Maharashtra State Board of Technical Education, Mumbai

Teaching And Examination Scheme For Post S.S.C. Diploma Courses

Program Name : Diploma in Instrumentation / Diploma in Instrumentation & Control

Program Code : IS / IC — **With Effect From Academic Year: 2017 - 18**

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

Semester : Fifth — **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	Environmental Studies	EST	22447	3	-	-	3	90 Min	70*#	28	30*	00	100	40	--	--	--	--	--	--	100
2	Industrial Automation	IAU	22534	3	-	2	5	3	70	28	30*	00	100	40	25#	10	25	10	50	20	150
3	Control Systems	CSY	22541	4	-	4	8	3	70	28	30*	00	100	40	50#	20	50	20	100	40	200
4	Process Instrumentation	PIN	22542	4	-	2	6	3	70	28	30*	00	100	40	25@	10	25	10	50	20	150
	Elective (Any One)																				
5	Embedded Systems	ESY	22532	3	-	2	5	3	70	28	30*	00	100	40	25#	10	25	10	50	20	150
	Analytical Instrumentation	AIN	22543	3	-	2	5	3	70	28	30*	00	100	40	25#	10	25	10	50	20	150
6	Enterprenureship Development	EDE	22032	2	-	2	4	--	--	--	--	--	--	--	50@	20	50~	20	100	40	100
7	Industrial Training	ITR	22049	-	-	6	6	--	--	--	--	--	--	--	75#	30	75~	30	150	60	150
8	Capstone Project Planning	CPP	22050	-	-	2	2	--	--	--	--	--	--	--	25@	10	25~	10	50	20	50
			Total	**19**	**-**	**20**	**39**	--	**350**	--	**150**	--	**500**	--	**275**	--	**275**	--	**550**	--	**1050**

Student Contact Hours Per Week: **39 Hrs.** Medium of Instruction: **English**

Theory and practical periods of 60 minutes each. Total Marks : **1050**

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.**
- **Evalution of Industrial Training and its reports is to done during this semester. Credit of Industrial Training will not affect the framing of time table.**

Program Name : **Diploma in Instrumentation / Instrumentation and Control**

Program Code : **IS / IC**

Semester : **Fifth**

Course Title : **Process Instrumentation**

Course Code : **22542**

1. RATIONALE

In Industrial processes, parameters involved are required to be measured, transmitted, recorded and displayed for efficient functioning of process operations. This subject gives a basic understanding about concept, facts, principles and working of various elements of Process Control Systems used in industries. The students can use this knowledge to develop competency to work in various Industrial sectors such as project engineering, maintenance, service and calibration departments.

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 Process Control Equipment in Instrumentation Systems.**

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 the elements of process feedback loop.
b. Use transmitters for various applications in process industry.
c. Maintain various process parameters on DAS and recording system.
d. Maintain control Panels for various applications in process industry.
e. Identify hazardous locations in process industry.

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	-	2	6	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 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 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 center of this map.

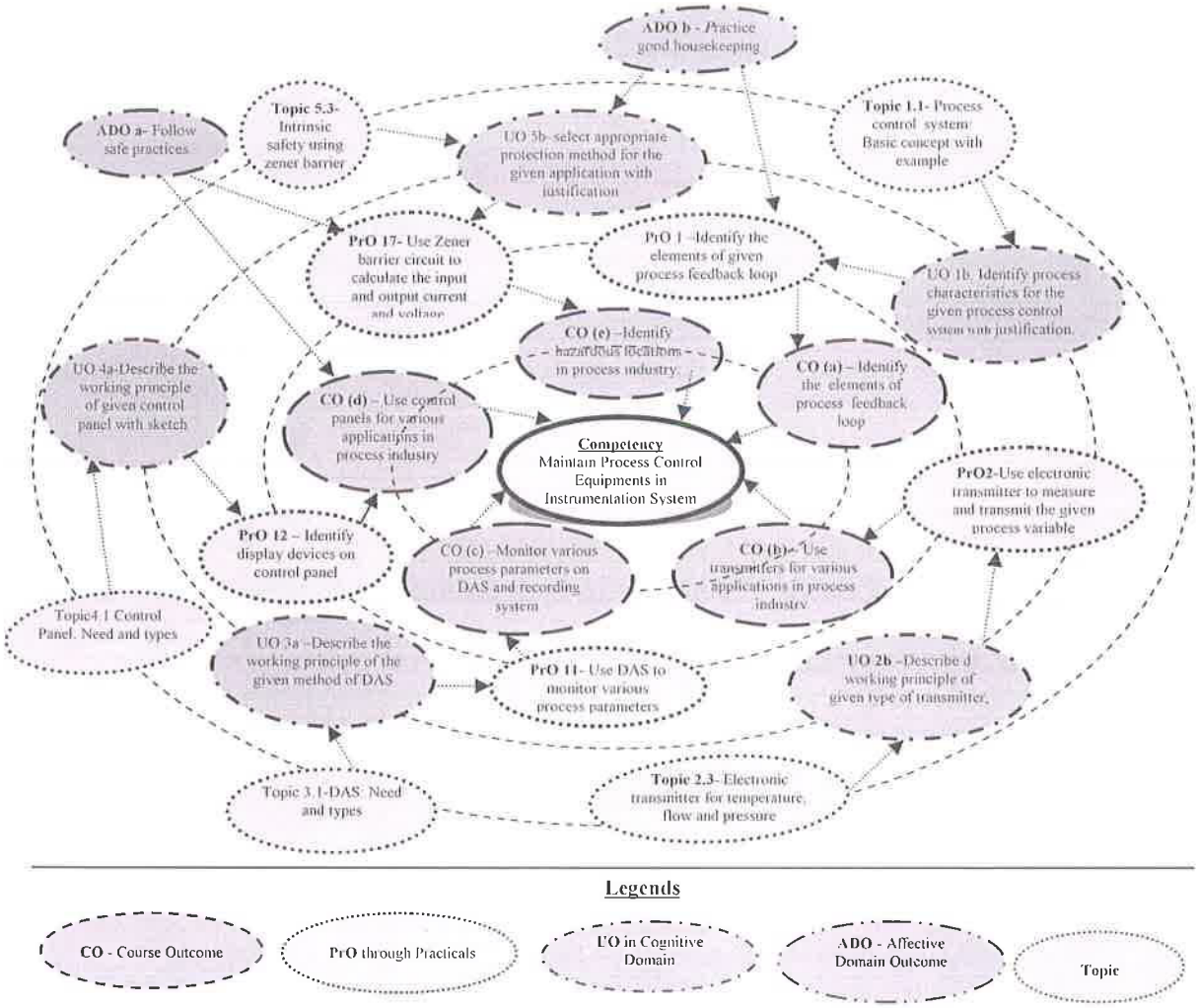

Figure 1 - Course Map

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 elements of the given process feedback loop	I	02*
2	Use electronic temperature transmitter to measure and transmit the given process variable.	II	02*
3	Use electronic DP transmitter to measure and transmit the given process variable	II	02
4	Calibrate the given temperature transmitter	II	02
5	Calibrate the given DP transmitter	II	02*
6	Use relevant Installation procedure to install the given temperature transmitter in the process loop.	II	02
7	Use relevant Installation procedure to install the given DP transmitter in the process loop.	II	02*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
8	Use SMART Transmitter to demonstrate the features.	II	02*
9	Use DAS to monitor various process parameters.	III	02*
10	Use Data Logger system to monitor various process parameters.	III	02
11	Use strip chart recorder to plot any one process parameter.	III	02*
12	Identify the display devices on the control Panel.	IV	02*
13	Sketch the typical control room layout.	IV	02
14	Use alarm annunciator to demonstrate the sequence of operations.	IV	02*
15	Use I/P convertor to convert the given standard signal	IV	02*
16	Use P/I convertor to convert the given standard signal	IV	02
17	Use zener barrier circuit to calculate the input and output currents and voltages.	V	02
	Total		**34**

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 %
a.	Preparation of experimental set up	20
b.	Setting and operation	20
c.	Safety measures	10
d.	Observations and Recording	10
e.	Interpretation of result and Conclusion	20
f.	Answer to sample questions	10
g.	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. Demonstrate working 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

- 'Organizing Level' in 2nd year
- 'Characterizing 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	Process control loop set up of flow or any other parameter.	1
2	Temperature Transmitter (0 to 100^0c).	2,4,6
3	DP Transmitter (0 to 3750 mmWC) or any other range available in the lab.	3,5,7
4	SMART Transmitter.	8
5	Alarm annunciator (16 window/24 window).	14
6	Data logger (8 channel/ 16 channel).	10
7	Strip chart recorder (Any make).	11
8	Control Panel.	12
9	I/P Converter (Any make) 3 to 15 psig output, 4 to 20 mA input).	15
10	P to I converter (Any make) 3 to 15 psig input, 4 to 20 mA output).	16

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 Process Instrumentation System	1a. Identify the element(s) of given process feedback loop, with justification. 1b. Identify process characteristics for the given process control system with justification. 1c. Describe the dynamics of the given process control system. 1d. Differentiate between the process characteristics and process dynamics	1.1 **Process Control System:** Basic concept with example 1.2 **Process Instrumentation:** Concepts, Examples, Benefits 1.3 **Process Characteristics**: Types such as Process equation, Process Load, Transient, Process Lag, self-regulation 1.4 **Process Dynamics:** Types such as Resistance lag, capacitance lag, Dead time, Inertia
Unit– II Signal Transmission and transmitters	2a. Differentiate between the given transmission system. 2b. Describe the working principle of the given type of transmitter(s). 2c. Describe the calibration procedures of the given transmitter 2d. Select the relevant type of transmitter for the given application with justification. 2e. Interpret the hook up installation sketch of the given	2.1 Need and types of signal transmission system. 2.2 Pneumatic transmission system: Standard signal 3-15 psi, Live zero, Flapper Nozzle Mechanism, Pneumatic transmitter: temperature transmitter and DP Transmitter-their diagram and working. 2.3 Electronic transmission system: Standard signal 4-20mA and 0-10V, Live zero, Electronics transmitter for temperature, flow (DP type) and pressure (force balance type).

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	transmitter	diagram and working. 2.4 SMART transmitters: Block diagram, explanation, Salient features. 2.5 Installation of temperature and DP transmitter. 2.6 Calibration of temperature and DP transmitter
Unit-III Data Monitoring and recording Instruments	3a. Describe the working principle of the given type of Data Acquisition system 3b. Describe the working principle of the given Data logger 3c. Describe the working principle of the given type of Recorder 3d. Select the DAS for a given application 3e. Select the recorder for a given application	3.1 DAS: Need, Types (single channel, multichannel), Block diagram, working and Applications. 3.2 Data logger: Block diagram, working and Applications. 3.3 Recorder: Need, Types -Strip Chart (Self Balancing, Potentiometric), X-Y Block diagram, working, specifications and Applications.
Unit IV Control Room Instrumentation	4a Describe the working principle of given control panel with sketch. 4b Differentiate between the given type of control panels 4c Describe the ergonomic considerations of control room. 4d Describe the working principle of given type of convertor with sketch. 4e Describe the working principle of Annunciator with sketch.	4.1 Control panels: Need; Types -Flat, Breakfront, Console; Ergonomic consideration, Documents needed to design the control panel Control room environment: Ergonomic considerations, Control room layout. 4.2 Electro-pneumatic convertors: Current to pressure convertor, Pressure to current convertor, diagram and principle of working of each 4.3 Alarm Annunciator: Working of annunciator, and the operational sequence.
Unit-V Instrumentation in hazardous area	5a. Select the appropriate material for the given hazardous location 5b. Select appropriate protection method for the given application with justification 5c. Select intrinsically safe equipment for hazardous location. 5d. Identify the enclosures for the given hazardous / nonhazardous location with justification.	5.1 Hazardous area: classification according to the materials as per NEC and IEC 5.2 Protection methods- Explosion proof, Intrinsic safety, oil immersion, purging, Nonincendive, increased safety and sealing 5.3 Intrinsic safety technique using passive zener barrier circuit 5.4 Enclosures: IP classification, NEMA types.

***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	Process Instrumentation System	12	4	4	2	10
II	Signal Transmission and Transmitters	16	4	6	10	20
III	Data Monitoring and recording Instruments	12	4	4	4	12
IV	Control Room Instrumentation	12	4	4	8	16
V	Instrumentation in hazardous area	12	4	4	4	12
Total		**64**	**20**	**22**	**28**	**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. Identify and interpret display devices on different control panels using trainer set up/ in industry
b. Draw control room layout and list out ergonomic considerations
c. Draw the process control loop for the level control system.
d. Draw the process control loop for the temperature control system
e. Survey few process industries and categorize them in appropriate hazardous class.
f. Draw the setup of level measurement using DP transmitter.
g. Perform the experiment of data logger in virtual lab.
h. Sketch the typical control room layout with scale on half imperial size drawing sheet.

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 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-projects 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 the data of 5 industries and list the important control parameters in them.
b. Make a Bill of Material for installation of temperature transmitter. Demonstrate the working of the set up.
c. Make a Bill of Material for installation of DP transmitter. Demonstrate the working of the set up.
d. Assemble control panel for the given application
e. Build annunciator for one process parameter and demonstrate its working.
f. Build intrinsically safe Zener barrier circuit for the given application in hazardous area.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Industrial Instrumentation and control	Singh S.K.	Tata McGraw Hill, New Delhi , 3rd edition ISBN: 978-0070678200
2	Process control Instrumentation Technology	Johnson C.D.	Prentice hall of India, NewDelhi,2015 ISBN: 978-9332549456
3	Instrumentation Engineer's handbook - Process control	Liptak Bela G	Chilton Book company,3rd edition ISBN:978-0801982422
4	Applied Instrumentation in the Process Industries, volume 2	William G.Andrew, WilliamsH.B	Gulf Publishing company,1974 ISBN:978-0872013940
5	Electronics Instruments and Instrumentation Technology	Anand M.M.S	Prentice hall India Learning Pvt. Ltd. New title edition(2004) ISBN: 9788120324541
6	Process Industrial instruments and control Handbook	Considine, Douglas	Tata McGraw Hill, 4th edition ISBN: 978-0070124455

14. SOFTWARE/LEARNING WEBSITES

a. http://www.pc-education.mcmaster.ca/Instrumentation/go_inst.htm
b. https://automationforum.in/t/basics-of-smart-transmitters/3030
c. https://automationforum.in/t/instrumentation-hook-up/3644
d. http://www.hse.gov.uk/comah/sragtech/techmeascontrol.htm
e. https://www.electrical4u.com/alarm-annunciator/
f. https://automationforum.in/t/current-to-pressure-convertion-using-flapper-nozzle-system/2691
g. http://literature.rockwellautomation.com/idc/groups/literature/documents/wp/800-wp004_-en-p.pdf

Program Name : **Diploma in Instrumentation / Instrumentation & Control**

Program Code : **IS / IC**

Semester : **Fifth**

Course Title : **Analytical Instrumentation**

Course Code : **22543**

1. RATIONALE

The area of analytical instrumentation involves a multidisciplinary approach covering instruments used in medical, drugs and pharmaceutical , petroleum, chemical, water treatment, dairy, environmental pollution monitoring etc. for qualitative and quantitative analysis of given sample. The fundamental knowledge of this course will enable the student to select appropriate instrument for analysis of given sample. The objective of the course is to maintain, understand the working principle and operation of analytical instruments.

