Maharashtra State Board of Technical Education, Mumbai

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

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

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

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

Semester : 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	Linear Integrated Circuits	LIC	22423	4	-	2	6	3	70	28	30*	00	100	40	25#	10	25	10	50	20	150
2	Microcontroller and Applications	MAA	22426	4	-	2	6	3	70	28	30*	00	100	40	25#	10	25	10	50	20	150
3	Basic Power Electronics	BPE	22427	3	-	2	5	3	70	28	30*	00	100	40	25@	10	25	10	50	20	150
4	Industrial Transducers	ITR	22432	4	2	4	10	3	70	28	30*	00	100	40	50#	20	50	20	100	40	200
5	VB.net Elementary Programming	VBN	22037	2	-	2	4	--	--	--	--	--	--	--	25@	10	25~	10	50	20	50
			Total	**17**	**2**	**12**	**31**	--	**280**	--	**120**	--	**400**	--	**150**	--	**150**	--	**300**	--	**700**

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

Theory and practical periods of 60 minutes each. Total Marks : **700**

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

Program Code : **IS / IC**

Semester : **Fourth**

Course Title : **VB.net Elementary Programming**

Course Code : **22037**

1. RATIONALE

Visual basic.net programming language is used to write efficient, compact and portable interfaces, drivers, software. This course will help the diploma pass-outs to develop applications having interfacing between front-end and back-end and graphical representation of data, using different types of controls. This course provide basic foundation of VB.net programming which will enable students to implement programs and interfaces along with generation of different kinds of reports in the real world of work such as SCADA.

2. COMPETENCY

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

- **Develop simple GUI based applications using Visual Basics.net.**

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 Visual Basic.net IDE to design simple applications.
b. Use basic VB.net controls to develop simple applications.
c. Use advanced VB.net controls with events.
d. Represent data graphically.
e. Interface the front-end and back-end (data) in Visual Basic.net.
f. Manage files using different controls.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme													
				Theory							Practical						
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total		
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	
2	-	2	4	-	-	-	-	-	-	-	25@	10	25~	10	50	20	

*(~): 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. 15 marks) and micro-project assessment (seen in section 12) has a weightage of 40% (i.e. 10 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 Examination*

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

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of

the course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

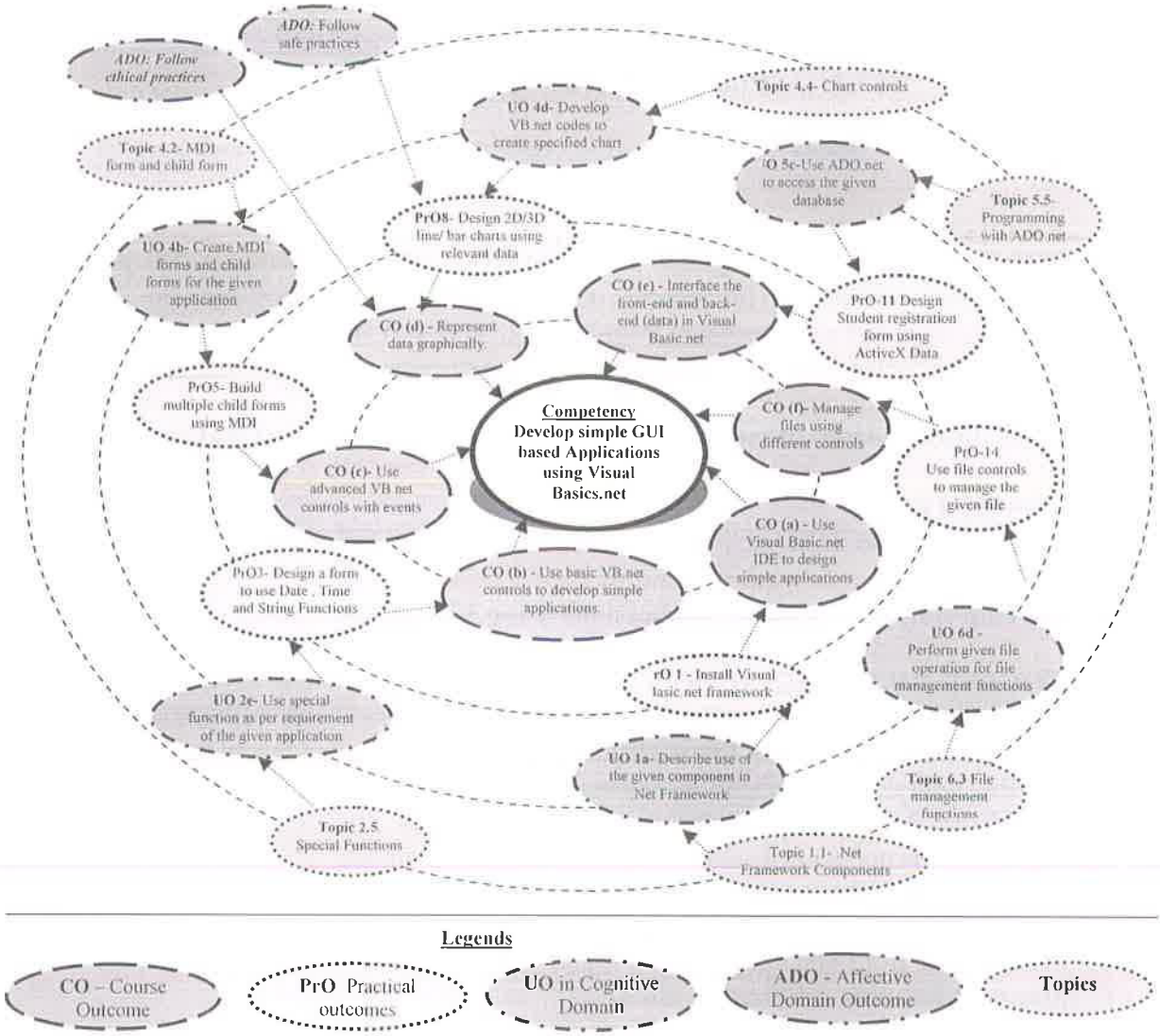

Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

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

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Install Visual Basic.net framework.	I	02*
2	Design a form to perform all Mathematical Operations with InputBox and MessageBox.	II, III	02*
3	Design a form to use Date , Time and String Functions.	II, III	02*
4	Design a form using picture box and timer Control to rotate the original image after certain fixed time.	III	02*
5	Build multiple child forms using MDI and include Menus like File , View , Help etc. (Part-I)	III	02*
6	Build multiple child forms using MDI and include Menus like File , View , Help etc. (Part-II)	III	02*
7	Use graphics functions such as line , circle, load picture,	IV	02*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	paint picture, and basic shapes.		
8	Design 2D/3D line/ bar charts using relevant data.	IV	02*
9	Design 2D/3D Pie charts using relevant data.	IV	02
10	Design Student registration form using ActiveX Data Object with Access as backend for date of birth using Date Time Picker.	V	02*
11	Design Student registration form using ActiveX Data Object with Access as backend for date of birth using Month View Control.	V	02
12	Generate Crystal report for experiment no.9 with relevant formatting.	V	02*
13	Generate Crystal report for experiment no.10 with relevant formatting.	V	02
14	Use file controls to manage the given file.	VI	02*
15	Use file controls to manage the given folders.	VI	02
16	Use file controls to manage the given drive controls.	VI	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 'Application Level' of Bloom's Taxonomy' as generally required by the industry.*

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

S. No.	Performance Indicators	Weightage in %
a.	Debugging ability	20
b.	Quality of output achieved (Product)	40
c.	Complete the practical in stipulated time	10
d.	Answer to sample questions	20
e.	Submit journal 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. 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 and
- '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 S. No.
1	Personal computer, (preferably i3-i5or higher processor based), RAM minimum 2 GB, Hard disk 10 GB minimum available space.	For all Experiments
2	Operating system: Windows 7/8/10	
3	Microsoft Visual Studio 2012 or later.	

8. UNDERPINNING THEORY COMPONENTS

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

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – I Visual Integrated Development Environment (IDE)	1a. Describe the use of the given component in .Net Framework. 1b. Describe the use of the given element in VB.Net IDE. 1c. Apply the given System Namespace in VB.net Application 1d. Use predefined forms in the given problem.	1.1 .Net Framework Components- Common Language Runtime (CLR),Microsoft Intermediate Language (MSIL) 1.1 Integrated Development Environment: Menu bar, toolbar, project explorer, toolbox, properties window, form designer, form layout. 2.1 Drag and drop operation. 3.1 Using predefined forms, menus and projects.
Unit– II rogramming Fundamentals	2a. Select the relevant data types for the given task. 2b. Write expression using operators for the given application. 2c. Develop Procedure/ Function for the given problem. 2d. Apply relevant control flow or Loop statement to solve the given problem. 2e. Use special function as per requirement of the given application.	2.1 Data types, variables, constants, arrays, collections. 2.2 Procedure and function. 2.3 Operators: Arithmatic, logical, relational, string functions. 2.4 Control flow statements, loop statements, nested control structure, exit statement. 2.5 Special Functions :Input Box(), Message Box(), Format() Date and Time function, financial functions.
Unit– III Basic Controls and	3a. Use basic controls and container for the given task. 3b. Apply DateTimePicker and	3.1 Basic control: text box, list box, Combo box, scroll bar, frame, option button.

