Maharashtra State Board Of Technical Education, Mumbai

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

Program Name : Diploma in Electronics & Tele-Communication, Diploma in Electronics, Diploma in Communication Technology, Diploma in Communication Engineering,Diploma in Electronics Engineering

Program Code : EJ/EN/EQ/ET/EX With Effect From Academic Year: 2017 - 18

Duration of Program : 6 SemestersDuration : 16 Weeks

Semester : Third Scheme – I

S. N.	Course Title	Course Abbre viation	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	Digital Techniques	DTE	22320	4	-	2	6	3	70	28	30*	00	100	40	25#	10	25	10	50	20	150
2	Applied Electronics	AEL	22329	4	-	4	8	3	70	28	30*	00	100	40	50#	20	50	20	100	40	200
3	Electric Circuits and Networks	ECN	22330	3	2	2	7	3	70	28	30*	00	100	40	25@	10	25	10	50	20	150
4	ElectronicMeasurements and Instrumentation	EMI	22333	4	-	4	8	3	70	28	30*	00	100	40	50@	20	50	20	100	40	200
5	Principles of Electronic Communication	PEC	22334	4	-	2	6	3	70	28	30*	00	100	40	25@	10	25	10	50	20	150
			Total	**19**	**2**	**14**	**35**	--	**350**	--	**150**	--	**500**	--	**175**	--	**175**	--	**350**	--	**850**

Student Contact Hours Per Week: **35 Hrs.**Medium of Instruction: **English**

Theory and practical periods of 60 minutes each. Total Marks : **850**

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 (5marks each for Physics and Chemistry) to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the cognitive domain LOs required for the attainment of the COs.

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

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

Program Name : **Computer and Electronics Engineering Program Group**

Program Code : **CO/CM/CW/DE/EJ/ET/EN/EX/EQ/IE/IS/IC/MU**

Semester : **Third**

Course Title : **Digital Techniques**

Course Code : **22320**

1. RATIONALE

In the present scenario most of the electronic equipment like computers, mobiles, music systems, ATM, automation and control circuits and systems are based on digital circuits which the diploma electronic engineering passouts (also called technologists) have to test them. The knowledge of basic logic gates, combinational and sequential logic circuits using discrete gates as well as digital ICs will enable the students to interpret the working of equipment and maintain them. After completion of the course, students will be able to develop digital circuits based 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:

- **Build/ test digital logic circuits consist of digital ICs.**

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 number system and codes for interpreting working of digital system.
b. Use Boolean expressions to realize logic circuits.
c. Build simple combinational circuits.
d. Build simple sequential circuits.
e. Test data converters and PLDs in digital electronics systems.

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.

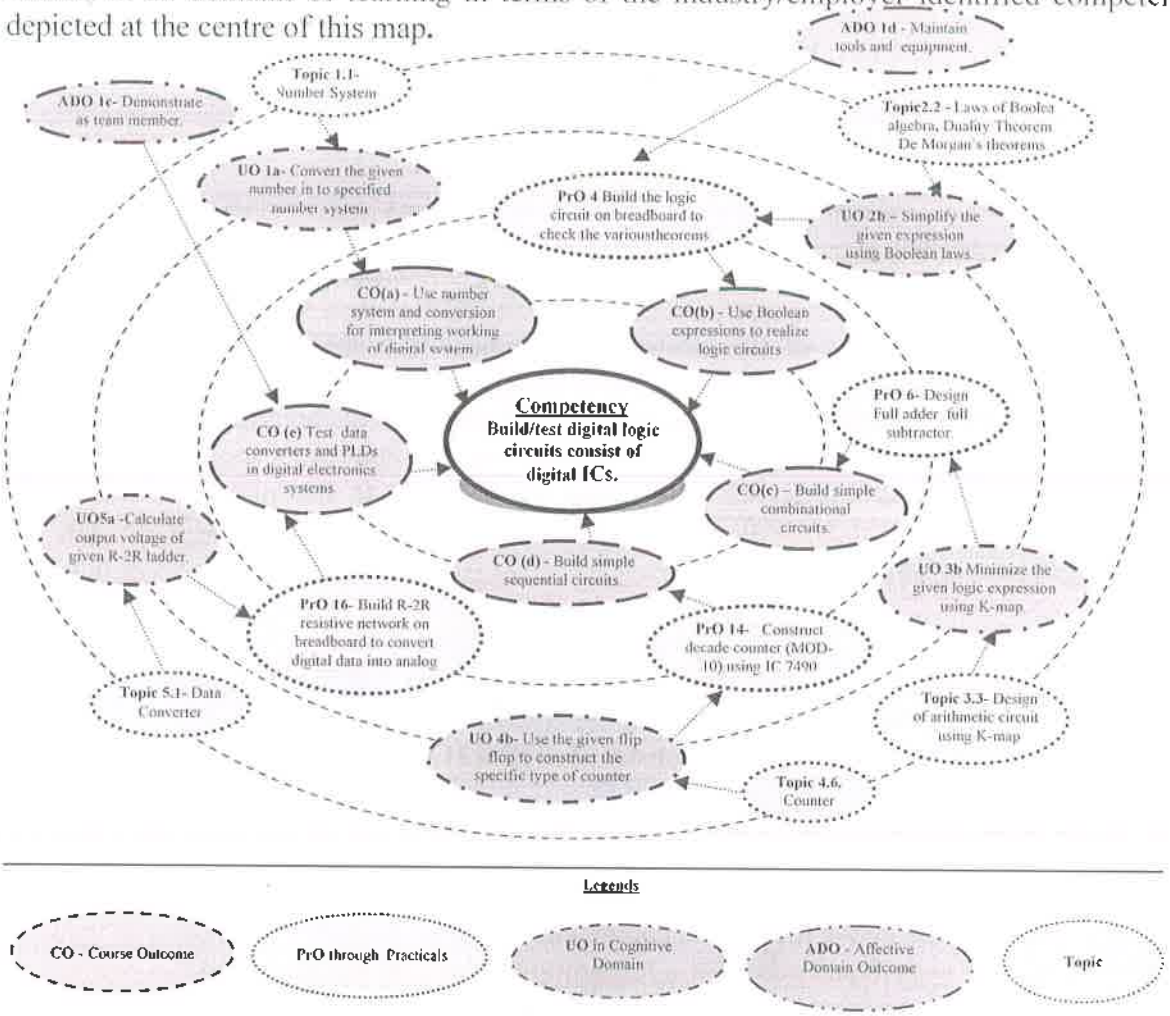

Figure 1 - Course Map

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	Test the functionality of specified logic gates using breadboard. (IC 7404, 7408, 7432, 7486)	II	02*
2	Test the functionality of NAND and NOR gate of using breadboard (IC 7400 and 7402)	II	02
3	Construct AND, OR, NOT gates using universal gates.	II	02
4	Build the logic circuit on breadboard to check the De Morgan's theorems.	II	02
5	Design Half adder and Half subtractor using Boolean expressions.	III	02*
6	Design Full adder and full subtractor.	III	02
7	Construct and test BCD to 7 segment decoder using IC 7447/ 7448.	III	02
8	Build / test function of MUX 74151/ [illegible]150/any other equivalant.	III	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
9	Build / test function of DEMUX 74155/74154/any other equivalant.	III	02
10	Build / test function of RS flip flop using NAND Gate.	IV	02*
11	Build / test function of MS JK flip flop using 7476.	IV	02
12	Use IC 7476 to construct and test the functionality of D and T flip flop.	IV	02
13	Implement 4 bit ripple counter using 7476.	IV	02
14	Use IC 7490 to construct decade counter (MOD-10).	IV	02
15	Implement 4 bit universal shift register.	IV	02
16	Build R-2R resistive network on breadboard to convert given digital data into analog.	V	02*
		Total	**32**

Note

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

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

S. No.	Performance Indicators	Weightage in %
a.	Preparation of experimental 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

- '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. S. No.
1	Digital Multimeter: 3 and ½ digit with R, V, I measurements, diode and BJT testing.	All
2	CRO : Dual Channel, 4 Trace CRT / TFT based Bandwidth 20 MHz/30 MHz X10 magnification 20 ns max sweep rate, Alternate triggering Component tester and with optional features such as Digital Read out.	16
3	Pulse Generator: TTL pulse generator	10-15
4	DIGITAL IC tester: Tests a wide range of Analog and Digital IC's such as 74 Series, 40/45 Series of CMOS IC's.	1-15
5	Bread Board Development System: Bread Board system with DC power output 5V, +/-12V and 0-5V variable , digital voltmeter , ammeter. LED indicators 8 no, logic input switches 8 no, 7 segment display 2 no, clock generator, Manual pulser, Breadboard with about 1,600 points, Potentiometer, relay etc	1-15
6	Trainer kits for digital ICs: Trainer kit shall consists of digital ICs for logic gates, flop-flop, shift registers, counter along with toggle switches for inputs and bi-colour LED at outputs, built in power supply.	1-15
7	Regulated power supply: Floating DC Supply Voltages Dual DC : 2 x 0 -30V; 0-2 A Automatic Overload (Current Protection) Constant Voltage and Constant Current Operation Digital Display for Voltage and Current Adjustable Current Limiter Excellent Line and Load Regulation	1-16
8	Trainer kit for 4 bit Counter using Flip Flops: 4 bit ripple counter, Synchronous Counter, IC 7476 based circuit. Input given by switches and output indicated on LED. Facility to select MOD 8 or MOD 16 mode. Built in DC power supply and manual pulser with indicator.	13

8. UNDERPINNING THEORY COMPONENTS

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

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Number System and Codes	1a. Convert the given number into the specified number system. 1b. Perform the binary arithmetic operation on the given binary numbers. 1c. Convert the given coded number into the other specified code.	1.1 Number System: base or radix of number system, binary, octal, decimal and hexadecimal number system. 1.2 Binary Arithmetic: Addition, subtraction, multiplication, division. 1.3 Subtraction using 1's complement and 2's complement. 1.4 Codes: BCD, Gray Code, Excess-3, and ASCII code.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	1d. Add the given two decimal numbers using BCD code.	1.5 BCD Arithmetic: BCD Addition
Unit – II Logic gates and logic families	2a. Develop the basic gates using the given NAND/NOR gate as universal gate. 2b. Simplify the given expression using Boolean laws. 2c. Develop logic circuits using the given Boolean expressions. 2d. Compare the salient characteristics of the given digital logic families.	2.1 **Logic gates**: Symbol, diode/ transistor switch circuit and logical expression , truth table of basic logic gates (AND, OR, NOT), Universal gates (NAND and NOR) and Special purpose gates (EX-OR, EX-NOR),Tristate logic 2.2 **Boolean algebra**: Laws of Boolean algebra, Duality Theorem, De-Morgan's theorems 2.3 **Logic Families**:Characteristics of logic families : Noise margin, Power dissipation, Figure of merit , Fan-in and fan-out, Speed of operation, Comparison of TTL, CMOS, types of TTL NAND gate
Unit– III Combinational Logic Circuits	3a. Develop logic circuits in standard SOP/ POS form for the given logical expression. 3b. Minimize the given logic expression using K-map. 3c. Use IC 7483 to design the given adder/ subtractor. 3d. Draw MUX/DEMUX tree for the given number of input and output lines. 3e. Write the specifications of the component for the given application. 3f. Develop the specified type of code converter.	3.1 **Standard Boolean representation:** Sum of Product (SOP) and Product of Sum(POS), Min-term and Max-term, conversion between SOP and POS forms. realization using NAND /NOR gates 3.2 **K-map reduction technique for the Boolean expression:** Minimization of Boolean functions up to 4 variables (SOP and POS form) 3.3 **Design of arithmetic circuits and code converter using K-map:** Half and full Adder, half and full Subtractor , gray to binary and binary to gray (up to 4 bits) 3.4 **Arithmetic circuits:** (IC 7483) Adder and Subtractor, BCD adder 3.5 **Encoder/Decoder:** Basics of encoder. decoder, comparison, (IC 7447) BCD to 7 segment decoder/driver 3.6 **Multiplexer and Demultiplexer:** working , truth table and applications of Multiplexers and Demultiplexures. MUX tree, IC 74151as MUX; DEMUX tree. DEMUX as decoder, IC 74155 as DEMUX 3.7 **Buffer:** Tristate logic, unidirectional and bidirectional buffer (IC74LS244,74LS245)

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit– IV Sequential Logic Circuit	4a. Use relevant triggering technique for the given digital circuit. 4b. Use the given flip-flop to construct the specific type of counter. 4c. Use excitation table of the given flip-flop to design synchronous counter. 4d. Design the specified modulo-N counter using IC7490. 4e. Construct ring/ twisted ring counter using the given flip-flop.	4.1 **Basic memory cell**: RS-latch using NAND and NOR 4.2 **Triggering Methods:** Edge trigger and level trigger 4.3 **SR Flip Flops**: SR-flip flop, clocked SR flip flop with preset and clear, drawbacks of SR flip flop 4.4 **JK Flip Flops**: Clocked JK Flip flop with preset and clear, race around condition in JK flip flop, Master slave JK flip flop, D and T type flip flop Excitation table of flip flops, Block schematic and function table of IC-7474, 7475 4.5 **Shift Register**: Logic diagram of 4-bit Shift registers – Serial Input Serial Output, Serial Input Parallel Output, Parallel Input Serial Output, Parallel Input Parallel Output, 4 Bit Universal Shift register **4.6 Counters:** Asynchronous counter: 4 bit Ripple counter, 4 bit up/down Counter, modulus of counter Synchronous counter: Design of 4 bit synchronous up/down counter Decade counter: Block schematic of IC 7490 Decade counter, IC 7490 as MOD-N Counter, Ring counter, Twisted ring counter
Unit– V Data Converters and PLDs	5a. Calculate the output voltage of the R-2R ladder for the given specified digital input. 5b. Calculate the output voltage of the weighted resistor DAC for the given specified digital input. 5c. Explain with sketches the working principle of the given type of ADC. 5d. Explain with sketches the working principle of the given types of memories. 5e. Explain with basic block diagram the working principle of the given type of programmable logic device.	5.1 **Data Converter**: DAC: Types, weighted resistor circuit and R-2R ladder circuit, DAC IC 0808 specifications ADC: Block Diagram, types, and working of Dual slope ADC, SAR ADC, ADC IC 0808/0809, specification 5.2 **Memory**: RAM and ROM basic building blocks, read and write operation ,types of semiconductor memories 5.3 **PLD:** Basic building blocks and types of PLDs, PLA, PAL, GAL 5.4 CPLD: Basic Building blocks, functionality.

***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	Number System	06	2	2	4	08
II	Logic gates and logic families	10	4	4	4	12
III	Combinational Logic Circuits	16	4	6	8	18
IV	Sequential Logic Circuit	16	4	6	8	18
V	Data Converters and PLDs	16	4	4	6	14
Total		**64**	**18**	**22**	**30**	**70**

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

10. SUGGESTED STUDENT ACTIVITIES

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

a. Prepare the survey report on the applications of different types of number system and code converters used in the design of digital system.
b. Compare technical specifications and applications of various types of memory, PLDs, CPLDs and Prepare report.
c. Test digital IC's using various testing equipment like digital IC tester, Digital multi-meter etc.
d. Give seminar on any course relevant topic.
e. Conduct library / internet survey regarding different data sheet and manuals.
f. Prepare power point presentation on digital circuits and their applications.
g. Undertake a market survey of different digital IC's required for different applications.
h. Search for video / animations / power point presentation on internet for complex topic related to the course and make a presentation.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

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

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

e. Guide student(s) in undertaking micro-projects.
f. PPTs/Animations may be used to explain the construction and working of electronic circuits.
g. Guide students for using data sheets / manuals.

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

a. Build a Digital IC tester circuit.
b. Build a 4bit parity generator and parity checker circuit.
c. Build a circuit to implement 4 bit adder.
d. Build a circuit to test 7 segment display.
e. Build a circuit to implement debounce switch.
f. Build a circuit for LED flasher.
g. Build a circuit for LED BAR display
h. Design and analyze digital arithmetic circuit

Note: *Use general purpose PCB for making micro projects*

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Modern Digital Electronics	Jain, R.P.	McGraw-Hill Publishing, New Delhi, 2009 ISBN: 97800706691l6
2	Digital Circuits and Design	Salivahanan S.; Arivazhagan S.	Vikas Publishing House, New Delhi, 2013, ISBN: 9789325960411
3	Digital Electronics	Puri, V.K.	McGraw Hill , New Delhi, 2016, ISBN: 97800746331751
4	Digital Principles	Malvino, A.P.; Leach, D.P.; Saha G.	McGraw Hill Education, New Delhi, 2014, ISBN : 9789339203405
5	Digital Design	Mano, Morris; Ciletti, Michael D.	Pearson Education India, Delhi, 2007, ISBN: 9780131989245
6	Digital Electronics, Principles and Integrated Circuits	Maini, Anil K.	Wiley India, Delhi, 2007, ISBN: 9780470032145

S. No.	Title of Book	Author	Publication
7	Digital Fundamentals	Floyd, Thomas	Pearson Education India, Delhi, 2014, ISBN : 9780132737968

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. www.cse.yorku.ca/~mack/1011/01.NumberSystems.ppt
b. www.people.sju.edu/~ggrevera/arch/slides/binary-arithmetic.ppt
c. www.mathsisfun.com/binary-number-system.html
d. www.codesandtutorials.com/hardware/electronics/digital_codes-types.php
e. www.ee.surrey.ac.uk/Projects/Labview/gatesfunc/
f. www.ee.surrey.ac.uk/Projects/Labview/boolalgebra/
g. www.eng.auburn.edu/~strouce/class/elec2200/elec2200-8.pdf
h. www.maxwell.ict.griffith.edu.au/yg/teaching/dns/dns_module3_p3.pdf
i. www.scs.ryerson.ca/~aabhari/cps213Chapter5.ppt
j. www.eng.wayne.edu/~singhweb/seql.ppt
k. www.cs.sjsu.edu/faculty/lee/Ch2Problems2.ppt
l. www.rogtronics.net/files/datasheets/dac/SedraSmith.pdf
m. www-old.me.gatech.edu/mechatronics_course/ADC_F04.ppt
n. www.allaboutcircuits.com/vol_4/chpt_13/3.html
o. www.youtube.com/watch?v=5Wz5f3n5sjs
p. www.eee.metu.edu.tr/~cb/e447/Chapter%209%20-%20v2.0.pdf
q. www2.cs.siu.edu/~hexmoor/classes/CS315-S09/Chapter9-ROM.ppt
r. www.cms.gcg11.org/attachments/article/95/Memory2.ppt
s. www.cosc.brocku.ca/Offerings/3P92/seminars/Flash.ppt
t. www.webopedia.com/TERM/R/RAM.html
u. www.cs.sjsu.edu/~lee/cs147/Rahman.ppt

Program Name : **Electronics Engineering, Digital Electronics and Instrumentation Engineering Program Group**

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

Semester : **Third**

Course Title : **Applied Electronics**

Course Code : **22329**

1. RATIONALE

Enhanced use of electronic gadgets has made electronics engineers to deal with the various types of electronic circuits which generate the required analog/digital output. Transistor has remarkably expanded the utility of electronic equipment. Discrete components are widely used in amplifiers and other electronic systems which the engineering diploma holders (also called as technologist) have to use or maintain. The learning of basic operating principles of electronic circuits will help the students to use the basic electronic equipment. This course is developed in such a way that, students will be able to apply the knowledge of basic electronic circuit working to solve broad based electronic engineering application problems.

