Maharashtra State Board of Technical Education, Mumbai

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

Program Name : Diploma in Electrical Engineering

Program Code : EE/EP/EU — **With Effect From Academic Year: 2017 - 18**

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

Semester : Fourth — **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	Electric Motors and Transformers	CNE	22418	4	2	2	8	3	70	28	30*	00	100	40	25#	10	25	10	50	20	150
2	Electrical Power Trasmision and Distribution	EPT	22419	3	2	-	5	3	70	28	30*	00	100	40	--	--	--	--	--	--	100
3	Industrial Measurement	IME	22420	3	-	2	5	3	70	28	30*	00	100	40	25#	10	25	10	50	20	150
4	Digital Electronics and Microcontroller Application	DEM	22421	4	-	2	6	3	70	28	30*	00	100	40	25@	10	25	10	50	20	150
5	Enviornmental Studies	EST	22447	3	-	-	3	90 Min	70*#	28	30*	00	100	40	--	--	--	--	--	--	100
6	Electrical Drawing and CAD	EDC	22033	-	-	4	4	--	--	--	--	--	--	--	50@	20	50	20	100	40	100
			Total	**17**	**4**	**10**	**31**	--	**350**	--	**150**	--	**500**	--	**125**	--	**125**	--	**250**	--	750

Student Contact Hours Per Week: **31 Hrs.** Medium of Instruction: **English**

Theory and practical periods of 60 minutes each. Total Marks : **750**

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.**
- **In-Plant Training during Summer vacation for minimum Six Weeks at the end of Fourth Semester (Second Year).**

Program Name : **Electrical Engineering Program Group**

Program Code : **EE/EP/EU**

Semester : **Fourth**

Course Title : **Electrical Drawing and CAD**

Course Code : 22033

1. RATIONALE

The electrical technician / supervisor are called upon to draw or interpret drawings of electrical systems that include machines, control panels, power system components such as transmission and distribution systems etc. This course aims to provide hands on practice in freehand sketches; drawings using relevant tools and computer based software. The course also provides practice to read and interpret electrical engineering drawings.

2. COMPETENCY

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

- **Use CAD software for drawing electrical circuits and components.**

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. Draw symbolic representation of electrical components manually.
b. Draw free hand sketches, isometric and orthographic views of electrical machines and components.
c. Use CAD tools to draw simple electrical components and machines.
d. Use CAD to create electrical circuits with components.
e. Edit electrical line drawings and control panel layouts in CAD.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme												
				Theory							Practical					
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
-	-	4	4	--	--	--	--	--	--	--	50@	20	50~	20	100	40

*(~): For the **practical only courses,** the PA has two components under practical marks i.e. the assessment of practicals (seen in section 6) has a weightage of 60% (i.e. 30 marks) and micro-project assessment (seen in section 12) has a weightage of 40% (i.e. 20 marks). This is designed to facilitate attainment of COs holistically, as there is no theory ESE.*

***Legends: L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** - Practical; **C** – Credit, **ESE** - End Semester Examination; **PA** - Progressive Assessment, #: No theory paper.*

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.

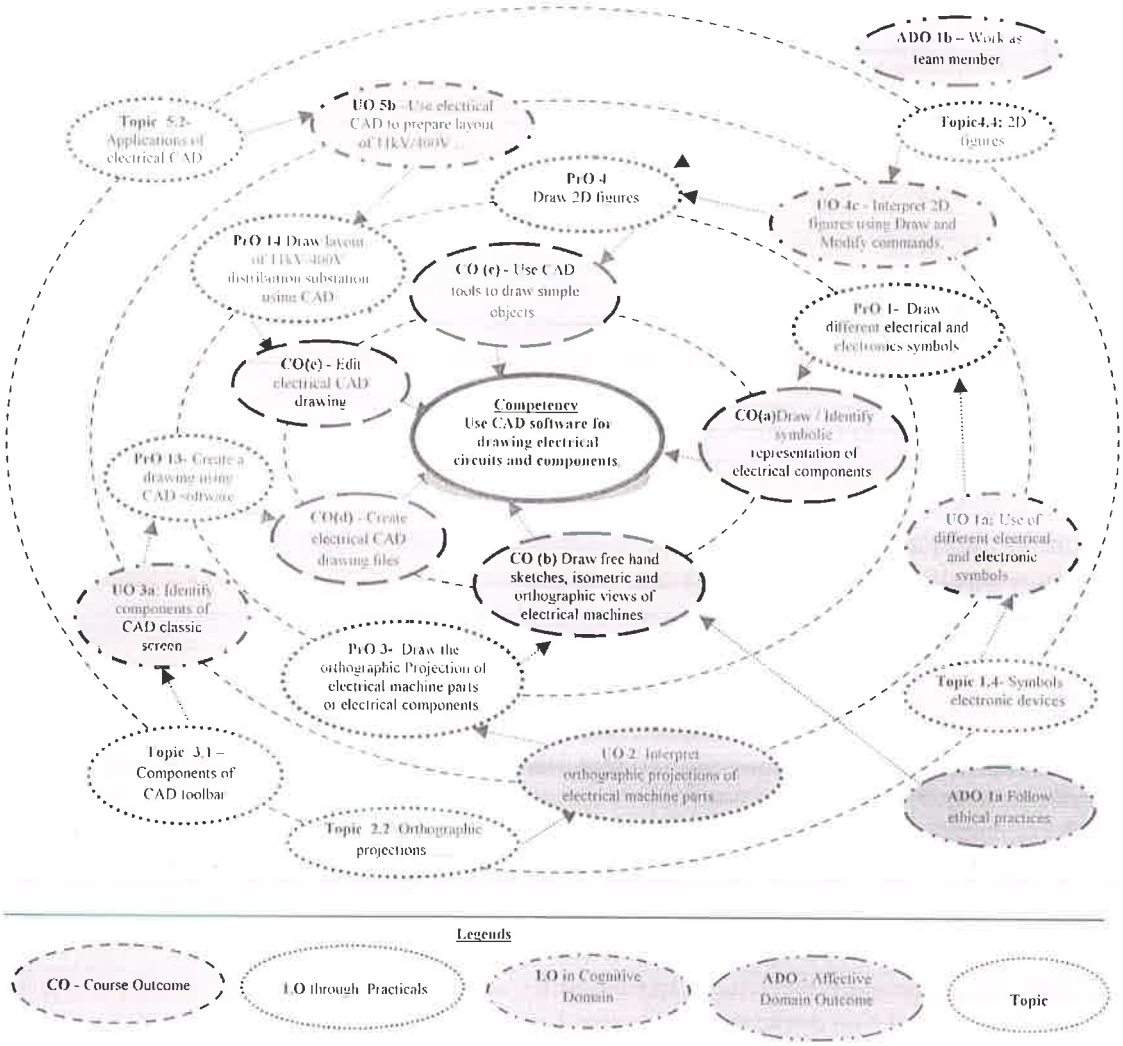

Figure 1 - Course Map

1. 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
	Using Manual Drawing Tools		
1	Draw different electrical (including electronics) symbols using drawing instruments as per IS: 1032 or new equivalent IS.	I*	02
2	Draw the freehand drawing of Electrical Machine parts and	II*	02
3	Draw the freehand drawing of electrical components.	II	02
4	Draw the orthographic Projection of Electrical Machine parts	II*	02
5	Draw the orthographic Projection of electrical components	II	02
6	Draw the isometric Projection of Electrical Machine parts	II*	02
7	Draw the isometric Projection of electrical components.	II	02
8	Draw labeled layout of Plate earthing.	II*	02

S. No.	Practical Outcomes (PrOs)	Unit No	Approx. Hrs. required
9	Draw labeled layout of Earth mat	II*	02
10	Draw labeled layout of Pipe earthing	II	02
	Using CAD software		
11	Locate components of CAD classic screen by creating new drawing: CAD screen layout, drawing area, menu and toolbars, status bar	III*	02
12	Work with toolbar and commands	III*	02
13	Change the drawing limits, creating rectangle etc, saving drawing for first time.	III*	02
14	Draw a line diagram using absolute coordinate method. Use LIMITS, UNITS, LINE, ARC Commands: Absolute coordinate method	III*	02
15	Drafting set-up: units, angle, area, coordinate system, limits, grid, object snap	III*	02
16	Creating two dimensional drawings using draw commands- line and arc	III*	02
17	Draw a line diagram using relative coordinate and relative polar coordinate method. Use LIMITS, UNITS, LINE, ARC, Commands: Relative coordinate and relative polar coordinate method	III*	02
18	Draft set-up: units, angle, area, coordinate system, limits, grid, object snap	III*	02
19	Create two dimensional drawings using draw commands-line and arc.	III*	02
20	Draw a 2D figure using Draw and Modify commands. Use LINE, CIRCLE, OFFSET, TRIM, FILLET commands	III	02
21	Create two dimensional drawings using draw commands- line and circle	III	02
22	Modify two dimensional drawings using modify commands- offset, trim, fillet	III	02
23	Draw a 2D figure using Draw and Modify commands. Use LINE, ARC, POLYGON, ELLIPSE, COPY, MIRROR, TRIM, ROTATE, CHAMFER commands:	III	02
24	Create two dimensional drawings using draw commands- line, arc, polygon, ellipse.	III	02
25	Modify two dimensional drawings using modify commands- copy, mirror, trim, rotate, chamfer.	III	02
26	Draw isometric drawing of electrical machine. Use LIMITS, UNITS, ZOOM, GRID, SNAP, LINE, COPY, ISOPLANE, ELLIPSE, TRIM, ERASE, PROPERTIES, SAVE commands.	IV*	02
27	Draft set-up: units, limits, zoom, grid, object snap, ortho mode	IV*	02
28	Snap and grid- snap spacing, grid spacing, isometric snap type	IV	02
29	Create a simple drawing using electrical CAD software for the given electrical circuit diagram.	IV*	02
30	Create a simple drawing using electrical CAD software for the given electrical circuit diagram.	IV	02
31	Modify the given electrical CAD drawings as per requirement. Part	IV	02

S. No.	Practical Outcomes (PrOs)	Unit No	Approx. Hrs. required
	I		
32	Modify the given electrical CAD drawings as per requirement. Part II	IV	02
33	Draw the layout of the 11 kV/400 V distribution substation using electrical CAD software.	IV*	02
	Total	-	**66**

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.*

i. 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	Plan the drawing.	20
2	Select relevant drawing / software tools.	20
3	Drawing skills judged by neatness and correctness.	20
4	Timely submission.	20
5	Answer to sample questions.	20
	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. Practice good housekeeping.
b. Demonstrate working as a leader/a team member.
c. Maintain tools and equipment.
d. 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.

2. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

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

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	Half imperial drawing boards.	1 to 5
2	Manual drawing tools: mini drafter, set squares protractor, compasses, and black lead pencil of hardness 'H'.	1 to 5
3	Any electrical CAD software.	6 to 14

8. UNDERPINNING THEORY COMPONENTS

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

Unit	Major Learning Outcomes (in cognitive domain)	Topics/sub-topics
Unit – I Symbolic representation of electrical components.	1a. Sketch the symbols of the given type of electric lamps. 1b. Sketch the symbols of the given type of electric wiring accessories. 1c. Sketch the symbols of the given type of electric machines, 1d. Sketch the symbols of the given type of electronic lamps.	**1.1.** Symbols: electrical lamps. **1.2.** Symbols: wiring accessories. **1.3.** Symbols: electrical machines. **1.4.** Symbols: electronic devices.
Unit – II Free hand sketches, isometric and orthographic views.	2a. Interpret freehand sketches of the given Electrical Machine parts 2b. Interpret freehand sketches of the given electrical components. 2c. Interpret orthographic Projection of the given Electrical Machine parts or electrical components. 2d. Interpret the isometric Projections of the given Electrical Machine parts or electrical components.	2.1. Need for free hand sketching with its importance. 2.2. Orthographic projections simple parts. 2.3. Isometric projections of simple parts.
Unit- III CAD tools.	3a. Identify the function of the given components of CAD classic screen. 3b. Identify the given components of CAD screen. 3c. Identify the given toolbar and commands.	**3.1.** Components of CAD classic screen **3.2.** Menu bar and status bar. **3.3.** CAD tool bar.
Unit– IV Simple drawings in CAD.	4a. Interpret the given line diagram using absolute coordinate method. 4b. Interpret the given line diagram using relative coordinate and relative polar coordinate method. 4c. Interpret the given 2D figures 4d. Interpret the given isometric drawing of electrical machine in	4.1 Absolute Coordinate Method: Commands: LIMITS, UNITS, LINE and ARC. 4.2 Relative coordinate Method: 4.3 Commands: LIMITS, UNITS, LINE and ARC. 4.4 Relative polar coordinate method: Commands: LIMITS, UNITS, LINE

	CAD.	and ARC. 4.5 2D figures: Commands: LINE, CIRCLE, OFFSET, TRIM, FILLET, ARC, POLYGON, ELLIPSE, COPY, MIRROR, TRIM, ROTATE and CHAMFER 4.6 Isometric drawings: commands: LIMITS, UNITS, ZOOM, GID, SNAP, LINE, COPY, ISOPLANE, ELLIPSE, TRIM, ERASE, PROPERTIES and SAVE.
Unit– V Electrical drawings in CAD.	4a. Interpret the given CAD electrical circuit diagram. 4b. Interpret the given CAD electrical layout of the 11 kV/400 V distribution substation. 4c. Interpret the given CAD layouts of two types of earthing systems.	5.1 Applications of electrical CAD software to: Draw electrical circuit diagrams. 5.2 Applications of electrical CAD software to: Draw layouts of substations. 5.3 Applications of electrical CAD software to: Draw layouts of earthing systems.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

- Not Applicable –

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. Collect information on different available electrical CAD software.
b. Read at least three different electrical drawings other than those covered in the practicals above.

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. Correlate subtopics with power system utility and electrical equipments.
g. Use proper equivalent analogy to explain different concepts.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably be ***individually*** undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should ***not exceed three.***

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

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

a. **2D Transmission**: Each batch will identify fasteners, couplings; joints used in electric motors and using CAD software prepare drawings. The figures should be labeled and dimensioned using software.
b. **2D Electric Machine Components**: Each batch will identify electric machine components and using CAD software and prepare drawings. The figures should be labeled and dimensioned using software.
c. **3D Transmission**: Each batch will identify fasteners, couplings; joints used in electric machines and using CAD software and prepare isometric drawings. The figures should be labeled and dimensioned using software.
d. **3D Electric Machine components**: Each batch will identify electric machine components and using CAD software and prepare isometric drawings. The figures should be labeled and dimensioned using software.
e. **Digital Drawings:** Each batch will identify manual drawings of electric machine components using CAD software and create digital drawings using relevant software

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1.	Electrical Engineering Drawing	Bhattacharya, S. K.	New Age International, New Delhi, 2005, ISBN:81-224-0855-9
2.	Electrical Drawing	Narang, K. L.	Satyaprakashan, New Delhi,2015 ISBN: 81-7684-150-1
3.	Electrical Drawing	Singh, Surjeet	SK Kataria and Sons, New Delhi, ISBN: 8177000454
4.	AutoCAD 2016 exercise workbook for windows	Shrock, Cheryl R. and Heather, Steve,	Industrial Press Inc. South Norwalk, USA, First, 2016 ISBN:978-0-8311-3518-8
5.	Computer Aided Electrical Drawing	Yogesh, M., Nagaraja, B. S., Nandan, N.	PHI Learning Pvt. Ltd., Delhi:110092 ISBN:978-81-203-4953-7
6.	Engineering Drawing with introduction to AutoCAD	Jolhe, Dhananjay A,	McGraw-Hill Co. Ltd., New Delhi, 2nd, 2008; ISBN:978-0-07-064837-1

S. No.	Title of Book	Author	Publication
7.	AutoCAD 2016 and AutoCAD LT 2016	Gladfelter. Donnie,	John Wiley and Sons. Inc. Indiana. 2016. ISBN:978-1-119-05955-4

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. www.mycadsite.com/tutorials/level_3/isometric-drawing-in-autocad-3-2.htm accessed on 27th June, 2016
b. www.cadlearning.com/courses/autocad-mechanical-training-tutorials/, accessed on 27th June. 2016
c. www.staff.city.ac.uk/~ra600/ME1105/Tutorials/CAD-1/Tutorial%20CAD-1a.pdf, accessed on 28th June, 2016
d. www.youtube.com/watch?v=yruPUj_61bw, , accessed on 29th June, 2016
e. www.youtube.com/watch?v=Nv8skZZcUlw , accessed on 29th June, 2016
f. www.youtube.com/watch?v=Lz6piHlBn7g , accessed on 30th June, 2016

Program Name : **Electrical Engineering Program Group**

Program Code : **EE/EP/EU**

Semester : **Fourth**

Course Title : **Electric Motors and Transformers**

Course Code : **22418**

1. RATIONALE

The electrical engineering applications in industries use small and large electric motors in some crucial application systems. This course will empower the students with the necessary skills to handle/maintain the motors in general. Further the electrical power systems of all sorts and at all levels are incomplete without the use of the relevant transformers employed to change the voltage/current levels according to the applications. This course will also make the students familiar with the working and applications of single phase and three phase transformers including those for special applications.

2. COMPETENCY

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

- **Use electric motors and transformers.**

3. COURSE OUTCOMES (COs)

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

a. Use different electric motors.
b. Use DC machines.
c. Use single phase transformer for different applications.
d. Use three phase transformers for different applications.
e. Use relevant special purpose transformers for different applications.

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
4	2	2	8	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.