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 industrial analytical instruments.**

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 analytical instruments for various applications.
b. Maintain the instruments based on absorption spectroscopy.
c. Maintain the instruments based on separation techniques.
d. Use relevant analytical instrument for specified industrial gases.
e. Maintain analytical instruments to monitor environment pollutants.

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 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 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 center of this map.

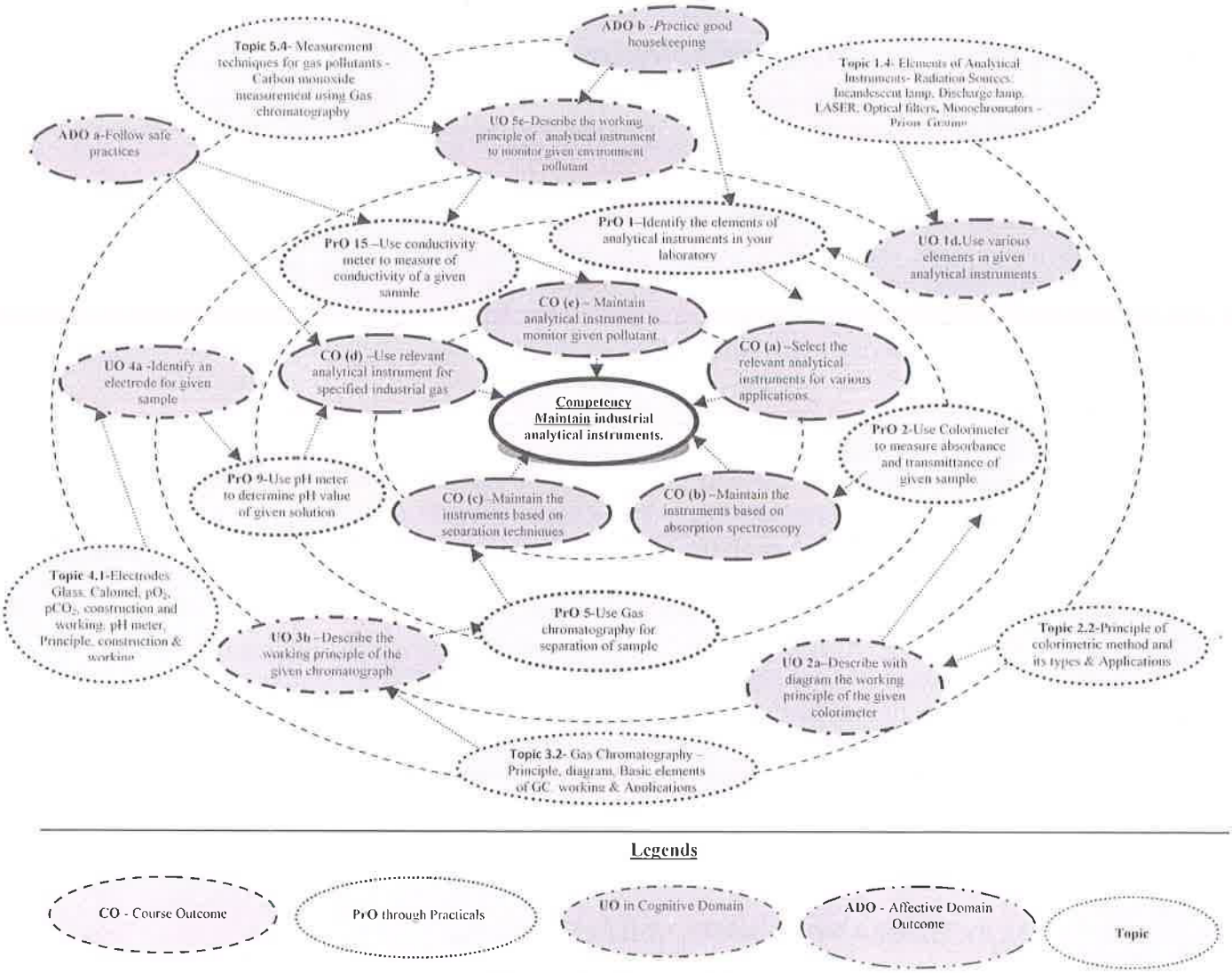

Figure 1 - Course Map

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 elements of analytical instruments in your laboratory	I	02*
2	Use Colorimeter to measure absorbance and transmittance of given sample	II	02*
3	Troubleshoot the given Colorimeter available in laboratory.	II	02
4	Use Spectrophotometer to Measure absorbance and transmittance of given sample	II	02*
5	Troubleshoot the given Spectrophotometer available in laboratory.	II	02
6	Use Flame photometer to Determine content of given sample	II	02*
7	Troubleshoot the given Flame Photometer available in laboratory.	II	02

8	Use Gas chromatograph for separation of given sample contents	III	02*
9	Use video programs to demonstrate High performance liquid chromatograph for separation of given sample contents.	III	02*
10	Use video programs to demonstrate Mass spectrometer for separation of sample contents.	III	02*
11	Use video programs to demonstrate GCMS/LCMS for separation of sample contents.	III	02*
12	Use pH meter to determine pH value of given solution	IV	02*
13	Calibrate pH meter using standard buffer solution	IV	02*
14	Troubleshoot the given pH meter available in laboratory.	IV	02
15	Use IR gas analyzer to analyze given gas sample.	IV	02
16	Use thermal conductivity gas analyzer to analyze given gas sample. .	IV	02
17	Use oxygen analyzer to measure the concentration of oxygen.	IV	02*
18	Troubleshoot the given oxygen analyzer available in laboratory.	IV	02
19	Use video programs to demonstrate Complete blood gas analyzer for measurement of pO2, pCO2.	IV	02*
20	Use conductivity meter to measure of conductivity of a given sample	V	02*
	Total		**40**

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 %
a.	Preparation of experimental set up	20
b.	Setting and operation	20
c.	Safety measures	10
d.	Observations and Recording	10
e.	Interpretation of result and Conclusion	20
f.	Answer to sample questions	10
g.	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. Demonstrate working 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
- 'Organizing Level' in 2nd year
- 'Characterizing Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTSREQUIRED

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	Single beam filter Colorimeter: wavelength range- 340-900nm	II
2	Double beam Spectrophotometer: wavelength range- 190-2700nm	II
3	Flame photometer: Ranges Na: 1-100ppm, K: 1-100ppm, Li: 1-100ppm, Ca: 15-100ppm, Ba: 50-1000ppm.	II
4	Gas chromatography: Retention time repeatability - < 0.008% or < 0.0008 min Area repeatability - < 1% RSD, using 2ng tetradecane, Must support simultaneously: - two inlets - three detectors	III
5	High performance liquid chromatography: The flow rate should be within a range from 0.001 to 20 ml/min, Flow Accuracy: ± 1.0% or better	III
6	Mass spectrometer: Mass range (m/z) 10 – 1250 with unit mass resolution, Power 100 – 240 VAC, 50/60 Hz	III
7	pH meter, Range 0-14,Accuracy-0.1% of range ,Temp compensation-0 to 100^0 C	IV
8	IR gas analyzer:Range:CO_2-20%,CO-30%,H_2-30%,O_2-5%,CH_4-10%	IV
9	Thermal conductivity gas analyzer: Components:H_2, He ,Ar,CH_4,Output signal:4–20 mA DC, 0–1 V DC, or 0–10 mV DC	IV
10	Paramagnetic oxygen analyzer: Measurement range : Auto ranging from 0.01 to 100% Oxygen	IV
11	Conductivity meter:SO2-0 ... 20 ppm O_3-0 ... 1 ppm	V

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 analytical instrumentation	1a. Describe function of given block(s) of the block diagram of the Analytical Instrument. 1b. Categorize the given analytical instrument based on property of analyte. 1c. Classify the given analytical instruments based on working principle. 1d. Use various elements in given analytical instruments.	1.1 Analytical Instrument: Block diagram, Explanation. 1.2 Properties of Analytes and techniques used in Analytical Instrument 1.3 Classification: Spectral, Electro-analytical, Separation method(Introduction to each method) 1.4 Elements of Analytical Instruments: Radiation Sources: Incandescent lamp, Discharge lamp, LASER; Optical filters:

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
		Absorption Filters, Monochromators –Prism, Grating
Unit– II Absorption Spectrometer	2a. Describe with diagram the working principle of the given colorimeter. 2b. Describe the working principle of given Spectrophotometer. 2c. Explain the working principle of the given Flame photometer /NMR Spectrometer 2d. Describe the procedure to troubleshoot the given Absorption Spectrometer	2.1 Interaction of radiation with matter, Beer Lambert's Law 2.2 Principle of colorimetric method and its types : Single – Beam filter photometer, Double- Beam filter photometer, Multi-channel photometer , Applications 2.3 Spectrophotometer : Using Prism, Using Grating, Applications 2.4 Flame photometer : Principle, Constructional details of Flame photometer, Applications 2.5 Principle of NMR, Constructional details of NMR spectrometer, Applications
Unit-III Analytical Instruments based on separation Techniques	3a. Classify the chromatograph for the given techniques 3b. Describe the working principle of the given chromatograph. 3c. Identify the elements of the given chromatograph. 3d. Select the chromatograph for analyzing the given sample. 3e. Describe the working principle of the given mass spectrometer 3f. Select the mass spectrometer to analyze the given sample. 3g. Describe the procedure to troubleshoot the given separation technique based analytical instrument.	3.1 Principle of chromatography, Classification of chromatography, 3.2 Gas Chromatography: Principle, diagram, Basic elements of GC, working, Application 3.3 Liquid Chromatography : Principle, diagram , Basic elements of LC, working, Application 3.4 Mass Spectrometer : diagram, working Principle, types: Magnetic deflection (Nier 60^0sector)type, Time of flight type, diagram, working, Applications - (i) GCMS (ii) LCMS
Unit –IV Industrial gas Analyzer	4a. Identify an electrode for given sample. 4b. Describe the working principle of given gas analyzer. 4c. Select the gas analyzer for the given gas sample. 4d. Categorize the gas analyzer for given industrial application. 4e. Describe the procedure to troubleshoot the given Industrial gas Analyzer	4.1 Electrodes: Glass, Calomel, pO_2, pCO2, construction and working. pH meter, Principle, construction & working. 4.2 Complete Blood gas Analyzer for measurement of pH, pCO_2,pO_2, TCO_2,HCO_3,Base excess - Block diagram of complete blood gas analyzer, working. 4.3 Infrared gas Analyzer: Principle, Block diagram, working, applications. 4.4 Thermal Conductivity Analyzer: Principle, diagram, working.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
		applications. 4.5 Paramagnetic Oxygen Analyzer
Unit-V Environmental Pollution monitoring Instruments	5a. Identify the necessity of environmental pollutants analysis. 5b. Classify different pollutants and their concentration in environment. 5c. Describe the working principle of analytical instrument to monitor given environment pollutant. 5d. Select the analyzer to analyze the given environmental pollutant. 5e. Describe the procedure to troubleshoot the given Pollutant Monitoring Instrument	5.1 Necessity of monitoring pollutants for environmental sustainability. 5.2 Representation of concentration of gases 5.3 Types and concentration of various gas pollutants 5.4 Measurement techniques for gas pollutants - Carbon monoxide measurement using Gas chromatography, 5.5 SO2 measurement using Conductivity method, 5.6 Nitrogen Oxides measurement using (i) Chemiluminescence(ii) CO Laser, 5.7 Ozone measurement using Conductivity meter.

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 FORQUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Introduction to analytical instrumentation	6	2	4	-	6
II	Absorption Spectrometry	12	4	8	4	16
III	Analytical Instruments based on separation Techniques	10	4	8	4	16
IV	Industrial gas Analyzer	10	4	8	4	16
V	Environmental Pollution monitoring Instruments	10	4	8	4	16
Total		**48**	**18**	**36**	**16**	**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. Visit to pathological laboratories to understand the operation of various analytical equipment.
b. Visit to industrial laboratories to understand the working of various analytical equipments.
c. Visit to PUC(Pollution under control) to measure the concentration of pollutants
d. Do internet survey and use various meters to calibrate analytical equipment
e. Read the safety precautions to operate various analytical equipment.
f. Library/Internet survey of advanced analytical equipment.
g. Prepare power point presentation or animation for understanding the concept of working of analytical instruments.

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 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. Use proper equivalent analogy to explain different concepts.
g. Use Flash/Animations to explain working principle of analytical instrument.

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. Build an analogous model showing internal construction of Gas Chromatography/ Liquid Chromatography.
b. Build an analogous model showing internal construction of Colorimeter.
c. Build an analogous model showing internal construction of Spectrophotometer.
d. Build an analogous model showing internal construction of Flame Photometer.
e. Analyze different environmental pollutant with the help of analytical instrument available in institute analytical instrumentation laboratory and prepare report on it.

f. Measure pH of different five water samples (drinking water, sewage water, Sea water etc.) with the help of pH meter and prepare a report on it.
g. Build a prism monochromator and prepare a report on it.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Handbook of Analytical Instrumentation	Khandpur R. S.	McGraw Hill Education, New Delhi, 2009, ISBN -13:978-0-07-060460-5 ISBN -10:0-07-060460-6
2	Analytical Instrumentation	Liptak Bela G.	CRC Press,1994,ISBN:9780801983979
3	Instrumental methods of analysis	Willard Merrit Dean	CRC Press ISBN-9780534290153
4	Instrumental method of chemical analysis	Ewing E. W.	McGraw Hill Education, New Delhi, ISBN-9780070198531
5	Introduction to instrumental analysis	Braun Robert D.	McGraw Hill Education, New Delhi, ISBN-978007100472
6	Principle of instrumental analysis	Skoog;Holler&Nieman	Sunder C ISBN-9781305577213
7	Bioinstrumentation	L. Veerakumari	MJP Publishers,Chennai2006, ISBN 81-8094-018-7

14. SOFTWARE/LEARNING WEBSITES

1. http://vlab.amrita.edu/?sub=1&brch=194&sim=802&cnt=4
2. http://vlab.amrita.edu/?sub=1&brch=192
3. http://ccnsb06-iiith.vlabs.ac.in/exp6_10/IR_Powder_exp6.swf
4. http://ccnsb06-iiith.vlabs.ac.in/exp7/index.php
5. http://ccnsb06-iiith.vlabs.ac.in/exp8/index.php
6. http://ccnsb06-iiith.vlabs.ac.in/cxp9/index.php
7. http://ccnsb06-iiith.vlabs.ac.in/exp5/index.php
8. http://ccnsb06-iiith.vlabs.ac.in/exp10/index.php
9. http://vlab.amrita.edu/?sub=1&brch=195&sim=359&cnt=1
10. https://www.youtube.com/watch?v=bVKASwadjQY

Program Name : **Diploma in Information Technology/ Automobile Engineering / Digital Electronics / Medical Electronics / Plastic Engineering / Production Engineering / Fashion & Clothing Engineering / Electrical Engineering Group/ Instrumentation/ Instrumentation & Control**

Program Code : **IF/AE/DE/MU/IS/IC/PS/PG/PT/DC/EE/EP/EU**

Semester : **Fifth**

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	

(@):*Online Examination;* (~):*PA has two components under practical marks. The assessment of practicals (seen in section 6) has a weightage of 60% (i.e.15 marks) and micro-project assessment (seen in section 12) and the remaining has a weightage 40% (i.e.10*

marks) will be 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* **$:** Online examination.

