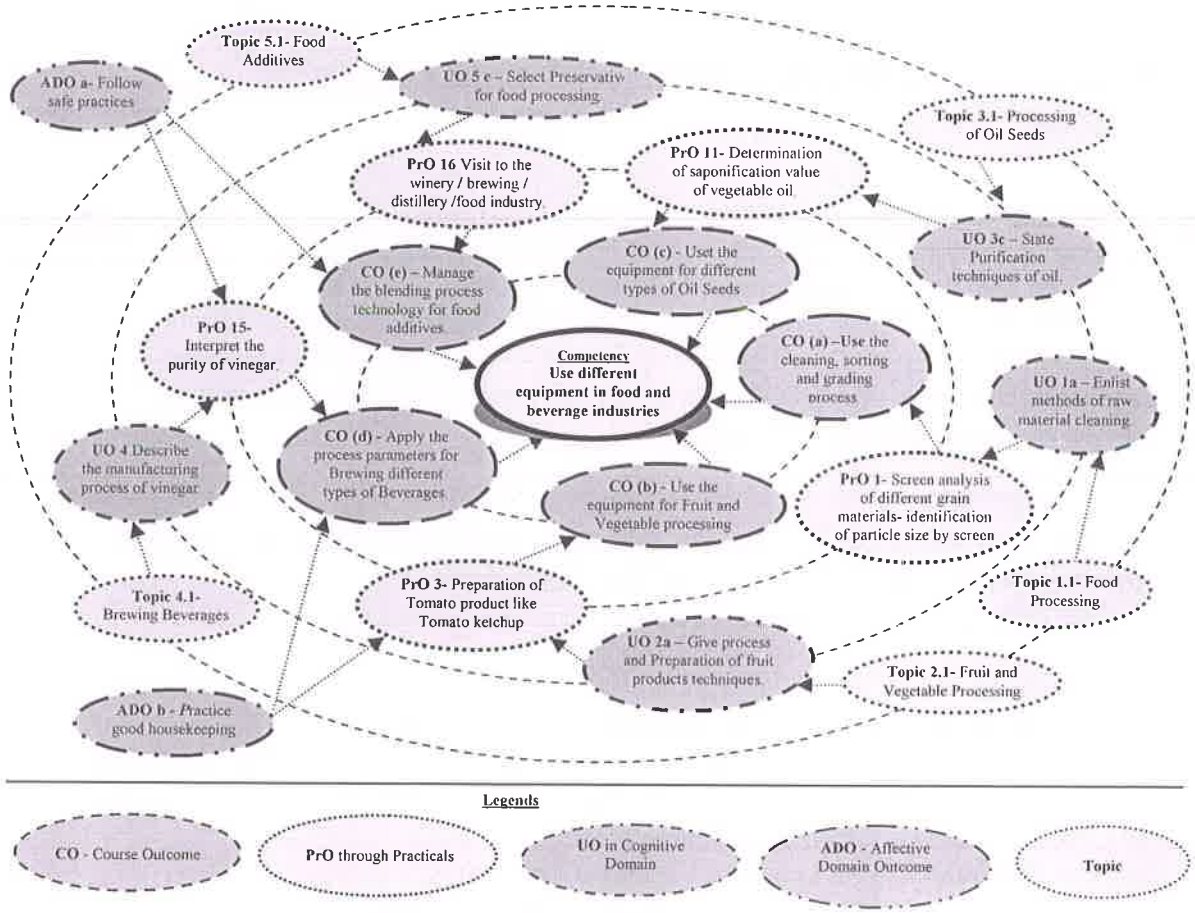

Figure 1 - Course Map

6. 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	Screen analyse of different grain materials- identification of particle size by screen analysis.	I	02*
2	Grade fruits, vegetable, grain according to size, colour etc.	I	02*
3	Estimate moisture content in different food materials.	I	02*
4	Prepare Tomato product like tomato ketchup.	II	02*
5	Prepare jam and jellies.	II	02*
6	Process certain vegetables by drying.	II	02*
7	Prepare Fermented Traditional food product any two Milk products and Food products	II	02
8	Measure specific gravity and viscosity of fruit juice sample.	II	02*
9	Use mechanical expeller to extract of active ingredient from oil seeds, coffee, lemon.	III	02
10	Determine iodine value of vegetable oil.	III	02*
11	Determine saponification value of vegetable oil.	III	02*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
12	Determine acid value of vegetable oil.	III	02*
13	Prepare white grape wine.	IV	02
14	Use PH meter Determine PH for wine.	IV	02*
15	Analyse the purity of vinegar.	IV	02
16	Report the hygiene and safe practices adopted after viewing the video of the winery.	V	02
17	Report the hygiene and safe practices adopted after viewing the video of the brewery.	V	02
18	Report the hygiene and safe practices adopted after viewing the video of any other mechanised food industry.	V	02*
	Total		**36**

Note

i. *A suggestive list of PrOs is given in the above table. More such PrOs can be added to attain the COs and competency. A judicial mix of minimum 12 or more practical need to be performed, out of which, the practicals marked as '*' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.*

ii. *The 'Process' and 'Product' related skills associated with each PrO is to be assessed according to a suggested sample given below:*

S. No.	Performance Indicators	Weightage in %
1	Preparation of experimental set up	20
2	Setting and operation	20
3	Safety measures	10
4	Observations and recording	10
5	Interpretation of result and conclusion	20
6	Answer to sample questions	10
7	Submission of report in time	10
	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	Sieve Shaker or vibrating screen.	1,2
2	Dryer.	3,6
3	Mixer or Hammer mill.	4,5,6,7
4	Mixer and Heating Bath.	4,5,6,7
5	Dryer and Oven.	3,6
6	Mixer	4,5,7
7	Specific gravity bottle and viscometer.	8
8	Extractor.	9
9	Titration set up	10,11,12,15
10	Fermentor and Filtration.	13
11	PH meter.	14
12	Video projection system	16 to 19

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	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit-I Food Processing	1a. Select suitable method for cleaning of specified food material with justification 1b. State the specifications of the specified raw food material cleaning equipment 1c. State the specifications of the given type raw food material Sorting or grading equipment. 1d. State parameters of cleaning, sorting and grading of the given raw food material.	1.1 Food Processing: a) Introduction to various raw materials used in food Production. b) Cleaning procedures for raw material and their importance. c) Equipment used for cleaning of raw materials (Vibrating screen, Dryer, Cyclone separator)- their specifications 1.2 Sorting and Grading :Types of sorters and graders- Color sorter, size sorter, shape sorter, weight sorter
Unit-II Fruits and Vegetable Processing	2a. Describe with sketches the process and preparation technique of the given fruit product. 2b. Explain with sketches the manufacturing of the given type of fruit beverages,. 2c. Describe with sketches the manufacturing of the given type of vegetable product.	2.1 Fruit Processing a) Processing of fruit (selection, juice extraction, deaeration, straining, filtration and clarification) b) Preservation of fruit juices (pasteurization, use of chemical preservatives, preservation by sugars, freezing, drying, aseptic processing, and carbonation). 1.2 Jam, Jellies and fruit Preserves :

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	2d. Explain regulations in production and preservation of the given type of food material. 2e. Explain the hygienic and safe practices to be followed for the specified fruit and vegetable processing techniques	Selection, Preparation, Regulations in production and preservation. 1.3 Vegetable Processing a) Potato and Sweet potato Processing: Chips, French fries processing. b) Tomato Processing: Pulping and processing of tomato juice, ketchup.
Unit– III Processing of Oil Seeds	3a. Describe with sketches the processing technology of the given type of oil seeds. 3b. Describe with sketches the Solvent Extraction for the specified type of oil seed 3c. Describe with sketches the working of the given type of mechanical expeller. 3d. Describe with sketches the purification techniques of the given type of oil. 3e. Describe with sketches the Hydrogenation, plasticizing of the given type of oil. 3f. Explain the hygienic and safe practices to be followed for the specified oilseed manufacturing process technology	3.1 Production of oil:Processing technology of oil seeds- Oil seed pressing, Solvent extraction, Purification (degumming, refining, bleaching, deodorization) 3.2 Oil Processing: Hydrogenation, plasticizing, tempering, winterization.
Unit– IV Brewing Beverages	4a. Describe the given terms related to brewing. 4b. Describe with sketches any one the given process (malting, mashing or fermentation). 4c. Describe the properties of the given types of wine. 4d. Explain the hygienic and safe practices to be followed for the specified beverage manufacturing process technology. 4e. Describe the process technology of the given type of .	4.1 Vinegar process: Introduction - Types of vinegar a. Mechanism of acetic acid fermentation Process - slow and quick process. Brewing raw materials and its role. 4.2 Malting of barley, Mashing, brew kettle boiling, brewing, carbonation, packaging, pasteurization. 4.3 Process of wine: Process technology of white wine-grape preprocessing, grape juice treatment, fermentation, clarification and aging. 4.4 Process technology of Red, Rose, fortified and sparkling wine.
Unit –VI Food Additives	5a. Select the relevant food additives for the specified processed food 5b. Describe properties of the specified type of additives. 5c. Select relevant preservative for the specified food processing. 5d. Select the relevant type of 'agent'	5.1 Food Additives: Introduction, Role and amount to be added of additives - Antioxidants, Coloring and Flavoring agents, Chelating agents, Curing agents, Stabilizers and Thickeners, Emulsifiers, Flour Improvers. 5.2 Humectants, Anti-caking agents, Leavening Agents, Nonnutritive

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	for the process the given type of food.	sweeteners, Preservatives such as sulphur dioxide and benzoic acid, Buffering agents.