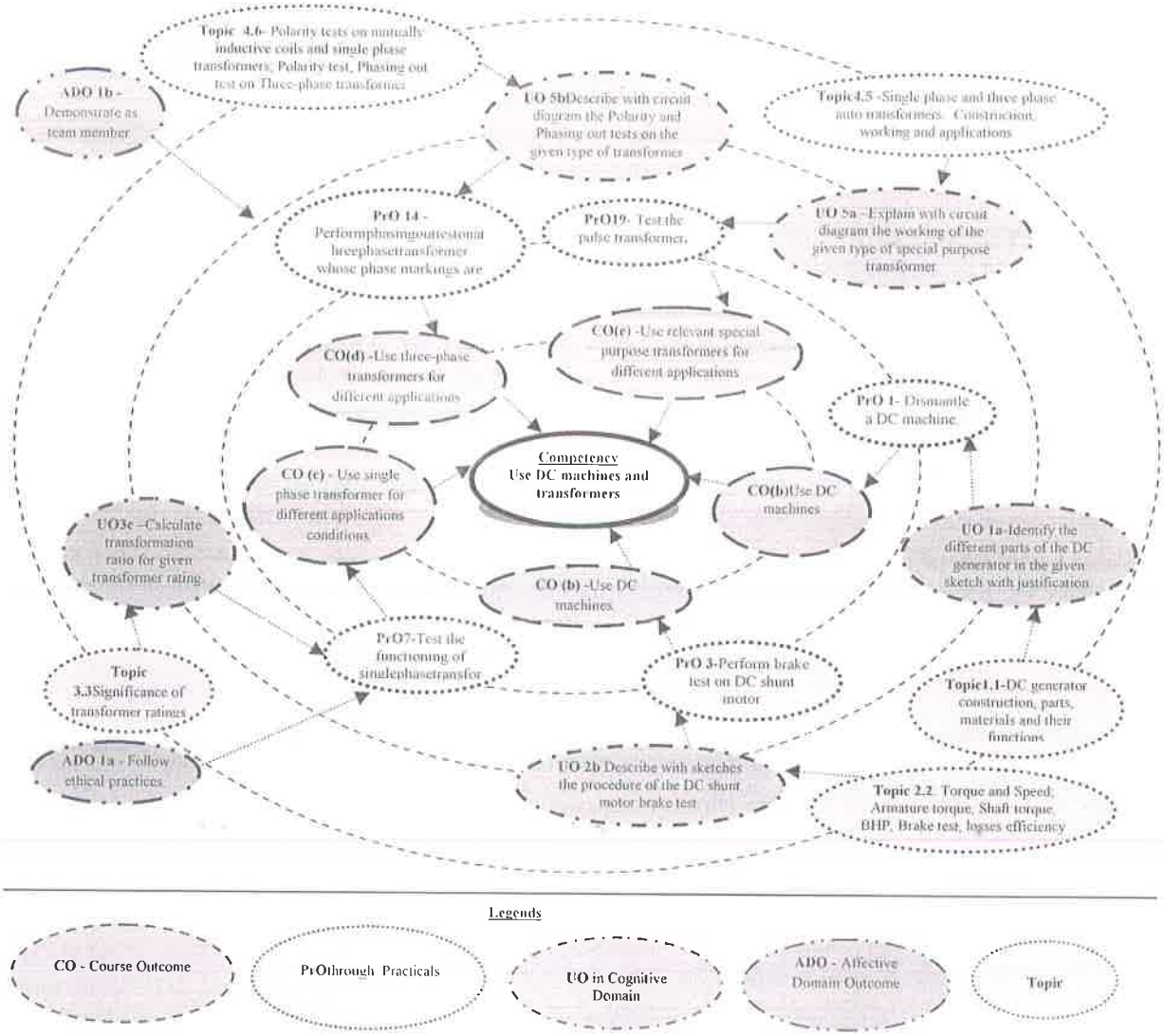

Figure 1 - Course Map

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	Dismantle a DC machine.	II	02*
2	Reverse the direction of rotation of the DC shunt motor.	II	02
3	Perform brake test on DC shunt motor.	II	02*
4	Control the speed of DC shunt motor by different methods.	II	02
5	Control the speed of DC series motor by different methods.	II	02
6	Perform the brake test on DC series motor.	II	02
7	Check the functioning of single phase transformer.	III	02
8	Determine regulation and efficiency of single phase transformer by direct loading.	III	02*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
9	Perform open circuit and short circuit test on single phase transformer to determine equivalent circuit constants.	III	02
10	Perform open circuit and short circuit test on single phase transformer to determine voltage regulation and efficiency.	III	02
11	Perform parallel operation of two single phase transformers to determine the load current sharing.	III	02
12	Perform parallel operation of two single phase transformers and determine the apparent and real power load sharing.	III	02*
13	Perform polarity test on a single phase transformer whose polarity markings are masked.	IV	02
14	Perform phasing out test on a three phase transformer whose phase markings are masked.	IV	02*
15	Connect the auto-transformer in step-up and step-down modes noting the input/output readings.	V	02*
16	Check the functioning of the CT.	V	02
17	Check the functioning of the PT.	V	02
18	Check the functioning of the isolation transformer.	V	02*
19	Test the pulse transformer.	V	02*
	Total		**38**

Note

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

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

S. No.	Performance Indicators	Weightage in %
1	Preparation of experimental set up	20
2	Setting and operation	20
3	Safety measures	10
4	Observations and Recording	10
5	Interpretation of result and conclusion	20
6	Answer to sample questions	10
7	Submission of report in time	10
	Total	**100**

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

a. Follow safety practices.
b. Practice good housekeeping.
c. Demonstrate working as a leader/a team member.
d. Maintain tools and equipment.
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 administrators.

S. No.	Equipment Name with Broad Specifications	PrO.No.
1	DC series and shunt machines at least one each (up to 230 V, 5 hp).	1 to 5
2	DC Ammeter range (0-5-10A), Portable analog PMMC type as per relevantBIS standard.	2, 3, 4, 5.
3	DC Voltmeter Range (0-150/300V), Portable analog PMMC type as per relevant BIS standard.	2, 3, 4, 5.
4	AC Ammeter range (0-2.5-5-10A), Portable analog MI type as per relevant BIS standard	6 to 12
5	AC Voltmeter Range (0-75/150/300V), Portable analog MI type as per relevant BIS standard.	6 to 12
6	Lamp load of 10-20 A	7, 9, 12.
7	Rheostat (0-500 Ohm, 1.2A), Nichrome wire wound rheostat on epoxy resin or class F insulating tube with two fixed and one sliding contact.	2, 3, 4, 5.
8	Rheostat (0-100 Ohm, 5A), Nichrome wire wound rheostat on epoxy resin or class F insulating tube with two fixed and one sliding contact.	2, 3, 4, 5.
9	Rheostat (0-50 Ohm, 10A), Nichrome wire wound rheostat on epoxy resin or class F insulating tube with two fixed and one sliding contact.	1, 2, 3, 4, 5.
10	Rheostat (0-350 Ohm,1.5A), Nichrome wire wound rheostat on epoxy resin or class F insulating tube with two fixed and one sliding contact.	1, 2, 3, 4, 5.
11	D. C. Supply, 230 V,25 A.	1, 2, 3, 4, 5.
12	Single phase transformer of suitable size (500 VA to 1 kVA).	7 to 13.
13	Three phase transformer of suitable size (1kVA to 3 kVA).	14
14	Single phase auto transformer 0-270 V, 15 A.	15
15	CT of suitable ratio.	16
16	PT of suitable ratio	17
17	Isolation transformer of suitable ratio	18
18	Pulse transformer of suitable ratio	19
19	Wattmeter 0-300/600 V, 5/10 A, for use in AC circuits.	7, 8, 9.
20	LPF Wattmeter, 0-300/600 V, 1A to 2A, for use in AC circuits.	8

8. UNDERPINNING THEORY COMPONENTS

The following topicsare to betaught 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 Introducti on to electric motors	1a. Explain the principle of working of given electric motor. 1b. Identify the different parts and their respective materials of the given motor with justification. 1c. Explain with sketches the functions of the given parts of the specified type of motor.	1.1 Electric motors: principles of operation of different motors. 1.2 Construction and representation: parts with their materials. Schematic diagrams. 1.3 Functions of parts of motors: Functions of the various parts of different electric motors.
Unit – II D.C. Machines	2a. Explain with sketches the working principle of the specified type of DC machine. 2b. Describe with sketches the procedure of the DC shunt motor brake test. 2c. Recommend relevant DC motor for given application with justification. 2d. Calculate the torque, speed, output power and efficiency of the given DC motor. 2e. Describe with sketch the working of the starter for the given type of DC motor. 2f. Explain with diagram using the given method(s) to control the speed of specified DC motor. 2g. Explain with diagram the working of the brushless DC motor.	2.1 DC machine: Types of DC machines. Fleming's right hand rule, Fleming's left hand rule, Principle of operation of dc generator and motor, Back e.m.f. and its significance , Voltage equation of DC motor 2.2 Torque and Speed; Armature torque, Shaft torque, BHP, Brake test, losses, efficiency 2.3 DC motor starters: Necessity, two point and three point starters. 2.4 Speed control of DC shunt and series motor: Flux and Armature control. 2.5 Brushless DC Motor: Construction and working.
Unit- III Single Phase Transform ers.	3a. Differentiate the salient features between the given types of transformers. 3b. Describe the functions of the given parts of a transformer. 3c. Calculate transformation ratio for given transformer rating. 3d. Explain with a phasor diagram for no load/on load for the given type of transformer. 3e. Calculate regulation and efficiency by OC/ SC tests and	3.1 Types of transformers: Shell type and core type; Construction: Parts and functions, materials used for different parts 3.2 Transformer: Principle of operation, EMF equation of transformer: Derivation, Voltage transformation ratio, 3.3 Significance of transformer ratings 3.4 Transformer No-load and on-load phasor diagram, Leakage reactance. 3.5 Equivalent circuit of transformer.

	direct loading for the given type of transformer.	Equivalent resistance and reactance. 3.6 Voltage regulation and Efficiency: Direct loading. OC/SC method. All day efficiency.
Unit– IV Three Phase Transformers	4a. Identify the different parts of the given type transformer. 4b. Describe with diagrams various connections of the given three phase transformer. 4c. Compare distribution transformer and power transformer on the given criteria. 4d. Calculate the given load sharing between two given transformers operating in parallel. 4e. Describe the criteria with justification for selection of the transformer for the given application. 4f. Describe with circuit diagram the Polarity and Phasing out tests on the given type of transformer. 4g. Explain the effects of harmonics on the operation of transformers.	4.1 Bank of three single phase transformers. Single unit of three phase transformer. 4.2 Distribution and Power transformers. 4.3 Construction. cooling, Three phase transformers connections as per IS:2026 (part IV)-1977. Three phase to two phase conversion (Scott Connection), 4.4 Selection of transformer as per IS: 10028 (Part I)-1985, Criteria for selection of distribution transformer, and power transformer, Amorphous Core type Distribution Transformer, Specifications of three-phase distribution transformers as per IS:1180 (part I)-1989 4.5 Need of parallel operation of three phase transformer, Conditions for parallel operation. 4.6 Polarity tests on mutually inductive coils and single phase transformers; Polarity test, Phasing out test on Three-phase transformer. 4.7 Harmonics and their effects on transformers.
Unit– V Special purpose Transformers	5a. Explain with circuit diagram the working of the given type of special purpose transformer. 5b. Calculate ratio for the specified instrument transformer of the given rating. 5c. Explain with justification the use of isolation transformer for the given application. 5d. Differentiate between the given two types of special purpose transformers. 5e. Explain the importance of 'K' factor of transformers.	5.1 Single phase and three phase auto transformers: Construction, working and applications. 5.2 Instrument Transformers: Construction, working and applications of Current transformer and Potential transformer. 5.3 Isolation transformer: Constructional Features and applications. 5.4 Single phase welding transformer: constructional features and applications. 5.5 Pulse transformer: constructional features and applications. 5.6 'K' factor of transformers: overheating due to non-linear loads and harmonics.