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.

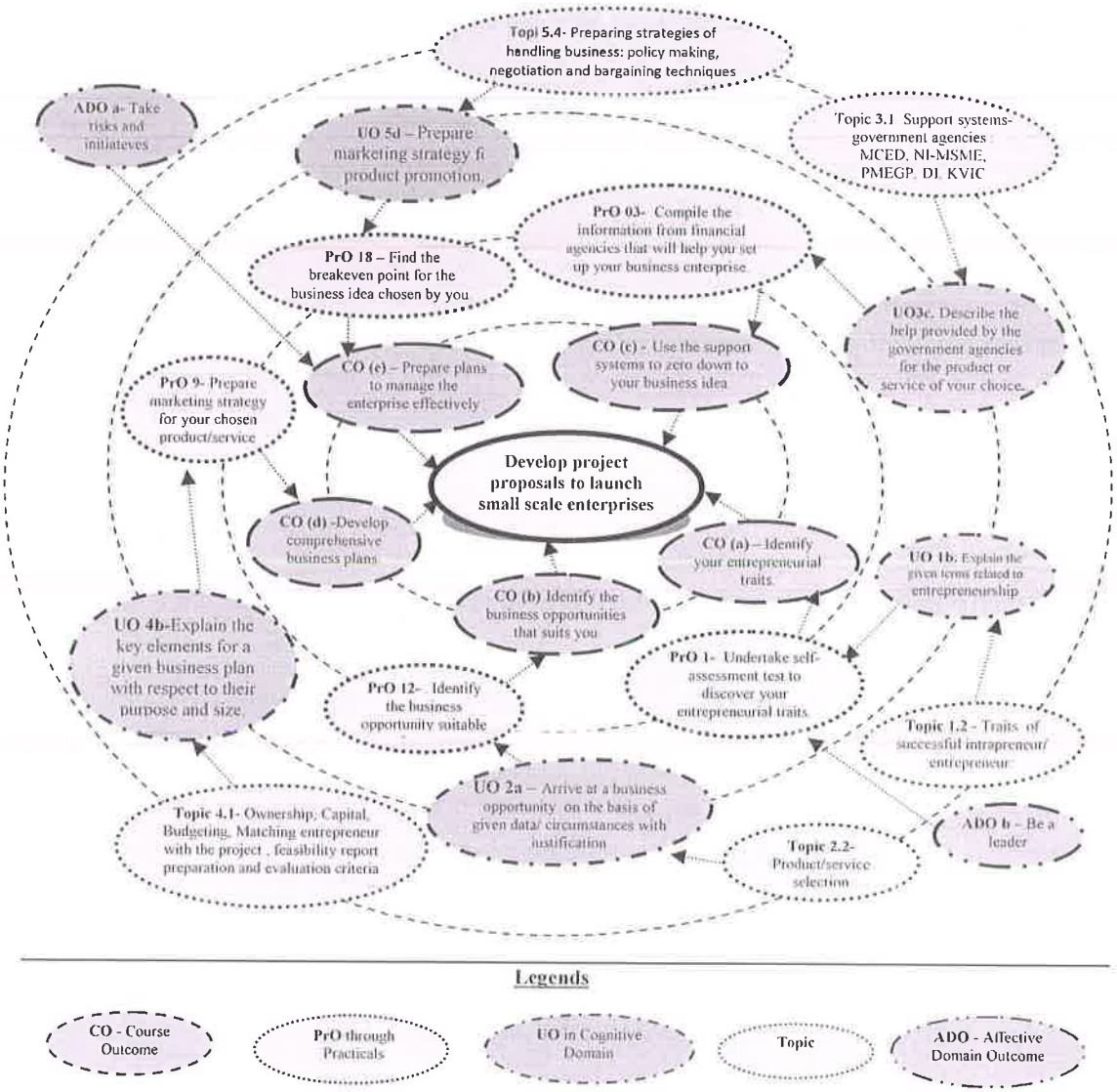

Figure 1 - Course Map

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
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

S. No.	Performance Indicators	Weightage in %
2	Team work	20
3	Lateral/creative thinking	10
4	Observations and recording	10
5	Self learning	20
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.	1.1 Entrepreneurship as a career 1.2 Traits of successful intrapreneur/ entrepreneur: consistency, creativity, initiative, independent decision making, assertiveness, persuasion, persistence, information seeking,

Unit	Unit Outcomes (In cognitive domain)	Topics and Sub-topics
	1b. Explain the given terms related to Entrepreneurship 1c. Describe the salient features of the resources required for starting the specified enterprise. 1d. Identify the characteristics for a given type of enterprise.	handling business communication, commitment to work contract, calculated risk taking. 1.3 Entrepreneurship : scope in local and 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	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
	point for the specified 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 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	Entrepreneurship Development - Concept and Scope	4	4	2	2	08
II	Entrepreneurial Opportunities and Process Selection	8	2	4	4	10
III	Support Systems	8	4	4	2	10
IV	Business Plan Preparation	8	6	4	4	14

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
V	Managing Enterprise	4	2	4	2	08
Total		**32**	**20**	**22**	**8**	**50**

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. 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.

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 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.

12. 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.

13. 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, 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

14. 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 : **Fourth**

Course Title : **Capstone Project – Planning**

Course Code : **22050**

1. RATIONALE

According to the requirement of National Board of Accreditation (NBA), 'learning to learn' is an important Graduate Attribute (GA No.11). It is required to develop this skill in the students so that they continue to acquire on their own new knowledge and skills from different 'on the job experiences' during their career in industry. An educational 'project' just does that and may be defined as ***'a purposeful student activity, planned, designed and performed by a student or group of students to solve/ complete the identified problem/task, which require students to integrate the various skills acquired over a period to accomplish higher level cognitive and affective domain outcomes and sometimes the psychomotor domain outcomes as well'***. Projects mainly serve this purpose of developing learning-to-learn skills with an aim to develop the following attributes in the students:

a) Initiative, confidence and ability to tackle new problems
b) Spirit of enquiry
c) Creativity and innovativeness
d) Planning and decision making skills
e) Ability to work in a team and to lead a team
f) Ability of self directed learning which is required for lifelong learning
g) Persistence (habit of not giving up quickly and trying different solutions in case of momentary failures, till success is achieved)
h) Resourcefulness
i) Habit of keeping proper records of events and to present a formal comprehensive report of their 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:

- **Plan innovative/creative solutions independently and/or collaboratively to integrate various competencies acquired during the semesters to solve/complete the identified problems/task/shortcomings faced by industry/user related to the concerned occupation.**

3. COURSE OUTCOMES (COs)

The following could be some of the major course outcomes depending upon the nature of the projects undertaken. However, in case of some projects few of the following course outcomes may not be applicable.

a) Write the problem/task specification in existing systems related to the occupation.
b) Select, collect and use required information/knowledge to solve the problem/complete the task.
c) Logically choose relevant possible solution(s).
d) Consider the ethical issues related to the project (if there are any).
e) Assess the impact of the project on society (if there is any).
f) Prepare 'project proposals' with action plan and time duration scientifically before beginning of project.

g) Communicate effectively and confidently as a member and leader of team.

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	--	--	--	--	--	--	--	25@	10	25~	10	50	20

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

5. Capstones Project

One of the dictionary meaning is the 'crown' or the stone placed on top of the building structure like 'kalash on top of Temples and Mosques' or 'Cross on top of churches'. Capstone projects are culminating experiences in which students synthesize the competencies acquired over whole programme. In some cases they also integrate cross-disciplinary knowledge. Thus Capstone projects prepare students for entry into a career and can be described as a 'rite of passage' or 'minimal threshold' through which participants change their status from student to graduate. A capstone project therefore should serve as a synthesis — reflection and integration — to bridge the real-world preparatory experience to real life. Thus capstone project should have emphasis on integration, experiential learning, and real-world problem solving and hence these projects are very important for students. To develop the highly essential industry oriented skills and competencies in the students, the capstone projects are offered in the last two semesters to serve for following purposes:

a) Integrate the competencies acquired by the students in the previous and current semesters.
b) Provide opportunities for interdisciplinary work in tackling problems likely to be faced by them in industry which are exciting and challenging.

6. Capstone Project Planning

Students are supposed to find out a suitable project and prepare a detailed plan in fifth semester so that it can be executed smoothly in sixth semester. The main characteristic of any project whether small or big is that it requires simultaneous application of various types of skills in the different domains of learning. Moreover, project normally do not have a predefined single solution, in other words for the same problem different students may come up with different but acceptable solutions. Further, in the process of arriving at a particular solution, the student must be required to make a number of decisions after scrutiny of the information s/he has accumulated from experiments, analysis, survey and other sources.

The projects will have a detailed project proposal, which must be executed or implemented within the time allocated, simultaneously maintaining a logbook periodically monitored by the teacher. A detailed project report is to be prepared as project progresses, which has to be submitted after the project is over. For self assessment and reflection students have to also prepare a portfolio of learning.

During the guidance and supervision of the project work, teachers' should ensure that students acquire following ***learning outcomes*** (depending upon the nature of the project work some of these learning outcomes may not be applicable):

a) Show the attitude of enquiry.
b) Identify the problems in the area related to their programme.
c) Identify the information suggesting the cause of the problem and possible solutions.
d) Assess the feasibility of different solutions and the financial implications.

e) Collect relevant data from different sources (books/internet/market/suppliers/experts etc. through surveys/interviews).
f) Prepare required drawings and detailed plan for execution of the work.
g) Work persistently and participate effectively in group work to achieve the targets.
h) Work independently for the individual responsibility undertaken.
i) Ask for help from others including guide, when required.
j) Prepare portfolio to reflect *(chintan-manan)* on experiences during project work.
k) Prepare seminar presentations to present findings/features of the project.
l) Confidently answer the questions asked about the project.
m) Acknowledge the help rendered by others in success of the project.

If students are able to acquire these *learning outcomes*, then they would be able to acquire the COs as discussed in section 3.

7. Scopes of Projects

Scope of the project work should be decided based on following criteria:

a) Relation to diploma programme curriculum: When students intend to select topics for the project work they need to choose a project which relates well to their curriculum (It may be beyond curriculum, but it should relate to it) and requires implementation of theories already learnt and skills already possessed by them from the previous semesters.

b) Abilities possessed by the group of students: Projects should be chosen so that it can be completed mainly using students' problem solving capabilities and depth of learning. It is natural that highly motivated students or high achievers may come out with projects which are more complex and challenging. Teachers should guide students to choose challenging projects according to the students' ability.

c) Resources Available: Students and Guides should keep in mind the availability of resources while deciding the topic and the scope of the project. Some of the important resources which need consideration are:

i. Time available
ii. Raw Material/Components required
iii. Manufacturing/Fabrication equipment and tools required
iv. Testing/Measuring equipment and instruments required
v. Access to Journals (Library/Digital)
vi. Expertise for theoretical guidance (available in polytechnic, nearby institutes or nearby industries)
vii. Expertise and technology required for fabrication (if required)
viii. Software required.

An important aspect to be considered is to decide who will choose a project. The best practice is that teacher should guide students about the above factors to be considered for choosing the project and based on these factors students should do the ground work and identify the possible projects and teachers should work as only facilitator and Guide in final selection of the project title and its scope.

d) Suggested Type of Capstone Projects

In general, the projects that the students can take up could be of the following types;

i. Feasibility studies.
ii. Design projects
iii. Market surveys about raw material, components or finished products.
iv. Prototype (design, make, test and evaluate).
v. Advanced experimental work requiring the development of existing equipment to be used and developed.
vi. Field works: This could include surveys, using equipment, charting data and information from visual observation.

vii. Comparative Studies: Theoretical study of two systems/mechanisms/ processes in detail and comparing them on the basis of cost/energy conservation/impact on environment/technology used etc.
viii. Application of Emerging technology: Theoretical study of some emerging technology and feasibility of its application in some real life situation in detail.
ix. Fabrication of some equipment/machine etc.
x. Construction of some structure.
xi. Development of software or use of software for solving some broad-based problem.

8. GUIDELINES FOR UNDERTAKING A PROJECT

The selection of the *Capstone Project title* must have emphasis to the Elective courses/ Elective Group taken for the study and exam for 5th and 6th semester. The students will then work on the identified problem/task through a rigorous process of understanding and analyzing the problem, conducting a literature search, deriving, discussing (monitored by the guide every fortnight) and designing the ***Semester V 'Project Proposal'*** with the following ***sub-titles***:

a) Rationale (one page)
b) Introduction
c) Literature Survey
d) Problem Definition
e) Proposed Methodology of solving Identified problem
f) In-case some prototype has to be fabricated then its tentative design and procedure for making it should be part of the proposal.
g) Resources and consumables required.
h) Action Plan (sequential list of activities with probable dates of completion)

As soon as the 'Project Proposal' is approved by the teacher, the student will begin to maintain a dated ***'Project Logbook'*** 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 logbook'* should be got signed by the teacher at regular intervals for progressive assessment to match the project proposal. If this is maintained sincerely and truthfully by the student, it will be very helpful in compiling the 'Project Report' at the end of the semester by him/her.

9. PORTFOLIO FOR SELF-DIRECTED LEARNING

To ensure that students acquire these outcomes, students should also be guided to prepare a **'Portfolio',** so that they may reflect on their weaknesses/mistakes and learn from them. ***Students should also be encouraged to discuss with their guide and record not only technical problems but also problems related to group work, planning, execution, leadership in the team etc., so that students can also identify their weaknesses in affective domain and take remedial actions to overcome the same.*** If they wish, the students can also show their portfolio to their teachers (whom they trust) for obtaining teachers' comments on their reflection for pointing out their mistakes so that they can improve their performance.

'Portfolio' is the record of the reflection (thinking or *chintan-manan*) on experiences to which students undergo during the different stages of the project. In a portfolio, students record their critical experiences and reflect (think or do *chintan-manan*) on them in writing. This process of reflecting on the experiences make them learn from their mistakes and build on their strengths. To help students in reflection, a Portfolio format with reflective prompts (simple thought provoking questions) for different stages of the project is given as annexure B.

12.1 Purposes of Portfolio Preparation

Reflection by self is important since group work is so complex that it is difficult for teachers to appreciate the real problems amongst the students. In a portfolio, prompts (simple thought provoking questions) are given to trigger reflection on different aspects of project work. Prompts help the students to ask questions from themselves regarding different aspects of the project work and interpersonal relationships. Process of answering these questions forces students to think about behavioral problems and possible remedies/solution to deal with those problems. Portfolio preparation therefore helps in reflection on building the strengths and elimination of the weaknesses of the students pertaining to following qualities which the industry also need.

a) Plan properly for execution of given work.
b) Take appropriate decisions.
c) Arrange resources.
d) Work as member and leader of team.
e) Communicate properly.
f) Resolve the conflicts.
g) Manage the time well.
h) Have concern for ethical, societal and environmental issues.
i) Learn-to-learn from experiences.