***Note**: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' and above 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	Food Processing	08	02	02	04	08
II	Fruit and Vegetable Processing	12	04	04	06	14
III	Processing of Oil Seeds	08	04	04	06	14
IV	Brewing Beverages	14	04	08	08	20
V	Food Additives	06	02	06	06	14
Total		**48**	**16**	**24**	**30**	**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 UOs. 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: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a) Prepare journals based on practical performed in laboratory.
b) Follow the safety precautions.
c) Visit any food processing industry and prepare report on it.
d) Prepare power point presentation on different food processing products.

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) 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) **Prepare report**: Prepare report on different equipment, machinery used in food processing industries.
b) **Prepare model**: Prepare demonstrative/working model of dryer/mixer/oven in laboratory.
c) **Prepare charts**: Prepare charts displaying various food products available in market.
d) **Prepare List:** Prepare list of various food processing industries in India.
e) **Prepare the report**: Collect information regarding various additives added in food products.
f) **Industrial Visit report**: Visit nearby food processing industry to observe various operation and prepare the report.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Food Processing Technology	Fellows, P. J.	Wood head Publishing Ltd., Cambridge
2	Food Processing and Preservation	Subbulakshmi, G.	New Age International Publisher, New Delhi.
3	Handbook of Food Engineering Practical	Valentas Rotstein Singh	CRC Press, New York
4	Principles of Fermentation Technology - 2nd Edition	Stanbury, P. F. and Whitaker, A. and Hall, S. J.	Aditya books Pvt. Ltd., New Delhi
5	Food, Facts and Principles	Shakuntala, Maney	New age international (P) Ltd., New Delhi
6	Food Additives Data Book	Smith, Jim, Lily Hong–Shum.	John Wiley and Sons. Second Edition.2011. New Delhi.
7	Food and Beverage Management	Andrews, Sudhir	Mc Graw-Hill Companies.
8	Food and Beverage Service	Singaravelaran, R.	Oxford University Press, New Delhi.

14. SOFTWARE/LEARNING WEBSITES

a) Food Production Methods -https://nptel.ac.in/courses/103107088/33
b) Food Processing Equipment - https:// nptel.ac.in/courses/103103029/35
c) Fundamentals of food processing engineering- https://public.wsu.edu/~rasco/.../Intro%20to%20Food%20Processing82905.pdf
d) Introduction to food processing - https://www.slideshare.net/shilleary/introduction-to-food-processing
e) Oil seed processing- https://www.slideshare.net/.../oilseed-processing-for-smallscale-producers-9582940
f) Food Additives - https://www.fda.gov/Food/.../Food Additives Ingredients/default.htm

Program Name : **Diploma in Chemical Engineering**

Program Code : **CH**

Semester : **Sixth**

Course Title : **Pharmaceutical Technology (Elective-III)**

Course Code : **22614**

1. RATIONALE

To acquire a deep-rooted theoretical and practical knowledge of the fundamental principles in pharmaceutical formulation. This course provides learning about pharmaceutics, the tools used to prepare pharmaceutical drug and the manufacturing processes used in pharmaceutical production. To acquire a comprehensive understanding of how pharmaceutical dosage forms are developed, manufactured and controlled. The chemical technologists will be able to handle various equipment used in pharmaceutical industries.

2. COMPETENCY

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

- **Use relevant equipment safely to produce pharmaceutical products.**

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) Apply good manufacturing practices in Pharmaceutical Industry.
b) Use relevant Extraction processes in Pharmaceutical Industry.
c) Undertake Emulsification and Homogenization process.
d) Use relevant filtration processes for the desired pharmaceutical product.
e) Use relevant sterilizer for the process.
f) Use different Active Pharmaceutical Ingredients in pharmaceutical processes.

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	-	2	5	3	70	28	30*	00	100	40	25@	10	25	10	50	20

(*): 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, Learning Outcomes i.e. LOs 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.

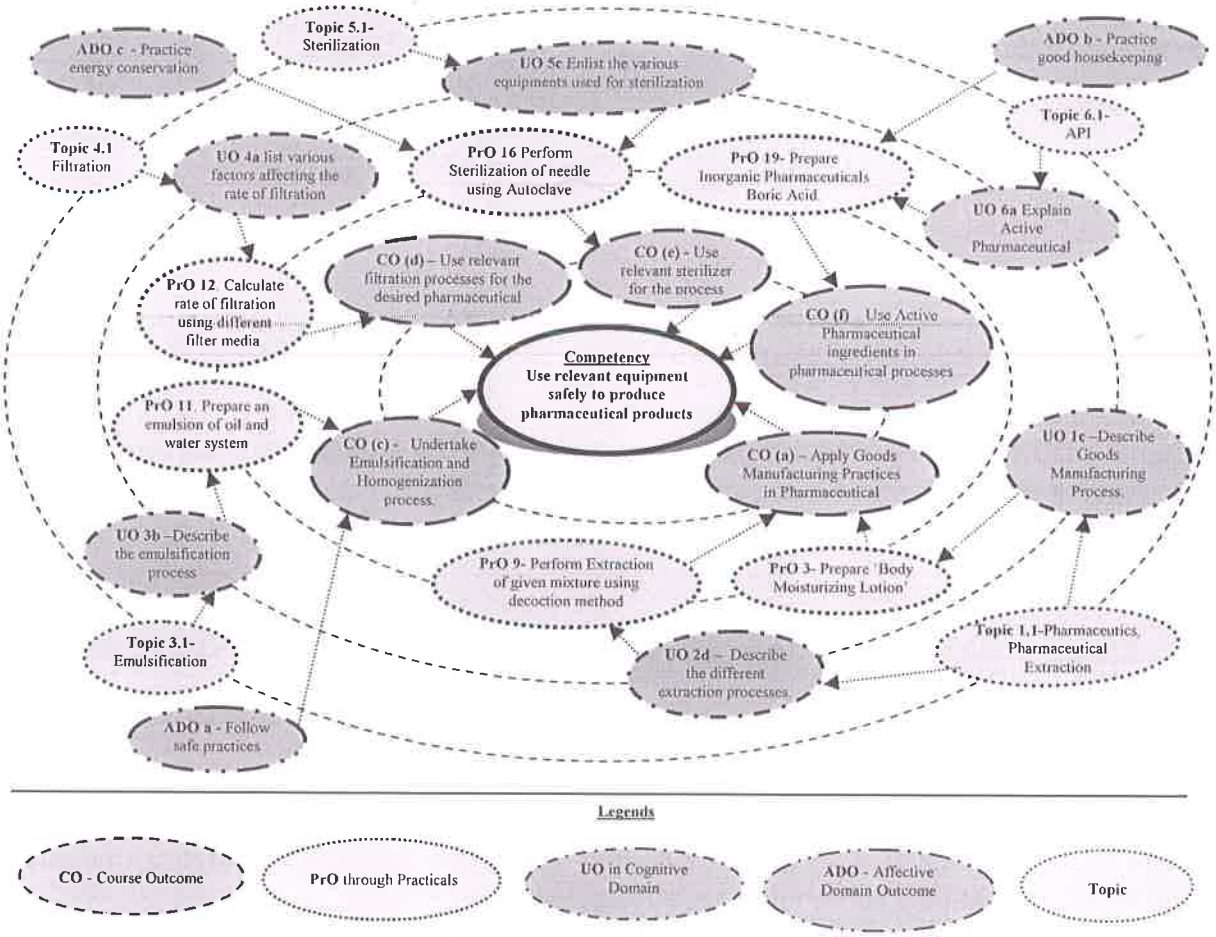

Figure 1 - Course Map

6. 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	Perform Qualitative test of Protein for dosage form.	I	02*
2	Perform Qualitative test of Amino Acids for dosage form.	I	02
3	Prepare 'Body Moisturizing Lotion' using provided Herbal Ingredients as per given instructions	I	02*
4	Prepare ' Face Scrub' using provided Herbal Ingredients as per given instructions	I	02*
5	Prepare 'Shampoo' using provided Herbal Ingredients as per given instructions.	I	02*
6	Perform the selection test of solvent for extraction as per given instructions.	I	02
7	Perform Extraction of given mixture using mixer settler assembly.	I	02
8	Perform Extraction of given mixture using Hot Extraction Process.	I	02
9	Perform Extraction of given mixture using decoction method.	I	02
10	Use the Rotary Ball Mill Size reduction of Powder (Coarse Sucrose)	II	02*
11	Prepare an emulsion of oil and water system and observe the effect of various Emulsifiers.	II	02
12	Use the different filter media to calculate rate of filtration.	III	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
13	Use the Nutsche Filter to calculate rate of filtration.	III	02
14	Perform Qualitative Analysis of Glucose.	III	02*
15	Perform Qualitative Analysis of Starch.	III	02*
16	Perform sterilization of needle using Autoclave equipment.	IV	02*
17	Perform Sterilization of hand gloves using Autoclave	IV	02
18	Use the hot air oven to calculate % of moisture removal of given sample using	IV	02*
19	Prepare Inorganic Pharmaceuticals Boric Acid.	V	02*
20	Prepare Inorganic Pharmaceuticals Potash Alum.	V	02
21	Perform Limit Test of Chloride contained in synthetic waste water	V	02*
22	Perform Limit Test of Sulphate contained in synthetic waste water	V	02*
	Total		**44**

1

Note

i. A suggestive list of practical Los are given in the above table, more such practical Los can be added to attain the COs and competency. A judicial mix of minimum 12 or more practical/tutorials need to be performed, out of which, the practical marked as '' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.*

ii. The 'Process' and 'Product' related skills associated with each PrO are to be assessed according to a suggested sample given below::