2. COMPETENCY

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

- **Use discrete electronic devices and voltage regulators.**

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 transistor as low Power amplifier.
b. Use BJT as high Power amplifier.
c. Use BJT as feedback amplifier.
d. Use BJT as waveform generator.
e. Maintain IC voltage regulator and SMPS.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme											
				Theory						Practical					
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
4	-	4	8	3	70	28	30*	00	100	40	50#	20	50	20	100	40

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

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

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

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

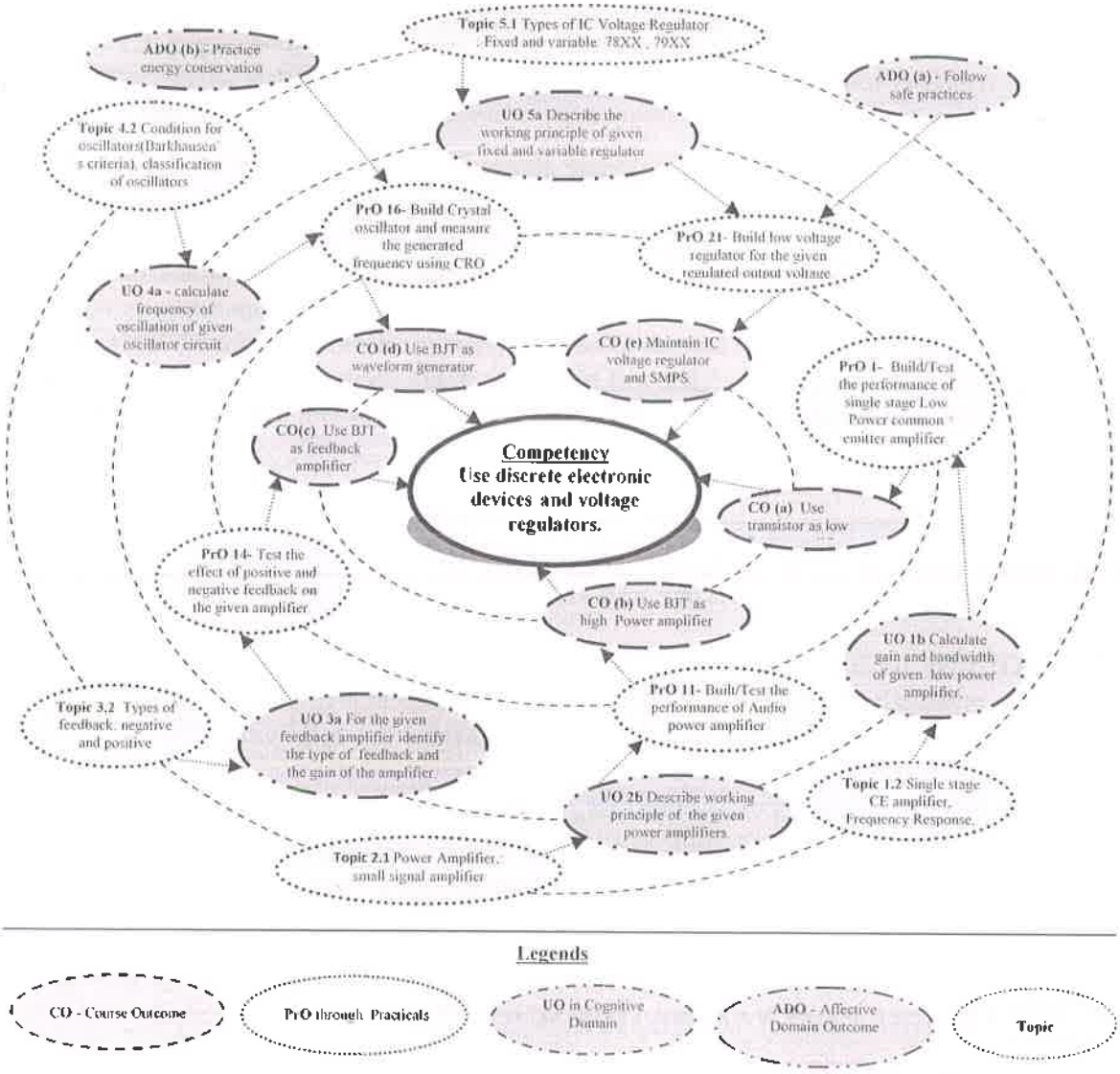

Figure 1 - Course Map

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.

** Use bread board for the following Practials (wherever applicable).*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Build/test the performance of single stage Low Power common emitter amplifier.	I	2*
2	Simulate / test out put Wave form of single stage common	I	2

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	emitter (CE) amplifier using simulation software(like spice, multisim).		
3	Simulate/test the output Wave form of single Stage common source FET amplifier using simulation software	I	2
4	Build/test the performance of single stage Common source FET amplifier.	I	2
5	Build/test the performance of two stage RC Coupled common emitter amplifier using transistor.	I	2*
6	Build/test the performance of two stage direct Coupled amplifier using transistor.	I	2
7	Build/Test the performance of transformer Coupled amplifier.(Part-I)	I	2*
8	Build/Test the performance of transformer Coupled amplifier.(Part-II)	I	2*
9	Build/test the performance of single tuned amplifier using transistor.	I	2
10	Build/test performance of double tuned common Emitter amplifier. (Part-I)	I	2
11	Build/test performance of double tuned common Emitter amplifier. (Part-II)	I	2
12	Build/test performance parameters of single stage class A power amplifier.	II	2
13	Build/test performance parameters of class B Push pull amplifier using transistor.	II	2
14	Build/test the performance of Audio power amplifier.	II	2*
15	Use transistor to build/ test voltage series Feedback amplifier parameters with and without feedback.	III	2
16	Use transistor to built/ test voltage shunt Feedback amplifier parameters with and without feedback.	III	2
17	Test the effect of positive and negative feedback on the given amplifier.(Part-I)	III	2*
18	Test the effect of positive and negative feedback on the given amplifier.(Part-II)	III	2*
19	Build RC phase shift oscillator and measure the generated frequency using CRO.	IV	2
20	Build Crystal oscillator and measure the generated frequency using CRO.	IV	2
21	Simulate Hartley oscillator using any relevant simulation software. (Like spice, multisim. Lab view, LTspice, Octeva).	IV	2*
22	Generate a waveform using Miller's sweep generator and measure sweep time and retrace time.	IV	2
23	Simulate dual voltage regulator using IC78XX and 79XX for the specified regulated output voltage	V	2*
24	Build dual voltage regulator for the specified Regulated output voltage.	V	2
25	Build low voltage regulator using IC723 for the given regulated output voltage. (2V to7V)	V	2*
26	Build high voltage regulator using IC723 for the given regulated output voltage.(7 V to 37 V)	V	2

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
27	Test the performance parameters of voltage regulator using IC LM317.	V	2*
	Total		**54**

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 %
1	Preparation of experimental set up	20
2	Setting and operation	20
3	Safety measures	10
4	Observations and Recording	10
5	Interpretation of result and conclusion	20
6	Answer to sample questions	10
7	Submission of report in time	10
	Total	**100**

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

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

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

- 'Valuing Level' in 1st year
- '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. S. No.

S. No.	Equipment Name with Broad Specifications	PrO. S. No.
1	Variable DC power supply 0- 30V, 2A, SC protection	All
2	Dual Power supply 0- 30V, 2A	All
3	Cathode Ray Oscilloscope, Dual Trace 30Mhz and above, 1MegaΩ Input Impedance	1-16
4	Digital storage Oscilloscope, Dual Trace 20Mhz and above, 1MegaΩ Input Impedance	1-16
5	Function Generator 0-2 MHz with Sine, square and triangular output with variable frequency and amplitude	1-12
6	Digital Multimeter: 3and1/2 digit display, 9999 counts digital multimeter measures: V_{ac}, V_{dc} (1000V max) , A_{dc}, A_{ac} (10 amp max) , Resistance (0 - 100 MΩ) , Capacitance and diode ,transistor tester	All
7	Electronic Work Bench : Bread Board 840 -1000 contact points, Positive and Negative power rails on opposite side of the board , 0-30 V , 2 Amp Variable DC power supply, Function Generator 0-2MHz, CRO 0-30MHz , Digital multimeter	All
8	LCR-Q meter, Test frequency standard 100 Hz / 1 kHz; Parameter L-Q, C-D, R-Q and Z-Q,Parameters L 100 Hz, 120 Hz 1 mH - 9999 H 1 KHz 0.1 mH - 999.9 Ht,C 100 Hz, 120Hz 1 pF - 9999 mF Range 1 KHz 0.1 pF - 999.9 mF,Terminals 4 terminals.	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 Low Power Amplifiers	1a. Explain with sketches the working principle of the given type of amplifier. 1b. Calculate gain and bandwidth of the given low power amplifier. 1c. Compare performance parameters of the given types of amplifier coupling. 1d. Select relevant tuned amplifier for the given frequency band with justification. 1e. Describe the environment employed for the given simulation work with justification.	1.1 Classification of Amplifiers, BJT as an amplifier . 1.2 Single stage CE amplifier, frequency response, gain, bandwidth 1.3 Multistage amplifier: General Multistage amplifier BJT based. 1.4 Type of BJT amplifier coupling: Circuit diagram , operation, frequency response and applications of RC, transformer and direct coupling 1.5 FET Amplifier: Common Source amplifier, working principle and applications 1.6 Tuned Amplifier: Need of tuned amplifier, basic tuned circuit, circuit diagram, operating principle and frequency response of Single tuned, Double tuned and stagger tuned amplifiers

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit– II High Power Amplifiers	2a. Explain with sketches the working of the given type of power amplifier. 2b. Select the relevant power amplifier for the given application with justification. 2c. Calculate efficiency of the given power amplifier. 2d. Compare the performance parameters of the given types of power amplifiers. 2e. Prepare the specifications of the given type of amplifier.	2.1 Power Amplifier: Comparison between small signal amplifier and power amplifier, performance parameter of power amplifier like : bandwidth, gain, frequency band, efficiency 2.2 Classification: Class A, Class B, Class AB and Class C 2.3 Circuit, operation, input /output waveforms, efficiency and power equations of Single Stage Class A, Class B, Class AB and Class C Power amplifier.
Unit III Feedback Amplifiers	3a. Calculate the gain of the amplifier for the given type of feedback amplifier. 3b. Explain effect of negative feedback on the given type of amplifier performance. 3c. Calculate Gain, Bandwidth, Input and Output resistance of the given feedback amplifier. 3d. Compare the performance of given types of negative feedback amplifiers.	3.1 Principle of feedback Amplifier 3.2 Types of feedback: negative and positive feedback, advantages and disadvantages of negative feedback 3.3 Types of feedback connections, voltage shunt, voltage series, current series and current shunt: block diagram, circuit diagram, and operation
Unit IV Wave form Generators	4a. Calculate frequency of oscillation for the given type of oscillator circuit. 4b. Select the relevant oscillator to obtain the given range of frequency with justification. 4c. Choose the relevant sweep generator to obtain the specified saw tooth waveform with justification. 4d. Prepare the specifications of the given oscillator.	4.1 Oscillators: Need, oscillator and amplifier 4.2 Condition for oscillation (Barkhausen's criteria), classification of oscillators 4.3 Sine wave Oscillator : RC Phase shift oscillator and crystal oscillator , concept , working and applications 4.4 Sweep generator: Miller sweep, Bootstrap circuit, current time base generator
Unit– V IC Voltage Regulators and SMPS	5a. Explain with sketches the working principle of given type of voltage regulator IC. 5b. Compare the working of the given types of regulators. 5c. Design voltage regulator for the specified output voltage. 5d. Interpret the working of given block of the SMPS.	5.1 Types of IC Voltage Regulator: Fixed and variable: 78XX, 79XX, specification, series and LM723, LM317, line and load regulation. 5.2 SMPS : Block diagram, working principle, specifications, special features, advantages , disadvantages and applications. Use of heat sink for regulated power supply.

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	Low Power Amplifiers	14	4	6	6	16
II	High Power Amplifiers	18	4	6	8	18
III	Feedback Amplifiers	12	4	4	4	12
IV	Waveform Generators	12	4	4	6	14
V	IC voltage Regulators and SMPS	08	2	4	4	10
Total		**64**	**18**	**24**	**28**	**70**

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

10. SUGGESTED STUDENT ACTIVITIES

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

a. Undertake micro-projects.
b. Give seminar on any relevant topic.
c. Library survey regarding different electronics circuits and voltage regulators.
d. Prepare power point presentation for electronic circuits.
e. Undertake a market survey of different electronics circuits and voltage regulators

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

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

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

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. Construct a doorbell using transistor.
b. Using transistor construct a clap switch.
c. Construct audio amplifier using.(IC810 or equivalent IC).
d. Construct power amplifier for FM receiver output.
e. Drive a 4Ω speaker using class A amplifier which is directly coupled and test its performance parameters.
f. Using ClassAB push pull amplifier drive (4Ω/8Ω) speaker, test its performance parameters.
g. IC regulators: Build a circuit of Dual regulated power supply on general purpose PCB to obtain +/- 15 V, 500mA using IC 78XX & 79XX series.
h. IC regulators: Build a regulated power supply on general purpose PCB to obtain + 5V, 500mA using IC 78XX series. Drive suitable load with regulated output.
i. IC regulators: Build a regulated power supply on general purpose PCB to obtain -20V, 500mA using IC 79XX series. Use suitable heat sink .Drive suitable load with regulated output.
j. IC Regulators: Build a constant current regulator on general purpose PCB for output current of 125mA using IC 317.
k. IC Regulators : Construct low voltage regulator on general purpose PCB for output voltage 5V using LM IC 723.Drive any 5v operated load.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Applied Electronics	Sedha, R.S.	S.Chand, New Delhi, 2015 ISBN:9788121927833
2	Principles of Electronics	Mehta, V.K. Mehta, Rohit	S.Chand, New Delhi, 2014 ISBN:8121924502
3	Electronic Devices and Circuit Theory	Boylestead, Robert, Neshelsky, Louis	Pearson Education, New Delhi, 2014, ISBN: 9780132622264
4	Fundamental of Electronic Devices and	Bell ,David	Oxford University Press, New Delhi, 2015, ISBN:9780195425239

S. No.	Title of Book	Author	Publication
	Circuits		
5	Electronic Devices and Circuits	Millman, Jacob Halkias, C. Christos Jit, Satyabrata	Mc Graw Hill Education, New Delhi 2015, ISBN:9789339219550
6	Modern Power Electronics	Sen, P.C.	S.Chand, New Delhi, 2015 ISBN:9788121924252

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. www.eng.uokufa.edu.iq/staff/alikassim/lectures/CH-4.pdf
b. www.electronics-tutorials.ws/amplifier/amp_1.html
c. www.colorado.edu/ physics/phys3330/PDF/Experiment7.pdf
d. www.alldatasheet.com/view.jsp?Searchword=Bc147
e. www.williamson-labs.com
f. www.futurlec.com
g. www.learnerstv.com/video/Free-video-Lecture-870-Engineering.htm
h. www.electronicspost.com/discuss-the-essentials-of-a-transistor-oscillator-explain-the-action-of-tuned-collector-oscillator-colpitts-oscillator-and-hartley-oscillator/
i. www.radio-electronics.com/info/power-management/switching-mode-power-supply/basics-tutorial.php
j. www.circuitstoday.com/ic-723-voltage-regulators
k. www.onsemi.com/pub_link/Collateral/LM317-D.PDF

Program Name : **Electronics Engineering, Digital Electronics and Instrumentation Engineering Program Group**

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

Semester : **Third**

Course Title : **Electric Circuits and Networks**

Course Code : **22330**

1. RATIONALE

In industry, to build and test electronic/electrical circuits in different situations knowledge of electric circuits and networks is very important. This course is intended to develop the skills to diagnose and rectify the electric network and circuit related problems in the industry. The concept and principles of circuit analysis lays the foundation to understand courses of higher level.

2. COMPETENCY

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

- **Diagonose the electrical and electronic circuits problems.**

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. Check the working of single phase a.c. circuits.
b. Check the resonance condition of electric/electronic circuits.
c. Check the functionality using the principles of circuit analysis.
d. Use network theorems to determine the various parameters in circuits.
e. Use two port networks to determine the circuit parameters.

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	2	7	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.

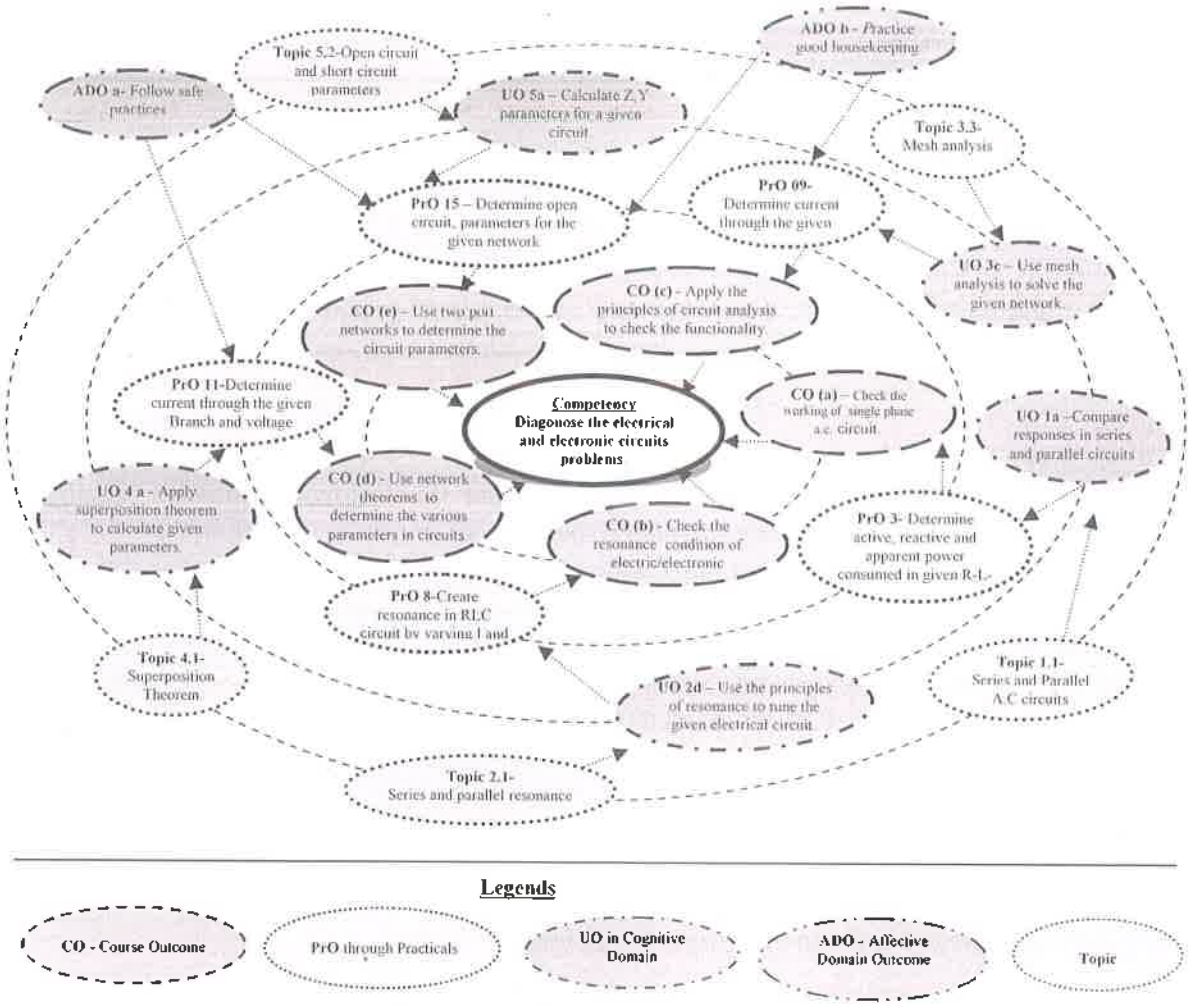

Figure 1 - Course Map

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	Determine active, reactive and apparent power consumed in given R-L series circuit and draw phasor diagram.	I	02*
2	Determine active, reactive and apparent power consumed in given R-C series circuit and draw phasor diagram.	I	02
3	Determine active, reactive and apparent power consumed in given R-L-C series circuit and draw phasor digram.	I	02*
4	a. Measure currents in R-C parallel A. C. circuit. b. Determine p.f., active, reactive and apparent power in R-C parallel a.c. circuit.	I	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
5	a. Measure currents in each branch of given R-L-C parallel a. c. circuit. b. Determine p.f., active, reactive and apparent power for given R-L-C Parallel circuit with series connection of resistor and inductor in parallel with capacitor.	I	02
6	Determine initial and final voltage across the capacitor at $t=0^-$ and $t=0^+$.	I	02
7	Determine initial and final current through the inductive coil at $t=0^-$ and $t=0^+$	I	02
8	Create resonance in given R-L-C circuit by varying L and C or by using variable frequency supply.	II	02*
9	Determine current through the given branch of a electric network by applying mesh analysis.	III	02
10	Determine voltage at the particular node and current through any given branch of the network by applying nodal analysis.	III	02*
11	Determine current through the given branch and voltage across the given element of circuit by applying superposition theorem .	IV	02*
12	Determine equivalent circuit parameter in a given circuit by applying Thevenin's and Norton's theorem .	IV	02
13	Determine load resistance for maximum power transfer for a given circuit by applying maximum power transfer theorem .	IV	02
14	Test the response of the given circuit by applying reciprocity theorem.	IV	02
15	Determine open circuit (Z) parameters for the given network.	V	02*
16	Determine short circuit (Y) parameters for the given network.	V	02
17	Determine transmission (ABCD) parameters for the given network.	V	02
	Total		**34**