It may be seen that these qualities are not directly related with the theoretical subject knowledge and can be developed only through real life experiences. Project work is one such type of experience where opportunity is available to develop all these qualities.

However, even during project work, emphasis of most of the students and teachers remains on development of the technical knowledge and skills while development of above qualities is neglected. Students can develop these qualities if they reflect (do thinking or *Chintan-Manan*) on their experiences from the point of view of these qualities and find out their own weaknesses and strengths. Because if somebody wants to improve his/her abilities then first step for that person is to have self awareness about his/her weaknesses and strengths.

Though portfolio preparation requires considerable time, it is essential, if we want to learn from the experiences and develop these qualities. Writing down reflections helps in better reflection as it is well known that when a person starts writing something he/she becomes more cautious about his/her view and evaluate those views before writing. Thus process of writing improves the quality of reflection or thinking. Moreover, if reflections on different stages of work are written down, over a period of time a large amount of reflection can be generated, and if this reflection is looked back, it may help in identifying some pattern of behaviour in individual which may be improved or rectified latter on as per requirement.

12.2 Guidelines for Portfolio Preparation and assessment

The main purpose of portfolio preparation is learning based on self-assessment and ***portfolio is not to be used for assessment in traditional sense.***

a) Each student has to prepare his/her portfolio separately. However, he/she can discuss with the group members about certain issues on which he/she wants to write in the portfolio.
b) For fifth semester and sixth semester, there will be only one portfolio but it will have two separate parts, first part for project planning (having two sections A and B) second part for project execution. (having two sections C and D)
c) Whatever is written inside the ***portfolio is never to be used for assessment***, because if teachers start giving marks based on whatever is written in the portfolio, then students would hesitate in true self-assessment and would not openly describe their own mistakes or shortcomings.

d) Some marks are allocated for portfolio, these marks are to be given based on how sincerely portfolio has been prepared and not based on what strengths and weaknesses of the students are mentioned in the portfolio.
e) Portfolio has to be returned back to the students after assessing it (assessment is only to see that whether portfolio is completed properly or not) by teachers. Because student is the real owner of the portfolio.
f) Students mainly learn during portfolio preparation, but they can further learn if they read it after a gap. And hence they are supposed to keep the portfolios with them even after completion of the diploma because it is record of their own experiences (it is like diary some people write about their personal experiences), because they can read it again after some time and can revise their learning (about their own qualities)

Even after completion of Diploma programme, students can continue to prepare portfolio related to different experiences in their professional and personal life and by refereeing back to old portfolios after a gap of some years, they can learn that how their personality has evolved over the years. They can also see a pattern of behaviour in their own personality which may be source of their weaknesses or strengths and they can take remedial measures based on this study of their portfolios.

Note

Since some sections of the portfolio are related with interpersonal relationships and student may find it difficult to write these experiences in English. Language should not be the barrier in reflection and hence students should be allowed to prepare the portfolio in their preferred language such as *Marathi* or *Hindi if they find it difficult to write in English.*

The amount and type of mistakes identified by students would not affect the marks received by the students. The total 7 Marks allocated for portfolio (4 marks for PA and 3 for ESE) are only for proper completion of the portfolio.

10. PROJECT REPORT

At the end of fifth Semester, the student will prepare a Semester V 'Project Report' with the following sub-titles:

- Certificate (in the Format given in this document as annexure A)
- Acknowledgements
- Abstract (in one paragraph not more than 150 words)
- Content Page
- Chapter-1 Introduction and background of the Industry or User based Problem
- Chapter-2 Literature Survey for Problem Identification and Specification,
- Chapter-3 Proposed Detailed Methodology of solving the identified problem with action plan
- References and Bibliography

Note: The report should contain relevant diagrams and figures, charts.

11. ASSESSMENT OF CAPSTONE PROJECT – PLANNING

Like other courses, assessment of Project work also has two components, first is progressive assessment, while another is end of the term assessment. The mentor faculty will undertake the progressive assessment to develop the COs in the students. They can give oral informal feedback about their performance and their interpersonal behaviour while guiding them on their project work every week. The following characteristics/ qualities informally or formally should be considered during different phases of the project work which will be assessed thrice as discussed in sub-section.

(A) Initial Phase

i. **Definition of the Problem**

a) Accuracy or specificity

b) Appropriateness with reference to desired course outcomes.

ii. **Methodology of Conduction the Project**
   a) Appropriateness
   b) Flexibility
   c) Clarity

iii. **General Behaviour**
   a) Initiative
   b) Resourcefulness
   c) Reasoning ability
   d) Imagination/creativity
   e) Self-reliance

(B) Intermediate Phase

i. **Performance of Student**
   a) Ability to follow correct procedure
   b) Manipulative skills
   c) Ability to collect relevant information
   d) Ability to observe, record & interpret
   e) Ingenuity in the use of material and equipment
   f) Target achievement

ii. **General Behaviour**
   a) Persistence
   b) Interest
   c) Commitment
   d) Confidence
   e) Problem solving ability
   f) Decision making ability
   g) Initiative to act
   h) Team spirit.
   i) Sharing of material etc.
   j) Participation in discussion
   k) Completion of individual responsibilities

(C) Final Phase

i. **Quality of Product**
   a) Dimensions
   b) Shape
   c) Tolerance limits
   d) Cost effectiveness
   e) Marketability
   f) Modernity

ii. **Quality of Report**
   a) Clarity in presentation and organization
   b) Styles and language
   c) Quality of diagrams, drawings and graphs
   d) Accuracy of conclusion drawn
   e) Citing of cross references
   f) Suggestion for further research/project work

iii. **Quality of presentation**
   a) Understanding of concepts, design, methodology, results, implications etc
   b) Communication skills
   c) Ability to draw conclusions and generalization

12. PROGRESSIVE ASSESSMENT (PA) GUIDELINES

15 Marks are allocated for the formal progressive assessment. However, following points need consideration during the three times of formal progressive assessment of the students at the end of 4th, 12th and 14th week.

a) ***Fortnightly monitoring*** by the mentoring teachers is necessary and marks given progressively (even the gradual chapter preparation) so that that students will not copy earlier reports or get things done or reports from the market. The ***students should not be awarded marks*** if they have not done on their own.

b) For progressive assessment at the end of 14th week, 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 capstone project work they have to carry out in future).

c) Although marks for *portfolio preparation* is to be given at the end of 14th week, students should be asked to bring their partly prepared portfolio (relevant sections prepared) also during their assessment at the end of 4th week and 12th week.

d) Marks for portfolio preparation should be based only on proper preparation of portfolio by writing answers to most of the prompts (self-questions to students) in the portfolio. These marks should not be based on the mistakes indicated by students in their working (while answering the prompts) and corrective actions taken by them.

e) 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.)

f) ***Originality of the report*** (written in own words) would be given more importance rather than use of glossy paper or multi-colour printing.

12.1 Progressive Assessment (PA) Criteria

Allocation Criteria of the ***25 marks*** are for the Progressive Assessment (PA).

S. No.	Criteria	Marks
	First Progressive Assessment at the end of 4th week	
1	**Problem Identification/Project Title** (Innovation /Utility of the Project for industry/ User/Academia) marks to be also given based on (i) Accuracy or specificity of the scope and (ii) Appropriateness of the work with reference to desired course outcomes.	02
2	**Industrial Survey and Literature Review**: marks to be given based on extent/volume and quality of the survey of Industry / Society / Institutes/Literature/Internet for Problem Identification and possible solutions	02
3	**General Behaviour**: initiative, resourcefulness, reasoning ability, imagination/creativity, self-reliance to be assessed **Note:** Oral feedback on general behaviour may also be given whenever relevant/ required during day to day guidance and supervision. **Only written feed-back/suggestions**	**00**
	Second Progressive Assessment at the end of 12th week	
4	**Project Proposal**: Marks to be given also based on appropriateness, flexibility, detail and clarity in methods/planning. (In case of working models, detailed design and planning of fabrication/assembly of the prototype has to be also assessed). This proposal should include whole project including work to be done in sixth semester	**03**

S. No.	Criteria	Marks
5	**Execution of Plan in fifth semester** (Since project is to be fully completed in sixth semester, the part of the project which is planned to be completed in fifth semester is only to be evaluated: marks to be also given based on ability to collect relevant information, ability to follow correct procedure, manipulative skills, ability to observe, record & interpret, ingenuity in the use of material and equipment, target achievement) In case of working models, quality of workman ship (including accuracy in dimensions, shape, tolerance limits), appropriateness of raw materials/components/ technology being used, functioning of the prototype, cost effectiveness, marketability, modernity etc. has to be also assessed.	02
6	**Log book** (for work done in fifth semester, detailed and regular entry would be basis of marks)	02
7	**General Behaviour** (persistence, interest, confidence, problem solving ability, decision making ability, initiative to act, team spirit, sharing of material etc., participation in discussions, completion of individual responsibilities, leadership) **Note:** Oral feedback on general behaviour should also be given whenever relevant/ required during day to day guidance and supervision. **Only written feed-back./suggestions**	00
	Third Progressive Assessment at the end of 14th week	
8	**Portfolio for Self learning and reflection** (marks based on amount of reflection and completion of the portfolio for work done in fifth semester)	**04**
9	**Final Report writing including documentation**. (marks based on: clarity in presentation and organization; styles and language; quality of diagrams, drawings and graphs; accuracy of conclusion drawn; citing of cross references; suggestion for further research/project work) Report has to be prepared for work done in fifth semester and planning for sixth semester work.	**06**
10	**Presentation** (presentation skills including communication skills to be assessed by observing quality of presentations and asking questions during presentation and viva/voce) Report has to be prepared for work done in fifth semester and plan for sixth semester.	**02**
11	**Defence** (ability to defend the methods/materials used and technical knowledge, and involvement of individual to be assessed by asking questions during presentation and viva/voce)	**02**
	Total	**25**

13. END-SEMESTER-EXAMINATION (ESE) ASSESSENT GUIDELINES

The ***remaining 25 marks*** are for the end semester examination (ESE). And marks would be given according to following criteria. Moreover, the suggested evaluation scheme can be changed slightly by the external faculty according to nature of problem / project following University guidelines..

a) For each project, the one or two students from the concerned group of students should be asked to present the power point presentation before the external and internal (for about 10 minutes) and then external should ask the questions from each member of the group separately to ascertain the contribution made by each student.

b) 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 commensurate with their efforts.)

c) The students would not be awarded marks if they have completed the project by getting done the work from market or some professionals (taking help and guidance is different as compared to getting the work or maximum part of the work completed from others on payment basis).

d) Originality of the report (written in own words, even if there are grammatical and spelling mistakes) would be given more importance rather than quality of printing and use of glossy paper (and preparing report by copy pasting from other reports).

Note: It is very common that people are not able to complete the project in time despite best of their efforts. (Please recall that how many times people are able to complete in time, personal projects such as building own house or professional projects such as developing the lab in the institute). So if students have put in enough genuine efforts but could not complete the project in time then we should consider it sympathetically and they should be given marks based on their efforts and they should get more marks as compared to students who have got their projects completed by taking major help from others/market.

13.1 End-Semester-Examination (ESE) Assessment Criteria.

Allocation Criteria of the ***25 marks*** are for the end-semester-examination (ESE)

S. No.	Description	Marks
1	**Problem Identification/Project Title** (innovation /utility of the project for industry/ user/academia) marks to be also given based on (i) accuracy or specificity of the scope and (ii) appropriateness of the work with reference to desired course outcomes.	**02**
2	**Industrial Survey and Literature Review** (marks to be given based on extent/volume and quality of the survey of industry / society / institutes/literature/internet for problem identification and possible solutions)	**02**
3	**Project Proposal**: Marks to be given also based on appropriateness, flexibility, detail and clarity in methods/planning. (In case of working models, detailed design and planning of fabrication/assembly of the prototype has to be also assessed). This proposal should include whole project including work to be done in sixth semester.	**02**
4	**Execution of Plan in fifth semester** (Since project is to be fully completed in sixth semester, the part of the project which is planned to be completed in fifth semester is only to be evaluated: marks to be also given based on ability to collect relevant information, ability to follow correct procedure, manipulative skills, ability to observe, record & interpret, ingenuity in the use of material and equipment, target achievement) In case of working models, quality of workman ship (including accuracy in dimensions, shape, tolerance limits), appropriateness of raw materials/components/ technology being used, functioning of the prototype, cost effectiveness, marketability, modernity etc. has to be also assessed.	**02**
5	**Log book** (for work during fifth semester, marks to be given based on detailed and regular entry	**03**
6	**Portfolio for Self learning and reflection** (for work during fifth semester) Marks based on amount of reflection and completion of portfolio.	**03**
7	**Project Report including Documentation** (for work during fifth semester and planning for sixth semester) (marks based on: clarity in	**04**

S. No.	Description	Marks
	presentation and organization; styles and language; quality of diagrams, drawings and graphs; accuracy of conclusion drawn; citing of cross references; suggestion for further research/project work)	
8	**Presentation** (presentation skills including communication skills to be assessed by observing the quality of presentations and asking questions during presentation and viva/voce) Presentation should be based on work done in fifth semester and planning for sixth semester.	**03**
9	**Defence** (ability to defend the methods/materials used and technical knowledge, and involvement of individual to be assessed by asking questions during presentation and viva/voce)	**04**
	Total	**25**

14. 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 guide students in selecting a topic which is relevant and challenging (but within capacity) for students according to their abilities.

c) 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.

d) Teachers should motivate students to maintain log book and prepare portfolio. 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.

e) Teachers should also encourage students to openly discuss their weaknesses and shortcomings in portfolio and teachers should develop confidence in students that admitting mistakes and weaknesses helps in improving them and their marks would not be affected by revealing their mistakes. Marks related to portfolio are awarded based only on the sincerity with which it is prepared and not based on strengths and weaknesses of students.

f) 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.

g) 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.

Annexure A

CERTIFICATE

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

From .....College having Enrolment No: .....

has completed ***Report on the Problem Definition/ Semester V Project Report/ Final Project Report*** having title .....

individually/ in a group consisting of..... persons under the guidance of the Faculty Guide.

.....
The mentor from the industry for the project
Name: .....
Telephone:.....

Annexure B

Portfolio for Self Directed Learning for Major Project Work

Name of Student:.....

Semester:.....Programme/Branch:.....

Roll Number:.....

Title of the Project:.....

Name and Designation of Project Guide:.....

Name of Polytechnic:.....

Part A: Selecting the Project and Team (Answers to the following questions to be included in 'Portfolio' as Reflection related to formation of group and finalization of project topic).

Note: This section has to be prepared just after the finalization of the Project topic and formation of the Project Team .

1. How many alternatives we thought before finalizing the project topic?
2. Did we consider all the technical fields related to branch of our diploma programme?
3. Why we found present project topic as most appropriate?
4. Whether all the group members agreed on the present project topic? If not? What were the reasons of their disagreements?
5. Whether the procedure followed in assessing alternatives and finalizing the project topic was correct? If not, discuss the reasons.
6. What were the limitations in other alternatives of project topic?
7. How we formed our team?
8. Whether we faced any problem in forming the team? If yes, then what was the problem and how was it resolved?