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Event Handling	Month View for the given task. 3c. Apply timer control to control time based action for the given operation. 3d. Create menus and dialogs to develop the given application.	3.2 DateTimePicker control and MonthView control. 3.3 Container: Picture box, frame 3.4 Image and timer controls 3.5 Displaying dialogs. 3.6 Menus: Menu editor, popup menu
Unit-IV Modules, MDI and Working with Graphics	4a. Design class module to solve the given problem. 4b. Create MDI forms and child forms for the given application. 4c. Draw basic geometric shapes to create given figure. 4d. Develop VB.net codes to create specified chart based on the given data.	4.1 Concept of module, class module 4.2 MDI form and child form 4.3 Drawing Line, circle, box etc. 4.4 Chart controls: Pie charts, 2D and 3D Lines charts, bar and Step charts.
Unit-V Working With Data Controls	5a. Create basic databases to solve the given problem. 5b. Use relevant data control to solve the given problem. 5c. Use ADO.net to access the given database. 5d. Generate report using data and crystal reports as per the given requirement.	5.1 Introduction to Database: Database, record, record set 5.2 Data control and Its properties 5.3 Data bound controls: Text box, combo box, list box, DBgrid etc. 5.4 Working with visual Data Manager 5.5 Programming with ADO.net (ActiveX Data Object) 5.6 Report Generation using data reports and Crystal reports
Unit-VI File Handling	6a. Select relevant file as per the given application. 6b. Identify drives and directories on the given system. 6c. Use relevant component for managing drives/directories in the specified manner. 6d. Perform the given file operation for file management functions.	6.1 Types of files, The System.IO namespace 6.2 Working with drives, files, and directories: My.Computer.FileSystem 6.3 File management functions: opening and closing files, reading and writing data to files.

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

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

- 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. Prepare journals based on practical performed in laboratory.
b. Undertake survey and prepare report on features of 'VB.Net' useful for preparing SCADA application interface.
c. Undertake survey and prepare comparative analysis report of different software products useful for developing SCADA applications.

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, observe them and monitor their performance 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 notepad using Menu editor and Dialog Controls.
b. Students' placement system: Store the students' details and find the entire eligible candidate for placement.
c. Salary system: Salary calculation of employees based on their earnings and deductions.
d. Hostel room allotment system: System shows the vacant rooms available and Store the details about students to allocate them the available rooms.
e. Students' fee management system: Report the information of fees due and deposited by students.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Visual Basic .NET The Complete Reference	Jeffrey R. Shapiro	McGraw–Hill, California, USA ISBN0–07–213381–3
2	Visual Basic .NET Programming Black Book	Holzner Steven	Dreamtech Press, 2015, New Delhi, ISBN-13:978-81-7722-609-6.
3	Beginning Visual Basic 2012	Bryan Newsome	Wrox Press, USA, Edition: 2012; ISBN: 9781118311813,

14. SUGGESTED SOFTWARE/ LEARNING WEBSITES

a. http://www.vbtutor.net/index.php/visual-basic-2012-tutorial
b. http://howtostartprogramming.com/vb-net
c. https://www.tutorialspoint.com/vb.net
d. http://vb.net-informations.com
e. http://www.java2s.com/Tutorial/VB/CatalogVB.htm
f. http://www.functionx.com/vbnet

Program Name : **Electronics Engineering Programme Group**

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

Semester : **Fourth**

Course Title : **Linear Integrated Circuits**

Course Code : **22423**

1. RATIONALE

Operational Amplifier (Op-Amp) is the most versatile Linear Integrated Circuit (IC) used to develop various application in electronic circuits and equipment. Hence this course is intended to develop the skills to build, test, diagnose and rectify the Op-Amp based electronic circuits.This course deals with various aspects of Linear Integrated circuits used in various industrial,consumer and domestic 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:

- **Maintain electronic circuits consisting of Linear Integrated Circuits**.

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 Op-Amp in linear electronic circuits.
b. Use various configurations of Op-Amp for different applications.
c. Troubleshoot various linear applications of Op-Amp for the given specifications.
d. Maintain filters and oscillators used in various electronic circuits.
e. Trooubleshoot specified applications using various linear ICs.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme												
				Theory							Practical					
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
4	-	2	6	3	70	28	30*	00	100	40	25#	10	25	10	50	20

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

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

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

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the

course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

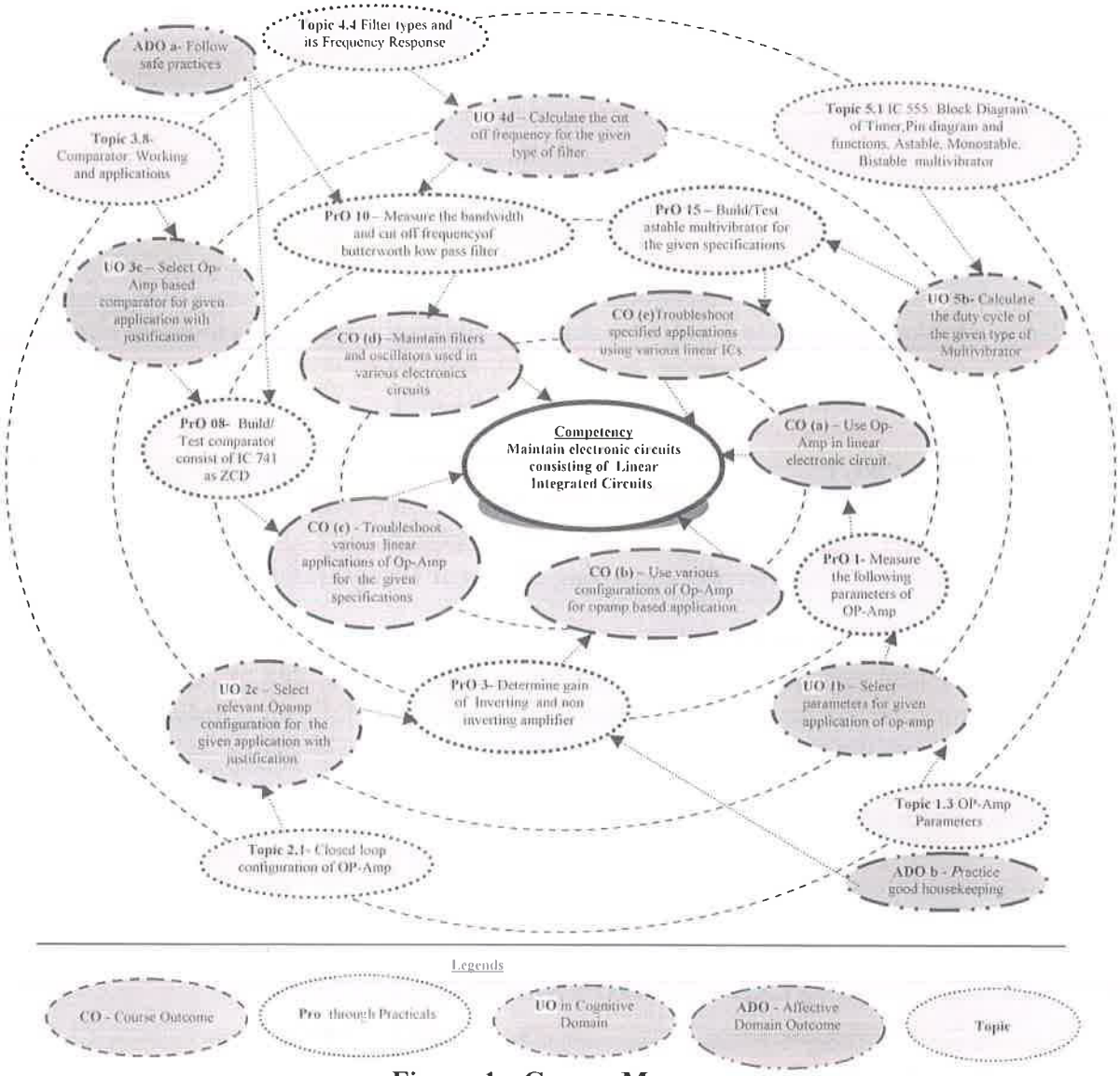

Figure 1 - Course Map

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 relevant instruments to measure the differential input resistance, input offset voltage, output offset voltage and common mode rejection ratio (CMRR) of IC741.	I	02*
2	Measure the Output voltage Swing parameter of Op-Amp IC 741.	I	02
3	Use relevant instruments to determine gain of the Inverting amplifier and Non Inverting amplifier consist of IC741.	II	02*
4	Build/Test adder and subtractor circuit consist of IC 741.	II	02*
5	Build/Test Integrator circuit consist of IC741.	II	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
6	Build/Test differentiator circuit consist of IC741.	II	02
7	Build/Test Voltage to Current converter and Current to Voltage converter circuit consist of IC 741.	III	02
8	Build/Test comparator circuit consist of IC741 as Zero crossing detector and active positive peak detector.	III	02*
9	Build/Test Instrumentation amplifier circuit using IC LM324.	III	02
10	Use relevant instruments to measure the bandwidth and cutoff frequency of the given first order low pass Butterworth filter .	IV	02*
11	Use relevant instruments to measure the bandwidth and cutoff frequency of the given first order high pass Butterworth filter .	IV	02*
12	Use relevant instruments to measure the cutoff frequency of the given notch filter .	IV	02
13	Use relevant instruments to measure the frequency of oscillation of the given RC Phase shift oscillator circuit using IC741.	IV	02
14	Measure the frequency of oscillation of the given wien bridge oscillator circuit using IC741.	IV	02
15	Build/Test astable multivibrator using IC555 for the given specifications.	V	02*
16	Build/Test monostable multivibrator using IC555 for the given specifications.	V	02
	Total		**32**