Note

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

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

S. No.	Performance Indicators	Weightage in %
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	Ammeters MI Type: AC/DC, 0-1Amp,0-1.5 Amp,0-2.5Amp,0-5Amp.	1 to 17
2	Voltmeter MI Type: AC/DC, 0-150/300V, 0-250/500V,0-75/150V.	1 to 17
3	Ammeters PMMC Type: DC, 0-1.5/3Amp, 0-2.5/5 Amp, 0-5/10Amp.	1 to 17
4	Voltmeter PMMC Type: DC, 0-150/300V, 0-250/500V,0-75/150V.	1 to 17
5	Wattmeter: Single phase 2.5/5Amp, 200/400V. Single phase 5/10Amp, 250/500V	1 to 17
6	Low power factor wattmeter : Single phase. 5/10Amp, 250/500V.	1 to 5
7	Wattmeter: Dynamometer type, single phase. 5Amp, 250V.	1 to 5
8	Power factor meters: AC, 230V,45-50-55 Hz , single phase, 5-10 Amp, 250V.	1 to 5
9	Digital storage oscilloscope 50MHz.	6 ,7
10	Trainer kit for all theorems.	9 to 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 Single Phase A.C. Circuits	1a. Compare the A.C. responses in the given type of series and parallel circuits. 1b. Explain with sketches the phasor diagram of the given AC circuit. 1c. Calculate active, reactive, apparent	1.1 Series A.C. circuits: R-L, R-C and R-L-C circuits, impedance, reactance, phasor diagram, impedance triangle, power factor, active(real) power, apparent power , reactive power, power triangle

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	power and power factor for the specified circuit. 1d. Suggest the power factor improve technique for the given situation with justification. 1e. Calculate admittance,conductance and susceptance for the given circuit. 1f. Determine the equivalent impedance and admittance for the given circuit. 1g. Interpret the working of the given R,L, and C component using initial and final condition.	1.2 AC Series circuit by using complex algebra 1.3 Parallel AC circuits: Resistance in parallel with pure inductance and capacitance, series combination of resistance and inductance in parallel with capacitance 1.4 Concept of admittance, conductance and susceptance 1.5 Concept of initial and final conditions in switching circuits, Meaning of t = 0 -, t = 0+ and t = ∞. R, L and C at initial and final conditions
Unit-II Resonance in Series and Parallel Circuits	2a. Find the resonance condition for the specified series and parallel circuits. 2b. Calculate current, voltage and frequency for the given resonant circuit. 2c. Determine bandwidth and quality factor(Q) for the given series and parallel resonant circuit. 2d. Describe the procedure to tune the given electrical circuit using the principles of resonance.	2.1 Series and parallel resonance 2.2 Impedance and phase angle of a Series and parallel resonant circuits 2.3 Voltage and current in a series and parallel resonant circuit 2.4 Bandwidth of a RLC circuit(series and parallel resonance) 2.5 Quality factor (Q) and its effect on bandwidth (series and parallel resonance) 2.6 Magnification in series and parallel resonance circuits
Unit– III Principles of Circuit Analysis	3a. Use source transformation techniques for the given circuit. 3b. Convert the given star connection to delta connection and vice versa. 3c. Use mesh analysis to solve the given network. 3d. Solve the given network using nodal analysis. 3e. Diagnose the fault in the given circuit using the relevant technique(s).	3.1 Source transformation 3.2 Star/delta and delta/star transformations 3.3 Mesh analysis 3.4 Node analysis
Unit– IV Network Theorems	4a. Use superposition theorem to calculate the given parameters in the given circuit. 4b. Apply Thevenin's theorem to calculate the given parameters in the given circuit. 4c. Use Norton's theorem to calculate the given parameters in the given circuit.	4.1 Superposition theorem for both AC voltage and DC source 4.2 Thevenin's theorem 4.3 Norton's theorem 4.4 Maximum power transfer theorem 4.5 Reciprocity theorem 4.6 Superposition theorem

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	4d. Calculate load impedance using maximum power transfer theorem for the given circuit. 4e. Use reciprocity theorem to analyse the given circuit.	
Unit –V Two Port Networks	5a. Calculate Z, Y, parameters for the given circuit. 5b. Find the ABCD parameters for the given circuit. 5c. Sketch the phasor diagram for the given T and π circuit with justification. 5d. Calculate Z and Y parameters to test whether the given circuit is reciprocal or symmetrical two port network .	5.1 Significance of two port network 5.2 Open circuit(Z) and short circuit(Y) Parameters 5.3 Transmission (ABCD) parameter 5.4 T and π representation of circuits 5.5 Reciprocal and symmetrical two port network(no derivation)

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	Single Phase A.C. Circuits	10	04	04	06	14
II	Resonance in Series and Parallel Circuits	10	02	06	06	14
III	Principles of Circuit Analysis	10	04	04	06	14
IV	Network Theorems	12	04	06	08	18
V	Two port networks	06	02	04	04	10
Total		**48**	**16**	**24**	**30**	**70**

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

10. SUGGESTED STUDENT ACTIVITIES

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

a. Prepare journals based on practical performed in laboratory.
b. Follow the safety precautions.
c. Use various meters to test electric/electronic equipment and component.
d. Library / Internet survey of electrical circuits and network

e. Prepare power point presentation or animation for understanding different circuits behaviour.

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. Use Flash/Animations to explain various theorems in circuit analysis
f. Guide student(s) in undertaking micro-projects

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably be ***individually*** undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should ***not exceed three.***
The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than ***16 (sixteen) student engagement hours*** during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs. Micro project report may be of four to five pages.

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

a. **Single Phase A.C. series and parallel Circuits:** Prepare series and parallel circuit using variable R, L and C combination on the bread board. Measure the response and draw vector diagram. Also calculate power factor for the circuit. Write report on the same.
b. **Resonance in series and Parallel Circuits:** Prepare series RLC circuit using variable R, L and C combination on the bread board. Tune the circuit for resonance condition. Measure the responses and calculate band width and Q-factor for the circuit. Write report on the same.
c. **Resonance in Series and parallel Circuits:** Prepare parallel RLC circuit using variable R, L and C combination on the bread board. Tune the circuit for resonance condition. Measure the response and calculate band width and Q-factor for the circuit. Write report on the same.

d. **Principles of circuit analysis:** Prepare power point presentation on source transformation, star delta transformation, mesh and nodal analysis and give presentation in the class room.
e. **Network Theorems:** Select suitable components for the given circuit and prepare the same on the bread board. Verify the following network theorem theoretically and practically.
   i. Superposition Theorem
   ii. Maximum power transfer theorem
   iii. Thevenin's theorem
   iv. Norton's theorem.
f. **Two Port Networks:** Design and prepare two port network on bread board for given values of open circuit Z parameter.
g. **Two Port Networks:** Design and prepare two port network on bread board for given values of short circuit Y parameter.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Basic Electrical Engineering	Mittle, V.N. ; Mittle, Arvind	McGraw Hill Education, Noida, 2005, ISBN: 9780070593572
2	A Text Book of Electrical Technology Vol-I	Theraja, B. L. ; Theraja, A. K.	S. Chand and Co., New Delhi, 2006 ISBN: 978-81-219-2440-5
3	Fundamentals of Electrical Engineering	Saxena, S.B.; Dasgupta, K.	Cambridge university press pvt. Ltd., New Delhi, 2016, ISBN : 9781107464353
4	Circuit and network	Sudhakar, A. ; Palli Shyammohan, S.	McGraw Hill, New Delhi, 2006 ISBN : 978-0-07-340458-5
5	Electric Circuits	Bell, David A.	Oxford University Press New Delhi, 2009 ISBN: 9780195425246
6	Electric Circuit Analysis	Paranjothi, S.R.	New Age Publisher, New Delhi, 2011, ISBN: 978-81-224-3154-4
7	Fundamentals of Electrical Networks	Gupta, B.R ; Singhal, Vandana	S.Chand and Co., New Delhi, 2005 ISBN: 978-81-219-2318-7
8	Schaum's Outline of Electric Circuits	Edminister,Joseph A. Nahvi,Mahmood	McGraw Hill, New Delhi, 2013 ISBN: 9780070189997
9	Introductory circuit Analysis.	Boylested, R.L.	Wheeler, New Delhi , 2013 ISBN: 978-0023131615

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. www.cesim.com/simulations
b. www.scilab.org/scilab
c. www.ni.com/multisim
d. www.youtube.com /electric circuits
e. www.dreamtechpress.com /ebooks
f. www.nptelvideos.in/electrical engineering/ circuit theory
g. www.learnerstv.com/free-engineering
h. electronicsforu.com/category/electronics-projects

Program Name : **Electronics & Tele-Communication Engineering, Electronics, Electronics & Communication Engineering, Electronics Engg. and Electronics & Communication Technology**

Program Code : **EJ/ET/EN/EX/EQ**

Semester : **Third**

Course Title : **Electronics Measurements and Instrumentation**

Course Code : **22333**

1. RATIONALE

Modern automated instrumentation system is an emerging field, used for data sensing, acquisition, transmission, analysis and control in various practical applications. Analog and digital instruments are mainly used to measure different process control parameters. The physical quantities/parameters are be converted into electrical signal with the help of various types of sensors and transducers and also used to maintain electronic control and automation system. Handling Test and Measuring Instrument is the essential activity of the diploma engineering passouts (also called technologists) when they work in any electronic automation industry.

2. COMPETENCY

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

- **Maintain electronic automated system in process and manufacturing industries.**

3. COURSE OUTCOMES (COs)

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

a. Interpret the characterstics of measuring instrument.
b. Calibrate different electronic instrument.
c. Use the relevant instrument to measure specified parameters.
d. Interpret working of various types of sensors and transducers.
e. Use various types of transducers and sensors to measure quantities.
f. Maintain signal conditioning and data acquisition system.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme											
				Theory							Practical					
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
4	-	4	8	3	70	28	30*	00	100	40	50@	20	50	20	100	40

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

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

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

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

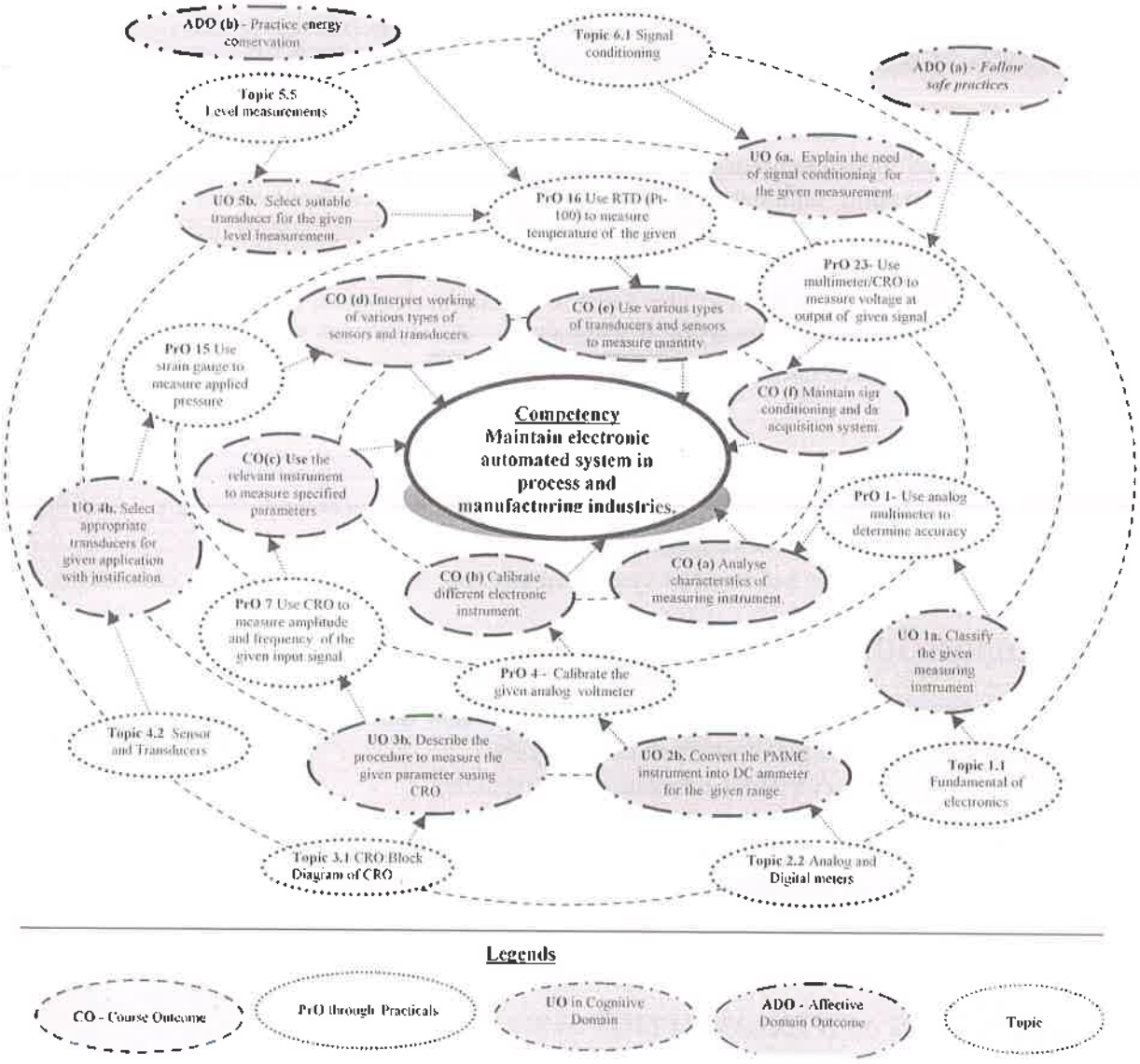

Figure 1 - Course Map

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 analog multimeter to determine accuracy, resolution and hysteresis for specified measured quantity.	I	02*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
2	Use analog meters to measure voltage, current and resistance	I	02*
3	Use digital meters to measure voltage, current and resistance.	III	02*
4	Calibrate the given analog voltmeter.	II	02*
5	Calibrate the given analog ammeter.	II	02
6	Select the relevant range of CRO for various measurement by varing positions of front panel knobs.	III	02
7	Use CRO to measure amplitude and frequency of the given input signal.	III	02
8	Generate Lissajous pattern on CRO to measure frequency of the given input signal.	III	02*
9	Generate Lissajous pattern on CRO to measure phase of the given input signal	III	02
10	Use function generator to generate different types of waveforms and observe them on DSO.	III	02
11	Use DSO to measure amplitude and frequency of the given input signal.	III	02
12	Use spectrum analyzer to measure frequency band of the given input signal .	III	02
13	Test the characteristics of the potentiometer.	IV	02*
14	Test relation between Linear displacement and output voltage using LVDT.	IV	02
15	Use strain gauge to measure applied pressure.	V	02*
16	Use RTD (Pt-100) to measure temperature of the given liquid.	V	02*
17	Use thermocouple to measure temperature of liquid .	V	02
18	Use bourdon tube and LVDT to measure applied pressure.	V	02*
19	Use venturi tube to measure flow of fluid.	V	02
20	Use orifice plate to measure flow of fluid.	V	02
21	Use rotameter to measure flow of liquid.	V	02*
22	Use pH meter to measure pH value of given solution.	V	02*
23	Use multimeter/CRO to measure voltage at output of given signal conditioning circuit.	VI	02
24	Test the performance of Portable Data Acquisition System.	VI	02*
25	Troubleshoot of potentiometer.	VI	02
26	Troubleshoot of strain guage.	VI	02
27	Troubleshoot of venture tube.	VI	02*
28	Troubleshoot of rotameter	VI	02
	Total		**56**

Note

*i. A suggestive list of **PrOs** is given in the above table. More such PrOs can be added to attain the COs and competency. A judicial mix of minimum 24 or more practical need to be performed, out of which, the practicals marked as '*' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.*

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

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

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

a. Follow safety practices.
b. Practice good housekeeping.
c. 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
- 'Organising Level' in 2nd year
- 'Characterising Level' in 3rd year.

7. MAJOR EQUIPMENT/INSTRUMENTS REQUIRED

S. No.	Equipment Name with Broad Specifications	PrO. S. No.
1	Analog multi-meter: 0-10A, 0-600V, 0-10MΩ	1,2,4,5
2	Digital multi-meter: 0-10A, 0-600V, 0-10MΩ	All
3	Dual trace CRO with probe: Bandwidth AC 10Hz ~ 20MHz (-3dB). DC ~ 20MHz (-3dB), X10 Probe	6,7,8,9
4	Digital storage oscilloscope: Bandwidth 60MHz, Dual Channel	10,11
5	Function generator: Frequency Ranges: 0.1 Hz to 11 MHz, Pulse and Ramp Aspect Ratio: 95:5	8,9,10
6	Spectrum analyzer: 9 kHz - 26.5 GHz	12
7	LVDT: Stroke range ±0.1 [±2.54]or available range	14
8	Strain gauge: Universal general – purpose strain gages	15
9	RTD and Thermocouple (any one type): Pt 100, Type K, Chromel (+) Alumel (-), 0 to 1260°C	16,17
10	Venturi tube: process temperatures between -20 °F and +350 °F (-30 °C and +175 °C), accuracy of ± 0.50% for standard meters and ± 0.25% for flow calibrated meters. Orifice plate and rotameter:30mm diameter	16,17
11	pH meter: Portable pH meter range from 0 to 14 resolution 0.1/0.01 pH.	22

S. No.	Equipment Name with Broad Specifications	PrO. S. No.
	RS.232C output and supply Data connector cable, digital display with 0.001 pH unit readability	
12	Portable Data Acquisition System Specification: 24-bit ADC/ch, 4 analog voltage inputs, Powered by USB	23,24

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 Fundamental of electronics measurements	1a. Classify the given measuring instrument. 1b. Determine static and dynamic characteristics of the measuring instruments with the given data. 1c. Identify the standards for calibration of the given instrument with justification. 1d. Explain with sketches the generalized procedure for calibration of the given instrument.	1.1 Fundamentals of electronic measurement: 1.2 Characteristics of measurement: statics and dynamics characteristics, error in measurement, types of error. 1.3 Standards of measurement 1.4 Calibration: Need and meaning of calibration
Unit– II Analog and Digital meters	2a. Determine resolution, sensitivity and accuracy of the given digital display. 2b. Convert the PMMC instrument into DC ammeter for the given range. 2c. Convert the PMMC instrument into DC voltmeter for the given range. 2d. Explain with sketches the working of given type of ohm meter, ACvoltmeter. 2e. Prepare specification of the given analog meter.	2.1 Indicating and display device: D Arsonval movement, PMMC , moving iron, LCD, LED 2.2 Analog and Digital meters: Type of analog and digital meters, voltmeter, ammeter, ohm meter, extension of measuring range of meters ,applications of meters, Calibration of meters
Unit– III Oscilloscope , Function generator, and Spectrum analyzer	3a. Explain with sketches the working of the given blocks and type of oscilloscope. 3b. Explain with sketches the procedure to measure the given parameters using CRO. 3c. Describe the function of the given blocks of signal/function generator. 3d. Explain with sketches the procedure to test the given types of signals using the relevant type test and measureing instrument. 3e. Select CRO/ DSO, Spectrum	3.1 CRO: Block diagram of CRO, CRT, vertical deflection system and horizontal deflection system, need of delay line, time base generator, amplitude and frequency measurement using CRO, lissajous patterns for phase and frequency measurement, component testing using CRO, dual trace and dual beam CRO 3.2 DSO: Block diagram of DSO, various function, and applications of DSO 3.3 Function generator: Block