9. Am I the leader of our project team? If yes, then why was I chosen? If not, why I could not become the project team leader?
10. Do I feel that present team leader is the best choice available in the group? If yes, then why? If not, then why?
11. According to me who should be the leader of the team and why?
12. Can we achieve the targets set in the project work within the time and cost limits?
13. What are my significant good/ bad sharable experiences while working with my team which provoked me to think? What I learned from these experiences?
14. Any other reflection which I would like to write about formation of team and finalization of project title, if any?

Part B: Reflection related to project planning (Answers to the following questions to be included in 'Portfolio' as reflection on planning)

Note: This section has to be prepared just after the finalization of the 'Project Proposal'.

1. Which activities are having maximum risk and uncertainty in our project plan?
2. What are most important activities in our project plan?
3. Is work distribution is equal for all project group members? If not? What are the reasons? How we can improve work distribution?
4. Is it possible to complete the project in given time? If not what are the reasons for it? How can we ensure that project is completed within time.
5. What extra precaution and care should be taken in executing the activities of high risk and uncertainty? If possible, how such risks and uncertainties can be reduced?
6. Can we reduce the total cost associated with the project? If yes, then describe the ways?
7. For which activities of our project plan, arrangement of resources is not easy and convenient?
8. Did we make enough provisions of extra time/expenditure etc. to carry out such activities?
9. Did we make enough provisions for time delays in our project activity? In which activities there are more chances of delay?
10. In our project schedule, which are the days of more expenditure? What provisions we have made for availability and management of cash?
11. Any other reflection which I would like to write about project planning?

Teacher Evaluation Sheet (ESE)
for
Capstone Project Planning

Name of Student: .....

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

Course Title and Code:.....

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

a) Unit Outcomes (Cognitive Domain)

i. .....
ii. .....
iii. .....
iv. .....

b) Practical Outcomes (in Psychomotor Domain)

i. .....
ii. .....
iii. .....
.....
iv. .....
.....

c) Affective Domain Outcomes

i. .....
ii. .....
iii. .....
iv. .....

D. SUGGESTED RUBRIC FOR ASSESSMENT OF CAPSTONE PROJECT

(please tick below the appropriate rating i.e. poor, average etc., for each characteristic to be assessed and give marks in the respective cell according to performance of student)

S. No.	Characteristic to be assessed	Poor	Average	Good	Excellent	Max. Marks	marks obtained
First Progressive Assessment (at the end of 4th week)							

S. No.	Characteristic to be assessed	Poor	Average	Good	Excellent	Max. Marks	marks obtained
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	i. Take care of more than three POs ii. Scope of problem/task very clear	02	
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	02	
Second Progressive Assessment (at the end of 12th week)							
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)	02	
4	**Execution of Plan in fifth semester (please write by hand about students performance in appropriate column)**					02	
5	**Log Book**	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	03	
Third progressive Assessment at the end of 14th week							
6	Portfolio Preparation	Answer to only few of the 'questions from self' (prompts)	Answer to only about 50% of the 'questions from self'	Answer to most of the 'questions from self' (prompts) written. Some	Answer to nearly all the 'questions from self' (prompts) written in detail	03	

S. No.	Characteristic to be assessed	Poor	Average	Good	Excellent	Max. Marks	marks obtained
		written. Answers are not in much detail	(prompts) written. Answers are not in much detail	answers are not in much detail			
7	**Final Report Preparation**	Very short, poor quality sketches, Details about methods, material, precaution and conclusions omitted, some details are wrong Nearly sufficient and correct details about methods, material, precautions and conclusion. but clarity is not there in presentation, not enough graphic description.	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, charts and sketches	**04**	
8	**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	**03**	
9	**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	**04**	
					Total marks	**25**	

Any Other Comment:

.....

.....

Name and designation of the Faculty Member.....**Signature**.....

.....

Program Name : **Diploma in Civil Engineering/ Computer Engineering / Information Technology /Automobile Engineering/ Fashion & Clothing Technology / Electrical Engineering Group / Electronics Engineering Group**

Program Code : **CE/CR/CS/CO/CM/CW/IF/AE/DC/EE/EP/EU/DE/EJ/ET/EN/ EX/EQ/IE/IS/IC**

Semester : **Fifth**

Course Title : **Environmental Studies**

Course Code : **22447**

1. RATIONALE

The world today is facing the biggest challenge of survival. Degradation of ecosystem, depletion of natural resources, increasing levels of pollution pose major threat to the survival of mankind. The need of the hour, therefore, is to concentrate on the area of environmental aspects, which shall provide an insight into various environment related issues. Environmental studies are an interdisciplinary academic field that integrates physical, chemical and biological sciences, with the study of the environment. It provides an integrated, quantitative, and interdisciplinary approach to the study of environmental system & gives an insight into solutions of environmental problems.

2. COMPETENCY

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

- **Diagnose and manage environment related issues**

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. Develop Public awareness about environment
b. Select alternative energy resources for Engineering Practice
c. Conserve Ecosystem and Biodiversity
d. Apply techniques to reduce Environmental Pollution
e. Manage social issues and Environmental Ethics as lifelong learning

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	-	-	3	90 Min	70*#	28	30*	00	100	40	--	--	--	--	--	--	

(#) Online Theory Examination.

(*): 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 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.

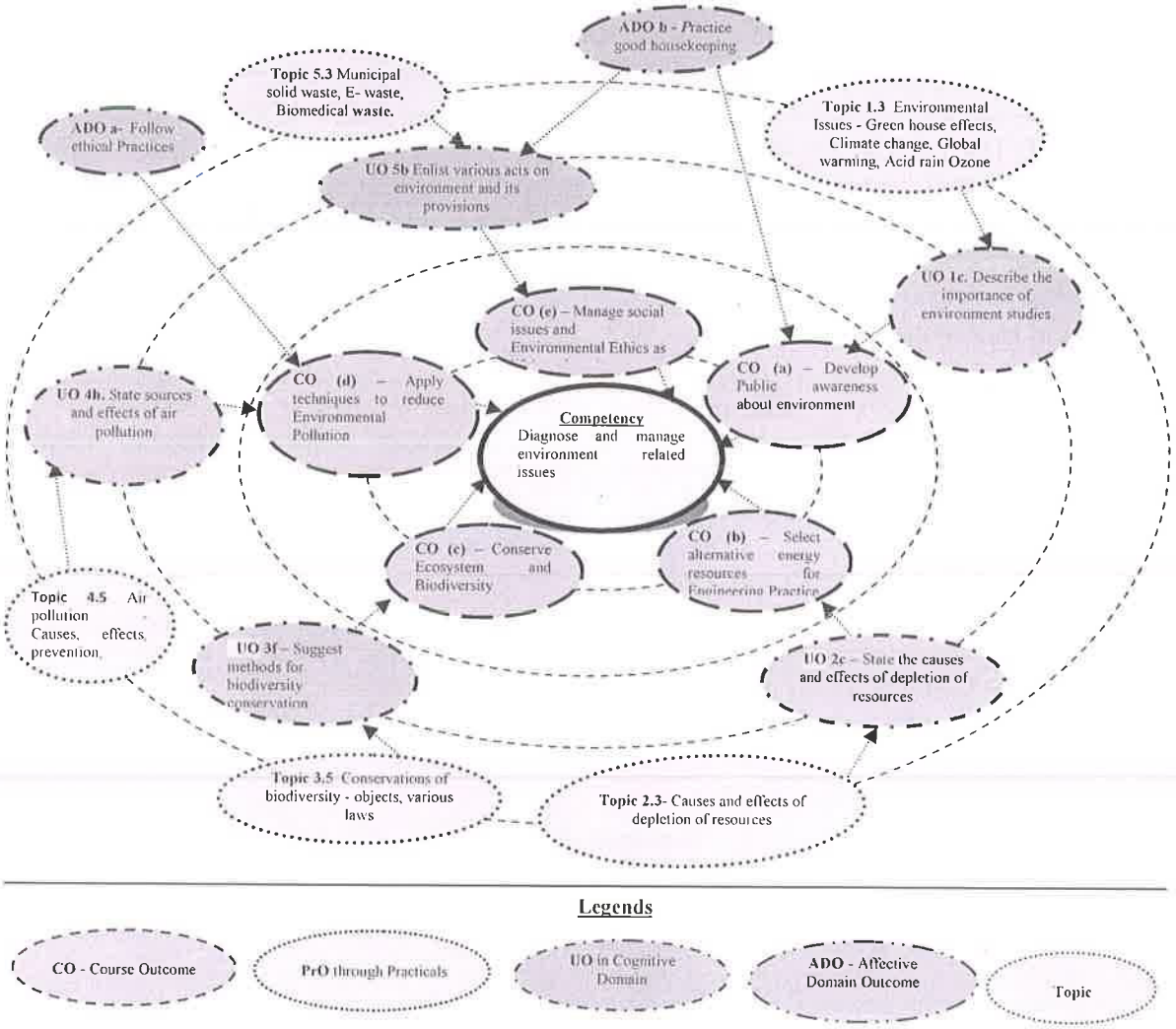

Figure 1 - Course Map

6. SUGGESTED 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

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	NIL		
	Total		

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	NIL	
Total		

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. 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

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	NIL	-

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 Environment	1a. Discuss the scope of Environment. 1b. Describe various types of environment 1c. Describe the importance of environment studies. 1d. Discuss about the need of public awareness about environment. 1e. Describe various environmental issues.	1.1 Definitions, need of environmental studies. 1.2 Segments of environment- Atmosphere, Hydrosphere Lithosphere, Biosphere. 1.3 Environmental Issues - Green house effects, Climate change, Global warming, Acid rain Ozone layer depletion, Nuclear accidents. 1.4 Concept of 4R (Reduce, Reuse, Recycle and Recover), 1.5 Public awareness about environment.
Unit– II Energy Resources	2a. List various natural resources. 2b. Describe Renewable, Nonrenewable and Cyclic resources. 2c. State the causes and effects of depletion of resources. 2d. State advantages and disadvantages of forms of energy. 2e. Select appropriate solutions of efficient use of energy. 2f. State the impacts of overuse of natural resources.	2.1 Natural Resources - Forest Resources, Water Resources, Energy Resources, Land resources, Mineral resources. 2.2 Renewable, Non-renewable and Cyclic Resources. 2.3 Causes and effects of depletion of resources. 2.4 Energy forms (Conventional and non-conventional). 2.5 Present global energy use and future demands. 2.6 Energy conservation. 2.7 Over use of natural resources and its impacts on environment.
Unit- III Ecosystem and Biodiversity	3a. State the aspects and division of ecosystem. 3b. State the general characteristics and function of ecosystem. 3c. List levels of biodiversity. 3d. Enlist the endangered species. 3e. Describe value of biodiversity. 3f. Suggest methods for biodiversity conservation.	3.1 Ecosystem - Definition , Aspects of ecosystem, Division of ecosystem, General characteristics of ecosystem, Functions of ecosystem. 3.2 Biodiversity - Definitions, Levels, Value and loss of biodiversity. 3.3 Biodiversity assessment initiatives in India. 3.4 Threats and Hotspots of biodiversity. 3.5 Conservations of biodiversity - objects, various laws.
Unit– IV Environmental Pollution	4a. Define pollution. 4b. State the sources of pollution. 4c. State the effects of land pollution on environment and lives. 4d. State various units and their functions of water treatment plant. 4e. State the needs of water conservation.	4.1 Definition of pollution, types- Natural & Artificial (Man- made). 4.2 Soil / Land Pollution – Causes and effects on environment and lives , preventive measures. 4.3 Water Pollution - Sources of water (surface and sub surface), sources of water pollution, effects on environment and lives, preventive measures, BIS water quality

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	4f. State the impacts of sewage. 4g. State various units and their functions of sewage treatment plant. 4h. State sources and effects of air pollution. 4i. Describe various methods to prevent air pollution. 4j. State sources and effects of noise pollution. 4k. Describe preventive measures for noise pollution. 4l. State characteristics of solid waste. 4m. State the impacts of solid waste. 4n. Describe incineration, RDF and sanitary landfilling. 4o. State the standards limiting/controlling values of various types of pollution.	standards, flow diagram of water treatment plant, Water conservation. 4.4 Wastewater - Generation(domestic and industrial), Impacts, flow diagram of sewage treatment plant, CPCB norms of sewage discharge. 4.5 Air pollution - Causes, effects, prevention, Ambient air quality standards. 4.6 Noise pollution - Sources, effects, prevention, noise levels at various zones of the city. 4.7 Municipal Solid Waste, Bio-medical waste and E-waste - Sources, generation, characteristics, effects, and methods to manage.
Unit-V Social Issues and Environmental Education	5a. Elaborate article (48-A) and (51-A (g)) 5b. Enlist various acts on environment and its provisions. 5c. State the roles and responsibilities of CPCB. 5d. Define sustainable development, and EIA. 5e. Describe rain water harvesting and groundwater recharge. 5f. Differentiate between formal and non formal education.	5.1 Article (48-A) and (51-A (g)) of Indian Constitution regarding environment, Environmental protection and prevention acts, CPCB and MPCB norms and responsibilities, The role of NGOs. 5.2 Concept of sustainable development, EIA and environmental morality. 5.3 Management Measures - Rain Water harvesting, Ground water recharge, Green Belt Development, Use of Renewable energy, water shed management, interlinking of rivers. 5.4 Role of information technology in environment and human health.

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	Environment	06	4	6	-	10
II	Energy Resources	10	4	8	-	16

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
III	Ecosystem and Biodiversity	08	4	4	4	12
IV	Environmental Pollution	16	8	8	4	20
V	Social Issues and Environmental Education	08	4	4	4	12
	Total	**48**	**24**	**30**	**16**	**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. Plant and adopt a tree in your nearby locality/Polytechnic campus and prepare report about its growth and survival after six months with photos.
b. Organize seminar on air pollutants of relevant MIDC area/vehicle
c. Organize poster exhibition about global warming and ozone depletion.
d. Visit a nearest water purification/effluent treatment plant.

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 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. Use proper equivalent analogy to explain different concepts.
g. Use Flash/Animations to explain various topics.

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 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 a report on visit to PUC Center.
b. Visit a near by RO plant and prepare detail technical report.
c. Prepare report on Household water filtration unit
d. Prepare a list of polluted natural resources which are responsible for pollution and collect information on how to manage them .
e. **Collection of Data from Hospital: Collect** everyday information on percentage of solid hazardous and toxic waste for two month
f. **Visit of Municipal Effluent Treatment Plant:** Visit effluent treatment plant and prepare report on waste management.
g. **Visit of Water Treatment Plant:** Visit water treatment plant and prepare report on various units of water treatment and its management.
h. **Preparation of report**: Prepare the chart of solid waste management showing effects on environment.
i. **And any other relevant topic related to course**

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Basic Environmental Sciences	Michael Allaby	Routledge Publication, 2nd Edition, 2000, ISBN: 0-415-21176-X
2	Environmental Science	Y. K. Singh	New Age International Publishers, 2006, ISBN: 81-224-2330-2
3	Environmental Studies	Erach Bharucha	University Grants Commission, New Delhi
4	Environmental Studies	Rajagopalan	Third Edition, Oxford University Press, USA, ISBN: 9780199459759, 0199459754
5	A text book of Environmental Science	Arvind Kumar	APH Publishing New Delhi
6	A text book of Environmental Studies	Shashi Chawla	Tata Mc Graw-Hill New Delhi

14. SOFTWARE/LEARNING WEBSITES

a. www.eco-prayer.org
b. www.teriin.org
c. www.cpcb.nic.in

d. www.indiaenvironmentportal.org.in
e. www.whatis.techtarget.com
f. www.sustainabledevelopment.un.org
g. www.conserve-energy-future.com

Program Name : **Electronics Engineering Programme Group**

Program Code : **DE/EJ/ET/EN/EX/EQ/IS/IC**

Semester : **Fifth**

Course Title : **Embedded System (Elective for IS/IC)**

Course Code : **22532**

1. RATIONALE

In the rapidly growing digital world, role of embedded systems is increasingly vital in various domains such as industrial and home automation, entertainment systems, medical equipments and many more. The core of all such system is powered by electronic hardware and associated software. It is therefore evident to impart the knowledge of the related technology and hands on skills to develop and maintain electronics hardware based embedded systems.