S. No.	Performance Indicators	Weightage in %
1	Preparation of experimental set up	20
2	Setting and operation	20
3	Safety measures	15
4	Observations and recording	15
5	Interpretation of result and conclusion	10
6	Answer to sample questions	10
7	Submission of report in time	10
	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	Beaker (250ml, 500ml), pipette (25ml),Test tube, Conical Flask (50ml), Burette(25ml), Measuring Cylinder (10ml, 50ml, 500ml)	1,2,3,4,5,6,11, 12,14,15,19,20 , 21,22
2	Extraction Column- Pressure : 20-100psi, Material : SS, Alloys, Finishing : Mirror polishing, Matt polishing, Temperature : 0-300 Degree Celsius	7,8,9
3	Rotary Ball Mill - Voltage (V): 220, Capacity (kg): 5 to 10 kg, Frequency (Hz): 60 Hz, Automation Grade: Semi-Automatic	10
4	Nutsche Filter – Working Capacity: 170lit, Filtration area: 1.29m^2 , Basket load : 200Kg, Motor Power: 10HP, Maximum Basket RPM: 1000 RPM	13
5	Plate and Frame Filter Press - Available Plate Size : 200x200mm, Plate Height – 13mm, Pressure Rating- 1-15 bar, Temperature Rating : -25°C to +65°C	11
6	Autoclave – Size: 200x200mm, Pressure Range:15-18psi, Voltage: 220V AC 50Hz Single Phase	16,17
7	Hot Air Oven – Size : 450x450x450, Temperature:50-200^{0}C, Voltage: 230V, 50Hz Single Phase	18

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	Unit Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – I Pharmaceutic Dosage and Extraction	1a. Explain Dosage form for the given type condition 1b. Describe Goods Manufacturing Practices for the given condition. 1c. Classify the given type of drugs. 1d. Describe the specified extraction processes. 1e. Select relevant extractor for the given process to maintain the purity of product with justification	1.1 Pharmaceutics and Pharmacopeia:- 1.2 Dosage form: Definition and Types (Tablets, Capsules, Sugar Coated Tablet, Extended Relief Tablet, Immediate Relief Tablet) 1.3 Goods Manufacturing Practices (GMP) and Alternative system of medicine; 1.4 Overview of Galenical process:- definition and Process description 1.5 types of drugs -Stimulants, Depressants, Hallucinogens, Dissociative, Opioids, Inhalants, Cannabis. 1.6 Extraction: Infusion, decoction, maceration, percolation, hot extraction 1.7 Equipment used for large scale extraction : Principle, construction and working of Mono-stage centrifugal extractor, multi stage centrifugal extractor, mixer settler, decanter
Unit– II Emulsification and Homogenization.	2a. Describe the features of the specified process. 2b. Explain with sketches the working of the specified process. 2c. Explain with sketches the given equipment.	2.1 Definition and Process: Emulsification Homogenization 2.2 Equipment: Principle, construction and working of Colloid Mills, Silverson Type Homogenizer. 2.3 Industrial Applications of Emulsification and Homogenization

Unit	Unit Outcomes (in cognitive domain)	Topics and Sub-topics
	2d. List the relevant applications of specified process	processes.
Unit– III Filtration Processes	3a. List the relevant factors affecting the rate of filtration with respect to the specified filter media. 3b. Classify the given filter media and filter aid used for filtration process. 3c. Explain with sketches the specified type of filtration equipment 3d. Describe the features of the specified type of air filtration units.	3.1 Filtration : Factors influencing rate of filtration 3.2 Filter media: Types (Polymeric membrane, Ceramic, Charcoal, Synthetic woolen filter, Sand Filter) 3.3 Filtration Equipment: Principle, construction and working of Nutsche filter, Sparkler, Leaf filter, Sintered glass and membrane filter. 3.4 Filtration of air: Principle, construction and working of HEPA (high efficiency particulate air) filters, Carbon Air Filters, Ionic Air Filters, UV Light Air Filters
Unit –IV Sterilizatio n	4a. Describe the need for the specified type of Sterilization. 4b. State the specification of the specified equipment used for sterilization 4c. Explain with sketches the working of the specified equipment used for sterilization.	4.1 Introduction of Disinfection. 4.2 Overview of Sterilization process. 4.3 Sterilization with moist heat: Autoclave 4.4 Dry heat sterilization: Incineration 4.5 Sterilization by radiation: Microwave 4.6 Sterilization by filtration: Vacuum or positive-pressure filtration
Unit –V Active Phar maceutical Ingredient	5a. Describe the properties of the given type of Active Pharmaceutical Ingredient. 5b. Draw the flow diagrams of the specified Pharmaceutical Products 5c. Describe the process of the given Pharmaceutical Products	5.1 Introduction of Active Pharmaceutical Ingredients (API) 5.2 Pharmaceutical Products: Process Flow Diagram with Process description of Rantadine, Metformine, Atenolol, Amoxicillin trihydrate

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	Pharmaceutic Dosage and Extraction	18	06	10	10	26
II	Emulsification and Homogenization.	08	02	04	06	12
III	Filtration Processes	08	02	04	06	12
IV	Sterilization	04	00	02	04	06
V	Active Pharmaceutical Ingredient	10	04	04	06	14
Total		**48**	**14**	**24**	**32**	**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 coursc:

a) Prepare journals based on practical performed in laboratory.
b) Follow the safety precautions.
c) Prepare charts of processes flow diagrams used in Pharmaceutical Industries.
d) Library / Internet survey of instruments used for various parameters
e) Prepare power point presentation or animation for understanding different pharmaceutical processes.

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 are given here. Similar micro-projects could be added by the concerned faculty:

a) Prepare report on the profile of Pharmacy and Pharmaceutical industries in India.
b) Prepare a list of different types of drugs produced in Pharmaceutical industries in India using internet and industries web sites.

c) Prepare model of colloidal mill using suitable material.
d) Prepare a chart of different filter media and filter aid used in different filters.
e) Visit nearby industry to observe different units and operations of sterilization processes.
f) Select any one medicine / pharmaceutical product and draw process flow diagram for identified product.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Pharmaceutical Dosage Form and drug delivery systems	Howard C.Ansel,Nicholas G., Popovich , Lord V. Alien	B.I.Waverly Pvt. Ltd.,New Delhi, 2015, ISBN: 9780781746120
2	Perry's Chemical Engineer's Handbook	Perry Robert H. Green Don W.	McGraw Hill New Delhi 2009 ISBN- 13: 9780070498419
3	Introduction to Chemical Engineering	Walter L. Badger, Julius T. Banchero	McGraw Hill, New Delhi, 2010, ISBN: 978-0070850279
4	Process Chemistry in Pharmaceutical Industry	Kumar Gadamasetti	CRC Press,First Edition 2007 ISBN 13: 9780824719814
5	Principle of Process Research and Chemical Development in Pharmaceutical Industry	O.Rapic	John Wiley &Sons. Inc Publication New York, ISBN: 0471165166
6	Good Pharmaceutical Manufacturing Practice: Rationale and Compliance	Sharp John	CRC Press,First Edition 2004 ISBN 13: 9780849319945

14. SOFTWARE/LEARNING WEBSITES

a) https://www.youtube.com/results?search_query=natural+way+to+prepare+shampoo
b) e Library: http://202.74.245.22:8080/xmlui/handle/123456789/292
c) https://www.fda.gov/downloads/ScienceResearch/FieldScience/UCM397228.pdf
d) https://www.lsu.edu/studentorgs/ispe/Welcome_files/PHARMACEUTICAL%20ENGINEERING.pdf
e) https://www.youtube.com/results?search_query=natural+way+to+prepare+lotion

Program Name : **Diploma in Chemical Engineering**

Program Code : **CH**

Semester : **Sixth**

Course Title : **Fertilizer Technology (Elective-III)**

Course Code : **22615**

1. RATIONALE

Indian economy is dominated by agriculture sector, it is therefore vital for chemical technologists to understand each fertilizer product, its flow diagram for industry production. For this purpose students should have skills for arranging treatment, reaction, raw materials for variety of fertilizer including Nitrogenous, phosphatic, Potash, and Biofertilizer is essential. Hence this course is designed to achieve this objective.

2. COMPETENCY

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

- **Use fertilizer manufacturing equipment safely.**

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 the proper micronutrients to improve fertility of soil.
b) Use relevant fertilizer on the basis of different properties.
c) Select the relevant manufacturing process for phosphatic fertilizers.
d) Select the relevant manufacturing process for potassic fertilizers.
e) Select proper micro-nutrient to produce bio-fertilizer.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme											
				Theory							Practical				
				Paper	ESE		PA		Total		ESE		PA		Total	
L	T	P		Hrs.	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
3	-	2	5	3	70	28	30*	00	100	40	25@	10	25	10	50	20

(*): Under the theory PA; Out of 30 marks, 10 marks of theory PA are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the UOs required for the attainment of the COs.