***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 QUESTIONPAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Introduction to Electric Motors	08	02	02	02	06
II	DC Machines	12	04	04	06	14
III	Single Phase Transformers	20	04	06	11	21
IV	Three Phase Transformers	16	04	06	09	19
V	Special Purpose Transformers	08	02	02	06	10
Total		**64**	**16**	**20**	**34**	**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 market survey of different electric motors
b. Prepare report on market survey of various three phase transformers(specification, manufacturer, application, cost)
c. Prepare model of single phase transformer.
d. Prepare power point presentation related to D.C. Machines.
e. Prepare power point presentation related to transformers.
f. Prepare a chart of industrial application of D.C. Machines.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment ofthe 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. Use Flash/Animations to explain various theorems in circuit analysis
f. Guide student(s) in undertaking micro-projects.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably be ***individually*** undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should ***not exceed three.***

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

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

a. **Types of D.C. Machines**: Prepare chart showing different material used for various parts of d.c. machines.
b. **D.C. Machines**: Collect specification from different manufacturers and prepare report.
c. **Single phase transformers:** Prepare a simple model of single phase transformer.
d. **Three phase transformers:** Collect photographs with details of various power/ distribution transformer and identify different parts (specification, application, cost, features, manufacturer)
e. **Special transformers:** Prepare report on different special transformer.(specification, application, cost, features, manufacturer)

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Basic Electrical Engineering	Mittle, V.N. and Mittle, Arvind	McGraw Hill Education. New Delhi ISBN :9780070593572
2	Electrical Machines	Kothari, D. P. and Nagrath, I. J.	McGraw Hill Education. New Delhi ISBN :9780070699670
3	Electrical Machines	Bhattacharya,S. K.	McGraw Hill Education. New Delhi ISBN : 9789332902855
4	Principles of Electrical Machines	Mehta, V. K. and Mehta, Rohit	S.Chand and Co.Ltd., New DelhiISBN : 9788121930888
5	Electrical Technology Vol-II (AC and DC machines)	Theraja, B.L.	S.Chand and Co.Ltd., New Delhi ISBN : 9788121924375
6	Electrical Machines Theory and Practice	Bandyopadhyay, M. N.	PHI Learning Pvt. Ltd., New Delhi ISBN :9788120329973 Vi
7	DC Machines and Transformers	Murugesh Kumar, K.	ISBN : 9788125916055

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. https://www.youtube.com/watch?v=fWyzPdyCAzU
b. https://www.youtube.com/watch?v=IC-PWxtcirI
c. https://www.youtube.com/watch?v=H2hYUu8lPY0
d. https://www.youtube.com/watch?v=mKbyFpoNZ_w
e. https://www.youtube.com/watch?v=b2MXK9oi_Gs

f. https://www.youtube.com/watch?v=SIIi_20pAWiE
g. www.nptel.ac.in
h. www.wikipedia.com
i. www.electricaltechnology.org
j. www.howstuffworks.com
k. www.electrical4u.com

Program Name : **Electrical Engineering Program Group**

Program Code : **EE/EP/EU**

Semester : **Fourth**

Course Title : **Electric Power Transmission and Distribution**

Course Code : **22419**

1. RATIONALE

In industry, to operate and maintain electric transmission and distribution systems by the electrical engineering diploma holder (also called technologist), the knowledge of its various components of the power system and their functions is one of the main duties and hence quite important. This course is intended to develop such skills to not only to maintain the proper functioning of the power system but also to diagnose and rectify the general problems related problems of associated to the transmission and distribution system.

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 proper functioning of the electrical transmission and distribution 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. Interpret the nomal operation of the electric transmission and distribution systems.
b. Maintain the functioning of the medium and high voltage transmission system.
c. Interpret the parameters of the extra high voltage transmission system.
d. Maintain the functioning of the low voltage AC distribution system.
e. Maintain the components of the transmission and distribution lines.

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	--	--	--	--	--	--

(*): 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.

***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.

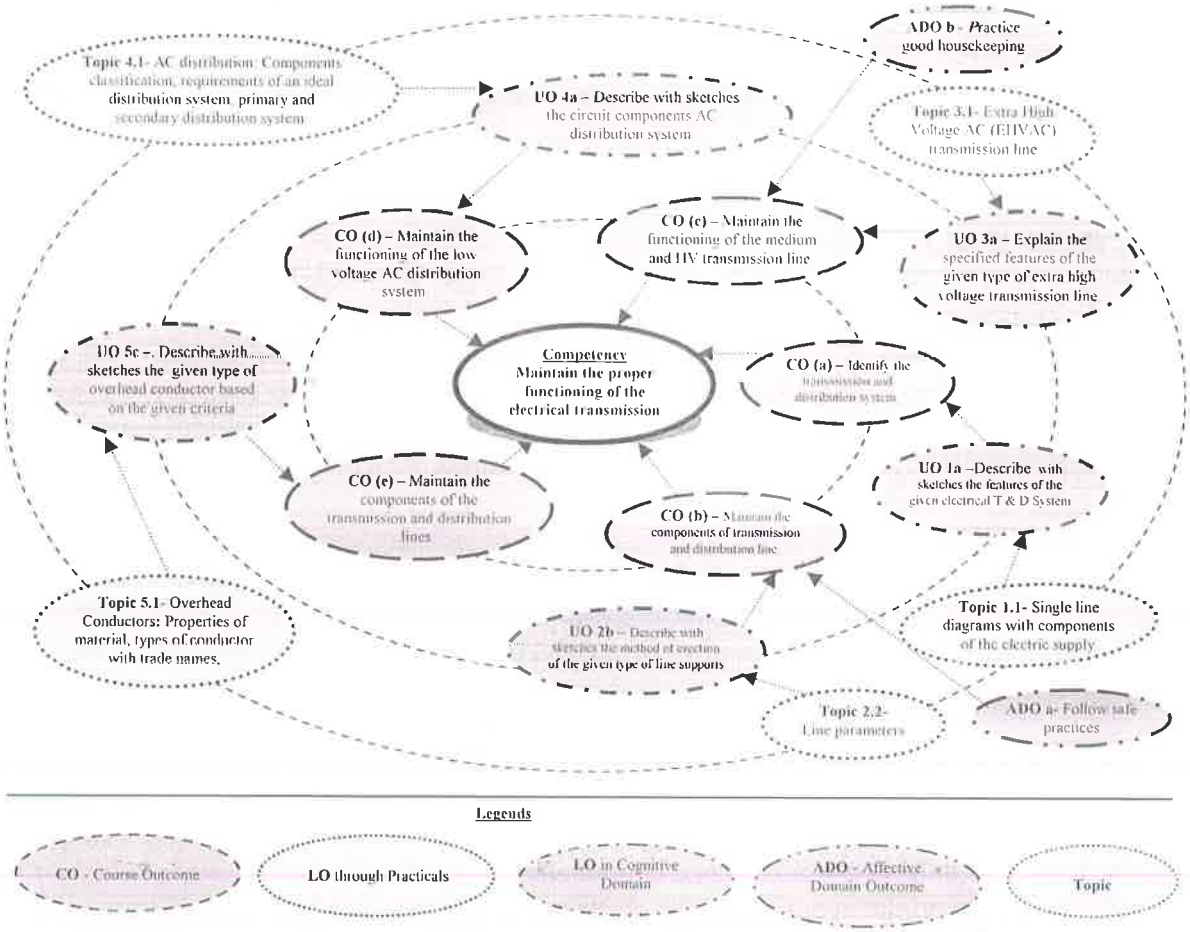

Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

- Not applicable -

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

- Not applicable -

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 Basics of Transmission and Distribution	1a. Describe with sketches the features of the given type of electric supply system. 1b. Interpret the implicagions of ghe voltage levels in the given transmission system. 1c. Explain the given charactistic (s) of the specified high voltage	1.1 Single line diagrams with components of the electric supply transmission and distribution systems. 1.2 Classification of transmission lines : Primary and secondary transmission; standard voltage level used in India. 1.3 Classification of transmission lines: based on type of voltage, voltage level, length and others

Unit	Unit Outcomes (in cognitive domain)	Topics and Sub-topics
	transmission line. 1d. Describe with sketches the construction method of the given type of transmission/ disribtion line.	1.4 Characteristics of high voltage for power transmission. 1.5 Method of construction of electric supply transmission system – 110 kV, 220 kV, 400 kV. 1.6 Method of construction of electric supply distribution systems – 220 V, 400V, 11 kV, 33 kV
Unit– II Transmission Line Parameters and Performance	2a. Describe with sketches the given line parameters and types of specified lines. 2b. Interpret the performance of the specified short line. 2c. Interpret the performance of the specified medium line. 2d. Describe the need for transposition of conductors. 2e. Explain specified effects occurring in the given type of transmission line.	2.1 **Line Parameters:** Concepts of R, L and C of line parameters and types of lines. 2.2 **Performance of short line:** Efficiency, regulation and its derivation, effect of power factor, vector diagram for different power factor. 2.3 **Performance of medium line:** representation, nominal 'T', nominal 'π' and end condenser methods. 2.4 Transposition of conductors and its necessity. 2.5 Skin effect and proximity effect.
Unit– III Extra High Voltage Transmission	3a. Explain the specified features of the given type of extra high voltage transmission line. 3b. Explain the specified effects occurring in the given type of high voltage transmission line. 3c. Describe with sketches the layout of given HVDC transmission line as per the given criterion. 3d. Explain the given feature of the Flexible AC Transmission line. 3e. Explain the features of given wireless transmission of electrical power.	3.1. **Extra High Voltage AC (EHVAC) transmission line:** Necessity, high voltage substation components such as transformers and other switchgears, advantages, limitations and applications and lines in India. Ferranti and Corona effect. 3.2. **High Voltage DC (HVDC) Transmission Line:** Necessity, components, advantages, limitations and applications. Layout of monopolar, bi-Polar and homo-polar transmission lines. Lines in India. 3.3. Features of EHVAC and HVDC transmission line. 3.4. Flexible AC Transmission line: Features, d types of FACTS controller. 3.5. New trends in wireless transmission of electrical power.
Unit –IV A.C Distribution System	4a. Describe with sketches the circuit components of the AC distribution system. 4b. Describe the factors to be considered for design of specified feeder and	4.1. AC distribution: Components classification, requirements of an ideal distribution system, primary and secondary distribution system. 4.2. Feeder and distributor, factors to be considered in design of feeder and

Unit	Unit Outcomes (in cognitive domain)	Topics and Sub-topics
	distributor. 4c. Describe with sketches the types of different schemes for given type of distribution system. 4d. Calculate the sending end and receiving end voltage of the given AC distribution system. 4e. Describe with sketches the components and their functions for the given type of distribution sub-station. 4f. Describe with sketches the single line diagram of a given type of distribution sub-station.	distributor. 4.3. Types of different distribution schemes: radial, ring, and grid, layout, advantages, disadvantages and applications. 4.4. Voltage drop, sending end and receiving end voltage. 4.5. Distribution Sub-Station: Classification, site selection, advantages, disadvantages and applications. 4.6. Single Line diagram (layout) of 33/11KV Sub-Station, 11KV/400V sub-station, symbols and functions of their components.
Unit-V Components of Transmission and Distribution Line	5a. Describe with sketches the given type of overhead conductor based on the given criteria. 5b. Describe with sketches the method of erection of the given type of line supports. 5c. Describe with sketches the types and properties of specified line insulator(s). 5d. Calculate the string efficiency for the specified string of the given type of insulator. 5e. Describe with sketches the specified underground cable based on the given criteria.	5.1 **Overhead Conductors:** Properties of material, types of conductor with trade names, significance of sag. 5.2 **Line supports:** Requirements, types of line structures and their specifications, methods of erection. 5.3 **Line Insulators:** Properties of insulating material, selection of material, types of insulators and their applications, causes of insulator failure, derivation of equation of string efficiency for string of three suspension insulator, methods of improving string efficiency. 5.4 **Underground Cables:** Requirements, classification, construction, comparison with overhead lines, cable laying and cable jointing.