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	analyzer and function generator for specified application with justification. 3f. Prepare specification for the given instrument.	diagram of function generator, application of function generator, 3.4 Spectrum analyzer : Block diagram of spectrum analyzer and its applications.
Unit-IV Sensors and Transducers	4a. Describe the function of the given block of instrumentation system with the help of suitable block diagram. 4b. Select relevant transducers for given application with justification. 4c. Differentiate the features transducers and sensors for the given quantity measurement. 4d. Explain with sketches the working principle of given type of thermal sensor. 4e. Select the relevant transducer for the given range of displacement measurement with justification.	4.1 Instrumentation System: Block diagram of instrumentation system, function of each block 4.2 Sensors and Transducers:basic definition,difference,classification of sensors 4.3 Thermal ,optical, magnetic and electric sensors 4.4 Transducer : Need of transducer, types of transducer: Primary, secondary, active, passive,analog,digital,resistive,capacitive,inductive (LVDT, RVDT), piezoelectric transducer , selection criteria of transducer.
Unit –V Applications of sensors and transducers	5a. Explain with sketches the working principle of the given transducers. 5b. Select suitable transducer for the given level measurement with justification. 5c. Select the relevant sensor for the given range of temperature measurement with justification. 5d. Select the relevant transducer for the given range of pressure measurement with justification 5e. Select the relevant sensor/ transducer for the specified application with justification.	5.1 Level measurement: Need of level measurement, float type, capacitive type, ultrasonic type, radiation type, working principle, construction of each. 5.2 Temperature measurement: thermister, RTD (Pt-100), thermocouple: seeback and peltier effects(J,K,R,S,T types),optical pyrometer 5.3 Pressure measurement: Types, Bourdon tube, Bellows, Diaphragm, pressure measurement using Bourdon tube and LVDT 5.4 Flow measurement: types, Variable head flow meter: Venturimeter, orifice plate meter, Variable area flow meter : Rotameter, electromagnetic flow meter, ultrasonic flow meter 5.5 Special transducers and measurement: Humidity measurement using hygrometer, pH measurement
Unit –VI Signal conditioning	6a. Explain the need of signal conditioning for the given measurement.	6.1 Signal conditioning: need of signal conditioning, Types of signal conditioning: Block

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
and Data acquisition system	6b. Differentiate between the given block of AC and DC signal conditioning circuits. 6c. Describe function of the given block of DAS . 6d. Explain with sketches the working of data acquisition system for the specified application .	diagram of AC and DC signal conditioning circuits 6.2 Data Acquisition System (DAS): type of DAS, Application of DAS with example

***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	Fundamental of electronics measurements	08	02	02	04	8
II	Analog and Digital meters	14	02	06	06	14
III	Oscilloscope,Function generator and Spectrum analyzer	14	02	04	08	14
IV	Sensors and transducers	10	02	04	06	12
V	Applications of sensor and transducers	12	02	04	06	12
VI	Signal conditioning and Data acquisition system	06	02	02	06	10
Total		**64**	**12**	**22**	**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. Prepare journals based on practical performed in laboratory.
b. Test different components using CRO.
c. Give seminar on any latest Test and measuring Instruments used in the Industry.
d. Library survey regarding different data books of different instruments and manuals.
e. Prepare power point presentation to demonstrate operation of DSO.
f. Undertake a market survey of different electronic instrument.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES

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

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

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

a. **Analog and digital meters**: Build and test voltmeter (0-10V, 1mA, 500ohms)using PMMC.
b. **Analog and digital meters**: Build and test ammeter (0-100 mA)using PMMC.
c. **Signal conditioning**: Design D.C.signal conditioning circuit using Wheatstone bridge and implement that on PCB.
d. **Function Generator**: Build and Test function generator using IC 8038(sine wave, square wave, triangular wave upto 100 kHz) on the PCB.
e. **Oscilloscope Function generator, Spectrum analyzer**: Survey of different electronic instruments.
f. (Use structure and other features of 'Electronic Measurement and Instrumentation' to develop above listed applications)

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Electrical and Electronic Measurements and Instrumentation	Sawhney, A.K.	Dhanpat Rai & Sons,New Delhi ,2005, ISBN: 13-9788177000160
2	Electronic Instrumentation	Kalsi, H.S.	McGraw Hill,New Delhi,2010 ISBN:13-9780070702066
3	Electronic Instrumentation and Measurements	David, A.Bell	Oxford University Press, New Delhi,2013, ISBN: 10:0-19-569614-X
4	Modern Electronic Instrumentation and Measurement Techniques	Helfrick, A.D. Cooper, W.D.	Pearson Eduction India,I[st] Edition, New Delhi, 2015 , ISBN-13: 978-9332556065

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. www.instrumentationcontrolbox.com
b. www.circuitstoday.com
c. www.myklassroom.com/Engineering.../Electronics-&-Instrumentation-Engg.-(EIE)
d. www.en.wikipedia.org/wiki/List_of_electrical_and_electronic_measuring_equipment
e. www.en.wikipedia.org/wiki/Electronic_test_equipment
f. www.en.wikibooks.org/wiki/Electronics/Measuring_Instruments

Program Name : **Electronics & Tele-Communication Engineering, Electronics, Electronics & Communication Engineering, Electronics Engg. and Electronics & Communication Technology**

Program Code : **EJ/ET/EN/EX/EQ**

Semester : **Third**

Course Title : **Principles of Electronics Communication**

Course Code : **22334**

1. RATIONALE

In the 21st century electronic communication plays vital role in every aspect of human life. Diploma Engineers (also called technologists) have to deal with the various electronic communication circuits while maintaining electronics communication systems. The study of basic operating principles and handling of various electronics communication system will help them to troubleshoot and maintain electronics communication systems used for various type of communication. This course is developed in such a way that, students will be able to apply the domain knowledge to solve broad communication engineering application problems in electronic communication engineering field.

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 basic Electronic Communication Systems.**

3. COURSE OUTCOMES (COs)

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

a. Use relevant frequency range for different communication systems.
b. Use relevant modulation technique for the specified application.
c. Maintain transmitter and receiver circuits of AM and FM.
d. Use relevant media for transmission and reception of signals.
e. Use relevant type of antenna for various applications.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme													
				Theory							Practical						
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total		
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	
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.

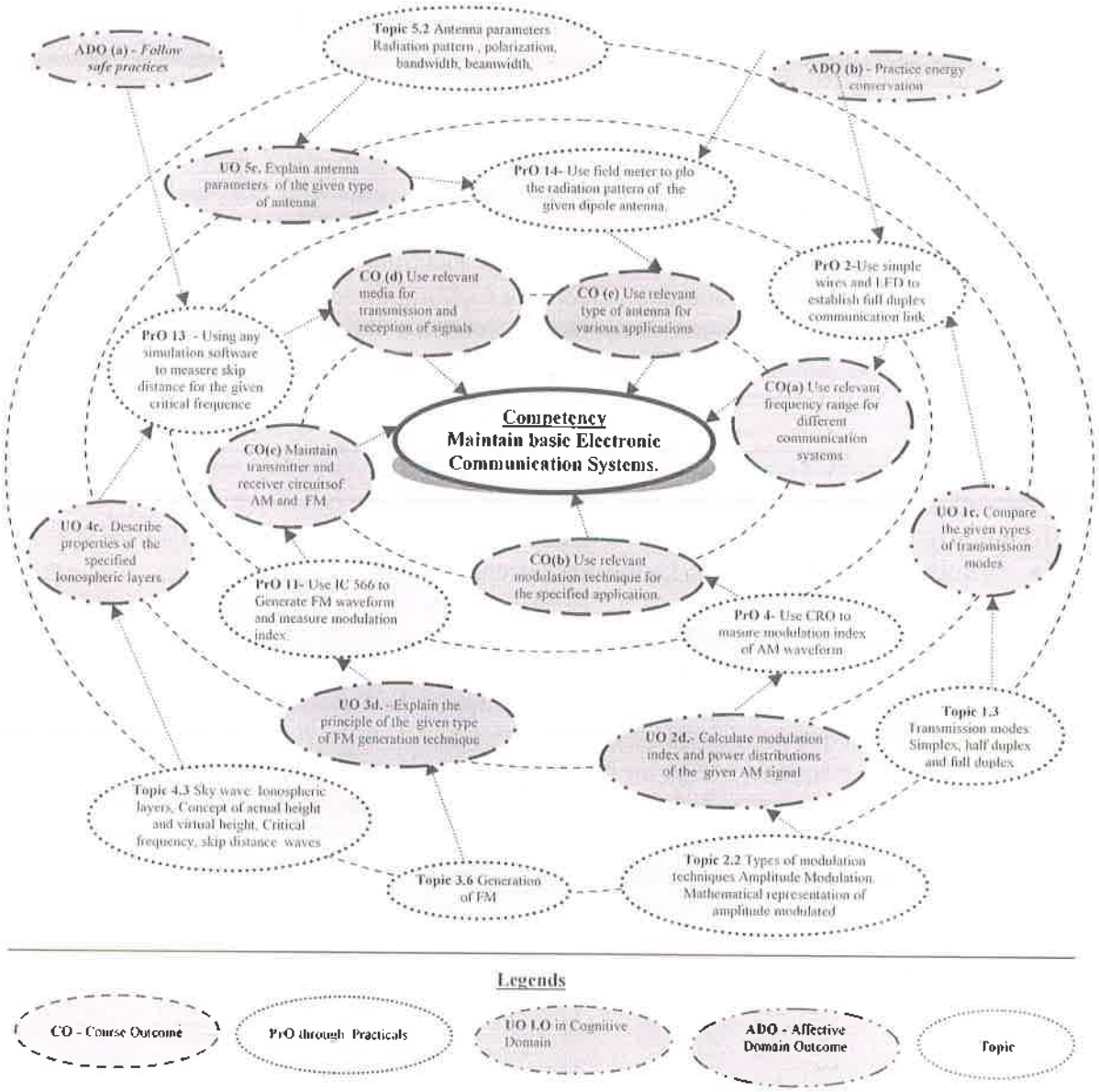

Figure 1 - Course Map

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 simple wires, switches and LEDs to establish simplex and half duplex communication link	I	02
2	Use simple wires, switches and LEDs to establish full duplex communication link	I	02
3	Observe the AM modulated waveforms generated for different carrier frequencies.	II	02
4	Generate AM wave and measure its modulation index .	II	02*
5	Use any simulation software to generate AM wave.	II	02
6	Use voltage controlled oscillator to generate FM wave and measure the frequency deviation.	II	02
7	Generate FM wave and measure its modulation index.	II	02
8	Use any simulation software to generate FM wave.	II	02*
9	Use AM demodulator circuit to detect the received AM signal.	III	02*
10	Use IC 566 to generate FM waveform and measure modulation index	III	02
11	Use IC 564 / IC 565for FM demodulation and trace it's input and output waveforms.	III	02
12	Use any simulation software to measure 1. MUF for the given critical frequency and incident angle. 2. Radio horizon for given height of transmitting and receiving antenna	IV	02*
13	Use field meter to plot the radiation pattern of the given dipole antenna.	V	02*
14	Use field meter to plot the radiation pattern of given Yagi-Uda antenna.	V	02
15	Use any simulation software to plot radiation pattern of the given type of antenna.	V	02
	Total		**30**

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

S. No.	Performance Indicators	Weightage in %
3	Safety measures	10
4	Observations and Recording	10
5	Interpretation of result and Conclusion	20
6	Answer to sample questions	10
7	Submission of report in time	10
	Total	**100**

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

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

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

- 'Valuing Level' in 1st year
- '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. S. No.
1	Cathode Ray Oscilloscope Dual Trace 20Mhz, 1MegaΩ Input Impedance	3 to12
2	RF signal generator with Wide frequency range 100 KHz to 150 MHz Fine frequency adjustment by calibrated dial built in audio frequency generator	3 to12
3	DSO with Bandwidth : 50/100MHz TFT Colour LCD Dual Channel Real Time Sampling: 1GSa/s Equivalent Sampling 25GSa/s Memory 1M pts 10 Waveforms & 10 Setups can be stored	3 to12
4	Regulated power supply: DC Supply Voltages Dual DC : 2 x 0 - 30V;0-2 A Automatic Overload (Current Protection) Constant Voltage & Constant Current Operation	1-12
5	AM trainer kit for DSB/SSB AM modulation and demodulation	3,4
6	Digital Multimeter : 3 1/2 digit display, 9999 counts digital multimeter measures: V_{ac}, V_{dc} (1000V max) , A_{dc}, A_{ac} (10 amp max) , Resistance (0 - 100 MΩ) , Capacitance and Temperature measurement	3 to12
7	FM trainer kit for FM modulation and demodulation	3
8	Trainer kit for FM modulator using IC566: AC Source: 600Hz to 2.5 KHz. FM Modulator : VCO Test Points , circuit diagram engraved on front panel with transparent rear panel	6,7,10, 11

S. No.	Equipment Name with Broad Specifications	PrO. S. No.
9	Trainer kit for FM demodulator using IC 564: AC Source: 600Hz to 2.5 KHz.FM Demodulator :PLL Test Points	12
10	Antenna trainer kit:for dipole and yagi-uda antenna, mobile antenna,omindirection antenna, horn antenna and other common type of antennas	14,15
11	Software for program : SCILAB,MATLAB ,TINA PRO.	5,8,13,16
12	Simulation software suitable for communication experiments .	5,8, 13,16

8. UNDERPINNING THEORY COMPONENTS

The following topics/subtopics should be taught and assessed in order to develop UOs in cognitive domain for achieving the COs to attain the identified competency.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Basics of Electronic Communication	1a. Interpret the working of the given block of basic electronic communication system. 1b. Identify the relevant frequency band of electromagnetic spectrum for the specified application with justification. 1c. Compare features of the given types of transmission modes. 1d. Differentiate properties of the given types of noise.	1.1 The elements of basic electronic communication system 1.2 Electromagnetic spectrum 1.3 Transmission modes: Simplex, half duplex and full duplex, Synchronous and Asynchronous 1.4 Sources of Noise (internal and external), signal to noise ratio

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – II AM and FM Modulation	2a. Interpret necessity of the given type of modulation technique . 2b. Compare the working of the given type of AM generation technique. 2c. Describe with sketches the given parameters of AM signal. 2d. Calculate modulation index and power distributions of the given AM signal. 2e. Describe with sketches the specified parameters of FM and PM signal. 2f. Determine the modulation index of given FM signal.	2.1 Need for modulation 2.2 Types of modulation techniques Amplitude Modulation: Mathematical representation of amplitude modulated wave, modulation index, bandwidth requirement , representation of AM signal in time and frequency domain, types of AM with respect to frequency spectrum (DSB, SSB and VSB), Power relations in AM wave 2.3 Frequency Modulation: representation of FM signal in time domain and frequency domain , frequency deviation ratio, modulation index(β), mathematical representation of FM, bandwidth requirement, types of frequency modulation (NB and WBFM) 2.4 Phase Modulation
Unit– III Transmitters and Receivers	3a. Explain with sketches the working of the given type of AM generation technique. 3b. Explain the function of the given blocks of AM super heterodyne receiver. 3c. Explain with sketches the given types of AM demodulation technique. 3d. Explain with sketches principle of the given type of FM generation technique. 3e. Compare the working of the given types of FM detectors.	3.1 Generation of AM 3.2 Block diagram of AM super heterodyne receiver and its working with waveforms 3.3 Demodulation of AM signal: Diode detector and practical diode detector 3.4 Automatic gain control and its types. 3.5 Concept of pre-emphasis and De-emphasis 3.6 Generation of FM using direct (varactor diode and reactance modulator) and indirect method (Armstrong method) 3.7 Block diagram of FM receiver and its working with waveforms 3.8 FM detector circuits: Ratio detector and PLL as FM demodulator
Unit– IV Wave Propagation	4a. Describe the properties of the given types of electromagnetic waves. 4b. Describe with sketches propagation mode of the given type of radio wave.	4.1 Concept of propagation of radio waves 4.2 Ground Wave propagation 4.3 Sky wave: Ionospheric layers, Concept of actual height and virtual height. Critical frequency, skip

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	4c. Describe properties of the specified Ionospheric layer. 4d. Explain parameters and properties of the given types of wave propagation. 4e. For the given application, identify the type of wave propogation to be used with justification.	distance , skip zone, concept of fading, maximum usable frequency, multiple hop sky wave propagation 4.4 Space Wave propagation : line of sight, multipath space wave propagation , optical and radio horizon, shadow zones 4.5 Duct propagation (microwave space-wave propogation) 4.6 Troposphere scatter propagation.
Unit– V Antennas	5a. Explain with sketches the working principle of the given type of antenna. 5b. Compare with sketches working of the given type of antenna on the basis of radiation pattern. 5c. Explain antenna parameters of the given type of antenna. 5d. Choose type of antenna required with broad specification for the given applications.	5.1 Antenna fundamentals :Resonant antenna and Non-resonant antennas 5.2 Antenna parameters : Radiation pattern , polarization, bandwidth, beamwidth, antenna resistance, directivity and power gain, antenna gain 5.3 Dipole antenna: Half wave dipole antenna (Resonant Antenna) and its Radiation pattern. Folded dipole antenna and its radiation pattern, Radiation pattern for Dipole Antenna of different length 5.4 Loop antenna, Telescopic antenna, Yagi-Uda antenna, Micro wave antenna – Dish antenna, Horn antenna and Micro-strip patch antenna ,rectangular, square and circular (Structure, radiation pattern and application of antennas)

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

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Basics of Electronic Communication	08	4	4	4	12
II	AM and FM Modulation	16	4	6	8	18
III	Transmitters and Receivers	16	2	6	6	14
IV	Wave propagation	10	4	4	6	14
V	Antennas	14	4	4	4	12
Total		**64**	**18**	**24**	**28**	**70**

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

10. SUGGESTED STUDENT ACTIVITIES

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

a. Prepare chart for electromagnetic spectrum.
b. Give seminar on any relevant topic related to electronic communication medium.
c. Library survey regarding different communication books and manuals.
d. Prepare power point presentation for recent communication applications.
e. Undertake a market survey of different communication devices.
f. Visit radio transmitter station.
g. Visit auditorium near your campus and make layout of PA system.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

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

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

12. SUGGESTED MICRO-PROJECTS

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

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to

maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than ***16 (sixteen) student engagement hours*** during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.
Micro project report may be of four to five pages.