***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.

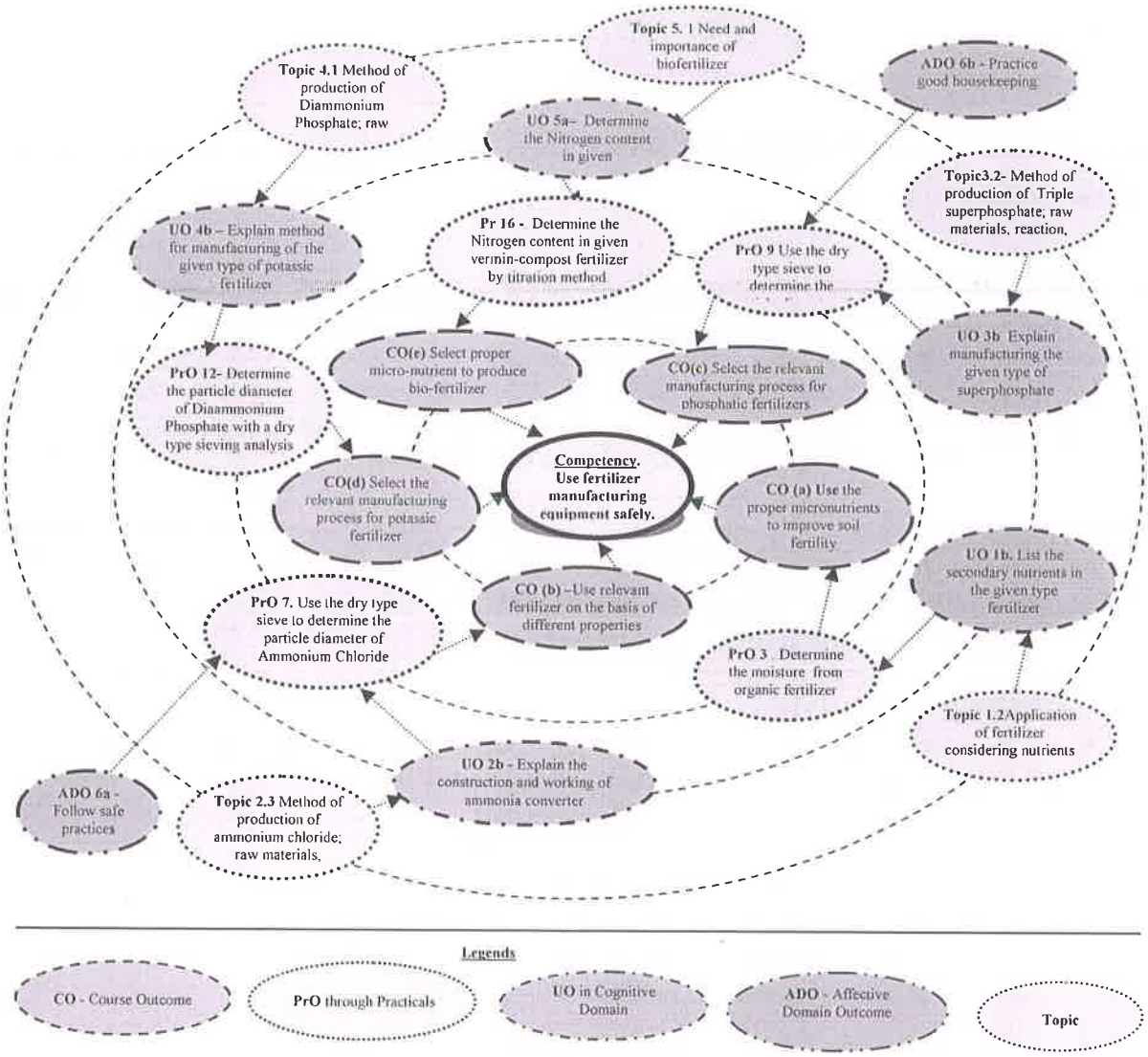

Figure 1 - Course Map

6. 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	Determine the moisture from sludge fertilizer.	I	02*
2	Determine the moisture from compost fertilizer	I	02*
3	Determine the moisture from organic fertilizer	I	02*
4	Measure of alkalinity of given Ammonia fertilizer by ethylenediamine tetra acetate method	II	02
5	Determine the particle diameter of calcium Ammonium nitrate with a dry type sieving analysis.	II	02*
6	Determine the Nitrogen content in given Ammonium Chloride fertilizer by titration method.	II	02*
7	Use the dry type sieve to determine the particle diameter of Ammonium Chloride.	II	02*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
8	Measure of alkalinity of given single superphosphate fertilizer by ethylenediamine tetra acetate method	III	02
9	Use the dry type sieve to determine the particle diameter of triple superphosphate	III	02*
10	Measure of alkalinity of given Diaammoium Phosphate fertilizer by ethylenediamine tetra acetate method.	IV	02
11	Determine the Nitrogen content in given Nitrophsphate fertilizer by titration method.	IV	02*
12	Determine the particle diameter of Diaammonium Phosphate with a dry type sieving analysis.	IV	02*
13	Determine the particle diameter of NPK with a dry type sieving analysis	IV	02*
14	Determine the Nitrogen content in given NPK fertilizer by titration method.	IV	02*
15	Measure of alkalinity of given NPK fertilizer by ethylenediamine tetra acetate method	IV	02*
16	Determine the Nitrogen content in given vermin-compost fertilizer by titration method.	V	02
	Total		**32**

Note

i. *A suggestive list of practical Los are given in the above table, more such practical Los can be added to attain the COs and competency. A judicial mix of minimum 12 or more practical/tutorials need to be performed, out of which, the practical marked as '*' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.*

ii. *The 'Process' and 'Product' related skills associated with each PrO are to be assessed according to a suggested sample given below::*

S. No.	Performance Indicators	Weightage in %
a.	Preparation of experimental set up	20
b.	Setting and operation	20
c.	Safety measures	20
d.	Observation and recording	10
e.	Interpretation of results and conclusion	10
f.	Answer to sample questions	10
g.	Submission of report on time	10
	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. S. No.
1.	pH meter {soil analyzer(9-1),luster Leaf rapitest1880}	4,8,10, 15
2.	Fertilzer Moisture analyzer –(analog range 1-10 moisture)	1,2,3
3.	Thermometer –(soil thermometer 0-120 degree centigrade range)	All
4.	Dry type sieving analyzer.(vibratory sieve shaker,range 20micron-20mm,feed capacity 3kg.)	5,7,12, 13
5.	DigitalWeighing balance—(10grams-5kg capacity)	All
6.	Glass wares (conical flask ,volumetric flask,beaker,Test tube,glass rod)	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	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Overview of fertilizers.	1a. Explain the importance of given micro nutrients in fertility of soil. 1b. List the secondary nutrients in the given type fertilizer. 1c. List the secondary nutrients in the given type of fertilizer. 1d. Name the location of the given fertilizer industry.	1.1 Essential elements: Role in plant growth, types and macro and micro elements. 1.2 Importance and applications of fertilizer nutrients. 1.3 Secondary nutrients; feedstock and raw materials for nitrogenous fertilizer. 1.4 Secondary nutrients; phosphatic and potassic fertilizer. 1.5 Development of fertilizer industry in India; fertilizer production and consumption in India
Unit– II Nitrogenous fertilizers	2a State the specified properties of ammonia. 2b Describe with sketches the construction of the given type of converter. 2c Explain with sketches the	2.1 Introduction to Ammonia; physical and chemical properties, applications, ammonia converter, storage and transportation of Ammonia. 2.2 Method of production of calcium ammonium nitrate; raw materials,

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	working of the given type of converter. 2d Explain with flow diagram the manufacturing of the given type of fertiliser. 2e Identify proper storage and handling of given type of fertilizer with justification	reaction, flow diagram and applications. 2.3 Method of production of ammonium chloride; raw materials, reaction, flow diagram and applications. 2.4 Storage and handling of ammonia, calcium ammonium nitrate ammonium chloride fertilizers.
Unit III- Phosphatic Fertilizers.	3a. Choose the relevant method for preparation of specified type of superphosphate, with justification 3b. Explain manufacturing the given type of phosphate fertiliser. 3c. Select proper storage and transportation method for the given type of phosphatic fertilizer.	3.1 Method of production of single superphosphate; raw materials, reaction, flow diagram andapplication 3.2 Method of production of Triple superphosphate; raw materials, reaction, flow diagram andapplications. 3.3 Storage and handling of superphosphate, fertilizer. 3.4 Method of production of Diammonium Phosphate; raw materials, reaction, flow diagram and applications
Unit-IV Potassic Fertilizers.	4a. Explain method for manufacturing of the given type of potassic fertilizer 4b. Explain with sketches the method for manufacturing of NPK type of fertilizer 4c. Identify the devices for storage and handling of potassic fertilizer.	4.1 Method of production of Nitro Phosphate; raw materials , reaction, flow diagram and applications 4.2 Method of production of (Mixed fertilizer) NPK fertilizer; raw materials, reaction, flow diagram and applications 4.3 Storage and handling of nitro phosphate and NPK fertilizer.
Unit –V Bio-fertilizers.	5a. Describe with sketches the construction of the given bio-fertilizer equipment. 5b. Explain with sketches the working of the given bio-fertilizer equipment. 5c. Identify the merits and demerits given bio-fertilizer unit. 5d. Select suitable method to produce the given bio-fertilizer	5.1 Need and importance of bio-fertilizer. 5.2 Vermi- Compost; method of preparation and precautions. 5.3 Bio-fertilizer; method of preparation by using kitchen waste. 5.4 Initiatives and schemes of Central and State Government towards bio-fertilizers.

***Note**: To attain the COs and competency, above listed UOs 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	Overview of fertilizer.	12	04	04	04	12
II	Nitrogenous fertilizers	12	02	08	08	18
III	Phosphatic Fertilizers.	08	02	08	08	18
IV	Potassic Fertilizers	08	02	02	08	12
V	Bio-fertilizers.	08	02	04	04	10
Total		**48**	**12**	**26**	**32**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)*
Note*: This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of UOs. 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: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a) Prepare journals based on practical performed in laboratory.
b) Give seminar on relevant topic.
c) Undertake micro-projects.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various learning 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 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) Guide student(s) in undertaking micro-projects.
f) Demonstrate students thoroughly before they start doing the practice.
g) Encourage students to refer different websites to have deeper understanding of the subject.
h) Observe continuously and monitor the performance of students in Lab.
i) Demonstrate students thoroughly before they start doing the practice.
j) Encourage students to refer different websites to have deeper understanding of the subject.