***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	Basics of Transmission and Distribution	06	02	04	04	10
II	Transmission Line Parameters and Performance	12	04	04	08	16

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
III	Extra High Voltage Transmission	06	04	04	06	14
IV	A.C Distribution System	12	02	06	08	16
V	Components Transmission and Distribution Line	12	02	06	06	14
	Total	**48**	**14**	**24**	**32**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)*

Note*: This specification table provides general guidelines to assist students for their learning and to teachers to teach and assess students with respect to attainment of 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 based on transmission line network in Maharashtra.
b. Collect the information on components of transmission line.
c. Evaluate transmission line performance parameters of a given line.
d. Library /Internet survey of electrical high voltage line and HVDC lines.
e. Visit to 33/11 KV and 11KV/400V Distribution Substation and write a report

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

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

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

12. SUGGESTED MICRO-PROJECTS

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

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

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

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

a. Prepare a model showing:
   i. Single line diagram of electric supply system.
   ii. Single line diagram of a given distribution system.
   iii. Short line and medium transmission line.
   iv. Write a report on the same by giving the details of lines in Maharashtra State.
b. Collect different samples of Overhead Conductors, Underground Cables, Line supports and Line Insulators.
c. Prepare a power point presentation:
   i. Extra High Voltage AC Transmission line.
   ii. High Voltage DC Transmission line.
   iii. Flexible AC Transmission line.
   iv. New trends in wireless transmission of electrical power.
d. Collect information on:
   i. A.C Distribution System adjacent to your institute.
   ii. Draw a layout diagram of 11KV/400 V substation in your campus/ adjacent substation.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Principles of Power System	Mehta, V.K.	S.Chand and Co. New Delhi ISBN : 9788121924962
2	A Course in Electrical Power	Soni;Gupta; Bhatnagar	Dhanpat Rai and Sons New Delhi ISBN : 9788177000207
3	A Course in Power Systems	Gupta,J.B.	S.K. Kataria and sons New Delhi ISBN: 9788188458523
4	A Textbook of Electrical Technology Vol. III	Theraja, B.L.; Theraja, A.K.	S.Chand and Co. New Delhi ISBN : 9788121924900
5	A Course in Electrical Power	Uppal,S.L.	S.K.Khanna Publisher New Delhi ISBN : 9788174092380
6	Electrical Power Transmission and Distribution	Sivanagaraju S.; Satyanarayana S.	Pearson ISBN : 8131707911, 9788131707913
7	Electrical Power System: A First Course	Ned Mohan	Wiley India Pvt. Ltd. New Delhi ISBN:9788126541959
8	Power System Analysis and Design	Gupta, B.R.	S.Chand and Co. New Delhi ISBN : 9788121923388
9	Electrical Power Distribution System	Kamraju, V.	Tata Mc.Graw Hill, New Delhi ISBN : 9780070151413

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. https://energy.gov/sites/prod/files/2013/07/f2/Transmission_Woodall_0.pdf
b. www.tpud.org/.../An_Introduction_to_Electric_Power_Transmission_Presentation.pdf
c. https://en.wikipedia.org/wiki/Electric_power_transmission
d. www.nct-tech.edu.lk/Download/.../Performance%20of%20Transmission%20Lines..pd...
e. https://www.electrical4u.com/performance-of-transmission-line/
f. https://www.slideshare.net/SumitKumar58/ppt-of-ehv-ac-transmission
g. https://www.slideshare.net/SameerGupta8/hvdc-vs-hvac
h. https://www.slideshare.net/sagnikroychowdhury/hvdc-presentation-13232932
i. http://www.nct-tech.edu.lk/Download/Technology%20Zone/Distribution % 20 Systems% 20-%20General..pdf
j. https://www.slideshare.net/surajprasad12/distribution-systems-44252619
k. https://www.slideshare.net/pbknprabhakaran/power-transmission-distribution
l. https://www.slideshare.net/gsgindia/construction-ehv-transmission-line
m. www.nptelvideos.in/electrical power

Program Name : **Electrical Engineering Program Group / Diploma in Industrial Electronics**

Program Code : **EE/EP/EU/IE**

Semester : **Fourth**

Course Title : **Industrial Measurements**

Course Code : **22420**

1. RATIONALE

In industry, engineering diploma holders (also called technologists) are expected to handle basic instruments for the measurement of various process parameters such as temperature, pressure, flow and level in different types of industries. The technologists should be able to select proper instruments for the measurement of above parameters and also maintain these instruments for for proper functioning in different applications. This course has been therefore designed to develop this competency and related outcomes.

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 different transducers used for measurement of various parameters.**

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 transducers for measuring various parameters.
b) Maintain the different types of pressure transducers.
c) Maintain the different types of flow transducers.
d) Maintain the different types of level transducers.
e) Maintain the different types of temperature transducers.

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.

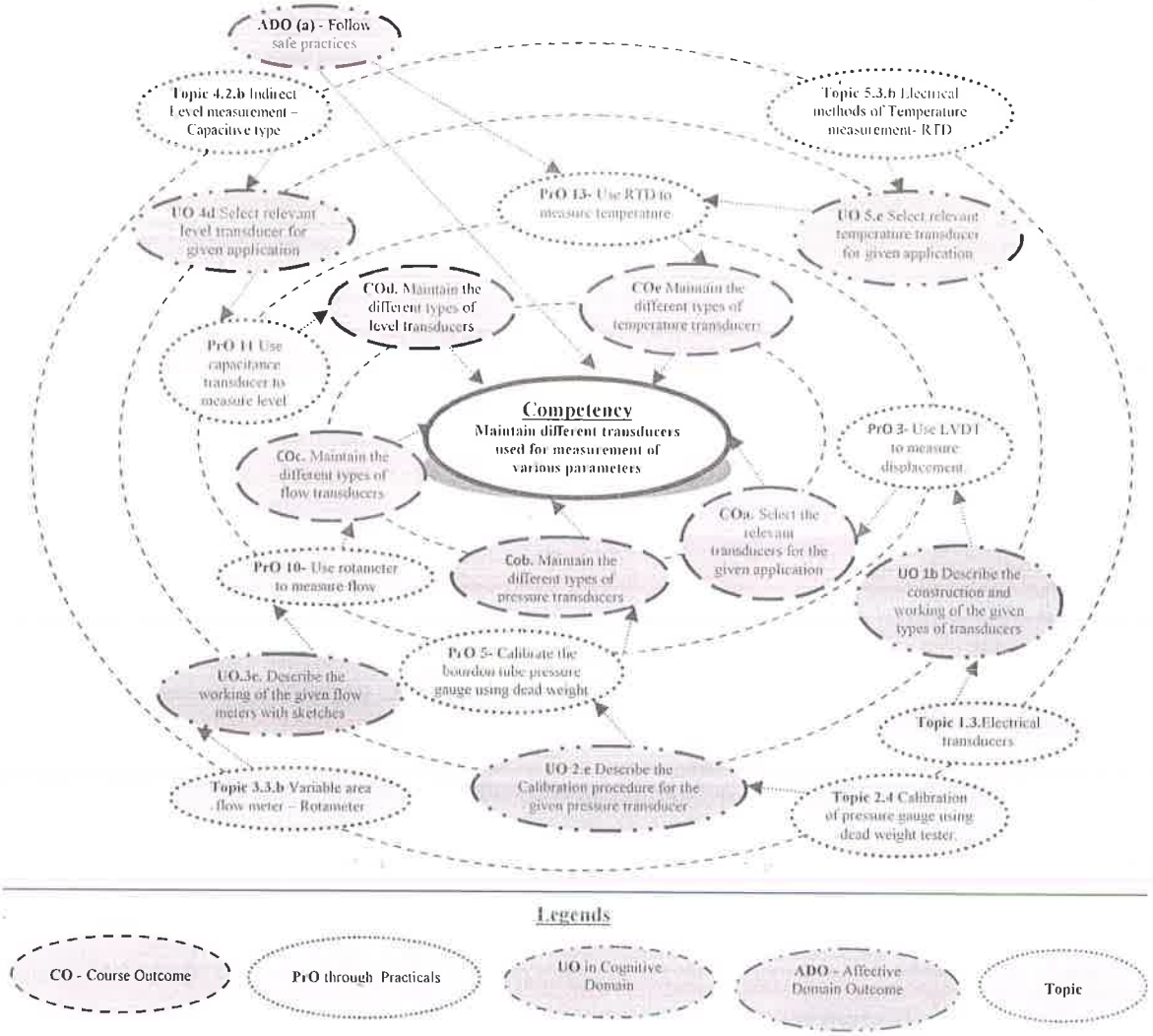

Figure 1 - Course Map

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	Use the potentiometer to measure the linear displacement	I	02*
2	Use the potentiometer to measure the angular displacement	I	02
3	Use LVDT to measure displacement.	I	02
4	Use the strain gauge to measure weights.	I	02
5	Use Bourdon tube pressure gauge to measure pressure	II	02*
6	Calibrate the bourdon tube pressure gauge using dead weight tester	II	02
7	Assemble/dismantle digital pressure measurement system	II	02
8	Use orifice meter for flow measurement	III	02*
9	Use venturimeter for flow measurement	III	02
10	Use rotameter for flow measurement	III	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
11	Use capacitance transducer to measure level	IV	02*
12	Use air purge method to measure level	IV	02
13	Use RTD to measure temperature	V	02*
14	Use Thermocouple to measure temperature	V	02
15	Calibrate RTD temperature measuring instruments	V	02
16	Calibrate Thermocouple temperature measuring instruments	V	02
	Total		**32**

Note

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

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

S. No.	Performance Indicators	Weightage in %
a.	Preparation of experimental setup	20
b.	Setting and operation	20
c.	Safety measures	10
d.	Observation 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. Demonstrate working as a leader/a team member.
d. Maintain tools and equipment.
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 help in uniformity in conduct of experiments, as well as aid to procure equipment by authorities concerned.