Note

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

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

S. No.	Performance Indicators	Weightage in %
1	Preparation of experimental set up	20
2	Setting and operation	20
3	Safety measures	10
4	Observations and recording	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	Variable DC power supply 0- 30V, 2A	All
2	Cathode Ray Oscilloscope Duel Trace 30Mhz, 1MegaΩ Input Impedance	2,3,5,6,8,9,10, 11,12,16,
3	Digital Storage Oscilloscope 25MHz/40MHz/60MHz/100MHz bandwidth,500MS/s to 1GS/s real time sample rate	2,3,5,6,8,9,10, 11,12,13,14,15 , 16
4	Function Generator 0-2 MHz with Sine , square and triangular output with variable frequency and amplitude range.	2,3,5,6,8,9,10, 11,12,13,14,15 ,16
5	Digital Multimeter : 4 1/2 digit display, 9999 counts digital multimeter measures: V_{ac}, V_{dc} (1000V max) , A_{dc}, A_{ac} (10 amp max)\, Resistance (0 - 100 MΩ)	All
6	Electronic Work Bench : Bread Board 840 1000 contact point, Positive and Negative power rails on opposite side of the board, connecting wires	All

8. UNDERPINNING THEORY COMPONENTS

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

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Fundamentals of Operational Amplifier(Op-Amp)	1a. Describe with sketches the function of the given block(s) of the Op-Amp. 1b. Select the parameters to be considered for the given applications of the Op-Amp with justification. 1c. Explain with sketches the	1.1 Operational Amplifier, Equivalent Circuit, Circuit symbols and Terminals. 1.2 Op-Amp IC 741 pin diagram and pin function; Op-Amp parameters: Input offset voltage, Input Offset current, Input bias current, Differential input resistence, Input capacitance, Input

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	working of the given type of Op-Amp configuration. 1d. Describe with sketches the procedure to troubleshoot the given Op-Amp circuit.	voltage range, offset voltage adjustment range, Common Mode Rejetion Ratio (CMRR), Supply Voltage Rejection Ratio (SVRR), Slew Rate, Large Signal Voltage Gain, Supply voltage, Supply Current, Output voltage Swing,Gain Bandwidth Product, Output Short Circuit Current 1.3 Transfer Characterstic- Ideal and Practical Voltage Transfer Curve 1.4 Op-Amp Configuration: Open Loop and Closed loop 1.5 Virtual Ground Concept 1.6 Features, pin diagram and pin function of dual Op Amp IC 747,
Unit-II Applications of Operational amplifier	2a. Explain with sketches the working of the given types of modes of Op-Amp operation. 2b. Calculate the output voltage of the given arithmetic circuit consist of Op-Amp . 2c. Select the relevant Op-Amp configuration for the given application with justification. 2d. Calculate the given parameter for the specified Op-Amp configuration.	2.1 Closed Loop configuration, modes of operations: Inverting and Non-Inverting, 2.2 Diffrential amplifier, Unity Gain Amplifier (voltage follower) 2.3 Arithmatic operations: Addition , Scaling, Averaging , Subtraction Integrator, Diffrentiator 2.4 Concept of frequency compensation of Op-Amp and offset nulling
Unit– III Linear Applications of Op-Amp	3a. Explain with sketches the working of an Instrumentation amplifier for the given application. 3b. Choose relevant Op-Amp converter for the given applications with justification. 3c. Select the Op-Amp based comparator for the given application with justification . 3d. Explain with sketches working of Op-Amp for the given application.	3.1 Op-Amp as an Instrumentation amplifier: Working, Derivation of output voltage, IC LM 324- Pin Configuration, specification and application 3.2 Voltage to Current converter with Floating and Grounded load 3.3 Current to Voltage converter 3.4 Sample and Hold Circuit 3.5 Logarithmic and Antilogarithmic amplifier using diodes 3.6 Analog Divider and analog multiplier 3.7 Comparators: IC LM710 a. Zero Crossing Detector b. Schmitt Trigger c. Window Detector d. Phase Detector e. Active Peak Detector f. Peak to Peak Detector

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit– IV Filters and Oscillators	4a. Explain working of the given type of filter with sketches. 4b. Explain with sketches procedure to identify the given type of filter based on frequency response. 4c. Calculate cut-off frequency for the given type of filter. 4d. Prepare the specifications of the given type of filter with justification. 4e. Explain with sketches the working principle of the given type of oscillator. 4f. Determine the frequency of oscillation of the given type of oscillator with frequency response. 4g. Describe with sketches the the procedure to troubleshoot the given filter/oscillator circuit.	4.1 Filter and its classification 4.2 Merits and demerits of active filters over passive filters 4.3 Filter characterstic terms:order of filter, cut off frequency,Pass band, Stop band, Centre frequency,Roll off rate, Bandwidth, Q factor 4.4 Filter types and its Frequency Response: Low pass(First Order and second order),High Pass (First Order and second order),Band pass(Wide and Narrow), Band Reject(Wide and Narrow), All Pass Filter 4.5 Ocsillator types using IC 741: Phase shift oscillator,Wein Bridge oscillator, Colpitts oscillator, Hartley oscillator
Unit –V Specialized IC Applications	5a. Explain with sketches the working of IC555 for the given application. 5b. Calculate the duty cycle of the given type of multivibrator. 5c. Explain with sketches the working of the given blocks of PLL. 5d. Calculate lock range and capture range of the given PLL. 5e. Describe with sketches the the procedure to troubleshoot the given circuit with IC.	5.1 IC 555: Block Diagram of Timer,Pin diagram and functions,Astable, Monostable, Bistable multivibrator, Schmitt trigger and Voltage Control Oscillator 5.2 Phase Lock Loop (PLL): Block diagram and its operation, lock range and capture range 5.3 Applications of PLL: PLL as a Multiplier, FM Demodulator. 5.4 IC 565: Pin diagram and function

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	Fundamentals of Operational Amplifiers	10	02	02	04	08
II	Applications of Operational Amplifiers	10	02	04	06	12
III	Linear Applications of Op-Amp	18	02	06	12	20

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
IV	Filters and Oscillators	16	02	06	10	18
V	Specialized IC Applications	10	02	04	06	12
Total		**64**	**10**	**22**	**38**	**70**

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

10. SUGGESTED STUDENT ACTIVITIES

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

a. Prepare journals based on practical performed in laboratory.
b. Follow the safety precautions.
c. Use various meters to test electronic equipment and component
d. Use datasheets ofvarious Linear ICs.
e. Library / Internet survey of Op-Amp based linear circuits and their applications.
f. Prepare power point presentation or animation for understanding different Op-Amp based circuit behavior.

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. Micro project report may be of four to five pages.

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

a. Build Instrumentation Amplifier (IC LM324) for measurement of tempreture using thermocouple/RTD/Thermister.
b. Develop sound sensor using LM324 and microphone.
c. Develop a shadow sensor circuit using IC741.
d. Develop a temperature control dc fan using IC 741.
e. Develop a remote control for switching devices (use IC 555 and TSOP 1738).
f. Develop sequential timer circuit using multiple timers.
g. Develop clap switch using op-amp.
h. Develop water level controller using IC555.
i. Develop a tone generator using using IC 555.
j. Develop PWM LED Dimmer/ Brightness Control using IC555.
k. Build frequency synthesizer using PLL IC565.
l. Develop FSK modulator and demodulator using PLL IC565
m. Simulate using software LT spice/ P psice / Scilab,/Matlab /Octave or any other open source software linear IC applications

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Op-Amps and Linear Integrated Circuits	Gayakwad, Ramakant A.	PHI Learning, New Delhi, 2011, ISBN: 9788120320581
2	Operational Amplifiers and Linear ICs	Bell, David A.	Oxford University Press, New Delhi, India,2011,ISBN: 9780195696134
3	Operation Amplifier with Linear Integrated Circuit	Stanley,Willam D.	Pearson Education India, New Delhi, 2002, ISBN: 9788131708453
4	Design with Operational Amplifier and Analog Integrated Circuit	Franco, Sergio.	McGraw-Hill Education, New Delhi, 2014, ISBN: 9780078028168
5	Linear Integrated Circuits	Sivakumar, Senthil M.	S.Chand Publishing,mNew Delhi, 2014, ISBN: 9788121941136
6	Linear Integrated Circuits	RoyChoudhury, D; Jain, Sail B.	New Age International Publisher, New Delhi, 2003, ISBN: 8122414702
7	Linear Integrated Circuits	Salivahanan S.	McGraw Hill, New Delhi, 2008,ISBN: 978-0-07-064818-0

S. No.	Title of Book	Author	Publication
8	Electronics Lab Manual	Navas, K .A.	PHI Learning, New Delhi, 2014 ISBN: 9788120351424
9	Industrial Electronics and Control	Paul, Biswanath	PHI Learning, New Delhi, 2015, ISBN: 9788120349902

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. Op-Amp:- http://www.jamia-physics.net/lecnotes/lab/opamp.pdf
b. IC555:-http://www.jamia-physics.net/lecnotes/lab/555.pdf
c. IC 555 data sheet:-http://www.electroschematics.com/650/lm555-datasheet/
d. Op-Amplifier basics:-https://www.khanacademy.org/science/electrical-engineering/ee-amplifiers
e. Data sheet555:-www.engineersgarage.com/electronic-components/ne555-timer-ic-datasheet
f. Vide lecture Op-Amp:-http://freevideolectures.com/Course/3062/Electronics-I/37
g. Voltage control Oscilator:- http://www.electronicshub.org/voltage-controlled-oscillators-vco/
h. Op-Amp:-http://www.talkingelectronics.com/projects/OP-AMP/OP-AMP-1.html


MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION, MUMBAI

Program Name : **Electronics Engineering Programme Group**

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

Semester : **Fourth**

Course Title : **Microcontroller and Applications**

Course Code : **22426**

1. RATIONALE

Microcontroller is used in almost all the domestic, industrial, consumer goods and other high end products.Automation is used in every field of engineering and microcontroller is inbuilt element of these systems and devices.Diploma engineers have to deal with various microcontroller based systems and maintain them. This course is intended to develop the skills to maintain and solve the application problems related to microcontrollers.