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 are given here. Similar micro-projects could be added by the concerned faculty:

a) Make working model of vermin compost.
b) Collect sample of various solid fertilizer with content specification available in market.
c) Visit nearest bio-fertilizer unit and collect information.
d) Collect sample of liquid fertilizer available in market andwrite report.
e) Make a model for small bio-fertilizer kitchen waste based unit.

13. SUGGESTED LEARNING RESOURCES :

S. No.	Title of Book	Author	Publication
1	Commercial fertilizer	Colling, G.H	5th Edn McGraw Hill, New York, 1955,ISBN-2045728/1/G16416
2	Hand Book fertilizer Technology.	Editorial board	The Fertilizer Association of India, New delhi,1977,ISBN-9781855734616
3	The chemistry and technology of fertilizer	Sauchelli	Reinhold publishing Corp. New York 1980, ISBN-9780278919075
4	Bio fertilizer in agriculture	Rao, N S Subba	Oxford and IBH Publishing Co. New Delhi, ISBN-9788120407916.

14. SOFTWARE/LEARNING WEBSITES

a) Fertilizer Technology……https://lecturenotes.in/subject/235/fertilizer-technology-ft.
b) Fertilizer Technology……https://ifdc.org/fertilizer-technology-developmet.
c) Handbook of fertilizer technology—https://book.google.com/books/about/handbook-on-fertilizer technology.

Program Name : **Diploma in Computer Engineering Group/ Diploma in Mechanical /Chemical Engineering /Diploma in Electronics Engineering Group/ Diploma in Fashion & Clothing**

Program Code : **CO/CM/CW/DC/EJ/ET/EN/EX/EQ/IE/ME/CH**

Semester : **Sixth**

Course Title : **Entrepreneurship Development**

Course Code : **22032**

1. RATIONALE

Globalisation, liberalization and privatization along with revolution in information technology have opened up new opportunities transforming lives of masses. In this context, there is immense opportunity of establishing manufacturing, service, trading, marketing and consultancy enterprises by diploma engineer. Our fast growing economy provides ample scope for diploma engineers to succeed as an entrepreneur. Entrepreneurship requires distinct skill sets which are attempted to be developed through this course. To begin with, this course aims to develop the competency and the related outcomes in order to start small enterprises.

2. COMPETENCY

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

- **Develop project proposals to launch small scale enterprises.**

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. Identify your entrepreneurial traits.
b. Identify the business opportunities that suits you.
c. Use the support systems to zero down to your business idea.
d. Develop comprehensive business plans.
e. Prepare plans to manage the enterprise effectively.

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	
2	-	2	4	--	--	--	--	--	--	--	50@	20	50~	20	100	40	

@ : Internal examination

(~): *For the* ***practical only courses,*** *the PA has two components under practical marks i.e. the assessment of practicals (seen in section 6) has a weightage of 60% (i.e.30 marks) and micro-project assessment (seen in section 11) has a weightage of 40% (i.e.20 marks). This is designed to facilitate attainment of COs holistically, as there is no theory ESE.*

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.

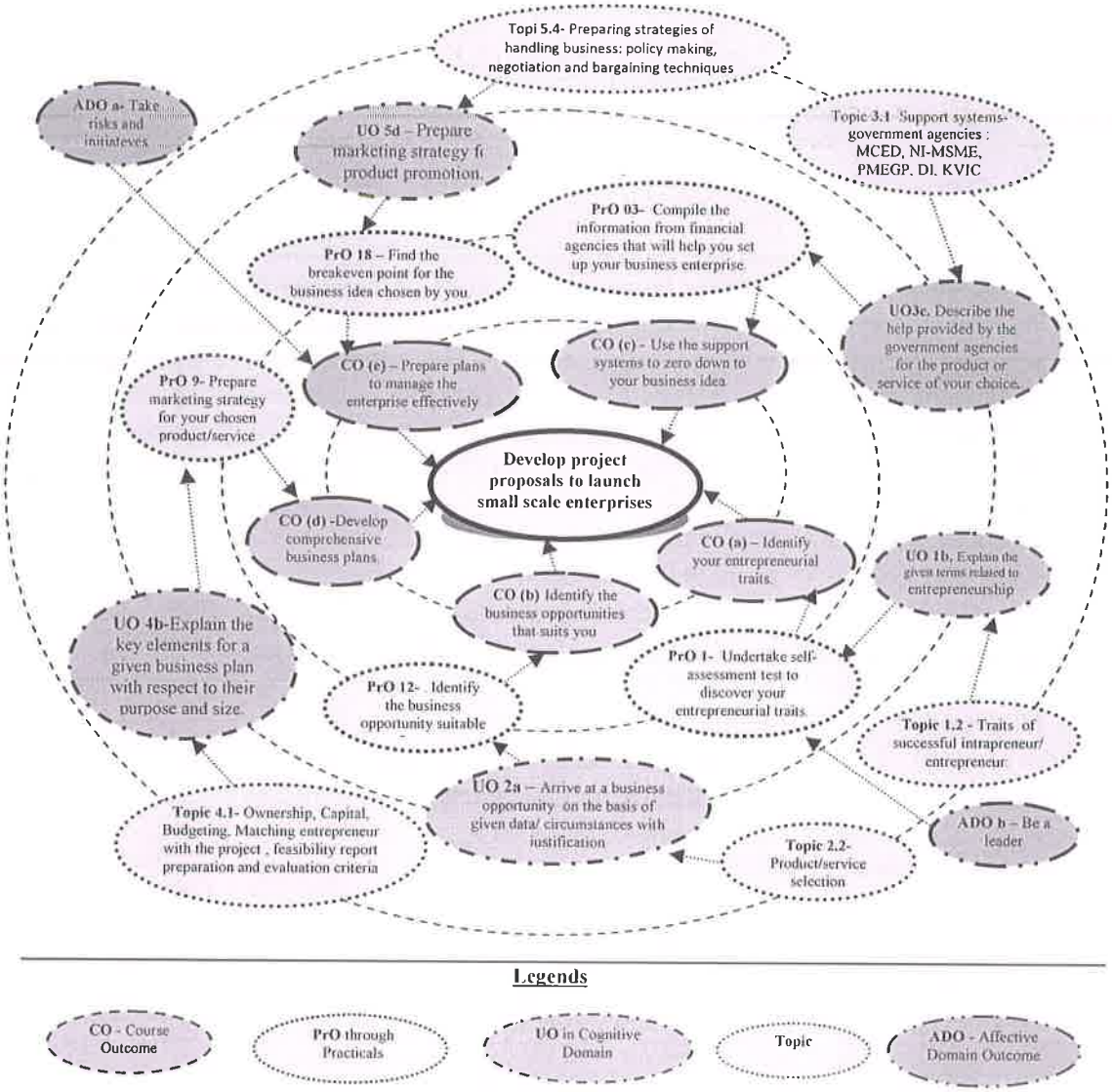

Figure 1 - Course Map

6. 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	Submit a profile summary(about500words) of a successful entrepreneur indicating milestone achievements.	I	02*
2	Undertake SWOT analysis to arrive at your business idea of a product/service.	I	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
3	Generate business ideas(product/service) for intrapreneurial and entrepreneurial opportunities through brainstorming.	II	02*
4	Undertake self-assessment test to discover your entrepreneurial traits.	II	02*
5	Identify the business opportunity suitable for you.	II	02
6	Arrange an exhibition cum sale of products prepared out of waste.	II	02
7	Survey industries of your stream, grade them according to the level of scale of production, investment, turnover, pollution to prepare a report on it.	II	02*
8	Visit a bank/financial institution to enquire about various funding schemes for small scale enterprise.	III	02*
9	Collect loan application forms of nationalise banks/other financial institutions.	III	02*
10	Compile the information from financial agencies that will help you set up your business enterprise.	III	02*
11	Compile the information from the government agencies that will help you set up your business enterprise.	III	02*
12	Prepare Technological feasibility report of a chosen product/service.	III	02*
13	Prepare financial feasibility report of a chosen product/service.	III	02*
14	Craft a vision statement and enabling mission statements for your chosen enterprise.	III	02
15	Prepare a set of short term,medium and long term goals for starting a chosen small scale enterprise	III	02*
16	Prepare marketing strategy for your chosen product/service.	IV	02*
17	Compile information about various insurance schemes covering different risk factors.	IV	02
18	Organize a funfair of your class and write a report of profit/loss	V	02
19	Find the breakeven point for the business idea chosen by you.	V	02
20	Arrange a discussion session with your institute's pass out students who are successful entrepreneurs.	V	02
21	Prepare a business plan for your chosen small scale enterprise	V	02*
	Total		**42**

Note:

i. *A suggestive list of PrOs is given in the above table. More such PrOs can be added to attain the COs and competency. A judicial mix of minimum 12 or more practical need to be performed, out of which, the practicals marked as '*' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.*

ii. *The 'Process' and 'Product' related skills associated with each PrO is to be assessed according to a suggested sample given below:*