S. No.	Equipment Name with Broad Specifications	Pro. S. No.
1	**LVDT trainer kit**- Displacement range +/- 20 mm. Accuracy of +/- 2% Primary Excitation 4 KHZ and 1 Volt. RMS Output : Digital display of +/- 20mm	3
2	**Strain gauge trainer kit**: Strain gages of 350 ohms. Accuracy: +/- 1% Power Supply 230 Vac. maximum of 5-kg load. Digital indication	4
3	**Bourdon tube pressure gauge**: Input pressure range 0 – 50 psi. Accuracy of +/- 2%. Dial gauge indication in the range 0 to 50 psi.	5
4	**Dead weight tester :** Input range 0-10 kg. Output on dial gauge 0 – 10kg/cm^2	6
5	**Orifice meter measurement setup:** 1''line size, concentric type. MOC-SS, U tube manometer 400 mm height, Range 0-1000LPH, Digital display	8
6	**Ventury flow measurement setup:** 1''line size, MOC-SS, U tube manometer 400 mm height. Range 0-1000LPH, Digital display	9
7	**Rotameter flow measurement setup:** Range 0-1000 LPH, Glass tube body, Bob Material-SS, connection 1'', Mounting inlet bottom top outlet.	10
8	**Capacitance level measurement:** Input range 0-500 mm, power supply 230 V ac , 2 wire capacitance type, top mounted, Digital display indication of 0 – 500mm.	11
9	**Air purge level measurement:** Level tank ,height 0-500mm ,air pressure regulator ¼" valve ,air compressor with ¼" connection and pressure gauge power supply 230 Vac, Level indication	12
10	**RTD temperature measurement:** Temp range 0-100 ^{0}C digital, temp bath, RTD Type pt100,accuracy +/- 1% , power supply 230v ac,	13
11	**Thermocouple temperature measurement:** Temp range 0-200^0 c, temp bath, Thermocouple K Type ,accuracy of +/- 1% , power supply 230v ac, digital indication of temp	14

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 Applications of Transducers	1a. Describe with sketches function of the given components used in instrumentation system. 1b. Explain with sketches the construction and working of the given type (s) of transducer(s). 1c. Differentiate the working of the given types of transducers with sketches. 1d. Select relevant transducer for given application with justification. 1e. Prepare the specification of	1.1 Function of each block of Instrumentation system. 1.2 Transducer: Need, Classification - Active and Passive, Analog and Digital, Primary and Secondary, Mechanical and Electrical. 1.3 Electrical Transducers: Resistive transducers- Linear and Angular potentiometers, strain gauge, types, gauge factor. 1.4 Capacitive transducer. 1.5 Inductive transducer –LVDT, RVDT 1.6 Piezoelectric transducer, photo electric transducer-LDR, photo voltaic cell.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	given transducer.	1.7 Selection criteria of transducers.
Unit– II Pressure measurement	2a. Describe with sketches the construction of the given type of pressure transducer. 2b. Explain with sketches the working of the given type of pressure transducer with sketches. 2c. Select the relevant pressure transducer for the given application with justification 2d. Describe with sketches the calibration procedure for the given pressure transducer. 2e. Prepare the specification of the given pressure transducer. 2f. Describe with sketches the procedure to troubleshoot the given type of pressure transducer.	2.1 Pressure and its units, Types - Absolute, Gauge, Atmospheric, Vacuum. 2.2 Classification of Pressure measuring devices: a. Manometer-U tube, Inclined Tube, Well type manometer b. Elastic pressure transducer: Bourdon Tube Bellows, Diaphragm, Capsule c. Electrical pressure transducers: Bourdon tube with LVDT, Bellow with LVDT Diaphragm with Strain gauge. 2.3 Specification of electrical pressure transducer. 2.4 Calibration of pressure gauge using dead weight tester.
Unit– III Flow measurement	3a. Describe with sketches the construction of the given type of flow transducer with sketches. 3b. Explain with sketches the working of the given type of flow transducer with sketches. 3c. Differentiate the salient features of the given type of flow transducers. 3d. Select relevant flow transducer for the given application with justification. 3e. Prepare the specification of given flow transducer. 3f. Describe with sketches the procedure to troubleshoot the given type of flow transducer.	3.1 Flow and its units, Types of Flow – Laminar, turbulent, Reynolds number 3.2 Classification of flow measuring transducers: a. Variable head flow meter: Venturimeter, orifice plate meter, flow nozzle, pitot tube b. Variable area flow meter – Rotameter c. Electrical flow meter: Turbine flow meter, Electromagnetic Flow meter, Ultrasonic flow meter- Time difference and Doppler Type, Hot wire anemometer, Vortex flow meter 3.3 Positive displacement meter-nutating disc type. 3.4 Typical specifications of various flow meters.
Unit-IV Level measurement	4a. Describe with sketches the construction of the given type of level transducer. 4b. Explain with sketches the working of the given type of level transducer. 4c. Different the salient features of the given type of level	4.1 Level and its units, Classification of level measurement methods: a. Direct methods- Hook type, Sight glass, Hydrostatic type (air purge). b. Indirect measurement method: Float type with linear and rotary potentiometer, Capacitive type Ultrasonic type, Nuclear Radiation

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	transducers. 4d. Select relevant level transducer for the given application with justification. 4e. Describe with sketches the calibration procedure for the given type of level transducer. 4f. Prepare the specification of given level transducer. 4g. Describe with sketches the procedure to troubleshoot the given type of level transducer.	type, Radar type. 4.2 Typical specifications of electrical level measurement methods. 4.3 Calibration of Air purge and Capacitance type level system.
Unit –V Temperature measurements	5a. Describe with sketches the construction of the given type of temperature transducer. 5b. Explain with sketches the working of the given type of temperature transducer. 5c. Differentiate the salient features of the given types of temperature transducers. 5d. Select relevant temperature transducer for the given application with justification. 5e. Describe the calibration procedure of temperature measuring system with inputs from RTD and thermocouple. 5f. Prepare the specification of given temperature transducer. 5g. Describe with sketches the procedure to troubleshoot the given type of temperature transducer.	5.1 Temperature and its Units, temperature scales and conversions. 5.2 Classification of temperature measuring transducers: a. Filled system thermometer- vapour pressure thermometer. b. Expansion thermometer-Bimetallic thermometer. 5.3 Electrical methods- a. Thermistors, b. RTD – (PT-100, 2 /3 wire) c. Thermocouple – Law of intermediate temp and intermediate metals Seebeck and Peltier effect, Types J, K, R, S, T 5.4 Pyrometer – Optical method, Radiation method. 5.5 Typical specifications of Thermistor, RTD and Thermocouple. 5.6 Calibration of temperature measuring transducers.

***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	Applications of transducers	8	02	04	06	12

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
II	Pressure Measurement	10	02	04	08	14
III	Flow Measurement	12	02	04	10	16
IV	Level Measurement	8	02	04	08	14
V	Temperature Measurement	10	02	04	08	14
Total		**48**	**10**	**20**	**40**	**70**

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

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a. Prepare charts for measurement system using temperature, pressure, flow, level system.
b. Prepare broad specifications for basic transducers of temperature, level, pressure and flow.
c. Market survey for procurement of above transducers in point 'b'.
d. Prepare installation sketches of above transducers in point 'b'.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES

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

a. Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b. ***'L' in item No. 4*** does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
c. About ***15-20% of the topics/sub-topics*** which is relatively simpler or descriptive in nature is to be given to the students for ***self-directed learning*** and assess the development of the COs through classroom presentations (see implementation guideline for details).
d. With respect to item No.10, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
e. Arrange visit to process industries and calibration workshops.
f. Use teaching aids such as videos/ YouTube of process industries.
g. Arrange expert lectures of industry person.
h. In respect of item 10 above, teachers need to ensure to create opportunities and provisions for such co-curricular activities.
i. Instruct students to safety concern of handling various transducers.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are

group-based. However, in the fifth and sixth semesters, it should be preferably be ***individually*** undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should ***not exceed three.***

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

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

a. Use RTD for indication of temperature.
b. Use Thermistor for indication of temperature.
c. Use level transducer for indicating and controlling the level of water tank.
d. Use float type level sensor for indication of level of water tank.
e. Use pressure transducer for indicating and controlling the compressor utility system.
f. Use strain gauge for weight measurement in simple platform.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Electrical and Electronic Measurements and Instrumentation	Sawhney, A.K.	Dhanpat Rai and Sons, N. Delhi 201; ISBN:9788177001006
2	Industrial Instrumentation and Control	Singh, S.K.	McGraw Hill Publishing; N. Delhi 2010; ISBN:9780070678200
3	Principles of Industrial Instrumentation	Patranabis, D.	McGraw Hill Publishing Co. Ltd; N. Delhi 2010; ISBN:9780070699717
4	Instrumentation Systems and Devices	Rangan,C.S; Sharma, G. R ; Mani,S.V.	McGraw Hill Publishing; N. Delhi 2011; ISBN:9780074633502
5	Process Measurement Instrument Engineers Handbook	Liptak,B.G.	Chilton Book Co. U.S.A 1970 ISBN:9780750622547
6	Instrumentation, measurement and analysis	Nakra,B.C; Choudhry, K.K.	McGraw Hill Publishing; N. Delhi 2015; ISBN:9780070151277

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. www.nptel.ac.in/courses/108105064/#
b. www.engineeringtoolbox.com/flow-meters-d_493
c. www.instrumentationtools.com/category/level-measurement/
d. www.web.mst.edu/~cottrell/ME240/Resources/Temperature/Temperature.pdf
e. www.instrumentationtools.com/how-rtd-measuring-the-temperature/
f. www.instrumentationtools.com/category/pressure-measurement/
g. www.electronics-tutorials.ws/io/io_3.html
h. www.isa.org

Program Name : **Electrical Engineering Program Group**

Program Code : **EE/EP/EU**

Semester : **Fourth**

Course Title : **Digital Electronics and Microcontroller Applications**

Course Code : **22421**

1. RATIONALE

In the present scenario most of the electronic equipment like computers, mobiles, music systems, ATM, automation and control circuits and systems are based on digital circuits which the diploma electronic engineering passouts (also called technologists) have to test them. The knowledge of basic logic gates, combinational and sequential logic circuits using discrete gates as well as digital ICs will enable the students to interpret the working of equipment and use them. Diploma engineers have to deal with various microcontroller based systems used in domestic, industrial and consumer goods. This course is intended to provide the back knowledge of digital electronics required to use microcontroller-based s 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:

- **Used digital electronics and microcontroller based 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. Use Boolean expressions to realize logic circuits.
b. Build simple combinational and sequential circuits.
c. Analyse the architecture of microcontroller ICs .
d. Write programs in assembly language for micro controllers.
e. Interface the memory and I/O devices to microcontrollers.

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
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 centre of this map.