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 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. Analyse architecture of microcontrollerICs.
b. Interpret the program for 8051in assembly language for the given operations.
c. Interpret the program by using timer, interrupt and serial ports /parallel ports.
d. Interface the memory and I/O devices to 8051 microcontroller.
e. Maintain microcontrollerused in differentapplication.

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.

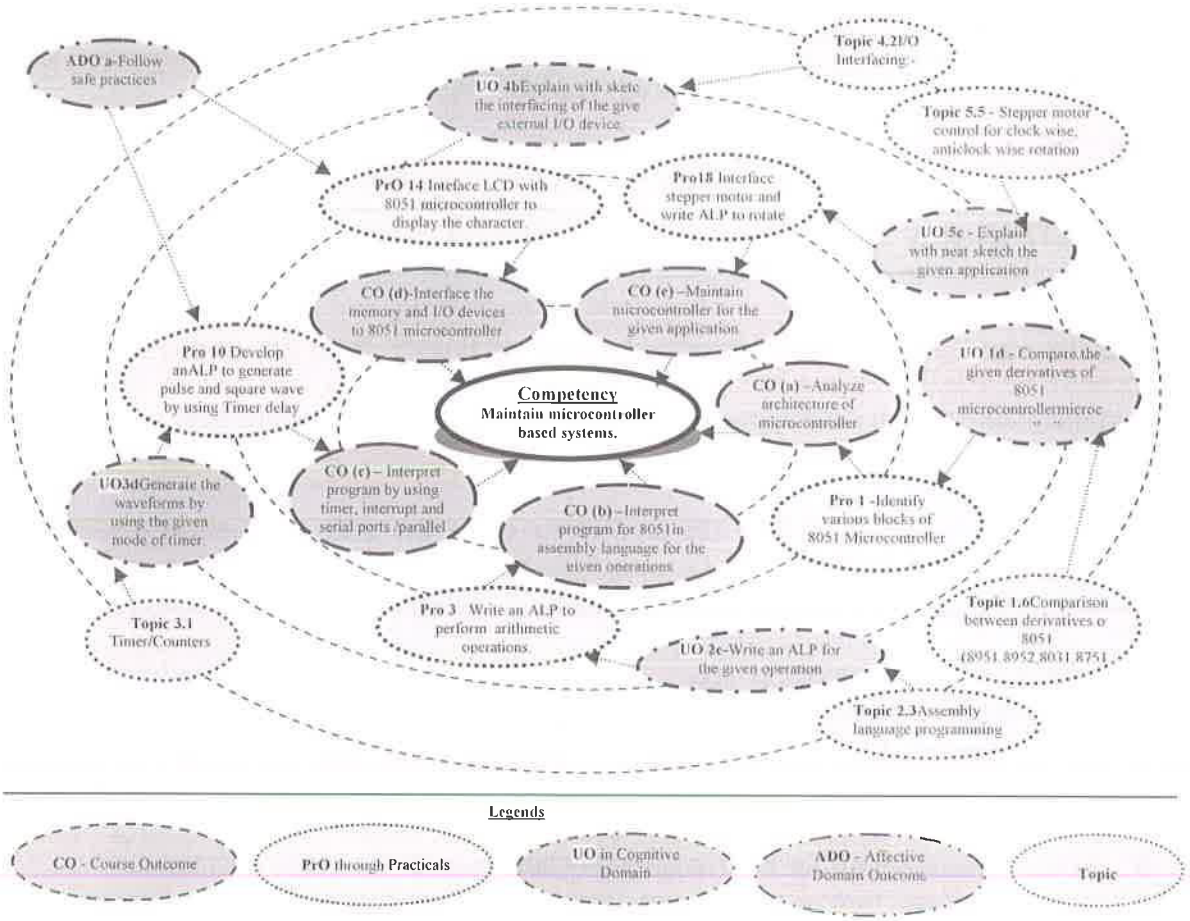

Figure 1 - Course Map

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	Identify various blocks of 8051 microcontroller development board.	I	02*
2	Write sample assembly language program using various addressing modes and assembler directives.	I	02
3	Write an assembly language program (ALP) to perform arithmetic operationsaddition, subtraction, multiplication and division.	II	02
4	Write an ALP to transfer data from source to destination location of internal/external data memory.	II	02*
5	Write an ALP to find smallest/largest number from the given data bytes stored in internal/external data memory locations.	II	02
6	Write an ALP for arranging numbers in ascending /descending order stored in external memory locations.	II	02
7	Write an ALP to generate delay using register.	II	02*
8	Write an ALP to transfer 8 bit data serially on serial port.	III	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
9	InterfaceLED with microcontroller and turn it ON with microcontroller interrupt.	III	02
10	Develop an ALP to generate pulse and square wave by using Timer delay.	III	02*
11	Interface 4 X 4 LED matrix with 8051 to display various pattern.	III	02*
12	Interface 7-segment display to display the decimal number from 0 to 9.	IV	02
13	Interfcerelay with microcontroller and turn it ON and OFF.	IV	02*
14	Interface LCD with 8051 microcontroller to display the character and decimal numbers.	IV	02*
15	Interface the given keyboard with 8051and display the key pressed.	IV	02
16	Interface ADC with 8051 microcontroller and verify input/output .	IV	02*
17	Interface DAC with 8051 microcontroller and observefollowingwaveforms: square wave, triangular wave, sawtooth wave.	IV	02*
18	Interface stepper motor to microcontroller and rotate in clockwise and anti-clockwise direction at the given angles.	V	02*
	Total		**36**

Note

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

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

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

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

a. Follow 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	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 or any other equivalent.	All
2	Desktop PC with microcontrollersimulation software.	All
3	Stepper Motor, 50/100 RPM	18
4	CRO- Bandwidth AC 10Hz ~ 20MHz (-3dB). DC ~ 20MHz (-3dB), X10 Probe	17
5	Keyboard 4*4trainer board	15
6	Relay trainer board suitable to interface with 8051 trainer kit	13
7	4 X 4 LED matrix suitable to interface with 8051 trainer kit	
8	7-segment LED Display:- 0.56 in 1-digit, common anode/common cathode	12
9	ADC (0808)trainer board	16
10	DAC (0808)trainer board	17
11	LCD trainer board	14

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 (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Basics of Microprocessor and 8051 Microcontroller	1a. Compare salient features microprocessor, microcontroller and microcomputer for the given parameters. 1b. Describewith sketches the function of the specified blocks of the thegiven type of microcontroller architecture. 1c. Explain with sketches memory organization of 8051 microcontroller. 1d. Compare the given derivatives	1.1 Microprocessor ,microcomputers, and microcontrollers (basic introduction and comparison) 1.2 Types of buses,addressbus,data bus and control bus 1.3 Harvard and Von-neuman architecture; 8051 microcontroller:Architecture,Pin configuration, stack ,memory organization 1.4 Boolean processor , power saving options - idle and power down

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	of the 8051 microcontroller. 1e. Describe with sketches the procedure to troubleshoot the simple given microcontroller-based circuit.	mode 1.5 Derivatives of 8051 (8951 , 8952 , 8031 ,8751)
Unit-II 8051 Instruction Set and programming	2a. Identify the addressing mode of the given instruction. 2b. Describe the function of the given instruction with suitable examples. 2c. Write an assembly languge program(ALP) for the given operation. 2d. Explain the function of the given software development tools. 2e. Explain the use of the given assembler directives with examples.	2.1 Addressing modes 2.2 Instruction set (Data transfer, Logical, Arithmatic, Branching, Machine control, Stack operation, Boolean) 2.3 Assembly language programming (ALP) 2.4 Software development cycle: editor , assembler , cross-compiler, linker,locator,compiler 2.5 Assembler Directives: ORG , DB , EQU , END,CODE,DATA
Unit III 8051 Timers, Interrupts , Serial and Parallel Communicatio n	3a. Write an ALP to generate a delay for the given crystalfrequencyfor the specified waveform on the given port 3b. Explain with sketch the operation of the given mode for timer and counter. 3c. Explain with sketch the operation of the given mode for serial communication. 3d. Generate the waveforms by using the given mode of timer. 3e. Describe with sketches the procedure to troubleshoot the simple given timer circuit.	3.1 Timer/Counters :SFRs:TMOD,TCON,Timer/Counter - Logic and modes,Simple programs on timer to generate time delay 3.2 Interrupts-SFRs:- IE, IP , Simple programs on interrupts 3.3 Serial communication - SFRs: SCON , SBUF , PCON, Modes of serial communication. Simple programs on serial communication 3.4 I/O port structure and configuration - P0 , P1 , P2 ,P3
Unit–IV 8051 Memory and I/O device Interfacing	4a. Describe with sketch the interfacing of the given external memory. 4b. Explain with sketch the interfacing of the given external I/O device. 4c. Write an assembly languge program to operate the given I/O device. 4d. Describe with sketches the interfacing diagram of the given ADC chip. 4e. Describe with sketches the	4.1 Memory interfacing :-Program and data memory 4.2 I/O Interfacing:-LED, relays, keyboard,LCD,seven segment display,Stepper motor. 4.3 Interfacing DAC - 0808 with 8051 and itssimple programming 4.4 Interfacing ADC - 0808/09 with 8051 and its simple programming