Sample Products that can be manufactured under SME

1. Badges cloth embroidered and metals

2. Bags of all types i.e. made of leather, cotton, canvas and jute etc. including kit bags, mail bags, sleeping bags and water-proof bag
3. Bandage cloth
4. Basket cane (Procurement can also be made from State Forest Corpn. and State Handicrafts Corporation)
5. Bath tubs of plastic
6. Battery Charger
7. Belt leather and straps
8. Bolts and Nuts
9. Boot Polish
10. Brooms
11. Domestic Brushes of different types
12. Buckets of all types of plastic
13. Button of all types
14. Chappals and sandals
15. Cleaning Powder
16. Cloth Covers for domestic use
17. Cloth Sponge
18. Coir mattress cushions and matting
19. Cotton Pouches
20. Curtains mosquito
21. Domestic Electric appliances as per BIS Specifications: Toaster Electric, Elect. Iron, Hot Plates, Elect. Mixer, Grinders Room heaters and convectors and ovens
22. Dust Bins of plastic
23. Dusters Cotton all types except the items required in Khadi
24. Electronic door bell
25. Emergency Light (Rechargeable type)
26. Hand drawn carts of all types
27. Hand gloves of all types
28. Hand numbering machine
29. Hand Pump
30. Hand Tools of all types
31. Handles wooden and bamboo (Procurement can also be made from State Forest Corpn. and State Handicrafts Corporation)
32. Haver Sacks
33. Honey
34. Invalid wheeled chairs.
35. Iron (dhobi)
36. Lamp holders
37. Letter Boxes
38. Nail Cutters
39. Oil Stoves (Wick stoves only)
40. Paper conversion products, paper bags, envelops, Ice-cream cup, paper cup and saucers and paper Plates
41. Pickles, Chutney and Pappads
42. Pouches for various purposes
43. Safe meat and milk
44. Safety matches
45. Safety Pins (and other similar products like paper pins, staples pins etc.)
46. Shoe laces

47. Sign Boards painted
48. Soap Liquid
49. Spectacle frames
50. Steel Chair
51. Umbrellas
52. Utensils all types

Sample Services that can be offered under SME

1. Marketing Consultancy
2. Industrial Consultancy
3. Equipment Rental & Leasing
4. Typing Centres
5. Photocopying Centres (Zeroxing)
6. Industrial photography
7. Industrial R & D Labs.
8. Industrial Testing Labs.
9. Desk Top publishing
10. Advertising Agencies
11. Internet Browsing/Setting up of Cyber Cafes
12. Auto Repair, services and garages
13. Documentary Films on themes like Family Planning, Social forestry, energy conservation and commercial advertising
14. Laboratories engaged in testing of raw materials, finished products
15. 'Servicing Industry' Undertakings engaged in maintenance, repair, testing or electronic/electrical equipment/ instruments i.e. measuring/control instruments servicing of all types of vehicles and machinery of any description including televisions, tape recorders, VCRs, Radios, Transformers, Motors, Watches.
16. Laundry and Dry Cleaning
17. X-Ray Clinic
18. Tailoring
19. Servicing of agriculture farm equipment e.g. Tractor, Pump, Rig, Boring Machines.
20. Weigh Bridge
21. Photographic Lab
22. Blue printing and enlargement of drawing/designs facilities
23. ISD/STD Booths
24. Teleprinter/Fax Services
25. Sub-contracting Exchanges (SCXs) established by Industry Associations.
26. Coloured or Black and White Studios equipped with processing laboratory.
27. Ropeways in hilly areas.
28. Installation and operation of Cable TV Network:
29. Operating EPABX under franchises
30. Beauty Parlours
31. Creches.

S. No.	Performance Indicators	Weightage in %
1	Leadership skills	20
2	Team work	20
3	Lateral/creative thinking	10
4	Observations and recording	10
5	Self learning	20

S. No.	Performance Indicators	Weightage in %
6	Answer the sample questions	10
7	Submission of report in time	10
	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 safe practices
b. Practice good housekeeping
c. Practice energy conservation
d. Demonstrate working as a leader/a team member
e. Maintain tools and equipment
f. 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
- 'Organising Level' in 2nd year
- 'Characterising 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	Seminar Hall equipped with conference table,chairs and multimedia facilities	All
2	Modern desktop Computer with internet connection.	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	Unit Outcomes (In cognitive domain)	Topics and Sub-topics
Unit – I Entrepreneurship Development - Concept and Scope	1a. Describe the procedure to evaluate your entrepreneurial traits as a career option for the given product to be manufactured or services to be rendered. 1b. Explain the given terms related to Entrepreneurship	1.1 Entrepreneurship as a career 1.2 Traits of successful intrapreneur/ entrepreneur: consistency, creativity, initiative, independent decision making, assertiveness, persuasion, persistence, information seeking, handling business communication, commitment to work contract, calculated risk taking. 1.3 Entrepreneurship : scope in local and

Unit	Unit Outcomes (In cognitive domain)	Topics and Sub-topics
	1c. Describe the salient features of the resources required for starting the specified enterprise. 1d. Identify the characteristics for a given type of enterprise.	global market. 1.4 Intrapreneur and entrepreneur 1.5 Types of enterprises and their features : manufacturing, service and trading. 1.6 Steps in setting up of a business.
Unit – II Entrepreneurial Opportunities and selection process	2a. Arrive at a business opportunity on the basis of given data/circumstances with justification. 2b. Describe the scheme(s) offered by the government for starting the specified enterprise. 2c. Suggest a suitable place for setting up the specified enterprise on the basis of given data/circumstances with justification. 2d. Suggest the steps for the selection process of an enterprise for the specified product or service with justification. 2e. Describe the market study procedure of the specified enterprise.	2.1 Product/Service selection: Process, core competence, product/service life cycle, new product/ service development process, mortality curve, creativity and innovation in product/ service modification / development. 2.2 Process selection: Technology life cycle, forms and cost of transformation, factors affecting process selection, location for an industry, material handling. 2.3 Market study procedures: questionnaire design, sampling, market survey, data analysis 2.4 Getting information from concerned stakeholders such as Maharashtra Centre for Entrepreneurship Development[MCED], National Institute for Micro, Small and Medium Enterprises [NI-MSME], Prime Minister Employment Generation Program [PMEGP], Directorate of Industries[DI], Khadi Village Instries Commission[KVIC]
Unit – III Support Systems	3a. Describe the support system required for the specified enterprise. 3b. Describe the help provided by the government agencies for the specified product/service. 3c. Describe the help provided by the non-governmental agencies for the specified product/service. 3d. Compute the breakeven point for the specified	3.1 Categorisation of MSME, ancillary industries 3.2 Support systems- government agencies: MCED, NI-MSME, PMEGP,DI, KVIC 3.3 Support agencies for entrepreneurship guidance, training, registration, technical consultation, technology transfer and quality control, marketing and finance. 3.4 Breakeven point, return on investment and return on sales.

Unit	Unit Outcomes (In cognitive domain)	Topics and Sub-topics
	business enterprise, stating the assumptions made.	
UNIT IV Business Plan Preparation	4a. Justify the importance of the business plan for the given product/service. 4b. Explain the key elements for the given business plan with respect to their purpose/size 4c. Prepare the budget for the given venture. 4d. Prepare the details of the given component of the given startup business plan.	4.1 Sources of Product for Business : Feasibility study 4.2 Ownership, Capital, Budgeting, Matching entrepreneur with the project , feasibility report preparation and evaluation criteria 4.3 Business plan preparation
Unit –V Managing Enterprise	5a. Justify the USP of the given product/ service from marketing point of view. 5b. Formulate a business policy for the given product/service. 5c. Choose the relevant negotiation techniques for the given product/ service with justification. 5d. Identify the risks that you may encounter for the given type of business/enterprise with justification. 5e. Describe the role of the incubation centre for the given product/service.	5.1 Unique Selling Proposition [U.S.P.]: Identification, developing a marketing plan. 5.2 Preparing strategies of handling business: policy making, negotiation and bargaining techniques. 5.3 Risk Management: Planning for calculated risk taking, initiation with low cost projects, integrated futuristic planning, angel investors, venture capitalist. 5.4 Incubation centres: Role and procedure.

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

9. 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: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a. Develop two products from household waste (attach photographs).
b. Download product development and innovative films from internet.
c. Prepare a collage for 'Traits of successful entrepreneurs'.
d. Invite entrepreneurs, industry officials, bankers for interaction.
e. Identify your hobbies and interests and convert them into business idea.

f. Convert you project work into business.
g. Choose a product and design a unique selling preposition, brand name, logo, advertisement (print, radio, television), jingle, packing, packaging, label for it.
h. Develop your own website. Share your strengths and weakness on it. Declare your time bound goals and monitor them on the website.
i. Choose any advertisement and analyse its good and bad points.
j. Decide any product and analyse its good and bad features.
k. Select any product and prepare its cost sheet.
l. Choose any product and study its supply chain.
m. Arrange brainstorming sessions for improvement of any product.
n. Study schemes for entrepreneurship promotion of any bank.
o. Visit industrial exhibitions, trade fairs and observe nitty-gritty of business.
p. Open a savings account and build your own capital.
q. Organise industrial visit and suggest modifications for process improvement.
r. Interview at least four entrepreneurs or businessman and identify Charms of entrepreneurship and Traits of successful entrepreneurs.
s. Analyse case studies of any two successful entrepreneurs.
t. Perform a survey and identify local resources available for setting up of an enterprise.
u. Engage in marketing of products.
v. Carry out a demand supply gap analysis for a particular product.
w. Organise a prototype development competition.
x. Arrange fairs, events in the institute and try for sponsorships.
y. Select any performance criteria and continuously compete with yourself.
z. On any performance criteria continuously compete with others.
aa. Foresee your dream and make a long term plan for its accomplishment.
bb. Dream for something unique and make a write-up.
cc. Read articles, books on creativity.
dd. Using morphological analysis technique, reduce cost or increase quality of a product.
ee. Conduct a market survey for a project. Collect data on machinery specifications, price, output/hr, power consumption, manpower requirement, wages, raw material requirement, specification, price, competitor's product price, features, dealer commissions, marketing mix.
ff. Prepare a business plan and organize a business plan competition.
gg. Select a social cause, set objectives, plan and work for its accomplishment.
hh. Videograph as many as possible from the above and upload on your website, YouTube, facebook.