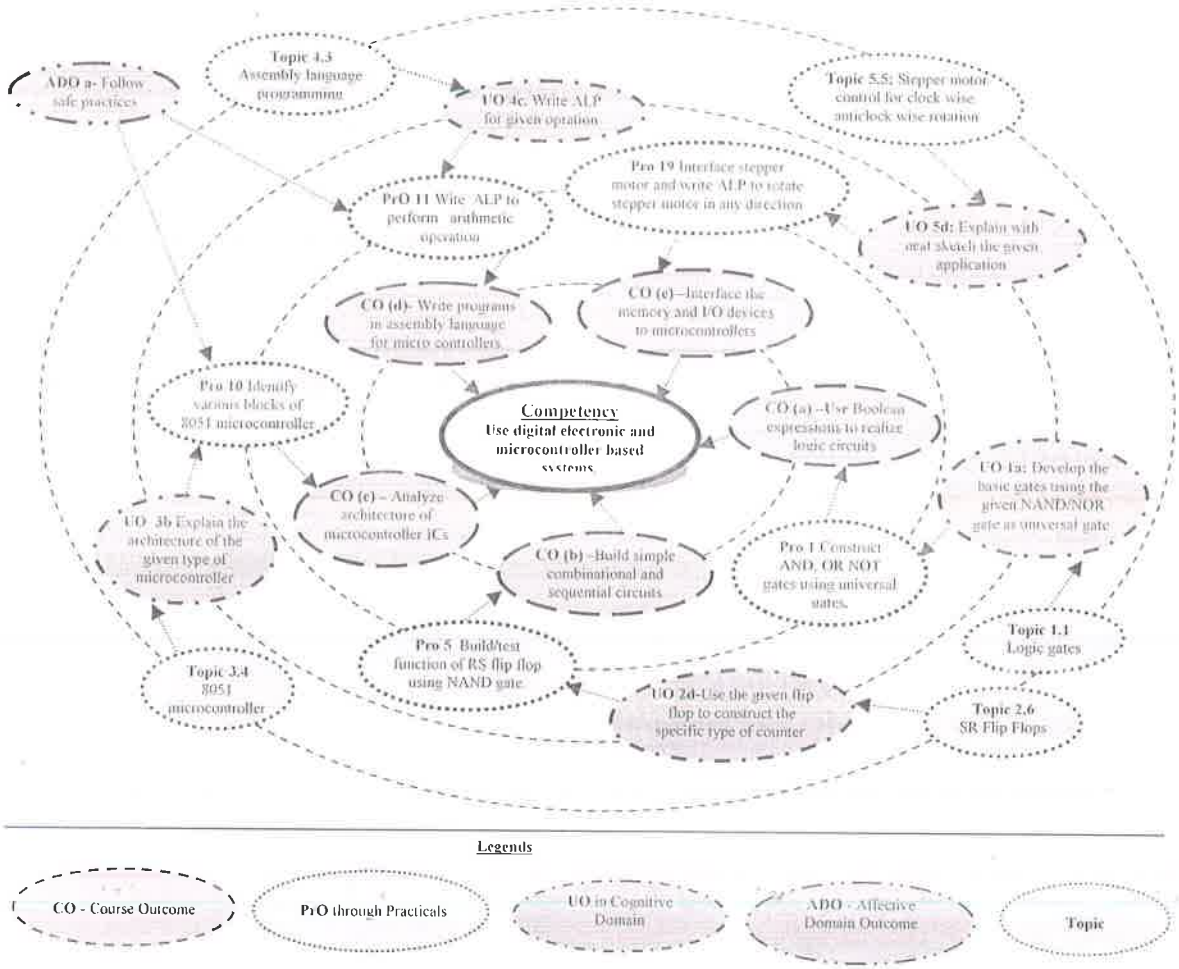

Figure 1 - Course Map

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	Construct AND, OR, NOT gates using universal gates.	I	02*
2	Build the logic circuit on breadboard to check the De Morgan's theorems.	I	02*
3	Design Half adder and Half subtractor using Boolcan expressions.	II	02
4	Design Full adder and full subtractor.	II	02*
5	Build / test function of RS flip flop using NAND Gate.	II	02
6	Build / test function of MS JK flip flop using 7476.	II	02
7	Use IC 7476 to construct and test the functionality of D and T flip flop.	II	02*
8	Implement 4 bit ripple counter using 7476.	II	02
9	Implement 4 bit universal shift register.	II	02
10	Identify various blocks of 8051 microcontroller.	III	02*
11	Write an assembly language program (ALP) to perform following	IV	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	arithmetic operations on 8-bit data:-addition, subtraction, multiplication and division.		
12	Write an ALP to transfer data from source to destination location of internal data memory.	IV	02*
13	Write an ALP to transfer data from source to destination location of external data memory.	IV	02
14	Write an ALP to exchange data from source to destination memory location.	IV	02
15	Inteface LED with 8051 to turn on the LED.	V	02
16	Interface 7-segment display to display decimal number from 0 to 9.	V	02*
17	Inteface the given keyboard with 8051and display the key pressed.	V	02
18	Inteface LCD with 8051 microcontroller to display the alphabets and decimal numbers.	V	02
19	Interface stepper motor and write ALP to rotate stepper motor in clockwise and anti-clockwise direction at given angles.	V	02*
	Total		**38**

Note

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

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

S. No.	Performance Indicators	Weightage in %
1	Preparation of experimental set up	20
2	Setting and operation	20
3	Safety measures	10
4	Observations and recording	10
5	Interpretation of result and conclusion	20
6	Answer to sample questions	10
7	Submission of report in time	10
	Total	**100**

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

a. Follow 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	Digital Multimeter: 3 and ½ digit with R. V. I measurements, diode and BJT testing.	All
2	CRO : Dual Channel, 4 Trace CRT / TFT based Bandwidth 20 MHz/30 MHz X10 magnification 20 ns max sweep rate, Alternate triggering Component tester and with optional features such as Digital Read out.	01-09
3	DIGITAL IC tester: Tests a wide range of Analog and Digital IC's such as 74 Series, 40/45 Series of CMOS IC's.	01-09
4	Bread Board Development System: Bread Board system with DC power output 5V, +/-12V and 0-5V variable , digital voltmeter , ammeter, LED indicators 8 no, logic input switches 8 no, 7 segment display 2 no, clock generator, Manual pulser, Breadboard with about 1,600 points, Potentiometer, relay etc	01-09
5	Trainer kits for digital ICs: Trainer kit shall consists of digital ICs for logic gates, flop-flop, shift registers, counter along with toggle switches for inputs and bi-colour LED at outputs, built in power supply.	01-09
6	Regulated power supply: Floating DC Supply Voltages Dual DC : 2 x 0 -30V; 0-2 A Automatic Overload (Current Protection) Constant Voltage and Constant Current Operation Digital Display for Voltage and Current Adjustable Current Limiter Excellent Line and Load Regulation	01-09
7	Microcontroller kit :-single board systems with 8K RAM,ROM memory with battery back up,16X4,16 X2, LCD display,PC keyboard interfacing facility, Hex keypad facility, single user cross c-compiler,RS-232,USB, interfacing facility with built in power supply.	All
8	Desktop PC with microcontroller simulation software	All
9	Stepper Motor, 50/100 RPM	19
10	Keyboard 4*4trainer board	17
11	7-segment LED Display:- 0.56 in 1-digit, common anode/common cathode	16
12	LCD trainer board	18

8. UNDERPINNING THEORY COMPONENTS

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

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Logic gates and logic families	1a. Develop the basic gates using the given NAND/NOR gate as universal gate. 1b. Simplify the given expression using Boolean laws. 1c. Develop the logic circuits using the given Boolean expressions. 1d. Compare the salient characteristics of the given digital logic families.	1.2 **Logic gates**: Symbol, diode/ transistor switch circuit and logical expression , truth table of basic logic gates (AND, OR, NOT), Universal gates (NAND and NOR) and Special purpose gates (EX-OR, EX-NOR) 1.3 **Boolean algebra**: Laws of Boolean algebra, Duality Theorem, De-Morgan's theorems 1.4 **Logic Families**: Characteristics of logic families : Noise margin, Power dissipation, Figure of merit , Fan-in and fan-out, Speed of operation, Comparison of TTL, CMOS, ECL, types of TTL NAND gate
Unit– II Combinational Logic and Sequential Logic Circuits	2a. Develop logic circuits in standard SOP/ POS form for the given logical expression. 2b. Minimize the given logic expression using K-map. 2c. Draw MUX/DEMUX tree for the given number of input and output lines. 2d. Use the given flip flop to construct the specified type of counter. 2e. Use excitation table of the given flip-flop to design synchronous counter. 2f. Construct asynchronous/ synchronous counter using the given flip-flop.	2.1 **Standard Boolean representation:** Sum of Product (SOP) and Product of Sum(POS) 2.2 K-map reduction technique for the Boolean expression 2.3 **Design of arithmetic circuits and code converter using K-map:** Half and full Adder, gray to binary and binary to gray (up to 4 bits) 2.4 **Multiplexer and Demultiplexer:** working , truth table and applications of Multiplexers and Demultiplexures 2.5 **Basic memory cell**: RS-latch using NAND and NOR 2.6 **SR Flip Flops**: SR-flip flop, clocked SR flip flop with preset and clear, drawbacks of SR flip flop 2.7 **JK Flip Flops**: Clocked JK Flip flop with preset and clear, Master slave JK flip flop, D and T type flip flop Excitation table of flip flops 2.8 **Counters:** Asynchronous counter Synchronous counter
Unit – III Basics of Microprocessor and 8051 Microcontroller	3a. Compare the salient features of the microprocessor , microcontroller and microcomputer for the given parameters. 3b. Explain given type of microcontroller architecture using the block diagram. 3c. Describe with sketches the	3.1 Microprocessor ,microcomputers, and microcontrollers (basic introduction and comparison) 3.2 Types of buses,address bus,data bus and control bus 3.3 Harvard and Von-neuman architecture 3.4 8051 microcontroller: Architecture , Pin configuration, stack ,memory organization