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	procedure to troubleshoot the simple given I/O device.	
Unit– V Applications of 8051 Microcontroller	5a. Generate the specified waveform using 8051 by the given method. 5b. Control the given parameter using 8051microcontronller. 5c. Explain with sketch the given application which uses the specified microcontroller. 5d. Program 8051 for the given application. 5e. Describe with sketches the procedure to troubleshoot the simple given microcontroller-based application.	5.1 Square wave generation using port pins of 8051 5.2 Square and triangular Waveform genertion using DAC 5.3 Water level controller 5.4 Temperature controller using ADC(0808/09). 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 FORQUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Basics of Microprocessor and 8051 Microcontroller	16	04	06	08	18
II	8051 Instruction Set and programming	12	02	04	06	12
III	8051 Timers,interrupts ,serial and parallel communication	14	04	04	08	16
IV	8051 Memory and I/O device Interfacing	12	02	04	06	12
V	Applications of 8051 Microcontroller	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 inlaboratory.
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 applications of microcontroller.
f. Undertake a market survey of different microcontrollers.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

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

a. Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b. ***'L' in item No. 4*** does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
c. About ***15-20% of the topics/sub-topics*** which is relatively simpler or descriptive in nature is to be given to the students for ***self-directed learning*** and assess the development of the COs through classroom presentations (see implementation guideline for details).
d. With respect to item No.10, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
e. Guide student(s) in undertaking micro-projects.
f. Demonstrate students thoroughly before they start doing the practice.
g. Encourage students to refer different websites to have deeper understanding of thecorse.
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.Micro project report may be of four to five pages.

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

a. Prepare a chart of various features using data sheets of 8051 microcontroller and its derivatives.
b. Prepare a chart of stepper motor to display its features and steps for its operations using data sheets.

c. Prepare a chart of various features and operations of temepature sensors using data sheets.
d. Prepare a chart of various types of ADC and DAC to display its features and pin functions using data sheets.
e. Prepare a chart of various types of LCDs to display its features,pin functions and steps of operations using data sheets.
f. Prepare a chart of various types of seven segment displays,keyboard to display its features and steps for its operations using data sheets.
g. Build a circuit using 8051 microcontroller to blink LED.
h. Build a circuit using 8051 microcontroller to blink LED in ring fashion.
i. Build a circuit to turn the buzzer ON after 10 seconds.
j. Build a circuit to turn the buzzer ON after a key pressed.
k. Build a circuit to display number 0 to 9 with a given delay.
l. Build a class period bell using microcontroller.
m. Build a room temperature measurement circuit using microcontroller.
n. Build a circuit to generate square waveform using DAC and microcontroller.
o. Build stepper motor controller using microcontrollers.
p. Build traffic light controller for specified delay.
q. Build a water level controller for given parameters.
r. Identify the advanced microcontrollers such as rasberipi,arduino
s. Build application based on advanced microcontroller such as rasberipi,arduino

Note: Use appropriate software for programming. Build the circuit on PCB.
Faculty may suggests other than above metionedmicroprojects.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	8051 Microcontroller Architecture, Programming and Application	Kenneth J.Ayala	PHI Learning New Delhi,July 2004, ISBN: 978-1401861582
2	Microcontroller Theory and Application	Ajay V.Deshmukh	McGraw Hill, New Delhi, 2011, ISBN- 9780070585959
3	Microcontrollers Principle and Application	AjitPal	PHI Learning,New Delhi, 2014, ISBN: 978-81-203-4392-4
4	The 8051 Microcontroller and Embedded system Using Assembly and C	Muhammad Ali Mazidi, Janice GillispieMazidi,Roli n D.Mckinlay	Pearson /Prentice Hall, , 2nd edition, Delhi,2008, ISBN 978-8177589030
5	Microcontroller Architecture Programming, Interfacing and System Design	Raj Kamal	Pearson Education, Delhi, 2012, ISBN:9788131759905
6	Microprocessors and Microcontrollers	Sunil Mathur, JeebanandaPanda	PHI Learning,NewDelhi, 2016,ISBN :978-81-203-5231-5
7	Microprocessors and Microcontrollers:Architecture programming and System Design	Krishna Kant	PHI Learning New Delhi, 2016,ISBN:978-81-203-4853-0

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

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


MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION MUMBAI

Program Name : **Electronics Engineering Programme Group**

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

Semester : **Fourth**

Course Title : **Basic Power Electronics**

Course Code : **22427**

1. RATIONALE

Electronic control circuits play major role in industries. In this era of automation in industry and manufacturing sector, the mechanical controls are largely replaced by power electronic devices. In this context this course aims at acquainting the pass outs with the basic principles and applications of basic power electronics devices, so that they can maintain the control circuits used in the field. Hence this course has been designed to achieve this aim.

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 power electronic devices in electronic circuits.**

3. COURSE OUTCOMES (COs)

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

a. Identify power electronic devices in circuits.
b. Maintain triggering and commutation circuits.
c. Use phase controlled rectifiers in different applications.
d. Use choppers and inverters in different applications.
e. Maintain control circuits consisting of power electronic devices.

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.

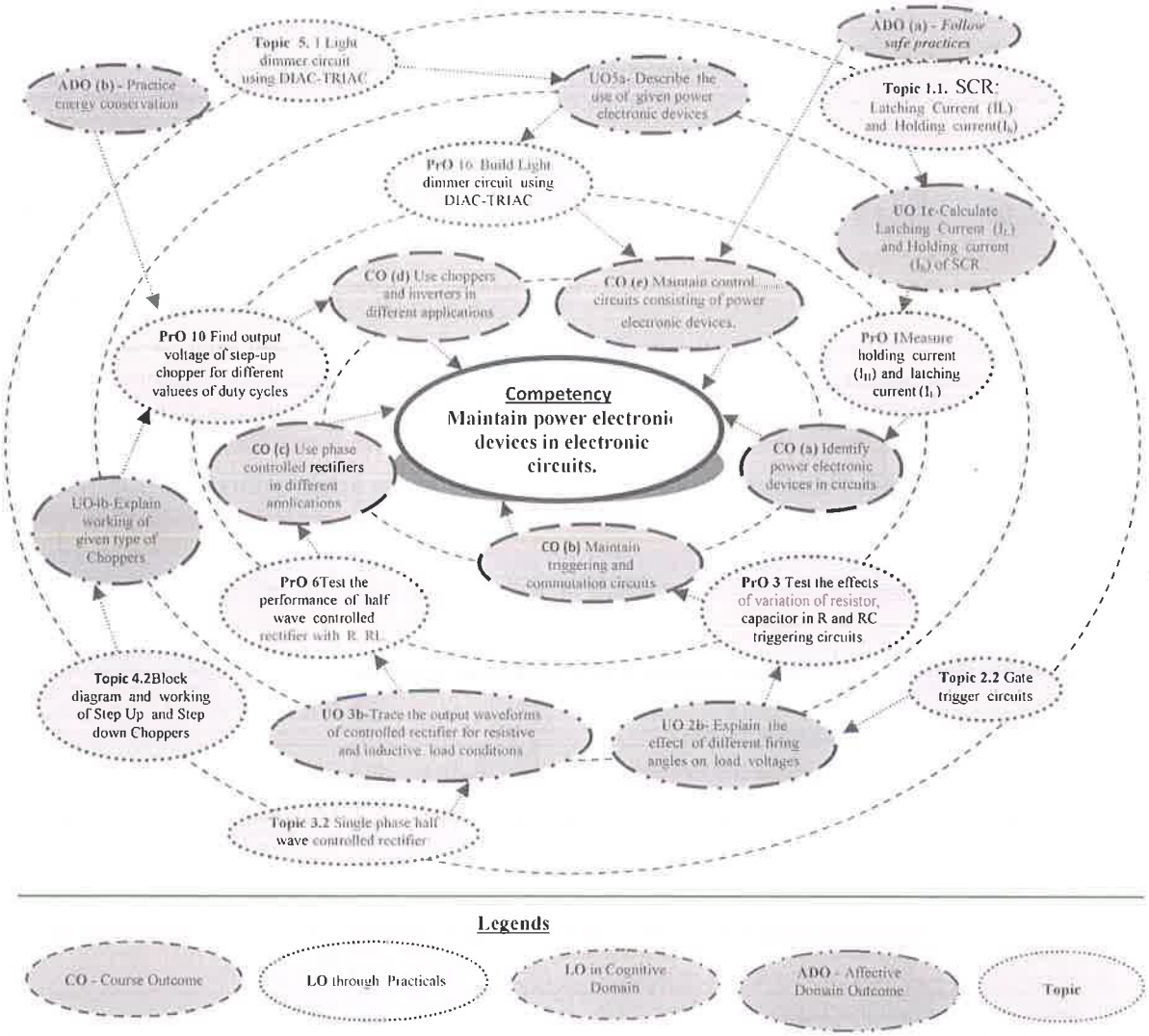

Figure 1 - Course Map

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 Exercises(PrOs)	Unit No.	Approx. Hrs. Required
1	Measure holding current (I_H) and latching current (I_L) of a given SCR from its V-I characteristic curve.	I	2*
2	Test the performance of given IGBT.	I	2*
3	Determine break over voltage of given DIAC from its V-I curve.	II	2
4	Test the effect of variation of resistor, capacitor in R and RC triggering circuits of firing angle of SCR.	II	2
5	Test the effects of variation of R on firing angle in synchronized UJT triggering circuit.	II	2
6	Test the performance of Class C-Complimentary type commutation circuit.	III	2*
7	Test the performance of half wave controlled rectifier with R, RL	III	2*