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 Embedded Systems.**

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 microcontrollers for various industrial applications.
b. Use 'Embedded C' programming language to maintain embedded systems.
c. Interpret the communication standards of embedded systems.
d. Develop basic applications using embedded systems.
e. Interpret features of Real Time Operating System.

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 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 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.

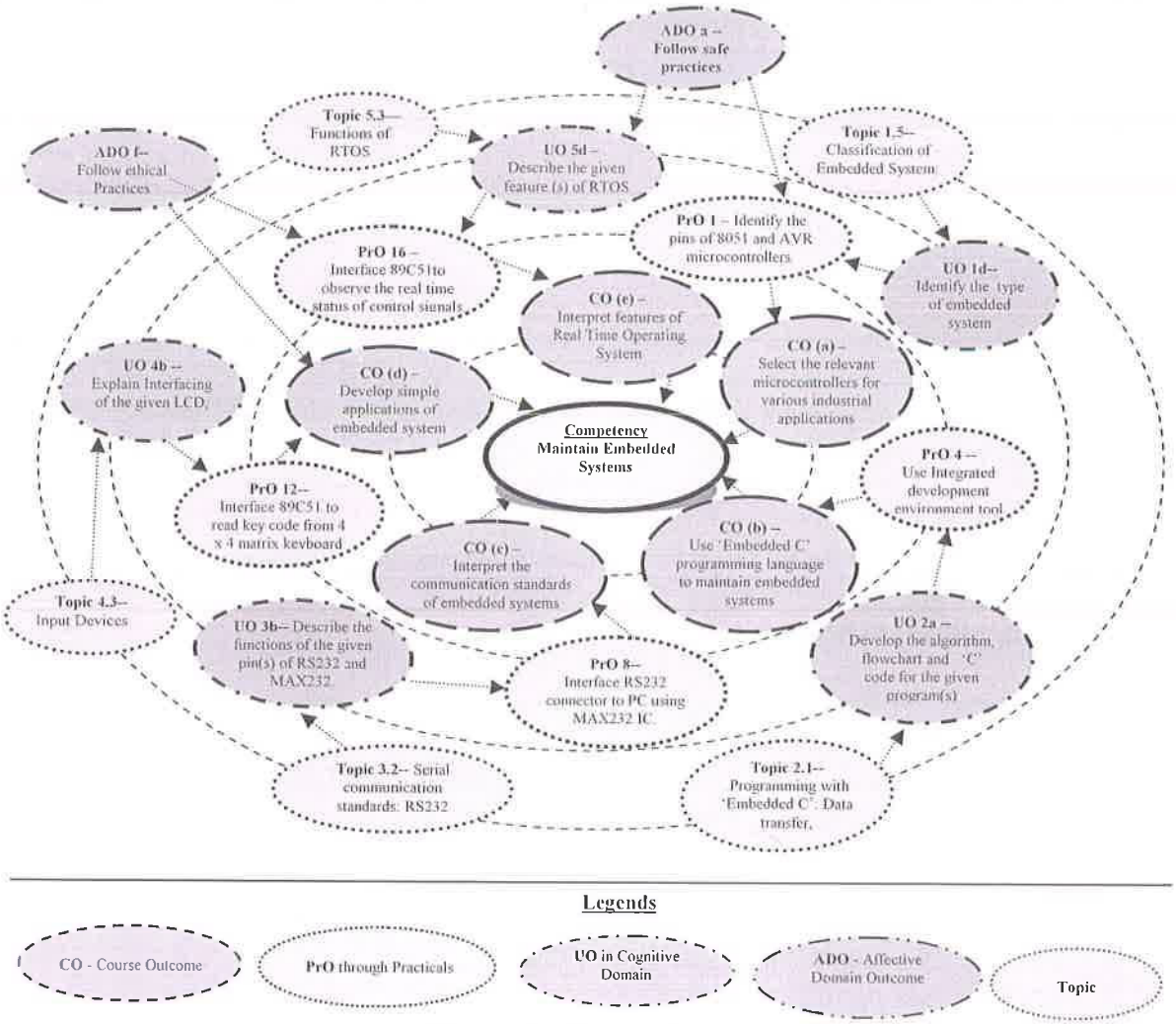

Figure 1 - Course Map

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:

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Identify the pins of 8051 and AVR microcontrollers.	I	2*
2	Identify the pins and features of PIC and ARM microcontrollers.	I	2
3	Identify the family of given microcontroller on the basis of IC number.	I	2
4	Use Integrated development environment tool for developing embedded 'C' programs (Using MicroProC, Keil).	II	2*
5	Execute the 'C' program to perform following arithmetic operations on 8-bit data: addition, subtraction, multiplication and division.	II	2*
6	Develop and Test the 'C' program to perform following arithmetic operations on 16-bit data: addition, subtraction.	II	2
7	Develop and Test the 'C' program to perform data transfer from	II	2*

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	source to destination (Use internal data memory locations).		
8	Interface RS232 connector to PC using MAX232 IC.	III	2
9	Develop and test the 'C' program to turn on LED (S) with key (S) press.	IV	2*
10	Interface 89C51/AVR microcontroller and write the 'C' program to display numbers from 0 to 9 on 7-segment display with specified delay.	IV	2
11	Interface 89C51/AVR microcontroller and write C program to display string on given 16 x 2 LCD.	IV	2*
12	Interface 89C51/AVR microcontroller and write 'C' language program to read key code from 4 x 4 matrix keyboard and display on 7-segment display.	IV	2*
13	Interface 89C51/AVR microcontroller and write C program to convert analog signal into digital form using given 8 bit ADC and store the converted digital data in memory.	IV	2*
14	Interface 89C51 and write C program to generate square, sawtooth and triangular waveforms using given 8 bit DAC.	IV	2*
15	Interface 89C51 /AVR microcontroller and write C program to rotate stepper motor with different speeds in clockwise and counter clockwise direction.	IV	2*
16	Interface 89C51 and write C program to observe the real time status of control signals for the triangular waveform generated using DAC (Use IDE tool MicroProC, Keil).	V	2
	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:

Sr. No.	Performance Indicators	Weightage in %
a.	Preparation of experimental set up	20
b.	Setting and operation	20
c.	Safety measures	10
d.	Observations and Recording	10
e.	Interpretation of result and Conclusion	20
f.	Answer to sample questions	10
g.	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 acquisitions of the ADOs take 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.

Sr. No.	Equipment Name with Broad Specifications	PrO. No.
1	Microcontroller kit (8051,AVR/PIC/ARM): Single board systems with minimum 8K RAM,ROM memory with battery back up,16X4, LCD display,7-segment Display, PC keyboard interfacing facility, 4X4 matrix keyboard, cross c-compiler, USB, interfacing facility with built in power supply.	All
2	Arduino Board with AVR microcontroller	All
3	Desktop PC with Integrated Development Environment (MicroPro C, Keil, Proteus).	All
4	Stepper Motor- 50/100 RPM (or any relevant).	15
5	CRO- Bandwidth AC 10Hz ~ 20MHz (-3dB). DC ~ 20MHz (-3dB), X10 Probe.	13,14,
6	ADC (0808) trainer board.	13
7	DAC (0808) trainer board.	14
8	Add on cards.	9
9	Digital Multimeter : 3 1/2 digit display, 9999 counts digital multimeter measures: V_{ac}, V_{dc} (1000V max) , A_{dc}, A_{ac} (10 amp max) , Resistance (0 - 100 MΩ) , Capacitance and Temperature measurement	13,14, 15,16

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 Embedded systems	1a. Describe the given component (s) of the given embedded system. 1b. Describe with the help of block diagram, the architecture of the given processor. 1c. Describe the given characteristic (s) of the specified embedded systems. 1d. Identify with justification the type of embedded systems used for the given application. 1e. Select with justification the relevant microcontroller from the existing microcontroller families for the given application.	1.1 Block diagram of embedded system with hardware components 1.2 Harvard and Von-Neumann architecture, RISC and CISC processors 1.3 Features of 89C51, PIC, AVR and ARM microcontrollers with their applications 1.4 Characteristics of embedded system: Processor power, memory, operating system, reliability, performance, power consumption, NRE cost, unit cost, size, flexibility, time-to-prototype, time-to-market, maintainability, correctness and safety 1.5 Classification of embedded system: small scale, medium scale, sophisticated, stand-alone, reactive/real time (soft and hard real time).
Unit– II Programming using Embedded C	2a. Develop the algorithm, flowchart and 'C' program (s) for the given microcontroller to perform the given operation. (data transfer, arithmetic /logical, decision control and looping operations). 2b. Develop the algorithm, flowchart and 'C' code for the given delay using timer/counter with microcontroller. 2c. Develop the algorithm, flowchart and 'C' code for the given data transfer through serial communication port. 2d. Develop the algorithm, flowchart and 'C' code to control the given interrupt.	2.1 Programming with 'Embedded C': arithmetic and logical operations, data transfer with memory and port, decision control & looping 2.2 Timer/Counter program using 'embedded C' for given microcontroller 2.3 Serial communication program using 'embedded C' for given microcontroller 2.4 Interrupt control program with 'embedded C' for given microcontroller
Unit-III Communication standards and protocols.	3a. Describe the given mode (s) of communication. 3b. Describe the functions of the given pin(s) of RS232 and MAX232 with suitable sketch. 3c. Describe the given communication protocol (s) with relevant sketch. 3d. Describe the given advanced serial communication interface.	3.1 Modes of data communication: serial parallel, synchronous and synchronous communication 3.2 Serial communication standards: RS232 3.3 MAX232 as a bidirectional level converter 3.4 Communication protocols i. Serial communication protocols: I^2C, CAN, USB, serial peripheral

Unit	Unit Outcomes (UOs) (In cognitive domain)	Topics and Sub-topics
		interface (SPI), synchronous serial protocol (SSP) ii. Parallel communication protocols: PCI, PCI-X 3.5 Features of advanced serial protocol IrDA, bluetooth, zigbee
Unit –IV Interfacing Input and Output devices	4a. Explain the steps for interfacing of the given basic input/output device (s) to the given microcontroller with embedded 'C' 'program. 4b. Explain the steps for interfacing of the given LCD, matrix key board, multiplexed 7-segment display, sensor to the given microcontroller with embedded 'C' program. 4c. Explain interfacing of DC motor to the given microcontroller to rotate in the given direction using embedded 'C' program. 4d. Explain the steps for interfacing of given stepper motor with the microcontroller to rotate in given direction, angle of rotation, with half step/full step with embedded 'C' program. 4e. Explain interfacing steps of the given ADC/DAC to convert data with the given microcontroller with embedded C program.	4.1 Interface the various input, output and special devices to the microcontroller 89C51/AVR 4.2 Output Devices : LED, LCD, relays, 7-segment displays, multiplex 7-Segment display 4.3 Input Devices : key, matrix keyboard 4.4 Motor : stepper motor, DC motor 4.5 ADC/DAC: 8 bit ADC/DAC (0808/09) 4.6 Sensor :Temperature sensor (LM35)
Unit-V Real Time Operating Systems	5a. Describe the given functions of the specified operating system with suitable sketch. 5b. Compare the given characteristics of RTOS and General OS. 5c. Explain deadlock condition in RTOS with suitable sketch. 5d. Explain the given features of RTOS with suitable sketch.	5.1 Operating system: general and real time operating system 5.2 Characteristics of real time operating system: consistency, reliability, scalability, performance, predictability 5.3 Functions of RTOS: i. Task management: inter task communication and multitasking ii. Scheduling: scheduling algorithms. iii. Resource allocation and interrupt handling 5.4 Features of RTOS: watchdog timer, semaphore 5.5 Deadlock: i. Reason of occurrence ii. Handling of deadlock: detection, prevention, ignoring

***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 embedded systems	08	04	04	04	12
II	Programming using embedded 'C'	12	02	06	08	16
III	Communication standards and protocols	08	02	04	06	12
IV	Interfacing input and output devices	12	04	06	08	18
V	Real Time Operating Systems	08	02	04	06	12
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 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 data sheets of all the components used in the practical.
b. Prepare a documentation of all the components and devices along with their specifications.
c. Deliver seminar on relevant topic.
d. Library / Web survey regarding different data books and manuals.
e. Prepare power point presentation on applications of microcontroller.
f. Undertake a market survey of different microcontrollers.

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 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 a chart of various features using data sheets of 8051, PIC, AVR, ARM microcontroller and its derivatives.
b. Prepare a chart of various features and operations of temperature sensors, devices using data sheets.
c. Prepare a chart of various types of LCDs to display its features, pin functions and steps of operations using data sheets.
d. Interface potentiometer with development board (Arduino) and write a program to generate LED pattern on it.
e. Programming of an Arduino (Arduino ISP) Interfacing Motor through L293D Driver with Arduino
f. Interfacing Accelerometer with Arduino Interfacing of Relay Driver ULN2803 with Arduino
g. Build a flashing display to flash advertisement of Mobile shop.
h. Build a system to display department name using rolling display.
i. Build a buzzer system for rapid fire quiz competition.
j. Build a two digit counter.
k. Build a class period bell as per the given time table which includes 7 teaching periods and lunch hour.
l. Build a temperature monitoring system to maintain temperature in given range.
m. Build a pollution monitoring system to observe the level of CO_2.
n. Build automated door control system to open and close the door.
o. Build traffic light controller for traffic signals as per specified delay.
p. Build a water level controller for given water levels.

Note: Use appropriate software for programming. Build the circuit on PCB or use development board such as Arduino.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	8051 Microcontroller	Ayala, Kenneth	Cenage learning, 3rd edition.