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	memory organization of 8051 microcontroller. 3d. Compare the salient features of the given derivatives of 8051 microcontroller.	3.5 Boolean processor . power saving options - idle and power down mode 3.6 Comparison between derivatives of 8051 (8951,8952,8031,8751)
Unit-IV 8051 Instruction Set and programming	4a. Identify addressing mode of the given instruction. 4b. Describe function of given instruction with suitable examples. 4c. Write an assembly languge program(ALP) for the given operation. 4d. Explain the use of given assembler directives with examples.	4.1 Addressing modes; Instruction set (Data transfer, Logical, Arithmatic, Branching, Machine control, Stack operation, Boolean) 4.2 Assembly language programming (ALP) 4.3 Software development cycle: editor,assembler,cross-compiler, linker,locator,compiler 4.4 Assembler Directives: ORG, DB, EQU, END, CODE, DATA
Unit–V 8051 Memory , device Interfacing And Application	5a. Describe with sketches the procedure to interface the given external memory. 5b. Explain with sketch the interfacing of the given external I/O device. 5c. Write an assembly languge program to operate the given I/O device. 5d. Explain with sketches the working of the given microcontroller application.	5.1 Memory interfacing :-Program and data memory 5.2 I/O Interfacing:-LED, relays, keyboard, LCD, seven segment display, Stepper motor. 5.3 Square wave generation using port pins of 8051 5.4 Water level controller 5.5 Stepper motor control for clock wise, anticlock wise rotation 5.6 Traffic light controller

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	Logic gates and logic families	12	02	04	06	12
II	Combinational Logic and Sequential Logic Circuits	16	04	06	08	18
III	Basics of Microprocessor and 8051 Microcontroller	14	04	04	08	16
IV	8051 Instruction Set and programming	12	02	04	06	12
V	8051 Memory ,I/O device Interfacing and Applications	10	02	04	06	12
Total		**64**	**14**	**22**	**34**	**70**

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

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a. Prepare journals based on practical performed in laboratory.
b. Follow the safety precautions.
c. Give seminar on relevant topic.
d. Library / Internet survey regarding different data books and manuals.
e. Prepare power point presentation on digital circuit microcontroller applications.
f. Undertake a market survey of different IC and 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.
f. Demonstrate students thoroughly before they start doing the practice.
g. Encourage students to refer different websites to have deeper understanding of the subject.
h. Observe continuously and monitor the performance of students in Lab.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably be ***individually*** undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should ***not exceed three.***

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

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

a. Build a circuit to test 7 segment display.
b. Build a circuit to implement debounce switch.
c. Build a circuit for LED flasher using D/T flip flop and continuous pulse using NOT/NAND gate.
d. Build a circuit for LED flasher using ring counter and negative edge triggering pulse.
e. Build a circuit for LED flasher using twisted ring counter and continuous pulse using NOT/NAND gate.
f. Build a circuit for object counter using 7490. Use LED-LDR or LED-Photodiode combination as clock input.
g. Build a circuit for water level indicator.
h. Prepare a chart of various features using data sheets of 8051 microcontroller and its derivatives.
i. Prepare a chart of stepper motor to display its features and steps for its operations using data sheets.
j. Prepare a chart of various features and operations of temepature sensors using data sheets.
k. Prepare a chart of various types of LCDs to display its features,pin functions and steps of operations using data sheets.
l. Prepare a chart of various types of seven segment displays,keyboard to display its features and steps for its operations using data sheets.
m. Build a circuit to turn the buzzer ON after 10 seconds.
n. Build a class period bell using microcontroller.
o. Build a room temperature measurement circuit using microcontroller.
p. Build stepper motor controller using microcontrollers.
q. Build traffic light controller for specified delay.
r. Build a water level controller for given parameters.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Modern Digital Electronics	Jain, R.P.	McGraw-Hill Publishing, New Delhi, 2009; ISBN: 9780070669116
2	Digital Electronics	Puri, V.K.	McGraw Hill , New Delhi, , 2016, ISBN: 97800746331751
3	Digital Circuits and Design	Salivahanan S.; Arivazhagan S.	Vikas Publishing House, New Delhi, 2013, ISBN: 9789325960411
4	Digital Principles	Malvino, A.P.; Leach, D.P.; Saha G.	McGraw Hill Education, New Delhi, 2014, ISBN : 9789339203405
5	8051 Microcontroller Architecture Programming and Application	Kenneth, Ayala	EEE/Prentice Hall of India, , New Delhi, 2004, ISBN: 978-1401861582
6	The 8051 Microcontroller and Embedded system	Mazidi, Mohmad Ali; Mazidi, Janice Gelispe; Mckinlay Roline D.	Pearson Education, Delhi,2008, ISBN 978-8177589030
7	Microcontroller Principle and Application	Pal, Ajit	PHI Learning,New Delhi,2014, ISBN13: 978-81-203-4392-4

S. No.	Title of Book	Author	Publication
8	Microcontroller Theory and Application	Deshmukh, Ajay	Mc Graw Hill., New Delhi,2011, ISBN- 9780070585959
9	Microcontroller Architecture Programming, Interfacing and System Design	Kamal, Raj	Pearson Education India, Delhi,2012, ISBN: 9788131759905
10	Microprocessors and Microcontrollers	Mathur:Panda	PHI Learning, 2016, ISBN:978-81-203-5231-5
11	Microprocessors and Microcontrollers:Architecture programming and System Design	Krishna Kant	PHI Learning, 2016, ISBN:978-81-203-4853-0

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. www.codesandtutorials.com/hardware/electronics/digital_codes-types.php
b. www.rogtronics.net/files/datasheets/dac/SedraSmith.pdf
c. Simulation software:-www.keil.com
d. Microcontroller:- www.faqs.org/microcontroller
e. Microcontroller:- www.nptel.ac.in/courses/Webcourse-contents/IITKANPUR/microcontrollers/micro/ui /Course_home2_5.htm
f. Memory:- www.slideshare.net/aismahesh/memory-8051
g. 8051 microcontroller:- www.intorobotics.com/8051-microcontroller-programming-tutorials- simulators-compilers-and-programmers/
h. Microcontroller instructions:- www.electrofriends.com/articles/electronics/microcontroller-electronics-articles/8051-8951/80518951-microcontroller-instruction-set/
i. Microcontroller:- www.ikalogic.com/part-1-introduction-to-8051-microcontrollers
j. Microcontroller:- www.binaryupdates.com/switch-with-8051-microcontroller/
k. Software:-www.edsim51.com
l. Microcontroller:- www.mikroe.com/chapters/view/64/chapter-1-introduction-to-microcontrollers/
m. Microcontroller project:- www.8051projects.net/download-c4-8051-projects.html

Program Name : **Diploma in Production Engineering/Production Technology/ Mechanical Engineering/Civil Engineering/Electrical Engineering**

Program Code : **PG/PT/ME/CE/CR/CS/EE/EP/EU**

Semester : **Fourth**

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.

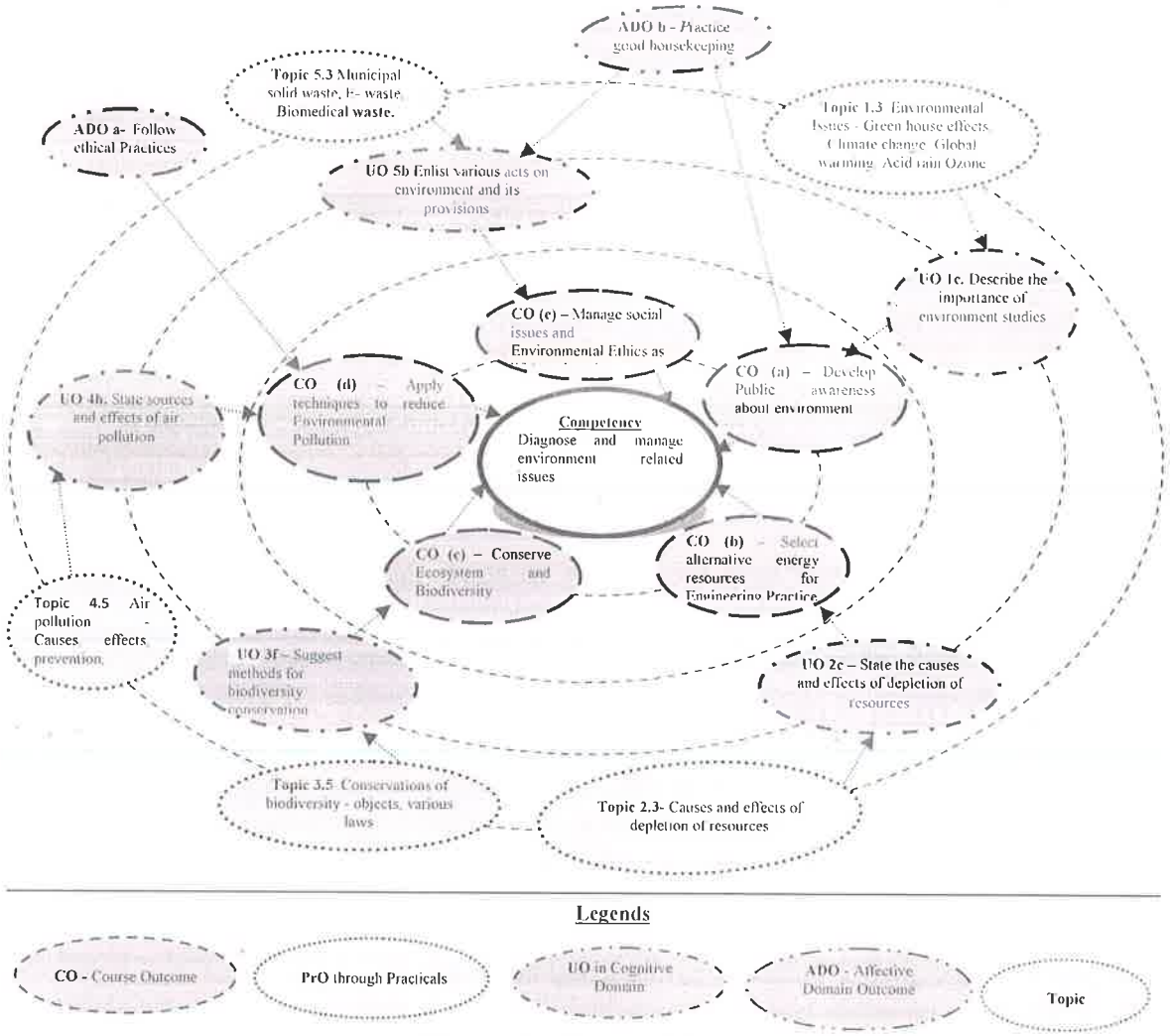

Figure 1 - Course Map

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
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	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,

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	environmental issues.	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. 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.	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 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,

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	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.	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	4	16
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