S. No.	Practical Exercises(PrOs)	Unit No.	Approx. Hrs. Required
	load and measure load voltage.		
8	Determine firing angle and output voltage of 3- phase half wave controlled rectifier using Delta-star transformer.	III	2*
9	Test the performance of full wave controlled rectifier with R, RL load and measure load voltage.	IV	2
10	Find output voltage of step-up chopper for different values of duty cycles.	IV	2
11	Test parallel inverter to the measure frequency and output voltages.	IV	2
12	Measure output voltages of step-down chopper for different values of duty cycles. Part I	IV	2*
13	Measure output voltages of step-down chopper for different values of duty cycles. Part II	IV	2*
14	Build/test SMPS for mobile phone charging. Part I	IV	2
15	Build/test SMPS for mobile phone charging. Part II	V	2
16	Build Light dimmer circuit using TRIAC test the effect of resistance variation on intensity of lamp.	V	2*
	Total		**32**

Note

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

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

S. No.	Performance Indicators	Weightage in %
a.	Preparation of experimental set up	20
b.	Setting and operation	20
c.	Safety measures	10
d.	Observations and Recording	10
e.	Interpretation of result and Conclusion	20
f.	Answer to sample questions	10
g.	Submission of report in time	10
	Total	**100**

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

a. Follow safety practices.
b. Practice good housekeeping.
c. 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 authorities concerned.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	Power scope: dual channel, dual trace,5Mhz,max .voltage 1000vp-p	4,6,8,9, 11-16
2	TONG Tester for ac line current measurement up to 100A	7
3	CRO:20 MHz with color display , dual channel, ac voltage 750v max	6-8
4	Digital Tachometer- non – contact type up to 2000rpm	Micro project
5	LCR Q meter Accurate 0.01% - up to 5 MHz	3,5,1
6	Multiple output DC regulated power supply: 0-30V,0-100V,0-300V up to 2A	1,2,10
7	Function generator: DC to 10 MHz , max output 0-30Vp-p, sine, triangle, square wave function within build counter.	10
8	Single phase DIMMERSTAT :0-300Vac,5A	6-8
9	Digital meter for DC voltage measurement up to 700V, DC current measurement up to 10A	1,2
10	Desktop PC, 32GHz with multimedia features, LED monitor	Micro project

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 Thyristor Family Devices	1a. Explain with sketches the working of the given type of thyristor device. 1b. Interpret V-I characteristics of the given power electronic device. 1c. Calculate latching current (I_L) and holding current (I_h) for the given type of SCR. 1d. Select relevant triggering device for the given circuit with justification. 1e. Identify various power electronic	1.1 SCR: Construction, operating Principle with Two transistor analogy, V-I characteristics, latching current (IL) and holding current(I_h), applications of SCR 1.2 Thyristor family devices: LASCR, SCS, GTO and TRIAC, power MOSFET, IGBT : Construction, operating principle, V-I characteristics and applications 1.3 Triggering devices- UJT, PUT,

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	devices along with their specifications. 1f. Describe with sketches the procedure to troubleshoot the simple given type of thyristor circuit	SUS, SBS and DIAC: Construction, operating Principle, V-I characteristics and applications
Unit– II Turn ON and Turn OFF methods of SCR	2a. Describe the turn-ON mechanism of the given SCR circuit. 2b. Explain with sketches the effect of the given firing angles on load voltages. 2c. Explain with sketches the methods of triggering for the given SCR. 2d. Explain with sketches the turn OFF method of the given SCR. 2e. Explain with sketches the working of protection circuits for the given SCR against over voltage, over current. 2f. Describe with sketches the procedure to troubleshoot the simple given type of thyristor turn-ON/OFF circuit.	2.1 Concept of turn ON mechanism of SCR: High voltage thermal triggering, illumination triggering, dv/dt triggering, gate triggering of SCR. 2.2 Gate trigger circuits : resistance triggering circuit, resistance, capacitance triggering circuit 2.3 SCR triggering Method: UJT/ PUT-relaxation oscillator circuit , synchronized UJT triggering circuit, pulse transformer and optocoupler (MCT2E) 2.4 Turn OFF methods : Class A-series resonant commutation circuit, class B-Shunt resonant commutation circuit, class C-Complimentary Symmetry commutation circuit 2.5 Protection circuits of SCR: over voltage, over current, snubber circuit and crowbar
Unit– III Phase controlled Rectifiers	3a. Explain with sketches the effect of change in firing angle on output current of the given rectifier considering concept of phase control. 3b. Interpret the output waveforms of the given phase controlled rectifier for given load condition. 3c. Calculate load voltage and load current of the given controlled rectifier. 3d. Explain effect of the given load on the output of the given controlled rectifier. 3e. Describe with sketches the procedure to troubleshoot the simple given type of phase controlled rectifier	3.1 Phase control parameters: Firing angle (**α**) and conduction angle (**Ø**) 3.2 Single phase half wave controlled rectifier: circuit diagram , working and waveforms with R and RL load, effect of freewheeling diode with RL load 3.3 Single phase centre tapped full wave controlled rectifier : circuit diagram , working and waveforms with R and RL load, effect of freewheeling diode with RL load 3.4 Basic three phase half wave controlled rectifier

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit-IV Choppers and Inverters	4a. Explain the working of the given Choppers with sketches and formulae. 4b. Explain with sketches the working of the given type of inverter circuit. 4c. Select the chopper and inverter for the given application. 4d. Describe with sketches the procedure to troubleshoot the simple given type of Chopper/Inverter	4.1 Convertors and its types 4.2 Block diagram and working of step up and step down choppers using power MOSFET 4.3 Inverters: circuit diagram, working of series inverter, parallel inverter
Unit –V Industrial applications of power electronic devices	5a. Describe the use of power electronic device in the given industrial circuit. 5b. Identify industrial control circuit in the given PCB. 5c. Describe the performance of the given Industrial control circuit. 5d. Explain with sketches the working of the given type of UPS 5e. Describe with sketches the procedure to troubleshoot the given power electronic application such as the UPS/SMPS and others.	5.1 Light dimmer circuit using DIAC-TRIAC 5.2 Battery charger using SCR 5.3 Emergency lighting system 5.4 Temperature controller using SCR 5.5 Block diagram and concept of UPS (on line and off line) 5.6 Block diagram and concept of SMPS

***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	Thyristor Family Devices	12	4	6	8	18
II	Turn ON and Turn OFF methods of SCR	10	4	4	6	14
III	Phase controlled Rectifiers	10	2	4	8	14
IV	Choppers and Inverters	10	2	4	8	14
V	Industrial Applications of power electronic devices	06	2	2	6	10
Total		**48**	**14**	**20**	**36**	**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. Library survey regarding different data sheets and manuals.
b. To collect the literature related to specification of available power devices in the market.
c. Refer technical magazine to collect information of current devices used in power electronics industry.
d. Prepare power point presentation for controlled rectifiers.
f. Visit to nearby industry related to power electronics.

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 PPTs to explain the construction and working of various power electronic devices.
g. Use PPTs to explain the construction and working of controlled rectifiers.
h. Guide students to use data manuals.
i. Deliver seminar on related topic.
j. Prepare industrial visit report with reference to specification, uses of power electronics application.