S. No.	Title of Book	Author	Publication
	Architecture, Programming and Application		New Delhi,2007, ISBN: 978-8131502006
2	The 8051 Microcontroller and Embedded system	Mazidi, Mohmad Ali; Janice, Gelispe and Mckinlay, Roline D.	Pearson, 2nd edition, Delhi, 2008, ISBN: 9788177589030
3	Microcontroller Principle and Application	Pal, Ajit	PHI, New Delhi,2014, ISBN: 9788120343924
4	Microcontroller Theory and Application	Deshmukh, Ajay	McGraw Hill Education, New Delhi, 2011, ISBN: 9780070585959
5	Microcontroller Architecture Programming, Interfacing and System Design	Rajkamal	Pearson Education India, Delhi, 2012, ISBN: 9788131759905
6	The Embedded Software Primer	David E. Simon	Addison-Wesley,Delhi ISBN: 9780201615692

14. SOFTWARE/LEARNING WEBSITES

a. Simulation Software :-www.keil.com
b. https://www.arduino.cc
c. https://scilab-arduino.fossee.in
d. www.nptel.ac.in/courses/Webcourse-contents/IITKANPUR/microcontrollers/micro/ui/Course_home2_5.html
e. www.nptelvideos.in/2012/11/real-time-systems.html
f. RTOS:- https://www.youtube.com/watch?v=rpdygqOI9mM
g. www.intorobotics.com/8051-microcontroller-programming-tutorials- simulators-compilers-and-programmers
h. www.electrofriends.com/articles/electronics/microcontroller-electronics-articles/8051-8951/80518951-microcontroller-instruction-set
i. www.ikalogic.com/part-1-introduction-to-8051-microcontrollers
j. www.binaryupdates.com/switch-with-8051-microcontroller
k. www.mikroe.com/chapters/view/64/chapter-1-introduction-to-microcontrollers
l. www.8051projects.net/download-c4-8051-projects.html
m. https://www.elprocus.com/difference-between-avr-arm-8051-and-pic-microcontroller


MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION MUMBAI

Program Name : **Electronics Engineering Programme Group**

Program Code : **DE/EJ/ET/EN/EX/EQ/IS/IC**

Semester : **Fifth**

Course Title : **Industrial Automation (Elective for DE/EJ/ET/EN/EX/EQ)**

Course Code : **22534**

1. RATIONALE

In present global scenario of manufacturing, industries are moving towards complete automation. Small and medium scale industries require PLC and SCADA technology for the data acquisition and control. Therefore, it is necessary for instrumentation / electronics engineers to have knowledge of both PLC and SCADA technology. This course attempts to provide basic knowledge of these technologies to develop operational competency. Hence this course is foundation for the engineers who want to make carrier in industrial automation.

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 Industrial Automation Systems.**

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 different types of automation system.
b. Interface a given I/O device with the appropriate PLC module.
c. Prepare a PLC ladder program for a given application.
d. Select the suitable motor drives for the specified application.
e. Prepare simple SCADA applications.

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 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 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.

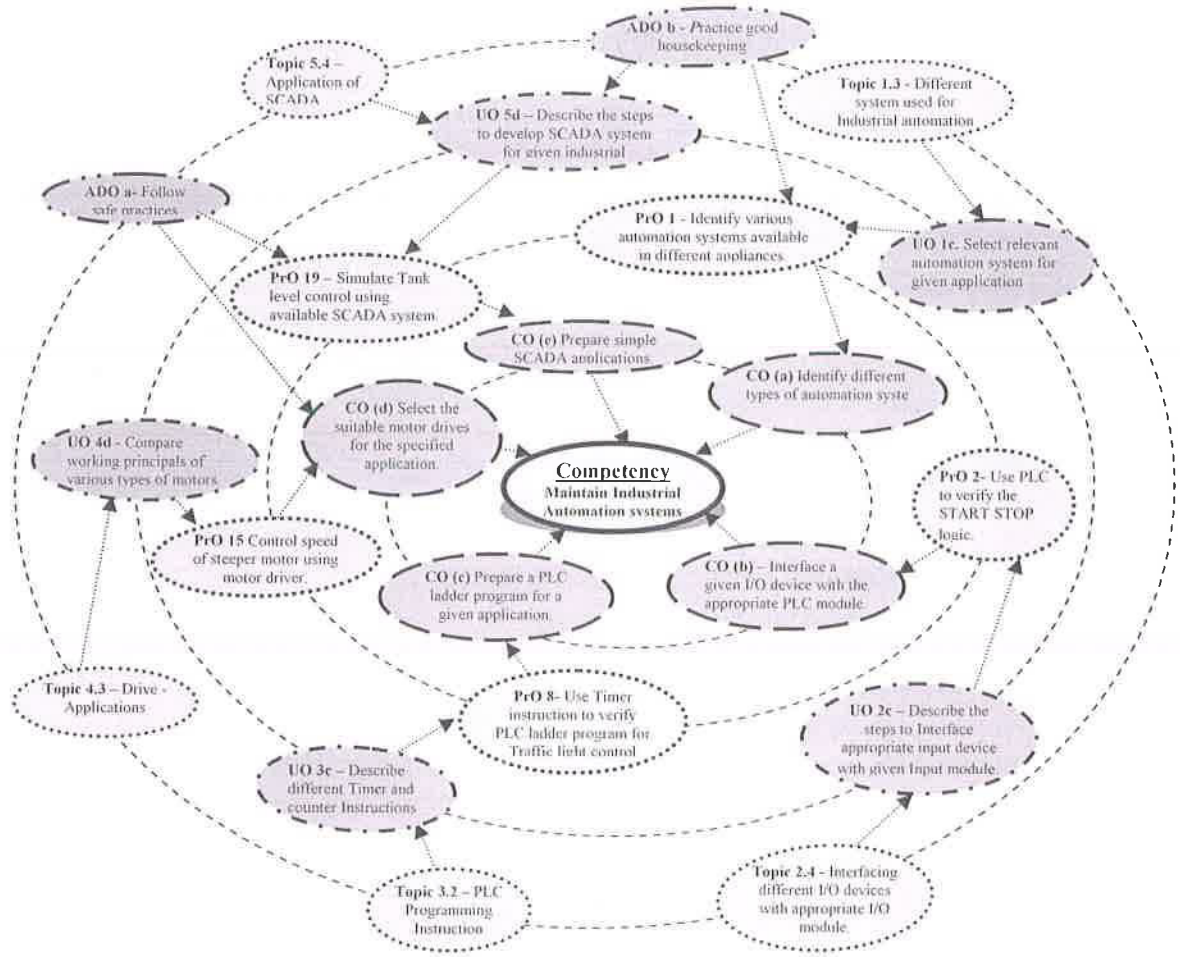

Figure 1 - Course Map

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 various automation systems available in different appliances/devices/machines in day to day use.	I	02
2	Identify various parts of the given PLC and front panel status indicators.	II	02
3	Use PLC to test the START STOP logic using two inputs and one output.	II	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
4	Develop/Execute a ladder program for the given application using following: - timer, counter, comparison, logical, arithmetic instructions.	II,III	02
5	Use PLC to control the following devices like lamp, motor, push button switches, proximity sensor	II,III	02
6	Measure the temperature of the given liquid using RTD or Thermocouple and PLC.	II,III	02
7	Develop/test ladder program to blink the LED/lamp.	III	02
8	Develop / test the Ladder program for sequential control application of lamps/ DC motors.	III	02
9	Develop ladder program for Traffic light control system.	III	02
10	Develop and test ladder program for pulse counting using limit switch /Proximity sensor.	III	02
11	Develop /test ladder program for Automated car parking system.	III	02
12	Develop / test ladder program for Automated elevator control.	III	02
13	Develop / test ladder program for rotating stepper motor in forward and reverse direction at constant speed.	III	02
14	Develop /test ladder program for tank water level control.	III	02
15	Develop / test ladder program for control of speed of stepper motor with suitable drivers.	IV	02
16	a. Identify various front panel controls of VFD (smart drive). b. Control speed of AC/DC motor using VFD.(VFD-Variable Frequency Drive)	IV	02
17	Use various functions of SCADA simulation editors to develop simple project.	V	02
18	Develop a SCADA mimic diagram for Tank level control.	V	02
19	Develop SCADA mimic diagram for Flow control in a given system.	V	02
20	Simulate Tank level control using available SCADA system.	V	02
	Total		**40**

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 %
a.	Preparation of experimental set up	20
b.	Setting and operation	20
c.	Safety measures	10
d.	Observations and Recording	10
e.	Interpretation of result and Conclusion	20

S.No.	Performance Indicators	Weightage in %
f.	Answer to sample questions	10
g.	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. Demonstrate working 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
- '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	IEC 1131-3 compatible PLC with programming Software and interfacing hardware, user manual, (complete PLC Trainer system)	1
2	Input and Output devices for PLC: like Lamp, DC Motor, Proximity sensors, Thermocouple/RTD, Red, green, yellow LEDs, Stepper Motor, limit switches, push button.	2,3,6
3	Nano PLC, Mini PLC, Micro PLC with analog and Digital I/O, memory, peripheral interfaces	1-16
4	Ladder logic simulator, Pico soft Simulator, Logixpro simulator, Using Simple EDA tools	1-13
5	Servomotor, DC motor, AC motor, steeper motor	14,15,16
6	Motor drives, drivers for special motors (VFD)	14,15,16
7	SCADA software: like Ellipse/FTVSE/Wonderware etc.	14-16

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 Industrial Automation	1a. Compare the features of the given type of automation system. 1b. Explain with sketches the working of the given type of automation system 1c. Select relevant automation system for the given application with justification 1d. Describe the features of the given stage of the PLC evolution	1.1 **Automation**: Need and benefits. 1.2 **Types of automation system:** Fixed, Programmable, Flexible 1.3 **Different systems used for Industrial automation:** PLC, HMI, SCADA, DCS, Drives. 1.4 Evolution of PLC.
Unit– II PLC Fundamentals	2a. Explain with sketches the redundancy concept for the given PLC. 2b. Identify the specified parts of the given PLC along with its function. 2c. Describe with sketches the steps to interface relevant Input module with the given input device. 2d. Describe with sketches the steps to interface relevant output device with given output modules. 2e. Explain the criteria to select relevant module for the given I/O devices.	2.1 **Building blocks of PLC:** CPU, Memory organization, Input-output modules (discrete and analog), Specialty I/O Modules, Power supply 2.2 Fixed and Modular PLC and their types, Redundancy in PLC module 2.3 I/O module selection criteria 2.4 Interfacing different I/O devices with appropriate I/O modules
Unit-III PLC Programming and Applications	3a. Specify the proper I/O addressing format for the given type of PLC. 3b. Describe with sketches the given type of relay instructions. 3c. Describe with sketches the given type of Timer Instructions. 3d. Describe with sketches the given type of counter Instructions. 3e. Describe with sketches the given type of instruction. 3f. Describe with sketches the given type of data handling instructions. 3g. Describe the elements of the given type of programming languages used to program PLC. 3h. Develop PLC ladder program for the given simple example. 3i. Develop a PLC ladder program for the given industrial application	3.1 PLC I/O addressing 3.2 **PLC programming Instructions:** Relay type instructions: No, NC, Latch, Unlatch, One Shot, Timer instructions: On delay, off delay, retentive, Timer reset, Counter instructions: Up, Down, High speed counter, Counter reset, Logical instructions, Comparison Instructions, Data handling Instructions: Move, Masked Move, Limit, Arithmetic instructions, Sequencer Instructions, PID Instruction, Scale with parameter instruction. 3.3 **PLC programming language:** Functional Block Diagram (FBD), Instruction List. Structured text, Sequential Function Chart (SFC), Ladder Programming. 3.4 **Simple Programming**

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
		examples using ladder logic: Language based on relay, timer counter, logical, comparison, arithmetic and data handling instructions. 3.5 **PLC Based Applications:** Motor sequence control, Traffic light control, Elevator control, Tank Level control, Conveyor system, Stepper motor control, Reactor Control
Unit – IV Electric Drives and special machines	4a. Describe with sketches the working of the given type of drives. 4b. Compare the salient features of the different types of motors drives. 4c. State the functions of given parameters of VFD. 4d. Describe the given application of Drives.	4.1 **Electric drives:** Types, functions, characteristics, four quadrant operation. 4.2 **DC and AC drive controls:** V/F control, Parameters, direct torque control. 4.3 **Drives:** Specifications, Applications- Speed control of AC motor /DC Motor.
Unit-V Supervisory Control and Data Acquisition System (SCADA)	5a. Describe the function of the given element of SCADA. 5b. Describe the steps to develop a simple SCADA screen for a given application. 5c. Interface the given PLC with the SCADA system using OPC. 5d. Describe the steps to develop SCADA system for given industrial application.	5.1 **Introduction to SCADA:** Typical SCADA architecture/block diagram, Benefits of SCADA 5.2 Various editors of SCADA 5.3 **Interfacing SCADA system with PLC:** Typical connection diagram, Object Linking & embedding for Process Control(OPC) architecture, Steps in Creating SCADA Screen for simple object, Steps for Linking SCADA object (defining Tags and Items) with PLC ladder program using OPC. 5.4 **Applications of SCADA:** Traffic light control, water distribution, pipeline control.

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 Industrial	04	02	04	-	06

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
	Automation					
II	PLC Fundamentals	12	04	08	08	20
III	PLC Programming and Applications	16	06	08	12	26
IV	Drives and Special Machines	08	02	04	04	10
V	Supervisory Control and Data Acquisition System	08	02	02	04	08
Total		48	**16**	**26**	**28**	**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. Do the internet survey and make a list of leading manufactures of the PLC, SCADA, DCS, HMI and other industrial automation tools with their brand name.
b. Read an operating manual of the PLCs of reputed Manufactures.
c. Prepare a Power point presentation on the troubleshooting techniques of PLC.
d. Read the safety precautions to be followed for installation of PLC system.
e. Download animated videos from the internet for any theory topic and make presentation on it.
f. Prepare a list of available analog input /output devices, digital input /output devices available in the market.
g. Guide the students for steps to be followed to configure available SCADA software.

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 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. Students can participate in the online industrial automation forums.

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 is 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. **Automatic street light controller:** Prepare a PLC based system to control the street light as per the intensity of natural light.
b. **Automatic agriculture irrigation system:** Prepare a PLC based system to control drip irrigation.
c. **Railway gate automation:** Prepare a PLC and SCADA based system to open or close the railway gate automatically.
d. **Home automation:** Implement the versatile automation system for home that can automate any three home appliances.
e. **Bottle filling station:** Prepare a PLC and SCADA based system for bottle filling.
f. Troubleshoot the Faulty Equipment/Kit available in automation Laboratory

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Introduction to Programmable logic controllers	Dunning, G.	Thomson /Delmar learning, New Delhi, 2005,ISBN 13 : 9781401884260
2	Programmable Logic Controller	Jadhav, V. R.	Khanna publishers, New Delhi, 2017, ISBN : 9788174092281
3	Programmable logic controllers	Petruzella, F.D.	McGraw Hill India, New Delhi, 2010, ISBN: 9780071067386
4	Programmable logic controllers	Hackworth, John; Hackworth, Federic	PHI Learning, New Delhi, 2003 ISBN : 9780130607188
5	Industrial automation and Process control	Stenerson Jon	PHI Learning, New Delhi, 2003 ISBN : 9780130618900
6	Programmable logic controllers and Industrial automation An introduction	Mitra, Madhuchandra; Sengupta, Samarjit	Penram International Publication, 2015, ISBN: 9788187972174
7	Supervisory control and Data acquisition	Boyar, S. A.	ISA Publication, USA ISBN: 978-1936007097
8	Practical SCADA for industry	Bailey David ; Wright Edwin	Newnes (an imprint of Elsevier), UK 2003, ISBN: 0750658053

14. SOFTWARE/LEARNING WEBSITES

a. Software:- www.fossee.com
b. www.logixpro.com
c. www.plctutor.com
d. www.ellipse.com
e. www.instrumentationengineers.org
f. PLC tutorial:-http://users.isr.ist.utl.pt/~jag/aulas/api13/docs/API_I_C3_3_ST.pdf

Program Name : **Diploma in Instrumentation / Instrumentation and Control**

Program Code : **IS / IC**

Semester : **Fifth**

Course Title : **Control Systems**

Course Code : **22541**

1. RATIONALE

Modern civilization is an indication of human endeavor to control nature's forces and to harness them for the benefit to mankind. The laws of nature are such that everything in this universe is controlled. Diploma engineers should be able to control the various parameters at desired value in industry. This course helps the students to understand and apply the concepts, principles and procedure of controlling various parameters in different processes in industry. Students will also able to apply the knowledge of given control systems for basic fault finding in industry.