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

a. **Modulation:** Build a circuit for modulation using IC MC1496/8038 on general purpose PCB and prepare the report.
b. **FM transmitter:** Build a circuit on general purpose PCB for FM transmitter using IC 8038/ transistor BF549 and prepare a report.
c. Find **different channels frequencies** associated with Am and FM stations.
d. **Antenna**: Simulate a microstrip patch antenna for frequency 2.4GHz frequency using HFSS (high frequency structure simulator) software.
e. **Tuning of IFT:** Build a circuit on general purpose PCB for tuning IFT at 455KHz.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Electronic Communication Systems	Kennedy George; Davis Bernard; Prasanna SRM	Mc-Graw Hill 5th Edition, New Delhi,2011, ISBN : 9780071077828
2	Principles of Electronics Communication system	Frenzel Louis E.	Mc-Graw Hill 5th Edition, New Delhi,2007, ISBN : 9780073222783
3	Electronic communication system: Fundamentals Through Advanced	Tomasi W.	Pearson Education India, New Delhi, 4th Edition, 2001, ISBN: 9780130221254
4	Antenna Theory: Analysis and Design	Constantine A. Balanis	Wiley-Student edition India,New Delhi, 2015-16, ISBN: 9788126524228
5	Audio and video systems principals, maintenance and troubleshooting	Gupta R.G.	Tata McGraw Hill,New Delhi, 2010, ISBN : 9780070699762

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. www. turbofuture.com/industrial/Elements-of-Electronic-Communications-System
b. www.st-andrews.ac.uk/~www_pa/Scots_Guide/iandm/part3/page1.html
c. www.antenna-theory.com/basics/main.php
d. www.explainthatstuff.com/antennas.html
e. www.circuitdiagram.org/am-radio-receiver-with-mk484.html
f. www.circuitstoday.com/single-chip-fm-radio-circuit

Maharashtra State Board Of Technical Education, Mumbai

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

Program Name : Diploma in Digital Electronics

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

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

Semester : Second | **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	Digital Techniques	DTE	22320	4	-	2	6	3	70	28	30*	00	100	40	25#	10	25	10	50	20	150
2	Applied Electronics	AEL	22329	4	-	4	8	3	70	28	30*	00	100	40	50#	20	50	20	100	40	200
3	Electric Circuits and Networks	ECN	22330	3	2	2	7	3	70	28	30*	00	100	40	25@	10	25	10	50	20	150
4	Electronic Instruments and Measurements	EIM	22331	4	-	2	6	3	70	28	30*	00	100	40	25@	10	25	10	50	20	150
5	Industrial Instrumentation and Sensor	IIS	22332	3	-	2	5	3	70	28	30*	00	100	40	25@	10	25	10	50	20	150
6	Electronics Simulation Software Practices	ESS	22025	-	-	4	4	--	--	--	--	--	--	--	25@	10	25~	10	50	20	50
			Total	**18**	**2**	**16**	**36**	--	**350**	--	**150**	--	**500**	--	**175**	--	**175**	--	**350**	--	**850**

Student Contact Hours Per Week: **36 Hrs.** Medium of Instruction: **English**

Theory and practical periods of 60 minutes each. Total Marks : **850**

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 (5 marks each for Physics and Chemistry) 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.**

MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION MUMBAI

Program Name : **Computer and Electronics Engineering Program Group**

Program Code : **CO/CM/CW/DE/EJ/ET/EN/EX/EQ/IE/IS/IC/MU**

Semester : **Third**

Course Title : **Digital Techniques**

Course Code : **22320**

1. RATIONALE

In the present scenario most of the electronic equipment like computers, mobiles, music systems, ATM, automation and control circuits and systems are based on digital circuits which the diploma electronic engineering passouts (also called technologists) have to test them. The knowledge of basic logic gates, combinational and sequential logic circuits using discrete gates as well as digital ICs will enable the students to interpret the working of equipment and maintain them. After completion of the course, students will be able to develop digital circuits based 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:

- **Build/ test digital logic circuits consist of digital ICs.**

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 number system and codes for interpreting working of digital system.
b. Use Boolean expressions to realize logic circuits.
c. Build simple combinational circuits.
d. Build simple sequential circuits.
e. Test data converters and PLDs in digital electronics systems.

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.

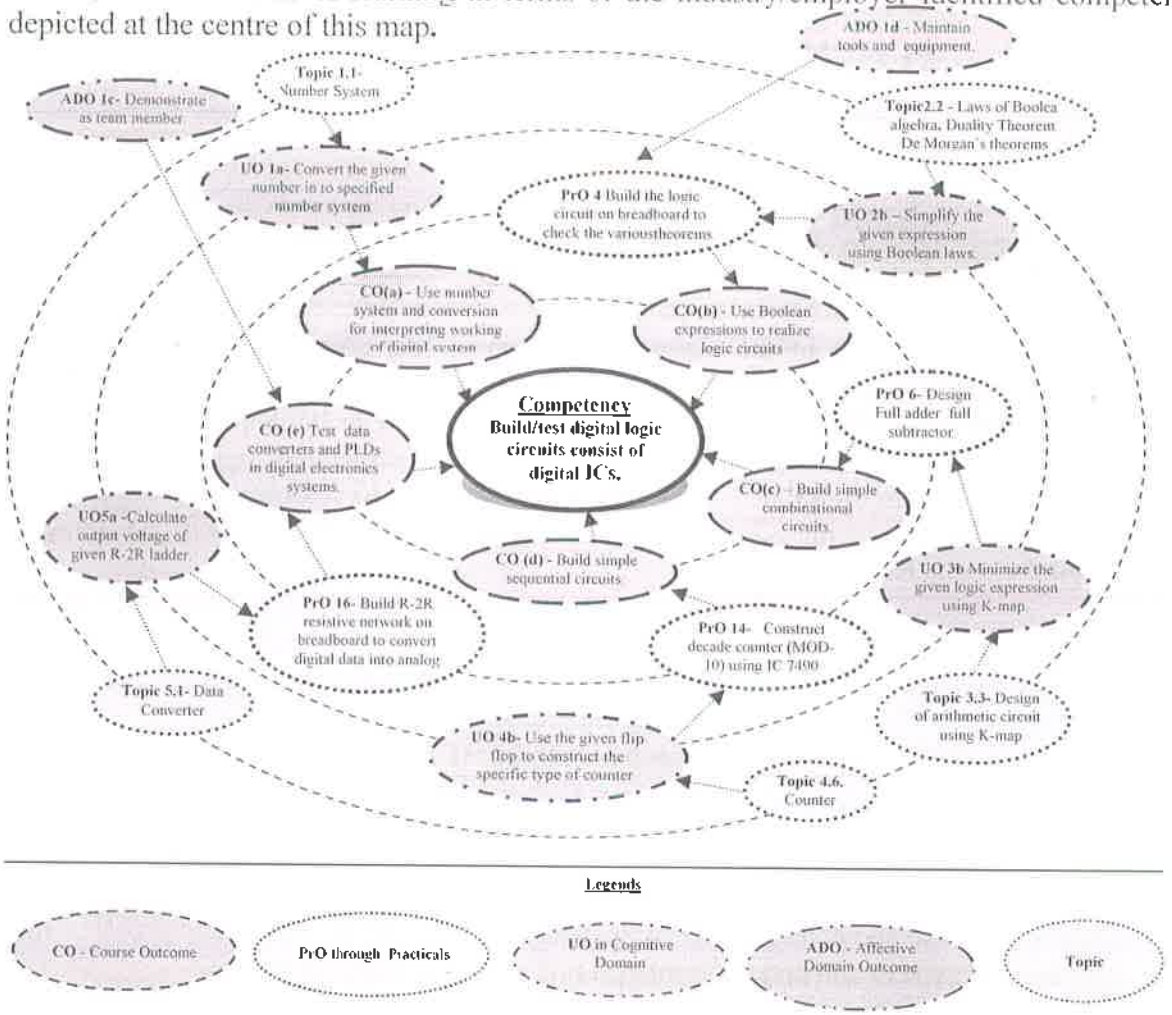

Figure 1 - Course Map

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	Test the functionality of specified logic gates using breadboard. (IC 7404, 7408, 7432, 7486)	II	02*
2	Test the functionality of NAND and NOR gate of using breadboard (IC 7400 and 7402)	II	02
3	Construct AND, OR, NOT gates using universal gates.	II	02
4	Build the logic circuit on breadboard to check the De Morgan's theorems.	II	02
5	Design Half adder and Half subtractor using Boolean expressions.	III	02*
6	Design Full adder and full subtractor.	III	02
7	Construct and test BCD to 7 segment decoder using IC 7447/ 7448.	III	02
8	Build / test function of MUX 74151/74150/any other equivalant.	III	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
9	Build / test function of DEMUX 74155/74154/any other equivalant.	III	02
10	Build / test function of RS flip flop using NAND Gate.	IV	02*
11	Build / test function of MS JK flip flop using 7476.	IV	02
12	Use IC 7476 to construct and test the functionality of D and T flip flop.	IV	02
13	Implement 4 bit ripple counter using 7476.	IV	02
14	Use IC 7490 to construct decade counter (MOD-10).	IV	02
15	Implement 4 bit universal shift register.	IV	02
16	Build R-2R resistive network on breadboard to convert given digital data into analog.	V	02*
		Total	**32**

Note

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

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

S. No.	Performance Indicators	Weightage in %
a.	Preparation of experimental 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

- '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. S. No.
1	Digital Multimeter: 3 and ½ digit with R, V, I measurements, diode and BJT testing.	All
2	CRO : Dual Channel, 4 Trace CRT / TFT based Bandwidth 20 MHz/30 MHz X10 magnification 20 ns max sweep rate, Alternate triggering Component tester and with optional features such as Digital Read out.	16
3	Pulse Generator: TTL pulse generator	10-15
4	DIGITAL IC tester: Tests a wide range of Analog and Digital IC's such as 74 Series, 40/45 Series of CMOS IC's.	1-15
5	Bread Board Development System: Bread Board system with DC power output 5V, +/-12V and 0-5V variable , digital voltmeter , ammeter, LED indicators 8 no, logic input switches 8 no, 7 segment display 2 no, clock generator, Manual pulser, Breadboard with about 1,600 points, Potentiometer, relay etc	1-15
6	Trainer kits for digital ICs: Trainer kit shall consists of digital ICs for logic gates, flop-flop, shift registers, counter along with toggle switches for inputs and bi-colour LED at outputs, built in power supply.	1-15
7	Regulated power supply: Floating DC Supply Voltages Dual DC : 2 x 0 -30V; 0-2 A Automatic Overload (Current Protection) Constant Voltage and Constant Current Operation Digital Display for Voltage and Current Adjustable Current Limiter Excellent Line and Load Regulation	1-16
8	Trainer kit for 4 bit Counter using Flip Flops: 4 bit ripple counter, Synchronous Counter, IC 7476 based circuit. Input given by switches and output indicated on LED. Facility to select MOD 8 or MOD 16 mode. Built in DC power supply and manual pulser with indicator.	13

8. UNDERPINNING THEORY COMPONENTS

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

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Number System and Codes	1a. Convert the given number into the specified number system. 1b. Perform the binary arithmetic operation on the given binary numbers. 1c. Convert the given coded number into the other specified code.	1.1 Number System: base or radix of number system, binary, octal, decimal and hexadecimal number system. 1.2 Binary Arithmetic: Addition, subtraction, multiplication, division. 1.3 Subtraction using 1's complement and 2's complement. 1.4 Codes: BCD, Gray Code, Excess-3, and ASCII code.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	1d. Add the given two decimal numbers using BCD code.	1.5 BCD Arithmetic: BCD Addition
Unit – II Logic gates and logic families	2a. Develop the basic gates using the given NAND/NOR gate as universal gate. 2b. Simplify the given expression using Boolean laws. 2c. Develop logic circuits using the given Boolean expressions. 2d. Compare the salient characteristics of the given digital logic families.	2.1 **Logic gates**: Symbol, diode/ transistor switch circuit and logical expression , truth table of basic logic gates (AND, OR, NOT), Universal gates (NAND and NOR) and Special purpose gates (EX-OR, EX-NOR),Tristate logic 2.2 **Boolean algebra**: Laws of Boolean algebra, Duality Theorem, De-Morgan's theorems 2.3 **Logic Families**:Characteristics of logic families : Noise margin, Power dissipation, Figure of merit , Fan-in and fan-out, Speed of operation, Comparison of TTL, CMOS, types of TTL NAND gate
Unit– III Combinational Logic Circuits	3a. Develop logic circuits in standard SOP/ POS form for the given logical expression. 3b. Minimize the given logic expression using K-map. 3c. Use IC 7483 to design the given adder/ subtractor. 3d. Draw MUX/DEMUX tree for the given number of input and output lines. 3e. Write the specifications of the component for the given application. 3f. Develop the specified type of code converter.	3.1 **Standard Boolean representation:** Sum of Product (SOP) and Product of Sum(POS), Min-term and Max-term, conversion between SOP and POS forms, realization using NAND /NOR gates 3.2 **K-map reduction technique for the Boolean expression:** Minimization of Boolean functions up to 4 variables (SOP and POS form) 3.3 **Design of arithmetic circuits and code converter using K-map:** Half and full Adder, half and full Subtractor , gray to binary and binary to gray (up to 4 bits) 3.4 **Arithmetic circuits:** (IC 7483) Adder and Subtractor, BCD adder 3.5 **Encoder/Decoder:** Basics of encoder, decoder, comparison, (IC 7447) BCD to 7 segment decoder/driver 3.6 **Multiplexer and Demultiplexer:** working , truth table and applications of Multiplexers and Demultiplexures, MUX tree. IC 74151as MUX; DEMUX tree, DEMUX as decoder, IC 74155 as DEMUX 3.7 **Buffer:** Tristate logic, unidirectional and bidirectional buffer (IC74LS244,74LS245)

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit– IV Sequential Logic Circuit	4a. Use relevant triggering technique for the given digital circuit. 4b. Use the given flip-flop to construct the specific type of counter. 4c. Use excitation table of the given flip-flop to design synchronous counter. 4d. Design the specified modulo-N counter using IC7490. 4e. Construct ring/ twisted ring counter using the given flip-flop.	4.1 **Basic memory cell**: RS-latch using NAND and NOR 4.2 **Triggering Methods:** Edge trigger and level trigger 4.3 **SR Flip Flops**: SR-flip flop, clocked SR flip flop with preset and clear, drawbacks of SR flip flop 4.4 **JK Flip Flops**: Clocked JK Flip flop with preset and clear, race around condition in JK flip flop, Master slave JK flip flop, D and T type flip flop Excitation table of flip flops, Block schematic and function table of IC-7474, 7475 4.5 **Shift Register**: Logic diagram of 4-bit Shift registers – Serial Input Serial Output, Serial Input Parallel Output, Parallel Input Serial Output, Parallel Input Parallel Output, 4 Bit Universal Shift register **4.6 Counters:** Asynchronous counter: 4 bit Ripple counter, 4 bit up/down Counter, modulus of counter Synchronous counter: Design of 4 bit synchronous up/down counter Decade counter: Block schematic of IC 7490 Decade counter, IC 7490 as MOD-N Counter, Ring counter, Twisted ring counter
Unit– V Data Converters and PLDs	5a. Calculate the output voltage of the R-2R ladder for the given specified digital input. 5b. Calculate the output voltage of the weighted resistor DAC for the given specified digital input. 5c. Explain with sketches the working principle of the given type of ADC. 5d. Explain with sketches the working principle of the given types of memories. 5e. Explain with basic block diagram the working principle of the given type of programmable logic device.	5.1 **Data Converter**: DAC: Types, weighted resistor circuit and R-2R ladder circuit, DAC IC 0808 specifications ADC: Block Diagram, types, and working of Dual slope ADC, SAR ADC, ADC IC 0808/0809, specification 5.2 **Memory**: RAM and ROM basic building blocks, read and write operation ,types of semiconductor memories 5.3 **PLD:** Basic building blocks and types of PLDs, PLA, PAL, GAL 5.4 CPLD: Basic Building blocks, functionality.

***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	Number System	06	2	2	4	08
II	Logic gates and logic families	10	4	4	4	12
III	Combinational Logic Circuits	16	4	6	8	18
IV	Sequential Logic Circuit	16	4	6	8	18
V	Data Converters and PLDs	16	4	4	6	14
Total		**64**	**18**	**22**	**30**	**70**

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

10. SUGGESTED STUDENT ACTIVITIES

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

a. Prepare the survey report on the applications of different types of number system and code converters used in the design of digital system.
b. Compare technical specifications and applications of various types of memory, PLDs, CPLDs and Prepare report.
c. Test digital IC's using various testing equipment like digital IC tester, Digital multi-meter etc.
d. Give seminar on any course relevant topic.
e. Conduct library / internet survey regarding different data sheet and manuals.
f. Prepare power point presentation on digital circuits and their applications.
g. Undertake a market survey of different digital IC's required for different applications.
h. Search for video / animations / power point presentation on internet for complex topic related to the course and make a presentation.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

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

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

e. Guide student(s) in undertaking micro-projects.
f. PPTs/Animations may be used to explain the construction and working of electronic circuits.
g. Guide students for using data sheets / manuals.

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

a. Build a Digital IC tester circuit.
b. Build a 4bit parity generator and parity checker circuit.
c. Build a circuit to implement 4 bit adder.
d. Build a circuit to test 7 segment display.
e. Build a circuit to implement debounce switch.
f. Build a circuit for LED flasher.
g. Build a circuit for LED BAR display
h. Design and analyze digital arithmetic circuit

Note: *Use general purpose PCB for making micro projects*

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Modern Digital Electronics	Jain, R.P.	McGraw-Hill Publishing, New Delhi, 2009 ISBN: 9780070669116
2	Digital Circuits and Design	Salivahanan S.; Arivazhagan S.	Vikas Publishing House, New Delhi, 2013, ISBN: 9789325960411
3	Digital Electronics	Puri, V.K.	McGraw Hill , New Delhi, 2016, ISBN: 97800746331751
4	Digital Principles	Malvino, A.P.; Leach, D.P.; Saha G.	McGraw Hill Education, New Delhi, 2014, ISBN : 9789339203405
5	Digital Design	Mano, Morris; Ciletti, Michael D.	Pearson Education India, Delhi, 2007, ISBN: 9780131989245
6	Digital Electronics, Principles and Integrated Circuits	Maini, Anil K.	Wiley India, Delhi, 2007, ISBN: 9780470032145

S. No.	Title of Book	Author	Publication
7	Digital Fundamentals	Floyd, Thomas	Pearson Education India, Delhi, 2014, ISBN : 9780132737968

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. www.cse.yorku.ca/~mack/1011/01.NumberSystems.ppt
b. www.people.sju.edu/~ggrevera/arch/slides/binary-arithmetic.ppt
c. www.mathsisfun.com/binary-number-system.html
d. www.codesandtutorials.com/hardware/electronics/digital_codes-types.php
e. www.ee.surrey.ac.uk/Projects/Labview/gatesfunc/
f. www.ee.surrey.ac.uk/Projects/Labview/boolalgebra/
g. www.eng.auburn.edu/~strouce/class/elec2200/elec2200-8.pdf
h. www.maxwell.ict.griffith.edu.au/yg/teaching/dns/dns_module3_p3.pdf
i. www.scs.ryerson.ca/~aabhari/cps213Chapter5.ppt
j. www.eng.wayne.edu/~singhweb/seql.ppt
k. www.cs.sjsu.edu/faculty/lee/Ch2Problems2.ppt
l. www.rogtronics.net/files/datasheets/dac/SedraSmith.pdf
m. www-old.me.gatech.edu/mechatronics_course/ADC_F04.ppt
n. www.allaboutcircuits.com/vol_4/chpt_13/3.html
o. www.youtube.com/watch?v=5Wz5f3n5sjs
p. www.eee.metu.edu.tr/~cb/e447/Chapter%209%20-%20v2.0.pdf
q. www2.cs.siu.edu/~hexmoor/classes/CS315-S09/Chapter9-ROM.ppt
r. www.cms.gcg11.org/attachments/article/95/Memory2.ppt
s. www.cosc.brocku.ca/Offerings/3P92/seminars/Flash.ppt
t. www.webopedia.com/TERM/R/RAM.html
u. www.cs.sjsu.edu/~lee/cs147/Rahman.ppt

Program Name : **Electronics Engineering, Digital Electronics and Instrumentation Engineering Program Group**

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

Semester : **Third**

Course Title : **Applied Electronics**

Course Code : **22329**

1. RATIONALE

Enhanced use of electronic gadgets has made electronics engineers to deal with the various types of electronic circuits which generate the required analog/digital output. Transistor has remarkably expanded the utility of electronic equipment. Discrete components are widely used in amplifiers and other electronic systems which the engineering diploma holders (also called as technologist) have to use or maintain. The learning of basic operating principles of electronic circuits will help the students to use the basic electronic equipment. This course is developed in such a way that, students will be able to apply the knowledge of basic electronic circuit working to solve broad based electronic engineering application problems.