10. 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 COs/UOs 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 maintenances techniquies.
f. Guide student(s) in undertaking micro-projects.
g. Instructors should emphasise more on deductive learning. Students should learn to recognise, create, shape opportunities, and lead teams for providing economic-social value to society.
h. Business simulations should be used to enhance behavioural traits of successful intrapreneurs and entrepreneurs amongst students. Emphasis should be on creating entrepreneurial society rather than only setting up of enterprise.
i. They must be encouraged to surf on net and collect as much information as possible.
j. Each student should complete minimum twenty activities from the suggested list. Minimum possible guidance should be given for the suggested activities.
k. Students should be promoted to use creative ideas, pool their own resources, finish their presentation, communication and team skills.
l. Alumni should be frequently invited for experience sharing, guiding and rewarding students.
m. Display must be arranged for models, collages, business plans and other contributions so that they motivate others.

11. SUGGESTED MICRO-PROJECTS

One Business Plan as a micro-project is planned to be undertaken by a student assigned to him/her in the beginning of the semester. S/he should submit it by the end of the semester to develop the industry oriented COs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation in the middle of the semester and one at the end of the semester before submission of the project proposal incorporating the concepts taught during semester. The total duration of the micro-project should not be less than ***16 (sixteen) student engagement hours*** during the course.

a. Choose any advertisement and analyse its good and bad points.
b. Decide any product and analyse its good and bad features.
c. Select any product and prepare its cost sheet.
d. Choose any product and study its supply chain.
e. Arrange brainstorming sessions for improvement of any product.
f. Study schemes for entrepreneurship promotion of any bank.
g. Visit industrial exhibitions, trade fairs and observe nitty-gritty of business.
h. Open a savings account and build your own capital.
i. Organise industrial visit and suggest modifications for process improvement.

12. SUGGESTED LEARNING RESOURCES

S. No.	Title of Books	Author	Publication
1	The Entrepreneurial Instinct : How Everyone Has the Innate Ability to Start a Successful Small Business	Mehta, Monica	McGraw-Hill Education, New Delhi, 2012, ISBN 978-0-07-179742-9
2	Entrepreneurship	Hisrich, R. D.	McGraw-Hill Education, New Delhi, 2013 ISBN-13: 978-1259001635
3	Part I Readings in Entrepreneurship Education	Sareen, S.B.	Entrepreneurship Development Institute of India (EDI), GOI,

S. No.	Title of Books	Author	Publication
			Ahmedabad, 2016; ISBN: 978-0078029196 ..
4	Reading Material of Entrepreneurship Awareness Camp	Gujral, Raman	Entrepreneurship Development Institute of India (EDI), GOI, 2016 Ahmedabad,
5	Product Design and Manufacturing	Chitale, A K	PHI Learning, New Delhi, 2014; ISBN: 9788120348738
6	Entrepreneurship Development Small Business Entrepreneurship	Charantimath, Poornima	Pearson Education India, New Delhi; ISBN: 9788131762264
7	Entrepreneurship Development: Special edition for MSBTE	CPSC, Manila	Tata Mc-Graw Hill, New Delhi,
8	Entrepreneurship and Small Business Management	Khanka, S.S.	S.Chand and Sons, New Delhi, ISBN: 978-93-5161-094-6
9	Entrepreneurship Development	S, Anil Kumar	New Age International, New Delhi, ISBN: 9788122414349

13. SUGGESTED SOFTWARE/LEARNING WEBSITES

1	MCED Books links	http://www.mced.nic.in/UdyojakSpecial.aspx?linktype=Udyojak
2	MCED Product and Plan Details	http://www.mced.nic.in/allproduct.aspx
3	The National Institute for Entrepreneurship and Small Business Development Publications	http://niesbud.nic.in/Publication.html
4	Courses : The National Institute for Entrepreneurship and Small Business Development	http://niesbud.nic.in/docs/1standardized.pdf
5	Entrepreneur.com	https://www.entrepreneur.com/lists
6	GOVT. SPONSORED SCHEMES	https://www.nabard.org/content1.aspx?id=23andcatid=23andmid=530
7	NABARD - Information Centre	https://www.nabard.org/Tenders.aspx?cid=501andid=24
8	NABARD – What we Do	http://www.nabard.org/content1.aspx?id=8andcatid=8andmid=488
9	Market Review	http://www.businesstoday.in/markets
10	Start Up India	http://www.startupindia.gov.in/pdffile.php?title=Startup%20India%20Action%20Planandtype=Actionandq=Action%20Plan.pdfandcontent_type=Actionandsubmenupoint=action
11	About - Entrepreneurship Development Institute of India (EDII)	http://www.ediindia.org/institute.html
12	EDII - Centres	http://www.ediindia.org/centres.html
13	EDII - Publications	http://www.ediindia.org/publication.html
14	Business Plans: A Step-by-Step Guide	https://www.entrepreneur.com/article/247574
15	The National Science and Technology Entrepreneurship Development Board (NSTEDB)	http://www.nstedb.com/index.htm

16	NSTEDB - Training	http://www.nstedb.com/training/training.htm
17	Tata Exposures	http://www.tatasocial-in.com/project-exposure
18	Ministry Of Micro, Small And Medium EnterpriseS	http://www.dcmsme.gov.in/schemes/TEQUPDetail.htm
19	List of Business Ideas for Small Scale Industry	https://smallb.sidbi.in/%20/thinking-starting-business/big-list-business-ideas-small-business
20	Thinking of Entrepreneurship	https://smallb.sidbi.in/entrepreneurship-stage/thinking-entrepreneurship
21	List of services for Small Scale Industry	http://www.archive.india.gov.in/business/Industry_services/illustrative.php
22	NSIC Schemes and Services	http://www.nsic.co.in/SCHSERV.ASP

Program Name : **All Branches of Diploma in Engineering and Technology.**

Program Code : **CE/CR/CS/CH/CM/CO/IF/CW/DE/EJ/EN/EQ/ET/EX/IE/ MU/EE/EP/EU/IS/IC/AE/FG/ME/PG/PT/DC/TX/TC**

Semester : **Sixth**

Course Title : **Capstone Project – Execution & Report Writing**

Course Code : **22060**

1. RATIONALE

This course on 'Capstone Project–Execution and Report Writing' is the continuation of the previous semester course on 'Capstone Project–Planning'. So, in this semester, the students are to implement the detailed Capstone Project Plan, which they have prepared in the preceding semester. Therefore, to successfully complete this Capstone Project by the end of this semester, it is necessary to incorporate the suggestions of the guide/examiners of the preceding semester. Hence, it is of utmost importance for the student to again re-capitulate and comprehend the importance, concept and need of the 'Capstone Projects' which are well explained in the 'Capstone Project–Planning' course in the previous semester.

Often, the jobs in the industry, which the diploma holders will come across when they join it and will be in the form of small or large projects. Such projects are generally an integration of the various types of skills which cut across the three major domains of learning i.e. cognitive, psychomotor and affective domain which must have acquired during their journey from first semester to the last semester. Hence, it is essential that students are also given an opportunity to do large projects which require more time compared to the micro-projects in order to develop and integrate the highly essential industry oriented competencies and associated skills in the students. Therefore, in this semester the 'Capstone Project – Execution and Report Writing' will continue to integrate some more additional competencies along with those in the previous semester and hence build up greater confidence to face such situations in the world of work.

2. COMPETENCY

The course should be taught and implemented with the aim to develop the required course outcomes (COs) so that students will acquire following competency needed by the industry:

- **Implement the Capstone Project Plan to solve the identified problem/task faced by industry/user related to the concerned occupation by integrating the various types of skills acquired during the programme.**

3. COURSE OUTCOMES (COs)

Depending upon the nature of the projects undertaken, the following could be some of the major course outcomes that could be attained, although, in case of some projects few of the following course outcomes may not be applicable.

a) Implement the planned activity individually and/or as team.
b) Select, collect and use required information/knowledge to solve the identified problem.
c) Take appropriate decisions based on collected and analysed information.
d) Ensure quality in product.
e) Incorporate energy and environment conservation principles.
f) Consider the ethical issues related to the project (if there are any).
g) Assess the impact of the project on society (if there is any).
h) Communicate effectively and confidently as a member and leader of team.

i) Prepare project report after performing due plagiarism check using appropriate tools.

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	
-	-	4	4	--	--	--	--	--	--	--	50#	20	50~	20	100	40	

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

5. Course details

As the implementation of the Capstone project progresses and which has to be submitted at the end of project work, one of the outputs of this course is a detailed ***Project Report*** that is continuously prepared by the student. There will also be regular progressive assessment by the teacher as per the criteria no 7 on the basis of rubrics mentioned in **Appendix –C** and in the formats as shown in **Appendix-B** and also for the end-of-semester examination.

5.1 Guidelines for Capstone Project–Execution and Report Writing

a) The students would like to revise the 'Capstone Project – Plan' based on the feedback received in the fifth semester examination.

b) This revised 'Capstone Project – Plan' would be again approved by the project guide. As soon as the revised plan is approved by the teacher, the student will begin to work according to it and would also continue to maintain a dated ***'Project Diary'*** for the whole semester. This is a sort of a 'weekly diary' indicating all the activities conducted by the student every week in the semester to complete the project. This 'Project Diary' should be got signed by the teacher at regular intervals for progressive assessment. If this is maintained sincerely and truthfully by the student, it will be very helpful in compiling the ***Final Project Report*** at the end of the semester by him/her.