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. **Controlled Rectifier**: Build a circuit of the Battery charger for charging a battery of 6V, 4AH.
b. **Controlled Rectifier:** Build fan speed regulator circuit using DIAC, TRIAC on zero PCB.
c. **Phase controlled Rectifiers:** Build the circuit for Speed control of 12V DC shunt motor using IGBT on zero PCB.
d. **Phase controlled Rectifiers:** Build AC power flasher using two SCRs on zero PCB.
e. **Industrial Applications of power devices:** Build DC time delay relay using PUT on zero PCB.
f. **Turn ON and Turn OFF methods of SCR:** Build Ramp and pedestal synchronized triggering circuit using UJT and pulse transformer on zero PCB.
g. **Industrial Applications of power devices:** Build temperature controller using PT-100 thermistor and thyristor on zero PCB.
h. **Industrial Applications of power devices:** Build Emergency light system. For 6V battery on zero PCB.
i. **Choppers and Inverters:** Build Step down chopper using MOSFET/IGBT on zero PCB.
j. **Industrial Applications of power devices:** Build low power SMPS of 0 to
k. 12V DC using suitable power electronic device on zero PCB.
l. **Industrial Applications of power devices:** Simulate control of intensity of light using phase control.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Power Electronics	Moorthi, V.R.	Oxford University Press , New Delhi 110001, 2013, ISBN 0-19-567092-2
2	Fundamentals of Power Electronics	Bhattacharya, S. K.	ISTE Learning materials centre,2006 , ISBN 9788125918530
3	Power Electronics Essentials and Applications	Umanand, L	Wiley India Pvt. Ltd, New Delhi, 2011, ISBN :9788126519453
4	Power Electronics Circuits Devices and Applications	Rashid, Muhammad H.	Pearson Education India, New Delhi, 2012,ISBN: 9780133125100
5	SCR Manual Including TRIACS and other thyristors (6th Edition)	General Electric(Author)	General Electric Co,2007, ISBN:9780137967636

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. www.nptel.ac.in/courses /108101038
b. PSIM software for power electronics
c. www.en.wikibooks.org/wiki/Power_Electronics
d. www.books.google.co.in/books/about/Power_Electronics

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

Program Code : **IS / IC**

Semester : **Fourth**

Course Title : **Industrial Transducers**

Course Code : **22432**

1. RATIONALE

In the industry, Instrumentation engineering diploma graduates (also called technologists) are expected to install, commission and maintain basic instruments used in the measurements of various parameters such as speed, force, thickness, vibration and sound. Many a time, they have also to interpret the specifications of these instruments. Often they have also to select the relevant instruments for the measurement of above parameters required for different 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:

- **Maintain different types of transducers.**

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. Maintain the different types of speed measuring transducers.
b. Maintain the different types of force measuring transducers.
c. Maintain the different types of thickness measuring transducers.
d. Maintain the different types of vibration measuring transducers.
e. Maintain the different types of sound measuring 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
4	2	4	10	3	70	28	30*	00	100	40	50#	20	50	20	100	40

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

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

5. COURSE MAP (with sample COs, Learning Outcomes i.e. LOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the

course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

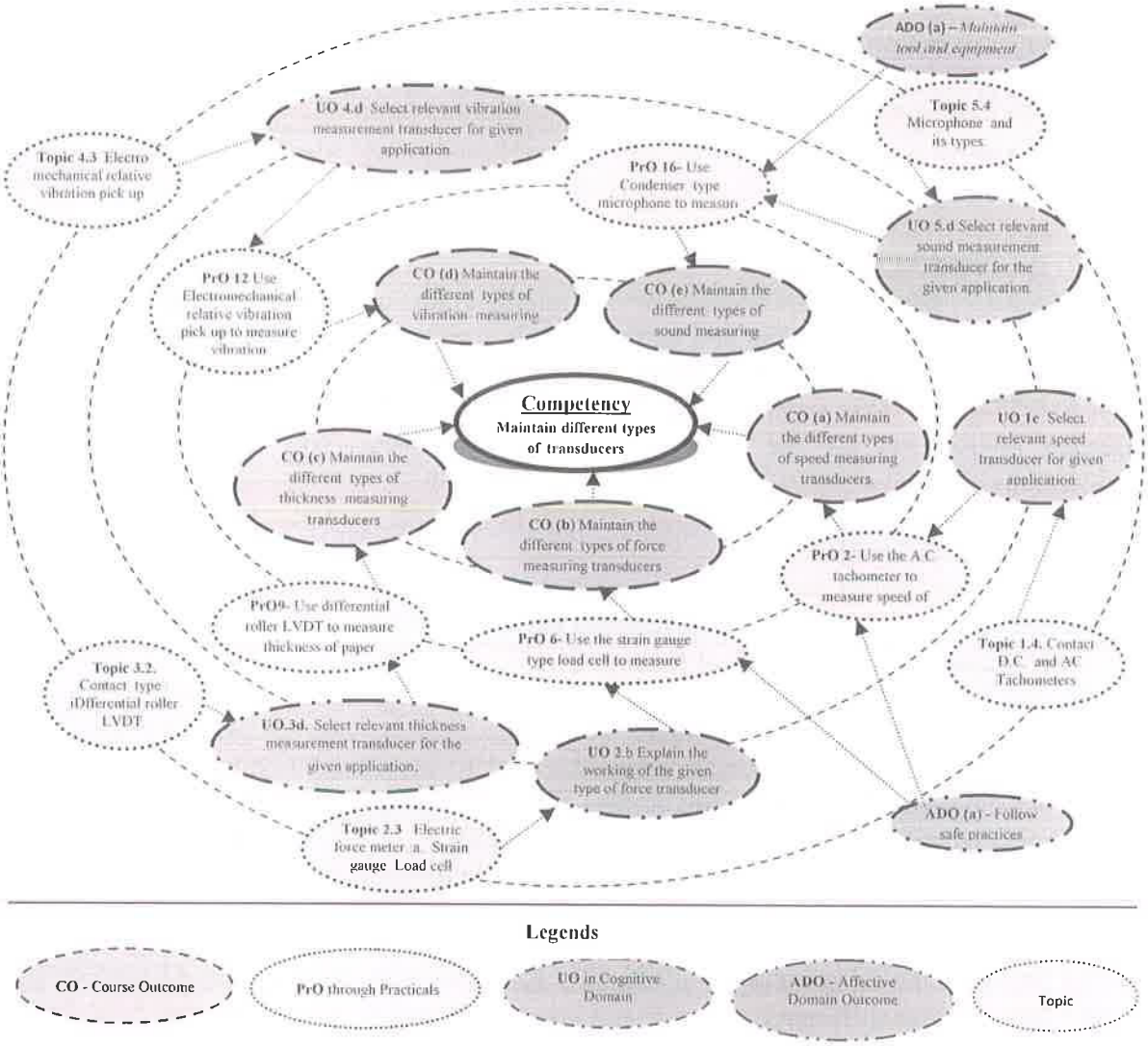

Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

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

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Use the magnetic pickup proximity switch to measure speed of motor.	I	02
2			
3	Use the A.C. tachometer to measure speed of motor. Part - I	I	02
4	Use the A.C. tachometer to measure speed of motor. Part - II	I	02
5	Use the D.C. tachometer to measure speed of motor. Part - I	I	02*
6	Use the D.C. tachometer to measure speed of motor. Part - II	I	02
7	Use Optical Encoder for speed measurement. Part - I	I	02*
8	Use Optical Encoder for speed measurement. Part - II	I	
9	Troubleshoot the given speed transducer. Part - I	I	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
10	Troubleshoot the given speed transducer. Part - II	I	02
11	Use the strain gauge type load cell to measure weights. Part - I	II	02*
12	Use the strain gauge type load cell to measure weights. Part - II	II	02
13	Calibrate the weight measuring system using strain gauge type load cell. Part - I	II	02*
14	Calibrate the weight measuring system using strain gauge type load cell. Part - II	II	02
15	Assemble and Dismantle weight measuring system. Part - I	II	02
16	Assemble and Dismantle weight measuring system. Part - II	II	02
17	Use differential roller LVDT to measure thickness of paper. Part - I	III	02*
18	Use differential roller LVDT to measure thickness of paper. Part - II	III	02
19	Calibrate differential roller LVDT thickness measuring system. Part - I	III	02*
20	Calibrate differential roller LVDT thickness measuring system. Part - II		
21	Use relative displacement vibration pickup to measure vibration. Part - I	IV	02*
22	Use relative displacement vibration pickup to measure vibration. Part - II	IV	02
23	Use Electromechanical relative vibration pick up to measure vibration. Part - I	IV	02*
24	Use Electromechanical relative vibration pick up to measure vibration. Part - II	IV	02
25	Calibrate relative displacement vibration pick up vibration measuring system. Part - I	IV	02
26	Calibrate relative displacement vibration pick up vibration measuring system. Part - II	IV	02
27	Assemble and Dismantle relative displacement vibration pickup vibration measuring system. Part - I	IV	02
28	Assemble and Dismantle relative displacement vibration pickup vibration measuring system. Part - II	IV	02
29	Use digital sound level meter to measure intensity of sound. Part - I	V	02*
30	Use digital sound level meter to measure intensity of sound. Part - II	V	02
31	Use Condenser type microphone to measure sound. Part - I	V	02*
32	Use Condenser type microphone to measure sound. Part - II	V	02
33	Calibrate Condenser type microphone sound measuring system.	V	02
			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.*

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 usher in uniformity in conduct of experiments, as well as aid to procure equipment by authorities concerned.