2. COMPETENCY

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

- **Use discrete electronic devices and voltage regulators.**

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 transistor as low Power amplifier.
b. Use BJT as high Power amplifier.
c. Use BJT as feedback amplifier.
d. Use BJT as waveform generator.
e. Maintain IC voltage regulator and SMPS.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme												
				Theory							Practical					
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
4	-	4	8	3	70	28	30*	00	100	40	50#	20	50	20	100	40

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

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

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

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

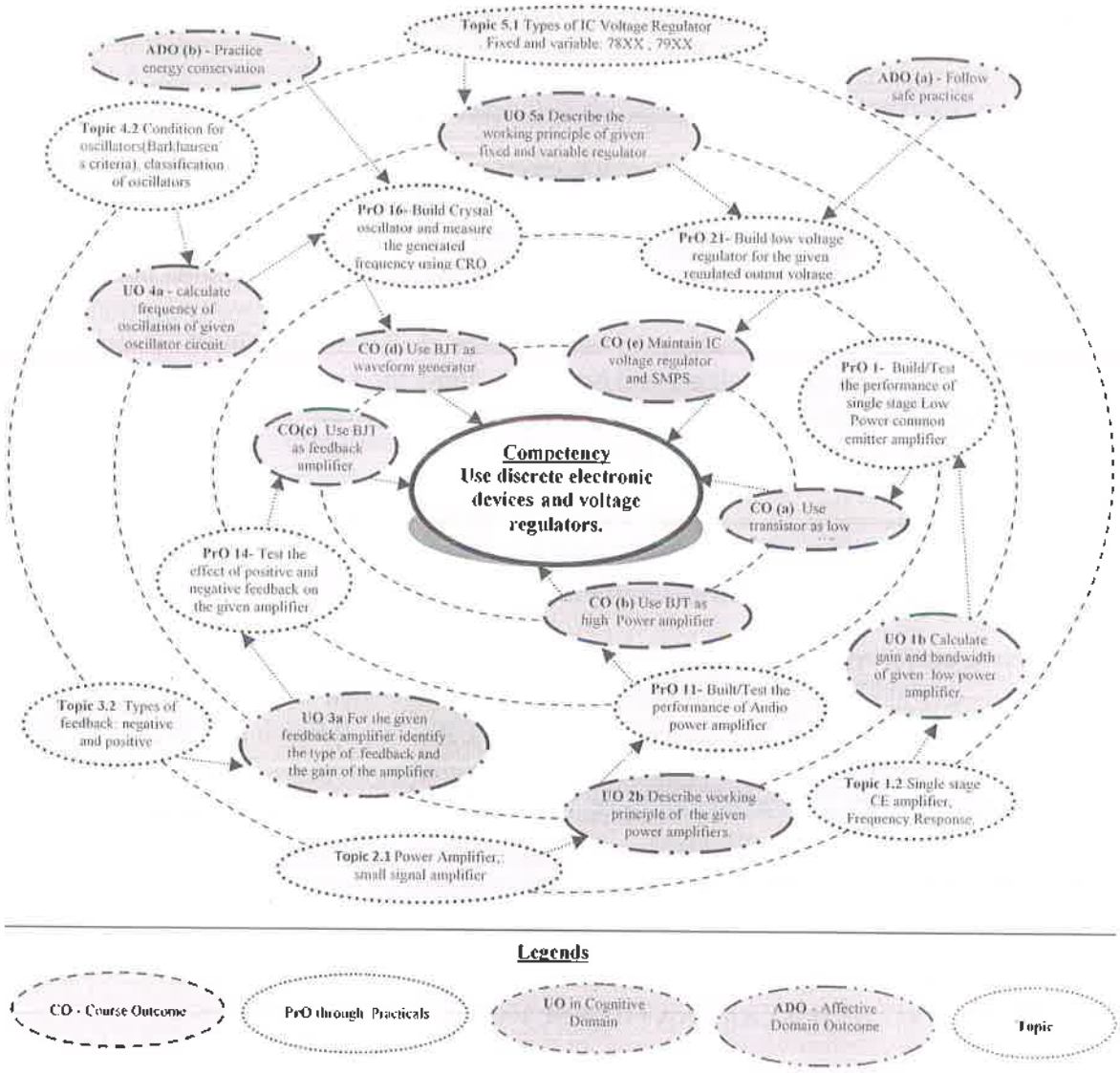

Figure 1 - Course Map

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.

* ***Use bread board for the following Practials (wherever applicable).***

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Build/test the performance of single stage Low Power common emitter amplifier.	I	2*
2	Simulate / test out put Wave form of single stage common	I	2

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	emitter (CE) amplifier using simulation software(like spice, multisim).		
3	Simulate/test the output Wave form of single Stage common source FET amplifier using simulation software	I	2
4	Build/test the performance of single stage Common source FET amplifier.	I	2
5	Build/test the performance of two stage RC Coupled common emitter amplifier using transistor.	I	2*
6	Build/test the performance of two stage direct Coupled amplifier using transistor.	I	2
7	Build/Test the performance of transformer Coupled amplifier.(Part-I)	I	2*
8	Build/Test the performance of transformer Coupled amplifier.(Part-II)	I	2*
9	Build/test the performance of single tuned amplifier using transistor.	I	2
10	Build/test performance of double tuned common Emitter amplifier. (Part-I)	I	2
11	Build/test performance of double tuned common Emitter amplifier. (Part-II)	I	2
12	Build/test performance parameters of single stage class A power amplifier.	II	2
13	Build/test performance parameters of class B Push pull amplifier using transistor.	II	2
14	Build/test the performance of Audio power amplifier.	II	2*
15	Use transistor to build/ test voltage series Feedback amplifier parameters with and without feedback.	III	2
16	Use transistor to built/ test voltage shunt Feedback amplifier parameters with and without feedback.	III	2
17	Test the effect of positive and negative feedback on the given amplifier.(Part-I)	III	2*
18	Test the effect of positive and negative feedback on the given amplifier.(Part-II)	III	2*
19	Build RC phase shift oscillator and measure the generated frequency using CRO.	IV	2
20	Build Crystal oscillator and measure the generated frequency using CRO.	IV	2
21	Simulate Hartley oscillator using any relevant simulation software. (Like spice, multisim, Lab view, LTspice, Octeva).	IV	2*
22	Generate a waveform using Miller's sweep generator and measure sweep time and retrace time.	IV	2
23	Simulate dual voltage regulator using IC78XX and 79XX for the specified regulated output voltage	V	2*
24	Build dual voltage regulator for the specified Regulated output voltage.	V	2
25	Build low voltage regulator using IC723 for the given regulated output voltage. (2V to7V)	V	2*
26	Build high voltage regulator using IC723 for the given regulated output voltage.(7 V to 37 V)	V	2

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
27	Test the performance parameters of voltage regulator using IC LM317.	V	2*
	Total		**54**

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 %
1	Preparation of experimental set up	20
2	Setting and operation	20
3	Safety measures	10
4	Observations and Recording	10
5	Interpretation of result and conclusion	20
6	Answer to sample questions	10
7	Submission of report in time	10
Total		**100**

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

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

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

- 'Valuing Level' in 1st year
- '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. S. No.

S. No.	Equipment Name with Broad Specifications	PrO. S. No.
1	Variable DC power supply 0- 30V, 2A, SC protection	All
2	Dual Power supply 0- 30V, 2A	All
3	Cathode Ray Oscilloscope, Dual Trace 30Mhz and above, 1MegaΩ Input Impedance	1-16
4	Digital storage Oscilloscope, Dual Trace 20Mhz and above, 1MegaΩ Input Impedance	1-16
5	Function Generator 0-2 MHz with Sine, square and triangular output with variable frequency and amplitude	1-12
6	Digital Multimeter: 3and1/2 digit display, 9999 counts digital multimeter measures: V_{ac}, V_{dc} (1000V max) , A_{dc}, A_{ac} (10 amp max) , Resistance (0 - 100 MΩ) , Capacitance and diode ,transistor tester	All
7	Electronic Work Bench : Bread Board 840 -1000 contact points, Positive and Negative power rails on opposite side of the board , 0-30 V , 2 Amp Variable DC power supply, Function Generator 0-2MHz, CRO 0-30MHz , Digital multimeter	All
8	LCR-Q meter, Test frequency standard 100 Hz / 1 kHz; Parameter L-Q, C-D, R-Q and Z-Q,Parameters L 100 Hz, 120 Hz 1 mH - 9999 H 1 KHz 0.1 mH - 999.9 Ht,C 100 Hz, 120Hz 1 pF - 9999 mF Range 1 KHz 0.1 pF - 999.9 mF,Terminals 4 terminals.	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 Low Power Amplifiers	1a. Explain with sketches the working principle of the given type of amplifier. 1b. Calculate gain and bandwidth of the given low power amplifier. 1c. Compare performance parameters of the given types of amplifier coupling. 1d. Select relevant tuned amplifier for the given frequency band with justification. 1e. Describe the environment employed for the given simulation work with justification.	1.1 Classification of Amplifiers, BJT as an amplifier . 1.2 Single stage CE amplifier, frequency response, gain, bandwidth 1.3 Multistage amplifier: General Multistage amplifier BJT based. 1.4 Type of BJT amplifier coupling: Circuit diagram , operation, frequency response and applications of RC, transformer and direct coupling 1.5 FET Amplifier: Common Source amplifier, working principle and applications 1.6 Tuned Amplifier: Need of tuned amplifier, basic tuned circuit, circuit diagram, operating principle and frequency response of Single tuned, Double tuned and stagger tuned amplifiers

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit– II High Power Amplifiers	2a. Explain with sketches the working of the given type of power amplifier. 2b. Select the relevant power amplifier for the given application with justification. 2c. Calculate efficiency of the given power amplifier. 2d. Compare the performance parameters of the given types of power amplifiers. 2e. Prepare the specifications of the given type of amplifier.	2.1 Power Amplifier: Comparison between small signal amplifier and power amplifier, performance parameter of power amplifier like : bandwidth, gain, frequency band, efficiency 2.2 Classification: Class A, Class B, Class AB and Class C 2.3 Circuit, operation, input /output waveforms, efficiency and power equations of Single Stage Class A, Class B, Class AB and Class C Power amplifier.
Unit III Feedback Amplifiers	3a. Calculate the gain of the amplifier for the given type of feedback amplifier. 3b. Explain effect of negative feedback on the given type of amplifier performance. 3c. Calculate Gain, Bandwidth, Input and Output resistance of the given feedback amplifier. 3d. Compare the performance of given types of negative feedback amplifiers.	3.1 Principle of feedback Amplifier 3.2 Types of feedback: negative and positive feedback, advantages and disadvantages of negative feedback 3.3 Types of feedback connections, voltage shunt, voltage series, current series and current shunt: block diagram, circuit diagram, and operation
Unit IV Wave form Generators	4a. Calculate frequency of oscillation for the given type of oscillator circuit. 4b. Select the relevant oscillator to obtain the given range of frequency with justification. 4c. Choose the relevant sweep generator to obtain the specified saw tooth waveform with justification. 4d. Prepare the specifications of the given oscillator.	4.1 Oscillators: Need, oscillator and amplifier 4.2 Condition for oscillation (Barkhausen's criteria), classification of oscillators 4.3 Sine wave Oscillator : RC Phase shift oscillator and crystal oscillator , concept , working and applications 4.4 Sweep generator: Miller sweep, Bootstrap circuit, current time base generator
Unit– V IC Voltage Regulators and SMPS	5a. Explain with sketches the working principle of given type of voltage regulator IC. 5b. Compare the working of the given types of regulators. 5c. Design voltage regulator for the specified output voltage. 5d. Interpret the working of given block of the SMPS	5.1 Types of IC Voltage Regulator: Fixed and variable: 78XX, 79XX, specification, series and LM723, LM317, line and load regulation. 5.2 SMPS : Block diagram, working principle, specifications, special features, advantages , disadvantages and applications. 5.3 Use of heat sink for regulated power supply.

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	Low Power Amplifiers	14	4	6	6	16
II	High Power Amplifiers	18	4	6	8	18
III	Feedback Amplifiers	12	4	4	4	12
IV	Waveform Generators	12	4	4	6	14
V	IC voltage Regulators and SMPS	08	2	4	4	10
Total		**64**	**18**	**24**	**28**	**70**

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

10. SUGGESTED STUDENT ACTIVITIES

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

a. Undertake micro-projects.
b. Give seminar on any relevant topic.
c. Library survey regarding different electronics circuits and voltage regulators.
d. Prepare power point presentation for electronic circuits.
e. Undertake a market survey of different electronics circuits and voltage regulators

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

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

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

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. Construct a doorbell using transistor.
b. Using transistor construct a clap switch.
c. Construct audio amplifier using.(IC810 or equivalent IC).
d. Construct power amplifier for FM receiver output.
e. Drive a 4Ω speaker using class A amplifier which is directly coupled and test its performance parameters.
f. Using ClassAB push pull amplifier drive (4Ω/8Ω) speaker, test its performance parameters.
g. IC regulators: Build a circuit of Dual regulated power supply on general purpose PCB to obtain +/- 15 V, 500mA using IC 78XX & 79XX series.
h. IC regulators: Build a regulated power supply on general purpose PCB to obtain + 5V, 500mA using IC 78XX series. Drive suitable load with regulated output.
i. IC regulators: Build a regulated power supply on general purpose PCB to obtain -20V, 500mA using IC 79XX series. Use suitable heat sink .Drive suitable load with regulated output.
j. IC Regulators: Build a constant current regulator on general purpose PCB for output current of 125mA using IC 317.
k. IC Regulators : Construct low voltage regulator on general purpose PCB for output voltage 5V using LM IC 723.Drive any 5v operated load.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Applied Electronics	Sedha, R.S.	S.Chand. New Delhi, 2015 ISBN:9788121927833
2	Principles of Electronics	Mehta, V.K. Mehta, Rohit	S.Chand, New Delhi, 2014 ISBN:8121924502
3	Electronic Devices and Circuit Theory	Boylestead, Robert, Neshelsky, Louis	Pearson Education, New Delhi, 2014, ISBN: 9780132622264
4	Fundamental of Electronic Devices and	Bell, David	Oxford University Press, New Delhi, 2015, ISBN:9780195425239

S. No.	Title of Book	Author	Publication
	Circuits		
5	Electronic Devices and Circuits	Millman, Jacob Halkias, C. Christos Jit, Satyabrata	Mc Graw Hill Education, New Delhi 2015, ISBN:9789339219550
6	Modern Power Electronics	Sen, P.C.	S.Chand, New Delhi, 2015 ISBN:9788121924252

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. www.eng.uokufa.edu.iq/staff/alikassim/lectures/CH-4.pdf
b. www.electronics-tutorials.ws/amplifier/amp_1.html
c. www.colorado.edu/ physics/phys3330/PDF/Experiment7.pdf
d. www.alldatasheet.com/view.jsp?Searchword=Bc147
e. www.williamson-labs.com
f. www.futurlec.com
g. www.learnerstv.com/video/Free-video-Lecture-870-Engineering.htm
h. www.electronicspost.com/discuss-the-essentials-of-a-transistor-oscillator-explain-the-action-of-tuned-collector-oscillator-colpitts-oscillator-and-hartley-oscillator/
i. www.radio-electronics.com/info/power-management/switching-mode-power-supply/basics-tutorial.php
j. www.circuitstoday.com/ic-723-voltage-regulators
k. www.onsemi.com/pub_link/Collateral/LM317-D.PDF

Program Name : **Electronics Engineering, Digital Electronics and Instrumentation Engineering Program Group**

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

Semester : **Third**

Course Title : **Electric Circuits and Networks**

Course Code : **22330**

1. RATIONALE

In industry, to build and test electronic/electrical circuits in different situations knowledge of electric circuits and networks is very important. This course is intended to develop the skills to diagnose and rectify the electric network and circuit related problems in the industry. The concept and principles of circuit analysis lays the foundation to understand courses of higher level.

2. COMPETENCY

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

- **Diagonose the electrical and electronic circuits problems.**

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. Check the working of single phase a.c. circuits.
b. Check the resonance condition of electric/electronic circuits.
c. Check the functionality using the principles of circuit analysis.
d. Use network theorems to determine the various parameters in circuits.
e. Use two port networks to determine the circuit parameters.

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	2	7	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.

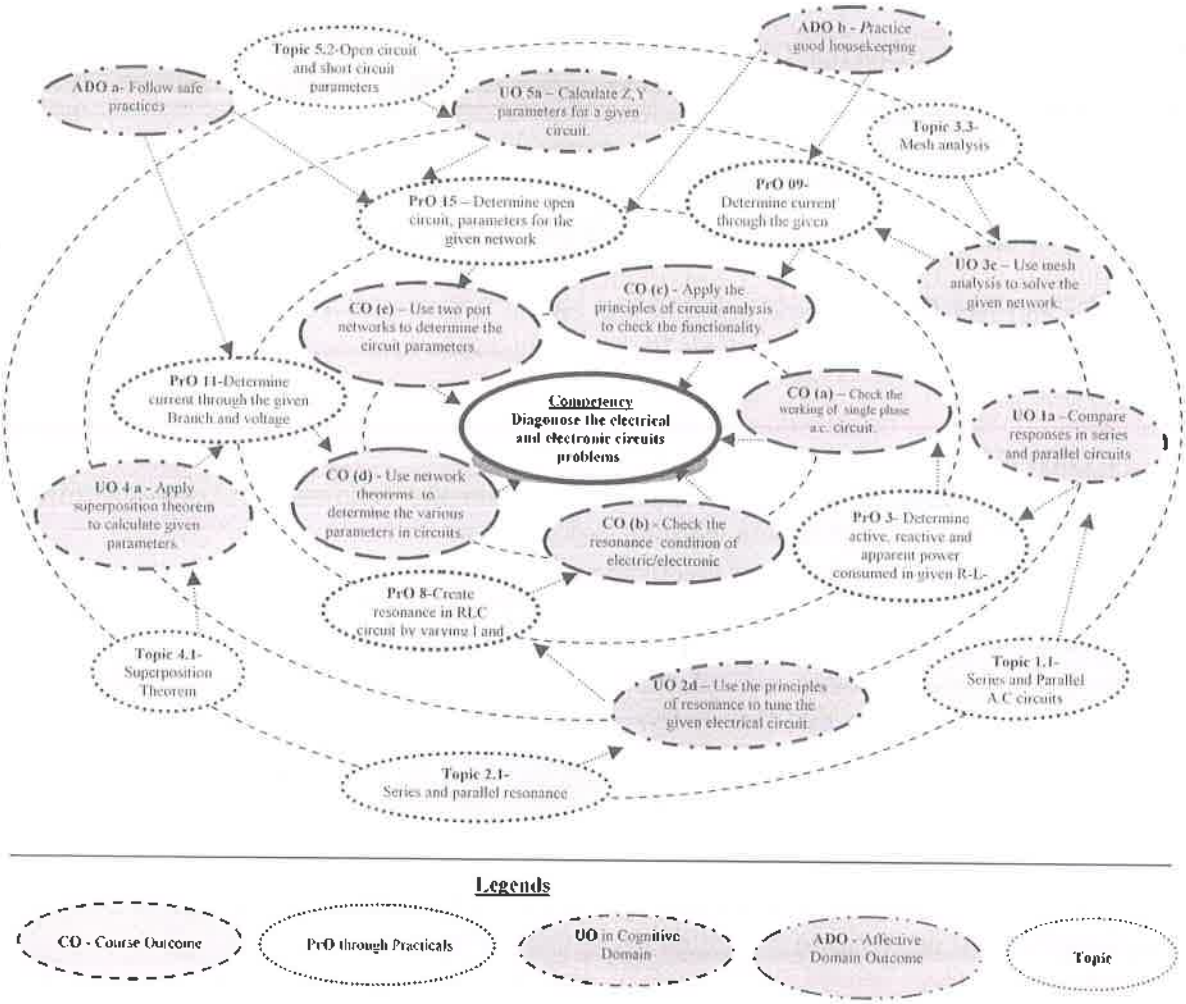

Figure 1 - Course Map

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	Determine active, reactive and apparent power consumed in given R-L series circuit and draw phasor diagram.	I	02*
2	Determine active, reactive and apparent power consumed in given R-C series circuit and draw phasor diagram.	I	02
3	Determine active, reactive and apparent power consumed in given R-L-C series circuit and draw phasor digram.	I	02*
4	a. Measure currents in R-C parallel A. C. circuit. b. Determine p.f., active, reactive and apparent power in R-C parallel a.c. circuit.	I	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
5	a. Measure currents in each branch of given R-L-C parallel a. c. circuit. b. Determine p.f., active, reactive and apparent power for given R-L-C Parallel circuit with series connection of resistor and inductor in parallel with capacitor.	I	02
6	Determine initial and final voltage across the capacitor at $t=0^-$ and $t=0^+$.	I	02
7	Determine initial and final current through the inductive coil at $t=0^-$ and $t=0^+$.	I	02
8	Create resonance in given R-L-C circuit by varying L and C or by using variable frequency supply.	II	02*
9	Determine current through the given branch of a electric network by applying mesh analysis.	III	02
10	Determine voltage at the particular node and current through any given branch of the network by applying nodal analysis.	III	02*
11	Determine current through the given branch and voltage across the given element of circuit by applying superposition theorem .	IV	02*
12	Determine equivalent circuit parameter in a given circuit by applying Thevenin's and Norton's theorem .	IV	02
13	Determine load resistance for maximum power transfer for a given circuit by applying maximum power transfer theorem .	IV	02
14	Test the response of the given circuit by applying reciprocity theorem.	IV	02
15	Determine open circuit (Z) parameters for the given network.	V	02*
16	Determine short circuit (Y) parameters for the given network.	V	02
17	Determine transmission (ABCD) parameters for the given network.	V	02
	Total		**34**