6. Project report

During the final Semester, the student will prepare a 'Project Report' in continuation with the activities conducted in fifth semester under Project Planning having following sub-titles:

Suggested contents of the Project report

- Title page (with name of team members and mentor teacher)
- Certificate (in the Format given in this document as annexure A)
- Acknowledgements (this may need revision at the end of the final semester)
- Abstract (in one paragraph not more than 150 words)
- Content Page

Chapters

1. Chapter–1 Introduction (background of the Industry or User based Problem/Task)
2. Chapter–2 Literature Survey (to finalise and define the Problem Statement)
3. Chapter–3 Scope of the project
4. Chapter–4 Methodology
5. Chapter-5 Details of designs, working and processes

6. Chapter-6 Results and Applications
7. Chapter-7 Conclusions And future scope
8. Appendix (if any)
9. References and Bibliography

Note:

i. The report should contain as many diagrams, figures and charts etc as relevant for the project.
ii. Originality of the report (written in own words) would be given more importance rather than quality of printing and use of glossy paper or multi-colour printing

7. ASSESSMENT OF PROJECT WORK

Project work has two components, first is Progressive Assessment (PA), while another is End Semester Examination (ESE).

7. 1. Progressive Assessment (PA) Guidelines and Criteria

Project guide is supposed to carry out this assessment. It is a continuous process, during which for developing desired qualities in the students, faculty should orally give **informal feedback** to students about their performance and interpersonal behaviour while guiding them on their project work every week. **F**ollowing criteria should be considered while assessing students informally or formally during different stages of the project work.

The following factors need consideration for both Capstone Project-Planning and Capstone Project-Execution and Report Writing.

a) Students should be assessed during the project work so that students can also get feedback for further improvement.
b) It should be kept in mind that project work is mainly experiential learning and it is not the research work, so emphasis should be on work based learning or learning from experience and development of attitudes and skills as mentioned in course outcomes. So focus of assessment should also be on learning from the process of completing project work rather than on novelty or innovation in the project work.
c) For progressive assessment at the end, students should be asked to give the power point presentation before group of teachers and junior students (so that junior students may also get awareness about the major project work they have to carry out in future)
d) The students would be awarded marks for their efforts (In some cases it may happen that due to some reasons such as unavailability of some material or component or some other resources, students may not be able to complete the project, but they have tried their best, in such cases students would be given appropriate marks if they have done enough efforts.)
e) The students would not be awarded marks if they have completed the project by getting done the work from market or some professionals (taking some help and guidance is different as compared to getting the work or maximum part of the work completed from others on payment basis).
f) Originality of the report (written in own words) would be given more importance.
g) The Project Guide will assure the quality of project done by his group.

Criteria of Marks for PA for Capstone Project -Execution and Report Writing.

S. No.	Criteria	Marks
1	**Project Proposal /Identification**	10
2	**Punctuality and overall contribution**	
3	**Project Diary**	
4	**Execution of Plan during sixth semester**	20
5	**Project Report including documentation**	15
6	**Presentation**	05
	Total	**50**

7.2 END SEMESTER EXAMINATION (ESE)

Evaluation shall be carried out according to following criteria. For each project, students from the concerned group should be asked to make presentation of their project , in front of the external and internal examiners which should be followed by question answer session to ascertain the contribution made by each student.

Criteria of Marks for ESE for Capstone Project -Execution and Report Writing

S. No.	Criteria	Marks
1	Project Proposal	05
2	Punctuality and overall contribution	
3	Project diary	
4	Execution of Plan during sixth semester	10
5	Project Report including documentation	10
6	Presentation	10
7	Question and Answer	15
	Total	**50**

8. SPECIAL TEACHING STRETAGIES (If any)

a) Teacher's should not spoon feed the students and let them try on their own at different stages of the project work and even first let them strive hard and only when efforts of students have failed, then teacher should guide them. Guidance should be in initially in the form of clues or hints rather than complete explanation, detailed explanation should be given only when students are not able to work based on clues/hints. The role of teacher should be limited to guide and facilitator

b) Teachers should help students in selecting a topic which is relevant and challenging (but within capacity) for students according to their abilities.

c) ***Teachers should come out of the mindset that there should be compulsorily some innovation and novelty in the project work. Because as discussed earlier, project is mainly opportunity for work based or experiential learning, the aim of which is to develop higher order cognitive skills and attitudes. Project at diploma level is not research or innovation.*** The main thing teachers have to ensure is that students choose a task or problem for their project work which is challenging but according to their capability i.e. a task which they can complete on their own without getting it done from market.

d) Teachers should ensure that students prepare the project plan in as much detail as possible, since this way only they would learn the importance of planning and how to do the detail planning. Teachers should allow students to proceed ahead only when they have detailed plan with them.

e) Teachers should motivate students to maintain project document project diary and project report. They should explain benefits of these activities to students and also train them in these activities, because most of them may be doing this first time.

f) Project Guide should ensure that students submit chapter of report one by one to him/her as per schedule and should check the content of the chapters. The Project guide should monitor that schedule is maintained and report writing is not left till last few weeks. It should not be a problem since first three chapters of the report should have been written in fifth semester itself.

g) Teachers should also encourage students to openly discuss their weaknesses and shortcomings .Teachers should develop confidence in students that admitting mistakes and weaknesses helps in improving them.

h) Teachers should continuously discuss with students about working of group and progress in the project and from this discussion should identify their personal qualities (both strengths and weaknesses) and suggest to them ways for improving those qualities.

i) Internal as well as external examiners should reward students for original work and efforts of students even if they are not fully successful or not able to complete the project in comparison to those students who have taken paid help from others to complete their project.

Appendix–A

CERTIFICATE

This is to certify that Mr./Ms.....

from .....Institute having Enrolment No: .....

has completed project of final year having title .....,.... during the academic year20__-20__. The project completed by individually/ in a group consisting of..... persons under the guidance of the Faculty Guide.

.....

.....

Name & Signature of Guide: .....

Telephone:.....

Appendix–B

PROGRESSIVE ASSESSMENT (PA) OF CAPSTONE PROJECT – EXECUTION AND REPORT WRITING

Evaluation Sheet for Internal Assessment

Name of Student: .....

Name of Programme..... **Semester: Sixth**

Course Title: Capstone Project : Execution and Report Writing **Code:22060.**

Title of the Capstone Project: .....

.....

A. **POs addressed by the Capstone Project** (Mention only those predominant POs)

a) .....
b) .....
c) .....
d) .....

B. **COs addressed by the Capstone Project** (Mention only those predominant POs)

a) .....
b) .....
c) .....
d) .....

C. **OTHER LEARNING OUTCOMES ACHIEVED THROUGH THIS PROJECT**

1. **Unit Outcomes (Cognitive Domain)**
   a) .....
   b) .....
   c) .....
   d) .....

2. **Practical Outcomes (in Psychomotor Domain)**
   a) .....
   b) .....
   c) .....
   d) .....

3. **Affective Domain Outcomes**
   a) .....
   b) .....
   c) .....
   d) .....

PROGRESSIVE ASSESSMENT (PA) Sheet		
S. No.	**Criteria**	**Marks**
1	Project Proposal /Identification	10
2	Punctuality and overall contribution	
3	Project Diary	
4	Execution of Plan during sixth semester	20
5	Project Report including documentation	15
6	Presentation	05
Total		**50**

Appendix–B

Suggested Rubric for Capstone Project – Execution and Report Writing

S. No.	Characteristic to be assessed	Poor	Average	Good	Excellent
1	**Problem/Task Identification (Project Title)**	Relate to very few POs Scope of Problem not clear at all	i. Related to some POs ii. Scope of Problem/Task vague	i. Take care of at-least Three POs ii. Scope of Problem/task not very specific	• Take care of more than three POs ii. Scope of problem/task very clear
2	**Literature Survey /Industrial Survey**	Not more than ten sources (primary and secondary), very old reference	At-least 10 relevant sources, at least 5 latest	At –least 15 relevant sources, most latest	About 20 relevant sources, most latest
3	**Project proposal**	Methods are not appropriate, All steps not mentioned, Design of prototype not started (if applicable).	Appropriate plan but not in much detail. Plan B for critical activities not mentioned. Time line is not developed. Design of Prototype is not complete. (if applicable)	Appropriate and detailed plan with Plan B for critical activities mentioned, but clarity is not there in methods, time line is given but not appropriate. Design of prototype is not detailed (if applicable)	Appropriate and detailed plan with Plan B for critical activities mentioned, clarity in methods with time line, Detailed design of prototype (if applicable)
4	**Project Diary**	Entries for most weeks are missing. There is no proper sequence and details are not correct.	Entries for some weeks are missing, details are not appropriate, not signed regularly by the guide.	Entries were made every week but are not in detail. Signed and approved by guide every week	Entries were made every week in detail, signed and approved by guide every week
5	**Final Report Preparation**	Very short, poor quality sketches, Details about methods, material, precaution and conclusions	Detailed, correct and clear description of methods, materials, precautions and	Conclusions. Sufficient Graphic Description.	Very detailed, correct, clear description of methods, materials, precautions and conclusions. Enough tables,

S. No.	Characteristic to be assessed	Poor	Average	Good	Excellent
		omitted, some details are wrong			charts and sketches
6	**Presentation**	Major information is not included, information is not well organized .	Includes major information but not well organized and not presented well	Includes major information and well organized but not presented well	Well organized, includes major information ,well presented
7	**Defense**	Could not reply to considerable number of question.	Replied to considerable number of questions but not very properly	Replied properly to considerable number of question.	Replied to most of the questions properly

Appendix C

Suggestive Project Diary format

Week no:
Activities planned:
Activities Executed:
Reason for delay if any
Corrective measures adopted
Remark and Signature of the Guide