S. No.	Equipment Name with Broad Specifications	PrO. S.No.
1	**Speed measurement kit**: Inductive proximity/photoelectric pick-up, 3wire, 24 V DC. RPM - Supply voltage-230 VAC. Input from- inductive proximity or photoelectric pick-up Mounting- flush on panel front Display – 7 segments Red LED to measure speed of shaft of motor. AC/DC motors - Supply voltage:12 V/230 VAC FHP Speed: 1000 RPM – 1500 RPM Torque: ½ Kg.	1,5
2	**Speed measurement using A.C tachometer:** O/p Voltage: 3- 50 V at 1000 RPM, Type: 2/8 / 48 Pole, Imax: 50 ma, Max Speed: 4000 rpm. Mounting: Foot / Flange.	2
3	**Speed measurement using D.C tachometer:** Voltage Per 1000 r/min - 50V +/- 5%. Imax- 70mA at 200V, Max O/p Voltage - 200VDC, Max Speed Range - 4000rpm, Carbon Brush - 2 Nos Per Arm.	3
4	**Speed measurement kit**: Optical encoder for speed measurement 360 pulses	4

S. No.	Equipment Name with Broad Specifications	PrO. S.No.
	per revolution (PPR) optical encoder is mechanically coupled through a special coupling to 20 RPM D.C. motor (gear train) excited by 12 volt D.C. supply.	
5	**Weight measurement kit**: An industrial type of strain gauge type load cell with 50-kg capacity. Provision is made for two- arm and four-arm operation. Bridge balance controls in terms of coarse control and fine control are provided. An amplifier with variable gain in the range of 0 to 1000 is used for signal processing. Accuracy: +/- 1% with DPM indication.	6,7,8
6	**Thickness measurement kit:** LVDT type with thickness range 0 to 10mm, with accuracy of +/- 1%, with DPM Indication. Power supply 230Vac.	9,10
7	**Vibration measurement kit**: using accelerometer (piezo electric sensor with built in signal conditioning) can be used to measure peak to peak displacement of 2000 microns. The system is battery operated with LCD display.The vibration measurement can be carried out over a frequency range of 10HZ to 1KHZ.	10,11, 12,13, 14
8	**Sound Level meter:** Measuring range: 30 ... 130 dB, Accuracy: ± 1.4 dB, Frequency: 31.5 Hz ... 8 kHz, Frequency weighting: A and C.	15,16, 17

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 Speed measurement	1a. Describe with sketches the construction and working of the given type of speed transducer. 1b. Differentiate the working of the given type of speed transducer with sketches. 1c. Select relevant speed transducer for the given application with justification. 1d. Prepare the specifications of the given speed transducer. 1e. Describe the calibration procedure for the given speed transducer. 1f. Describe the troubleshooting procedure of the given speed measurement transducer.	1.1 Speed and its units, types. 1.2 Contactless speed transducer. 1.3 Contactless Tachometers a. Magnetic pickup. b. Photo pickup. c. Stroboscope. d. Digital encoder. 1.4 Contact Tachometers a. D.C. Tachometer. b. A.C. Tachometer.
Unit– II Force measurement	2a. Describe with sketches the construction of the given type of force transducer with sketches. 2b. Explain with sketches the working of the given type of force transducer. 2c. Describe the calibration procedure for the given force transducer. 2d. Prepare the specifications of the given force transducer. 2e. Select relevant force transducer for the given application with justification. 2f. Describe the troubleshooting procedure of the given force measurement transducer.	2.1 Force and its units, Types. 2.2 Hydraulic force meter. 2.3 Electric force meter a. Strain gauge Load cell. b. Pressductor Load cell. c. Proving ring Load cell. d. Piezoelectric Load cell 2.4 Calibration of Strain

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
		gauge Load cell weight measurement setup. 2.5 Conveyor belt weigh feeding system.
Unit– III Thickness measurement	3a. Describe with sketches the construction of the given type of thickness measurement transducer with sketches. 3b. Explain with sketches the working of the given type of thickness measurement transducer. 3c. Differentiate the given type of thickness measurement transducers. 3d. Select relevant thickness measurement transducer for the given application with justification. 3e. Prepare the specification of the given thickness measurement transducer. 3f. Describe the troubleshooting procedure of the given thickness measurement transducer.	3.1 Thickness and its units, Types. 3.2 Contact type : a. Differential roller LVDT. b. Inductive Pickup type. c. Capacitive Pickup type. d. Ultrasonic vibration type. 3.3 Noncontact type: Radiation type.
Unit-IV Vibration measurement	4a. Describe with sketches the construction of the given type of vibration measurement transducer with sketches. 4b. Explain with sketches the working of the given type of vibration measurement transducer. 4c. Differentiate the given type of vibration measurement transducers. 4d. Select relevant vibration measurement transducer for the given application with justification. 4e. Describe the calibration procedure for the given type of vibration measurement transducer. 4f. Prepare the specification of the given vibration measurement transducer. 4g. Describe the troubleshooting procedure of the given thickness measurement transducer.	4.1 Vibration and its units, types, common causes of vibration 4.2 Absolute vibration sensors. 4.3 Electro mechanical relative vibration pick up 4.4 Relative displacement vibration pick up 4.5 Electromagnetic relative vibration pick up. 4.6 Calibration of vibration pick up
Unit –V Sound measurement	5a. Describe with sketches the construction of the given type of sound measurement transducer with sketches. 5b. Explain with sketches the working of the given type of sound measurement transducer. 5c. Differentiate the salient features of the given types of sound measurement transducers. 5d. Select relevant sound measurement transducer for the given application with justification. 5e. Describe the calibration procedure of sound	5.1 Sound and its Units. 5.2 Sound pressure, sound power and intensity level. 5.3 Sound level meter. 5.4 Microphone and its types: a. Condenser type. b. Electrets type. c. Piezoelectric crystal

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	measurement measuring system. 5f. Prepare the specification of the given sound measurement transducer. 5g. Describe the troubleshooting procedure of the given sound measurement transducer.	type. d. Electro dynamic type. 5.5 Calibration of sound measuring system.

***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	Speed Measurement	10	02	04	08	14
II	Force Measurement	10	02	04	10	16
III	Thickness Measurement	08	02	02	06	10
IV	Vibration Measurement	10	02	04	10	16
V	Sound Measurement	10	02	04	08	14
Total		**48**	**10**	**18**	**42**	**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 LOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.*

10. SUGGESTED STUDENT ACTIVITIES

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

a. Prepare charts for measurements of various parameters such as speed, force, thickness, vibration and sound.
b. Prepare broad specifications for measurements of various parameters such as speed, force, thickness, vibration and sound.
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 LOs/COs through classroom presentations (see implementation guideline for details).

d. With respect to item No.10, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
e. Guide students in undertaking micro projects.
f. Arrange visit to process industries and calibration workshops.
g. Use teaching aids such as videos/ YouTube of process industries.
h. Arrange expert lectures of industry person.
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. Build digital speed indication circuit using Proximity switch.
b. Build digital weight indication circuit using strain gauge load cell.
c. Sound level meter for indication of intensity of sound in different environment.
d. Clamp switch project for Lamp ON-OFF.
e. Build digital vibration indication circuit using vibration pick.
f. Build Foot step power generator circuit using Piezoelectric crystal.
g. Build LVDT based circuit for thickness measurement of paper sheet and its digital indication.
h. Build capacitive sensor based circuit for thickness measurement of paper sheet and its digital indication.

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, New Delhi . 2011; ISBN:9788177001006
2	Introduction to measurement and instrumentation	Ghosh, A.K.	PHI Learning, New Delhi , 2014; ISBN:9788120346253
3	Industrial Instrumentation and Control	Singh, S.K.	McGraw Hill Publishing Co. New Delhi , 2010 ISBN:9780070678200
4	Instrumentation,	Nakra,B.C;	McGraw Hill Publishing New

S. No.	Title of Book	Author	Publication
	measurement and analysis	Choudhry, K.K.	Delhi , 2015 ISBN:9780070151277
5	Instrumentation Systems and Devices	Rangan, C.S; Sharma, G. R ; Mani, S.V.	McGraw Hill Publishing Co. New Delhi , 2011 ISBN:9780074633502
6	Principles of Industrial Instrumentation	Patranabis, D.	McGraw Hill Publishing, New Delhi , 2010 ISBN:9780070699717
7	Process Measurement Instrument Engineers Handbook	Liptak, B.G.	Chilton Book Co U.S.A 1970 ISBN:9780750622547

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. http://webcache.googleusercontent.com/search?q=cache:o9gctY3KoVkJ:web.iitd.ac.in/~akdarpe/courses/MEL314/Fundamental%2520of%2520Noise.ppt+andcd=1andhl=enandct=clnkandgl=in
b. https://www.thermofisher.com.au/Uploads/file/Environmental-Industrial/Process-Monitoring-Industrial-Instruments/Sound-Vibration-Stress-Monitoring/Stress-Analysis/VishayMM/technology/technotes/Custom-Transducer-Design.pdf
c. https://www.engineersgarage.com/articles/speed-sensor-types?page=1
d. http://nritech.edu.in/eLearning/MECH-4-1/IV-I-MECH-AE-IandCS-Unit-5.pdf
e. http://www.kvc.com.my/StorageAttachment/Kvcsb/datasheet/945/mitutoyo-7327.pdf
f. ftp://ftp.unicauca.edu.co/Facultades/FIET/DEIC/Materias/Instrumentacion%20Industrial/Instrument_Engineers__Handbook_-_Process_Measurement_and_Analysis/Instrument%20Engineers'%20Handbook%20-%20Process%20Measurement%20and%20Analysis/1083ch7_20.pdf
g. https://www.bksv.com/media/doc/br0094.pdf
h. https://www.pce-instruments.com/english/measuring-instruments/test-meters/thickness-meter-kat_40043_1.htm
i. http://www.npl.co.uk/upload/pdf/forceguide.pdf
j. https://www.edx.org/course/subject/engineering


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