Note

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

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

S. No.	Performance Indicators	Weightage in %
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	Ammeters MI Type: AC/DC, 0-1Amp,0-1.5 Amp,0-2.5Amp,0-5Amp.	1 to 17
2	Voltmeter MI Type: AC/DC, 0-150/300V, 0-250/500V,0-75/150V.	1 to 17
3	Ammeters PMMC Type: DC, 0-1.5/3Amp, 0-2.5/5 Amp, 0-5/10Amp.	1 to 17
4	Voltmeter PMMC Type: DC, 0-150/300V, 0-250/500V,0-75/150V.	1 to 17
5	Wattmeter: Single phase 2.5/5Amp, 200/400V, Single phase 5/10Amp, 250/500V	1 to 17
6	Low power factor wattmeter : Single phase, 5/10Amp, 250/500V.	1 to 5
7	Wattmeter: Dynamometer type, single phase, 5Amp, 250V.	1 to 5
8	Power factor meters: AC, 230V,45-50-55 Hz , single phase, 5-10 Amp, 250V.	1 to 5
9	Digital storage oscilloscope 50MHz.	6 ,7
10	Trainer kit for all theorems.	9 to 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 Single Phase A.C. Circuits	1a. Compare the A.C. responses in the given type of series and parallel circuits. 1b. Explain with sketches the phasor diagram of the given AC circuit. 1c. Calculate active, reactive, apparent	1.1 Series A.C. circuits: R-L, R-C and R-L-C circuits, impedance, reactance, phasor diagram, impedance triangle, power factor, active(real) power, apparent power , reactive power, power triangle

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	power and power factor for the specified circuit. 1d. Suggest the power factor improve technique for the given situation with justification. 1e. Calculate admittance,conductance and susceptance for the given circuit. 1f. Determine the equivalent impedance and admittance for the given circuit. 1g. Interpret the working of the given R,L, and C component using initial and final condition.	1.2 AC Series circuit by using complex algebra 1.3 Parallel AC circuits: Resistance in parallel with pure inductance and capacitance, series combination of resistance and inductance in parallel with capacitance 1.4 Concept of admittance, conductance and susceptance 1.5 Concept of initial and final conditions in switching circuits, Meaning of t = 0 -, t = 0+ and t = ∞. R, L and C at initial and final conditions
Unit-II Resonance in Series and Parallel Circuits	2a. Find the resonance condition for the specified series and parallel circuits. 2b. Calculate current, voltage and frequency for the given resonant circuit. 2c. Determine bandwidth and quality factor(Q) for the given series and parallel resonant circuit. 2d. Describe the procedure to tune the given electrical circuit using the principles of resonance.	2.1 Series and parallel resonance 2.2 Impedance and phase angle of a Series and parallel resonant circuits 2.3 Voltage and current in a series and parallel resonant circuit 2.4 Bandwidth of a RLC circuit(series and parallel resonance) 2.5 Quality factor (Q) and its effect on bandwidth (series and parallel resonance) 2.6 Magnification in series and parallel resonance circuits
Unit– III Principles of Circuit Analysis	3a. Use source transformation techniques for the given circuit. 3b. Convert the given star connection to delta connection and vice versa. 3c. Use mesh analysis to solve the given network. 3d. Solve the given network using nodal analysis. 3e. Diagnose the fault in the given circuit using the relevant technique(s).	3.1 Source transformation 3.2 Star/delta and delta/star transformations 3.3 Mesh analysis 3.4 Node analysis
Unit– IV Network Theorems	4a. Use superposition theorem to calculate the given parameters in the given circuit. 4b. Apply Thevenin's theorem to calculate the given parameters in the given circuit. 4c. Use Norton's theorem to calculate the given parameters in the given circuit.	4.1 Superposition theorem for both AC voltage and DC source 4.2 Thevenin's theorem 4.3 Norton's theorem 4.4 Maximum power transfer theorem 4.5 Reciprocity theorem 4.6 Superposition theorem

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	4d. Calculate load impedance using maximum power transfer theorem for the given circuit. 4e. Use reciprocity theorem to analyse the given circuit.	
Unit –V Two Port Networks	5a. Calculate Z, Y, parameters for the given circuit. 5b. Find the ABCD parameters for the given circuit. 5c. Sketch the phasor diagram for the given T and π circuit with justification. 5d. Calculate Z and Y parameters to test whether the given circuit is reciprocal or symmetrical two port network .	5.1 Significance of two port network 5.2 Open circuit(Z) and short circuit(Y) Parameters 5.3 Transmission (ABCD) parameter 5.4 T and π representation of circuits 5.5 Reciprocal and symmetrical two port network(no derivation)

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	Single Phase A.C. Circuits	10	04	04	06	14
II	Resonance in Series and Parallel Circuits	10	02	06	06	14
III	Principles of Circuit Analysis	10	04	04	06	14
IV	Network Theorems	12	04	06	08	18
V	Two port networks	06	02	04	04	10
Total		**48**	**16**	**24**	**30**	**70**

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

10. SUGGESTED STUDENT ACTIVITIES

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

a. Prepare journals based on practical performed in laboratory.
b. Follow the safety precautions.
c. Use various meters to test electric/electronic equipment and component.
d. Library / Internet survey of electrical circuits and network

e. Prepare power point presentation or animation for understanding different circuits behaviour.

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. Use Flash/Animations to explain various theorems in circuit analysis
f. Guide student(s) in undertaking micro-projects

12. SUGGESTED MICRO-PROJECTS

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

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

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

a. **Single Phase A.C. series and parallel Circuits:** Prepare series and parallel circuit using variable R, L and C combination on the bread board. Measure the response and draw vector diagram. Also calculate power factor for the circuit. Write report on the same.
b. **Resonance in series and Parallel Circuits:** Prepare series RLC circuit using variable R, L and C combination on the bread board. Tune the circuit for resonance condition. Measure the responses and calculate band width and Q-factor for the circuit. Write report on the same.
c. **Resonance in Series and parallel Circuits:** Prepare parallel RLC circuit using variable R, L and C combination on the bread board. Tune the circuit for resonance condition. Measure the response and calculate band width and Q-factor for the circuit. Write report on the same.

d. **Principles of circuit analysis:** Prepare power point presentation on source transformation, star delta transformation, mesh and nodal analysis and give presentation in the class room.
e. **Network Theorems:** Select suitable components for the given circuit and prepare the same on the bread board. Verify the following network theorem theoretically and practically.
   i. Superposition Theorem
   ii. Maximum power transfer theorem
   iii. Thevenin's theorem
   iv. Norton's theorem.
f. **Two Port Networks:** Design and prepare two port network on bread board for given values of open circuit Z parameter.
g. **Two Port Networks:** Design and prepare two port network on bread board for given values of short circuit Y parameter.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Basic Electrical Engineering	Mittle, V.N. ; Mittle, Arvind	McGraw Hill Education, Noida, 2005, ISBN: 9780070593572
2	A Text Book of Electrical Technology Vol-I	Theraja, B. L. ; Theraja, A. K.	S. Chand and Co., New Delhi, 2006 ISBN: 978-81-219-2440-5
3	Fundamentals of Electrical Engineering	Saxena, S.B.; Dasgupta, K.	Cambridge university press pvt. Ltd., New Delhi, 2016, ISBN : 9781107464353
4	Circuit and network	Sudhakar, A. ; Palli Shyammohan, S.	McGraw Hill, New Delhi, 2006 ISBN : 978-0-07-340458-5
5	Electric Circuits	Bell, David A.	Oxford University Press New Delhi, 2009 ISBN: 9780195425246
6	Electric Circuit Analysis	Paranjothi, S.R.	New Age Publisher, New Delhi, 2011, ISBN: 978-81-224-3154-4
7	Fundamentals of Electrical Networks	Gupta, B.R ; Singhal, Vandana	S.Chand and Co., New Delhi, 2005 ISBN: 978-81-219-2318-7
8	Schaum's Outline of Electric Circuits	Edminister.Joseph A. Nahvi,Mahmood	McGraw Hill, New Delhi, 2013 ISBN: 9780070189997
9	Introductory circuit Analysis.	Boylested, R.L.	Wheeler, New Delhi , 2013 ISBN: 978-0023131615

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. www.cesim.com/simulations
b. www.scilab.org/scilab
c. www.ni.com/multisim
d. www.youtube.com /electric circuits
e. www.dreamtechpress.com /cbooks
f. www.nptelvideos.in/electrical engineering/ circuit theory
g. www.learnerstv.com/free-engineering
h. electronicsforu.com/category/electronics-projects

Program Name : **Digital Electronics, Medical Electronics and Instrumentation Engineering Program Group**

Program Code : **DE/IE/IS/IC/MU**

Semester : **Third**

Course Title : **Electronic Instruments and Measurement**

Course Code : **22331**

1. RATIONALE

Diploma pass outs (also called as technologists) should be able to measure various electrical and electronic parameters in industry using relevant instruments. This course is designed to provide the basic understanding about the concepts, principles and procedures of analog and digital electronic measuring instruments. Students will be able to use the various electronic measuring instruments for fault finding in the industry.

2. COMPETENCY

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

- **Use basic electrical and electronic instruments for measuring various parameters.**

3. COURSE OUTCOMES (COs)

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

a. Use relevant type of measuring instruments for different applications.
b. Use analog meters to measure electrical parameters.
c. Use digital meters to measure electrical parameters.
d. Use CRO and signal generator to measure electrical parameters.
e. Use AC and DC bridges to measure electrical parameters.

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.

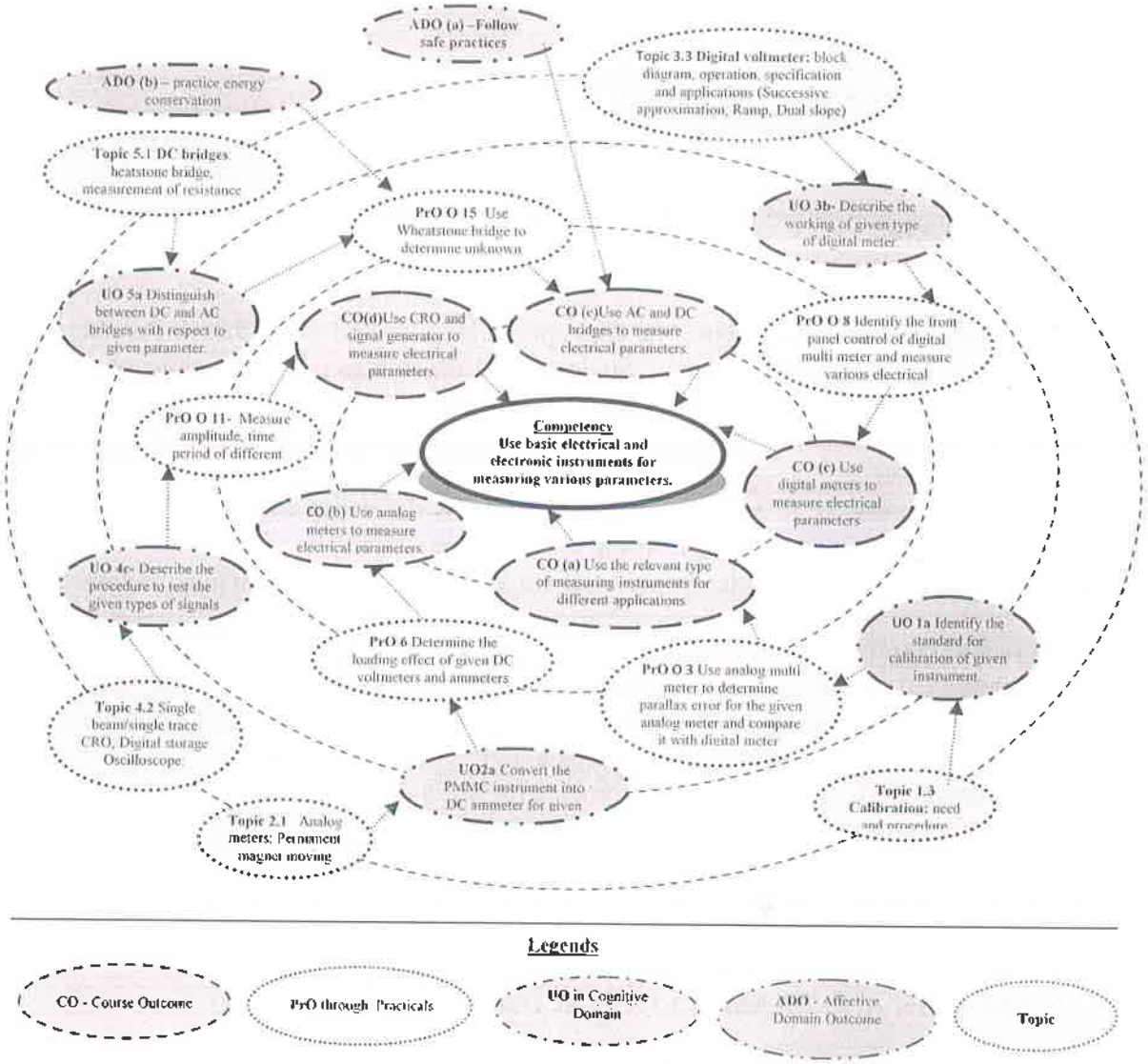

Figure 1 - Course Map

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 analog multi meter to determine accuracy, resolution and hysteresis.	I	02*
2	Calibrate the analog multi meter by comparing with given standard instrument.	I	02
3	Use analog multi meter to determine parallax error for the given analog meter and compare it with digital meter.	I	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
4	Convert basic PMMC movement of 1mA into DC voltmeter for measuring 5V, 10V, 15V.	II	02
5	Convert basic PMMC movement of 1mA into DC ammeter for measuring 10mA, 50mA, 100mA	II	02*
6	Determine the loading effect of given DC voltmeters and ammeters	II	02
7	Use LCR meter to calculate the value of resistance, Inductance, capacitance and compare those with component codes.	III	02
8	Identify the front panel control of digital multi meter and measure various electrical parameters using DMM	III	02*
9	Use analog multi meter to determine accuracy, resolution and hysteresis loop of given digital meter.	III	02
10	Identify the front panel control of logic Analyzer and Test the given digital circuit	III	02
11	Measure amplitude, time period of different signals generated by function generator using CRO.	IV	02*
12	Measure unknown frequency and phase difference with respect to given signal using Lissajous pattern	IV	02
13	Identify the front panel control of DSO and measure various parameters of applied signal	IV	02
14	Identify the front panel control of Spectrum Analyzer and determine frequency content of given signal.	IV	02
15	Use Wheatstone bridge to determine unknown resistance	V	02*
16	Use Maxwell Bridge to determine unknown inductance.	V	02
17	Use Schering Bridge to determine unknown capacitance.	V	02
18	Measure intensity of bulb available in the laboratory using Lux meter.	III	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 setup	20
2.	Setting and operation	20
3.	Safety measures	10
4.	Observation and recording	10
5.	Interpretation of result and conclusion	20
6.	Answer to sample questions	10
7.	Submission of report in time	10
	Total	**100**

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

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

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

- 'Valuing Level' in 1st year
- 'Organising Level' in 2nd year
- 'Characterising Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specification mentioned here will use 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	Analog multi meter 1mA, 500 ohms.	1,2,3
2	Digital Multi meter 4 ½ digit display	2,3,8,9
3	Voltmeter 0-10V,0-50V,0-100V,0-300V	3,4,6
4	Ammeter 0-100mA, 0-50μA,0-1mA	3,5
5	LCR meter 20Hz – 2MHz	5
6	Cathode ray Oscilloscope single beam dual trace 0-30 MHz	11,12
7	Function generator 0-2MHz, 0-3MHz	11,12, 14,16, 17
8	Digital Storage Oscilloscope 60 MHz bandwidth	13
9	Logic Analyzer: 32 channel	10
10	Spectrum Analyzer: Heterodyne type 3GHz	14
11	Lux Meter range 400.0/4000 lux sensor diameter 2 to 2 inch, Accuracy 5%, memory 16000 reading, resolution 100 lux, foot candle resolution 0.1 fc. Display type- numeric	18

8. UNDERPINNING THEORY COMPONENTS

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

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Fundamentals of measure	1a. Identify the standard for calibration of the given instrument with justification. 1b. Classify the given measuring instruments.	1.1 Measurement: Concept , units of measurement of fundamental quantities, standard and their classification, Static and

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
ments	1c. Determine static and dynamic characteristics of the measuring instruments with the given data. 1d. Explain with sketches the generalized procedure for calibration of the given device.	dynamic characteristics, types of errors 1.2 Classification of instruments: (i) absolute and secondary instruments, (ii) analog and digital instruments, (iii) mechanical, electrical and electronic instruments 1.3 Calibration: need and procedure
Unit– II Analog meters	2a. Explain with sketches the construction and working principle of the given permanent magnet moving coil (PMMC) instrument with sketches. 2b. Describe with sketches the procedure to convert the PMMC instrument into DC ammeter for the given range. 2c. Describe with sketches the procedure to convert the PMMC instrument into DC voltmeter for the given range. 2d. Explain with sketches the working of given type of ohm meter. 2e. Explain with sketches the working of given type of AC voltmeter. 2f. Prepare specification for given analog meters.	2.1 Permanent magnet moving coil (PMMC) and Permanent magnet moving iron (PMMI) meter their construction, principle, working, salient features 2.2 DC Ammeter: Basic, Multi range, Universal shunt/Ayrton, simple numerical based on R_{sh} 2.3 DC Voltmeter: Basic, Multi range, simple numerical based on R_s, concept of loading effect and sensitivity 2.4 Ohm meter: Series and shunt 2.5 AC voltmeter: Rectifier type (half wave and full wave)
Unit– III Digital Meters	3a. Determine resolution, sensitivity and accuracy of the given digital display. 3b. Explain with sketches the working of given type of digital meter. 3c. Explain with sketches the construction and working of the given types of digital meters. 3d. Describe with sketches the procedure to measure the given electric parameter using the relevant type of digital meter. 3e. Describe with sketches the procedure to test the given digital circuits using logic analyser. 3f. Prepare specification for given digital instrument.	3.1 Resolution, sensitivity and accuracy of digital Instruments. 3.2 Digital frequency meter, Digital multi meter, LCR-Meter, Lux Meter, Logic Analyser: block diagram, operation, specification and applications 3.3 Digital voltmeter: block diagram, operation, specification and applications (Successive approximation, Ramp, Dual slope)
Unit-IV CRO and signal generato	4a. Describe the given blocks and working of given type of oscilloscope with sketches. 4b. Describe with sketches the procedure to measure the given parameter using the	4.1 Single beam/single trace CRO, Digital storage Oscilloscope: Basic block diagram, working, Cathode ray tube, electrostatic deflection, vertical amplifier.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
rs	CRO. 4c. Describe with sketches the working of given type of type of signal/function generator with sketches. 4d. Describe with sketches the procedure to test the given type of signal using the relevant type of function generator/signal generator/CRO. 4e. Select CRO/ DSO, Spectrum analyzer and function generator for the given application. 4f. Prepare specification for given instrument.	time base generator, horizontal amplifier, attenuator, delay line and specifications. 4.2 CRO Measurements: voltage, time period, frequency, phase angle, Lissajous pattern. 4.3 Signal generator: need, working and Basic block diagram 4.4 Function generator: need, working and basic block diagram and specifications. 4.5 Spectrum analyzer: Basic block diagram, operation , specification and applications.
Unit V DC and AC bridges	5a. Explain with sketches the the working of the given type of bridge with sketches. 5b. Describe with sketches the procedure to measure given unknown resistance using the relevant type of bridge with sketches 5c. Describe with sketches the procedure to measure given unknown capacitance using relevant type of bridge with sketches. 5d. Describe with sketches the procedure to measure given unknown inductance value using relevant type of bridge with sketches.	5.1 DC bridges: Wheatstone bridge, measurement of resistance 5.2 AC bridges: Use of Schering bridge, Maxwell bridge, Hays bridge

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 measurements	08	02	02	04	08
II	Analog meters	16	04	06	08	18
III	Digital meters	14	02	06	10	18
IV	CRO and Signal generator	18	02	06	10	18
V	DC and AC bridges	08	02	02	04	08
Total		**64**	**12**	**22**	**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. Compile broad specification of DSO, LCR meter, logic analyzer, Spectrum analyser using data sheets and handbook.
b. Develop a report after performing market survey of electronic instruments used in the laboratory.
c. Prepare a chart of static and dynamic characteristics of the instrument/equipment available in the laboratory.
d. Prepare chart to display types of Units.
e. Prepare chart to display front panel control of DSO, LCR meter, Logic analyser and Spectrum analyser
f. Visit nearby institutes, exhibition and industries to collect information about electronic instruments.
g. Assist to the technicians who are doing repair or maintenance work of electronic instruments.
h. Prepare instruction chart for safe handling of electronic instruments

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

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

a. Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b. ***'L' in item No. 4*** does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
c. About ***15-20% of the topics/sub-topics*** which is relatively simpler or descriptive in nature is to be given to the students for ***self-directed learning*** and assess the development of the COs through classroom presentations (see implementation guideline for details).
d. With respect to item No.10, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
e. Guide student(s) in undertaking micro-projects.
f. Video programs/YouTube may be used to teach various topics and sub topics.
g. Demonstrate set-up arrangement to the students thoroughly before they start doing the practical.
h. Encourage students to refer different book and websites to have deeper understanding of the subject.
i. Observe continuously and monitor the performance of students in Lab.
j. Encourage students to use front/rear panel control of electronic instruments.
k. Encourage students to visit nearby electronic instruments repair workshop units or manufacturing industries.

l. Instruct students to safety concern of handling electronic instruments and also to avoid any damage to the electronic instruments.