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 the Control system components in Instrumentation systems.**

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 the type of given control system.
b. Interpret the given control system for different input signals.
c. Test the stability of the given control system.
d. Maintain control action for controlling various processes.
e. Maintain different components in given control system.

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	8	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 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 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 center of this map.

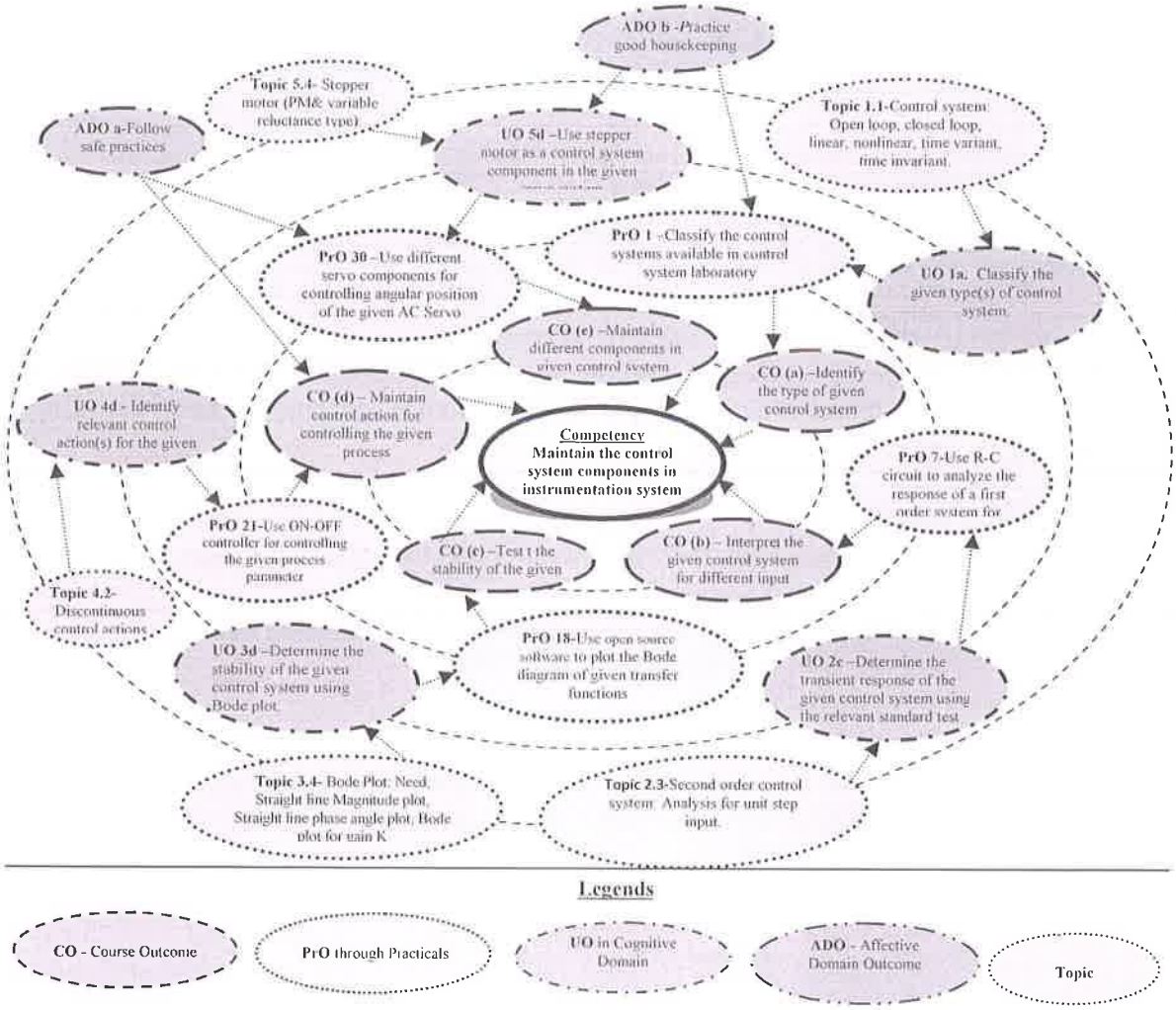

Figure 1 - Course Map

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	Classify the control systems available in control system laboratory.	I	02*
2	Use open source software to find out the transfer function and order of the given system.	I	02*
3	Use open source software to represent the given transfer function in state variable form.	I	02*
4	Use open source software to obtain the state model of the given transfer function.	I	02
5	Use open source software to find the poles and zeroes of given transfer function.	II	02
6	Use open source software to find the transient response specifications of given second order transfer function.	II	02
7	Use R-C circuit to analyze the response of a first order system for	II	02*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	standard test inputs.		
8	Use open source software to analyze the response of first order RC circuit for the different standard inputs.	II	02
9	Use R-L-C circuit to analyze the response of a second order system for standard test inputs.	II	02*
10	Use open source software to analyze the response of first order R-L-C circuit for the different standard inputs.	II	02
11	Use the standard test signal generator to analyze the given Type 0 control system.	II	02*
12	Use open source software to analyze the given Type 0 control system.	II	02
13	Use the standard test signal generator to analyze the given Type 1 control system.	II	02*
14	Use open source software to analyze the given Type 1 control system.	II	02
15	Use the standard test signal generator to analyze the given Type 2 control system.	II	02*
16	Use open source software to analyze the given Type 2 control system.	III	02
17	Use open source software to find the Routh's table and hence analyze the stability of the given control system.	III	02*
18	Use open source software to plot the Bode diagram of given transfer functions and hence analyze the stability of the given control system.	III	02*
19	Use ON-OFF controller for controlling the given process parameter.	IV	02*
20	Use Proportional controller for controlling the given process parameter.	IV	02
21	Use PI controller for controlling the given process parameter.	IV	02
22	Use PD controller for controlling the given process parameter.	IV	02
23	Use PID controller for controlling the given process parameter.	IV	02*
24	Use open source software to verify the equation of P controller	IV	02
25	Use open source software to verify the equation of PI controller	IV	02
26	Use open source software to verify the equation of PD controller	IV	02
27	Use open source software to verify the equation of PID controller	IV	02
28	Use potentiometer as an error detector.	V	02
29	Use synchro as an error detector.	V	02*
30	Use different servo components for controlling the angular position of the given DC Servo system	V	02*
31	Use different servo components for controlling angular position of the given AC Servo system	V	02*
32	Use stepper motor as a servo system component and measure its speed by applying generated pulses.	V	02
	Total		**64**

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 24 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 %
a.	Preparation of experimental set up	20
b.	Setting and operation	20
c.	Safety measures	10
d.	Observations and Recording	10
e.	Interpretation of result and Conclusion	20
f.	Answer to sample questions	10
g.	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. Demonstrate working 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
- 'Organizing Level' in 2nd year
- 'Characterizing Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTSREQUIRED

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	Open source software	2,3,4,5,6,8,10,12,14,16,17,18, 24, 25, 26
2	Standard test signal generator kit: Step, Ramp, and parabolic signals.	7,9,11,13,15
3	Type 0 system trainer kit	11
4	Type 1 system trainer kit	13
5	Type 2 system trainer kit	15
3	On-off controller: heater, Temperature sensor, Relay.	19
4	Proportional, PI, PD, PID controllers and the control system setup	20, 21, 22, 23
5	Potentiometer as an error detector trainer kit.	28

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	Open source software	2,3,4,5,6,8,10,12,14,16,17,18, 24, 25, 26
6	Synchro transmitter, control transformer and power supply.	29
7	D.C. Position control system trainer kit.	30
8	A.C. Position control system trainer kit.	31
9	Stepper motor trainer kit.	32

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 Fundamentals of control systems	1a. Classify the given type(s) of control system. 1b. Describe the procedure to determine the transfer function of the given control system. 1c. Determine the transfer function of the given control system. 1d. Form the state variables for the given system.	1.1 Control system: Open loop, closed loop, linear, nonlinear, time variant and time invariant. 1.2 Transfer function: order of a control system (0, 1, 2), transfer function with respect to R-C and R-L-C electrical circuits, 1.3 Block diagram reduction technique: Need, reduction rules. 1.4 State space representation: Advantages, state variables identification, State space models from transfer functions.
Unit– II Time response analysis	2a. Identify the poles and zeroes of given control system with justification. 2b. Explain the salient features of the given type of test inputs/ responses/control system. 2c. Determine the transient response of the given control system using the relevant standard test inputs. 2d. Determine the steady state response of the given control system using the relevant standard test input signals.	2.1 Time domain analysis: Transient and steady state response, Concept of Poles and zeros ;examples 2.2 Standard test inputs :Step, Ramp, Parabolic and Impulse: mathematical equation, graph, transfer function 2.3 First order control system: Analysis for unit step input, Concept of time constant. 2.4 Second order control system: Analysis for unit step input, Concept, and effect of damping. 2.5 Time response specifications (no derivations) Tp, Ts, Tr, Td, Mp, Ess; numerical Problems. 2.6 Steady state analysis: Type 0, type 1, type 2 systems, Steady state error and error constants.
Unit-III Stability of Control systems	3a. Explain the conditions for stability of the given control system. 3b. Determine the stability of the given control system	3.1 Stability :Definition of stability, Analysis of Stable, unstable, critically stable and conditionally stable system, Relative stability, Location of the Poles in the S-plane for stable and unstable systems.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	using Routh's stability criteria. 3c. Explain frequency response specifications of the given control system. 3d. Determine the stability of the given control system using Bode plot.	3.2 Routh's stability criterion: Different cases and conditions (statement method), Numerical Problems. 3.3 Frequency Response Analysis method: Concept, Advantages and Disadvantages, Frequency response specifications. 3.4 Bode Plot: Need, Straight line Magnitude plot, Straight line phase angle plot, Bode plot for gain K, poles and zeros at origin, and 1^{ST} order system, Analyze stability from Bode plot using Gain margin and Phase margin.
Unit –IV Process Control Actions	4a. Explain with sketches the discontinuous control actions used for controlling the given process control system. 4b. Explain with sketches the basic continuous control actions used for controlling the given process control system. 4c. Explain with sketches the composite continuous control actions used for controlling the given process control system. 4d. Identify relevant control action(s) for the given process control system with justification and sketches.	4.1 Discontinuous control actions - two position or ON-OFF: Operation, neutral zone 4.2 Continuous control actions-proportional, integral and derivative: operation, output equations, corresponding transfer function, Response graph. 4.3 Composite controllers - PI, PD, PID controllers : operation, output equations, Response graph, comparison, application 4.4 Electronic op-amp based PI, PD, PID controllers: circuit diagram, equations.
Unit-V Position control systems	5a. Identify the components of a given servo system with justification. 5b. Explain different components of given DC servo system. 5c. Explain different components of given AC servo system. 5d. Use stepper motor as a control system component in the given servo system. 5e. Choose the relevant servo system for the given situation with justification.	5.1 Servo system: concept, generalized block diagram. 5.2 DC servo system: functional diagram, potentiometer as an error detector, DC servo motor - characteristics, difference from a normal DC motor 5.3 AC servo system: functional diagram, Synchro, Synchro transmitter, control transformer, synchro as an error detector, applications, AC servo motor-characteristics, difference from a normal 2 phase induction motor. 5.4 Stepper motor (PM and variable reluctance type): Working and applications, comparison with DC servo motor.

***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 FORQUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Fundamentals of control system	14	04	04	06	14
II	Time response analysis	18	02	06	08	16
III	Stability Analysis of Control systems	16	02	06	08	16
IV	Process Control actions	08	02	06	04	12
V	Control system components	08	02	06	04	12
Total		**64**	12	**28**	**30**	**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 a report on the market survey for availability of different Servo components.
b. Prepare a report on the market survey for availability of different controllers.
c. Visit nearby process industries and prepare a report on control systems used.
d. Visit nearby engineering institutes and prepare a report on different control systems used in that institute laboratory.
e. Prepare a chart on comparison of different control actions.
f. Prepare a chart on effect of damping on the response of different types of control systems.
g. Prepare a chart on effect of location of poles on the stability of different types of control 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 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. Use proper equivalent analogy to explain different concepts.
g. Use Flash/Animations to explain various control actions.

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 is 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. Build/test an automatic feedback temperature control system.
b. Build/test an automatic feedback water level control system.
c. Build/test RC circuit and check its output response.
d. Build/test RLC circuit for a stable system using MATLAB.
e. Build / test ON-OFF controller for the given type of control loop.
f. Simulate Bode plot of given system using MATLAB and improve the stability of the system by varying necessary parameters.
g. Built / test opamp based P controller for the given type of control loop.
h. Built / test opamp based PI controller for the given type of control loop.
i. Built / test opamp based PD controller for the given type of control loop.
j. Built / test opamp based PID controller for the given type of control loop.
k. Built / test Potentiometer as an error detector for the given control system.
l. Troubleshoot faulty equipment/kit available in control system lab.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Control System Engineering	Nagrath I.J, M. Gopal	New age International, New Delhi, Sixth edition, ISBN: 9788122420081
2	Modern Control Engineering	Ogata K.	Pearson India, Noida, Fifth edition ISBN: 978-9332550162
3	Process Control Instrumentation Technology	Johnson C. D.	PHI Learning, NewDelhi,2015 ISBN: 978-9332549456
4	Control Systems Engineering	Nise Norman S	Willey India, Delhi, Sixth Edition ISBN:978-8126519477
5	Control System Engineering using MATLAB	Sivanandan S. N. Deepa S. N.	Vikas Publication House, New Delhi,2012 ISBN:9788125937104
6	Principles of Control Systems	S.P. Eugene Xavier Joseph Cyril Babu, J.	S. Chand, New Delhi,2014 ISBN:9788121917780

S. No.	Title of Book	Author	Publication
7	Control Systems	Anand Kumar	PHI Learning, NewDelhi,2014 ISBN:9788120349391
8	Control Systems	Varmah K.R	McGraw Hill, New Delhi,2010 ISBN: 9780070678750

14. SOFTWARE/LEARNING WEBSITES

a. www.scilab.org/scilab
b. www.nptel.ac.in/courses/101108056/23
c. www.nptel.ac.in/courses/108101037/3
d. www.nptel.ac.in/courses/108101037/14
e. www.nptel.ac.in/courses/108101037/46
f. www.nptel.ac.in/courses/108105062/12
g. www.nptel.ac.in/courses/108101037/20
h. www.nptel.ac.in/courses/108103008/12
i. www.nptelvideos.com/control_systems/
j. www.electrical4u.com/control-engineering
k. www.automationfederation.org/filestore/af/resources/control