12. SUGGESTED MICRO-PROJECTS

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

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

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

a. Prepare a report on market survey of Dual beam CRO, Dual trace CRO, Sampling Oscilloscope, DSO, function generator, logic analyzer and LCR meter.(technical specification and manufacturers).
b. Build and test given power supply using CRO and DMM.
c. Build, test and commission Wheatstone bridge using LDR / thermistor / RTD / potentiometer.
d. Find the fault in the given laboratory electronic measuring instrument.
e. Build, test and commission Schering Bridge using LDR / thermistor / RTD / potentiometer.
f. Build the circuit of LED bulb using white LED arrays and measure its intensity using lux meter.
g. Take two similar circuit board. One is faulty another is in working condition. Test both circuit boards using component test function on CRO/DSO and find out the faulty component in faulty circuit.
h. Take laminated copper wire and construct inductor and measure inductance using LCR meter. Now change the number of turns and test different inductors.
i. Take copper clad and form capacitor by etching copper clad and measure the capacitance using LCR meter.
j. Construct voltage Doubler /trippler circuit and measure voltage at every capacitor using CRO.
k. Build and test function generator using IC (eg.ICL8038, MAX038, XR2206 etc.).

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Electronic Instrumentation	Kalsi, H.S.	Mc Graw Hill Education, New Delhi, 2010 ISBN:9780070702066
2	Electronic Measurement and instrumentation	Sedha, R.S.	S Chand and Company, New Delhi , 2004 ISBN: 9788121997751
3	Electronic instruments and	Anand, M.M.S.	PHI Learning., New Delhi,2004

S. No.	Title of Book	Author	Publication
	instrumentation Technology		ISBN: 9788120324541
4	A course in electrical and electronic measurement and instrumentation	Sawhney, A.K.	Dhanpat Rai and Company, New Delhi, 2005 ISBN-13: 978-8177000160
5	Electronic Measurement and instrumentation	Rajput, R.K.	S Chand and Company, New Delhi , 2008 ISBN: 9788121929172
6	Electronic instrumentation and Measurement	Khurana, Rohit.	Vikas Publications House. New Delhi, ISBN: 9789325990203
7	Electronic instrumentation and Measurement	Bell, David A.	Oxford University Press, New Delhi, 2013; ISBN: 9780195696141
8	Elements of electronic instrumentation and measurements	Carr, Joseph J.	Pearson Education ,New Delhi, 2003 ISBN: 9788131712115

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. www.nptel.iitg.ernet.in/courses/Elec.engg/IIT%20Bombay/electrical/%20and
b. www.electrical4u.com/permanent-magnet-moving-coil-instrument/
c. www.electrical4u.com/digital-frequency-meter/
d. www.electrical4u.com/digital-multimeter/
e. www.electrical4u.com/wheatstone-bridge-circuit-theory-and-principle/
f. www.electrical4u.com/maxwell-bridge-inductance-capacitance-bridge/
g. www.electrical4u.com/hays-bridge-circuit-theory-phasor-diagram-advantages-applications/
h. www.electrical4u.com/schering-bridge-measurement-of-capacitance-using-schering-bridge/
i. www.electrical4u.com/cathode-ray-oscilloscope-cro/
j. www.nprcet.org/eee/document/MI.pdf
k. web.mst.edu/~cottrell/ME240/Resources/basic_inst/Basic_Instrumentation.pdf

Program Name : **Diploma in Digital Electronics Engineering**

Program Code : **DE**

Semester : **Third**

Course Title : **Industrial Instrumentation and Sensors**

Course Code : **22332**

1. RATIONALE

Diploma engineers (also called technologists) have to operate instruments and control different parameters in industry. In order to measure and control the physical parameters in industry, it requires adequate knowledge of operating principles and construction of sensors/transducers and instrumentation system. In practical situation engineers are required to select sensor/ transducer for given application, handle, maintain and calibrate it. This course is designed keeping in view developing these skills.

2. COMPETENCY

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

- **Maintain the electronic circuits in instrumentation systems.**

3. COURSE OUTCOMES (COs)

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

a. Select transducer and sensor for given application.
b. Calibrate given pressure transducer/sensor.
c. Test given flow/level/speed transducer/sensor.
d. Use temperature/humidity transducer for given application.
e. Maintain industrial instrumentation system.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme											
				Theory							Practical						
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
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.

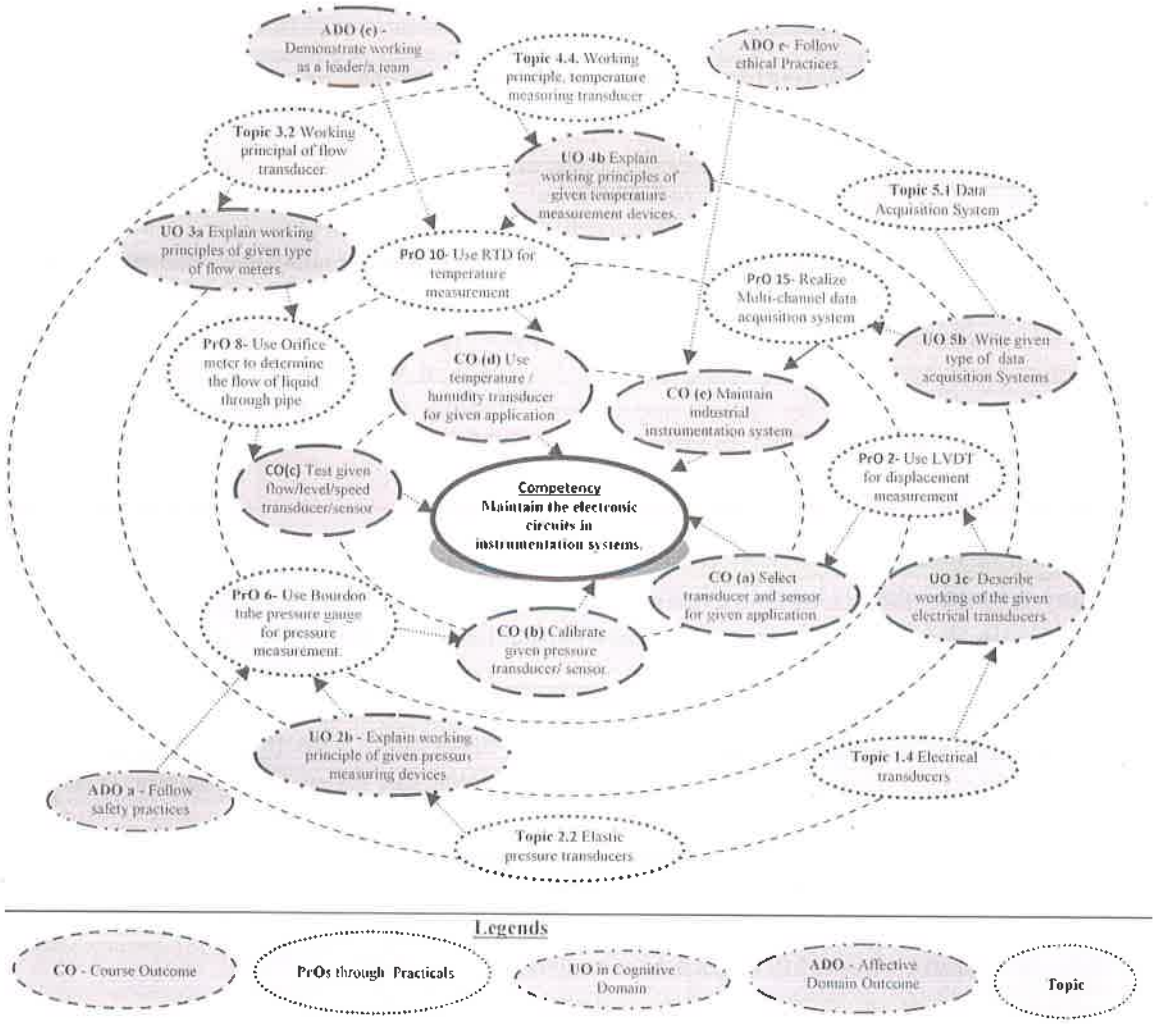

Figure 1 - Course Map

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	Use proximity sensor to measure speed of motor.	I	02*
2	Use LVDT for displacement measurement.	I	02
3	Determine LDR characteristics	I	02
4	Measure output voltage and force in strain gauge and plot Force/voltage characteristics.	I	02
5	Use strain gauge with cantilever setup for weight measurement.	II	02*
6	Use Bourdon tube pressure gauge for pressure measurement.	II	02
7	Calibrate pressure gauge using Dead weight pressure gauge tester.	II	02
8	Use Orifice meter/rotameter to determine the flow of liquid through pipe.	III	02*

S. No.	Practical Exercises(PrOs)	Unit No.	Approx. Hrs. Required
9	Determine level of liquid in a tank using capacitive type level measurement technique.	III	02
10	Use RTD for temperature measurement.	IV	02*
11	Use thermocouple to temperature measurement.	IV	02
12	Use non contact type photo electric tachometer to measure speed of motor.	IV	02
13	Determine relative humidity by wet and dry bulb hygrometer.	IV	02
14	Realize single- channel data acquisition system.	V	02*
15	Realize Multi-channel data acquisition system.	V	02
16	Convert current to pressure (I to P) and pressure to current (P to I) using electric transmission.	V	02
	Total		**32**

Note

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

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

S. No.	Performance Indicators	Weightage in %
a.	Identify the requirements of practical set up	20
b.	Arrange and operate the set up	30
c.	Observe and understand the performance	20
d.	Answer to sample questions	15
e.	Submit report in time	15
	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 instrumentation systems.
e. Follow ethical practices.

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

- 'Valuing Level' in 1st year
- 'Organising Level' in 2nd year and
- 'Characterising Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipments 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	Educational trainer kit for measurement of speed of motor using proximity sensor.	1
2	Educational trainer kit for measurement of linear displacement using LVDT.	2
3	Educational trainer kit for measurement of weight using strain gauge with cantilever setup.	5
4	Educational trainer kit for measurement of pressure using bourdon pressure gauge.	6
5	Educational trainer kit for calibration of pressure gauge using dead Weight tester.	7
6	Educational trainer kit for measurement of liquid flow using rotameter.	8
7	Educational trainer kit to calculate flow of liquid through pipe using Orifice meter.	8
8	Educational trainer kit to determine level of liquid in a tank using capacitive type level measurement	9
9	Educational trainer kit to measure the temperature using RTD.	10
10	Educational trainer kit to measure temperature using thermocouple.	11
11	Educational trainer kit to measure speed of motor using non contact type photo electric tachometer.	12
12	Educational trainer kit to determine relative humidity by wet and dry bulb hygrometer.	13
13	Educational trainer kit to determine LDR characteristics	3
14	Educational trainer kit to measure output voltage and force in strain gauge and plot Force/voltage characteristics.	4
15	Electric transmission setup.	16
16	Single channel data acquisition system educational setup.	14
17	Multi-channel data acquisition system educational setup.	15
18	CRO -30 MHz, dual channel, Y-deflection: 5mV/div,~20V/div, sweep rate 0.1µsec/div, ~0.2sec/div. Input- 230V AC mains, sensitivity 1mV/div.	All
19	Digital Multimeter :- 3 ½ digit, Voltage range-(0-750 V AC, 0-1000V DC), Transistor and diode test, continuity test, Resistance range- (0-200MΩ), Current Range-(0-2000mA) .	All
20	Single phase AC motor, ½ HP	12
21	Hand held Pressure gauge.	2,3
22	Function generator –(0-30MHz in the decade ranges), Output amplitude-(1mV to 10 V p-p), Attenuation: 20db,40db, 60db.	All
23	Voltmeter (0-20V)	All
24	Ammeter (0-100 mA)	All
25	Photo electric type tachometer- Non contact type, handheld	1,12

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 Transducers and Sensors	1a. Describe function of the given blocks of instrumentation system. 1b. Describe selection of relevant transducer for the given application. 1c. Explain with sketches the working of the given electrical transducers. 1d. Explain with sketches the working principle of the given sensor. 1e. Describe selection of relevant sensor for the given application.	1.1 **Instrumentation Systems:** Block diagram of instrumentation system, function of each block. 1.2 **Transducers:** Need of transducer, classification of transducer: Active and passive, analog and digital, primary and secondary. 1.3 **Need of Signal Conditioning.** 1.4 **Electrical Transducers:** a. **Resistive Transducer**- Linear and angular potentiometer, Strain gauge, types of strain gauge, Wheatstone's bridge. b. **Capacitive Transducer: -** Variable area, variable plate distance and variable dielectric constant. c. **Inductive Transducer**- Linear variable differential transformer, Rotary variable differential transformer. d. **Piezoelectric Transducer:-** Piezo electric effect, piezo electric materials, Selection criterion for transducers. 1.5 **Sensors**: pneumatic sensor ,light Sensors, proximity sensors, tactile sensor, smart sensor.
Unit– II Pressure measurement	2a. Differentiate the features of the given type of pressures. 2b. Explain with sketches the working principle of the given pressure measuring device. 2c. Describe with sketches the construction of the given type of pressure measuring device. 2d. Explain with sketches the procedure for calibration of the given pressure transducer.	2.1 **Pressure:** Definition, types of pressure- Atmospheric, absolute, gauge, vacuum 2.2 **Pressure Transducers:** a. **Non elastic pressure transducers**: U-tube, inclined tube, well type manometer (Working principle, construction) b. **Elastic pressure transducers:** Bourdon tube, bellows, diaphragm, capsule (Working principle, construction,). c. **Electronic pressure transducers:** Bourdon tube with LVDT, diaphragm with strain gauge. 2.3 **Calibration:** Calibration of pressure gauge using dead weight tester
Unit– III Flow, Level and Speed measurement	3a. Explain with sketches the working principle of the given type flow meter. 3b. Describe with sketches the construction of the	3.1 **Flow**: definition, Types of flow- Laminar, turbulent, Reynolds number, Classification of flow measuring transducers: Working principle, construction, advantages, disadvantages and applications of Venturimeter, orifice plate meter, Rotameter.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	given type of flow meter. 3c. Explain with sketches the working principles of the given type of level measuring device. 3d. Explain with sketches the working principle of the given speed measurement technique.	time difference ultrasonic flow meter and Doppler type ultrasonic flow meter, Coriolis mass flow meter 3.2 **Level**: definition, need of level measurement, Classification of level measurement, working principle, construction, of float type, capacitive type, ultrasonic types, radiation types and RADAR type. 3.3 **Speed and Distance**: speed measurement methods (contact type and non contact type), distance (Ultrasonic, proximity) measurement, working principle, construction of photoelectric pick-up, Magnetic pick-up.
Unit –IV Temperature and Humidity Measurement	4a. Explain with sketches the working principle of the given type of temperature measurement device. 4b. Describe with sketches the construction of given temperature measuring device. 4c. Explain with sketches the working principle of the given type of humidity measurement device. 4d. Select the relevant transducer for the given temperature/humidity measurement application with justification.	4.1 **Temperature:** Definition and unit of measurements ,different temperature scale and their conversion, Law of thermodynamics, 4.2 **Temperature Measuring Transducer**: filled system types, bimetallic thermometer types, and electric / electronics types, optical types, working principle, construction and application of RTD, thermistors, thermocouple, and pyrometer 4.3 **Humidity:** Definition, types- absolute and relative; Humidity Measurement Devices: Psycho meter- dry & wet bulb thermometer, Hygrometer- hair type, capacitive type, resistive type.
Unit – V Data Acquisition systems.	5a. Explain functions of the given component of data acquisition system. 5b. Explain with sketches the working of the given the data acquisition system. 5c. Explain with sketches the given method of data transmission. 5d. Explain with sketches the working of the given data telemetry system. 5e. Explain with sketches	5.1 **Data Acquisition System**: Introduction, objective and configuration of data acquisition system, analog and automated data acquisition system, single channel data acquisition system, multi channel data acquisition system, application of data acquisition system. 5.2 **Data Transmission**: Mechanical Transmission, Hydraulic transmission, pneumatic transmission, magnetic transmission, electric type transmission. 5.3 **Data Telemetry**: definition, general telemetering system, types of telemetry voltage telemetry, current telemetry, RF telemetry, position telemetry.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	the working of the given display device and recorder.	5.4 **Display Devices and Recorders**: Indication instruments: analog and Digital; Display units LED, LCD,EPID and LVD, Recorders: Strip chart, X-Y, Oscillographic and printers

***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	Transducers and Sensors	10	02	06	06	14
II	Pressure measurement	08	04	04	06	14
III	Flow, Level and Speed measurement	10	02	04	06	12
IV	Temperature and Humidity measurement	08	02	06	06	14
V	Data Acquisition systems	12	04	06	06	16
Total		**48**	**14**	**26**	**30**	**70**

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

10. SUGGESTED STUDENT ACTIVITIES

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

a. Visit to local industry where data acquisition system is used and collect the data.
b. Market survey: Collect from local market the technical specifications and prices of three to four sensors/transducers and prepare comparative analysis.
c. Form a group of three to four students and discuss curriculum contents.
d. Prepare list of local instrumentation industries employing digital controls.
e. Prepare a sheet to display construction of selected transducer.
f. Prepare journals consist of free hand sketches of transducer and equipment's in each practical , detail specification and precautions to be observed while using transducer and equipment
g. Explore datasheet /technical specification of transducer.
h. Explore circuits of temperature/pressure control.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

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

a. Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.

b. ***'L' in item No. 4*** does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
c. About ***15-20% of the topics/sub-topics*** which is relatively simpler or descriptive in nature is to be given to the students for ***self-directed learning*** and assess the development of the COs through classroom presentations (see implementation guideline for details).
d. With respect to item No.10, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
e. Guide student(s) in undertaking micro-projects.
f. Demonstrate students thoroughly before they start doing the practice.
g. Encourage students to refer different websites to have deeper understanding of the subject.
h. Encourage students to visit local industries.
i. Observe continuously and monitor the performance of students in Lab.
j. Encourage students to analyze local market related to digital electronics.

12. SUGGESTED MICRO-PROJECTS

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

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

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

a. Water level measurement.
b. Turn on or off the electric equipment using some transducer.
c. Object detector measurement using some transducer.
d. Open or close the door using some device.
e. Temperature measurement using some transducer.
f. Pressure measurement using some transducer.
g. Smoke detector measurement using some transducer.
h. Light detection using measurement using some transducer
i. Object counter using measurement using some transducer.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Electrical and Electronics Measurements	Sawhney A.H.	Dhanpat rai and sons. New Delhi, 2012. ISBN: 978-8177001006

S. No.	Title of Book	Author	Publication
2	Industrial Instrumentation and Control	Singh S.K.	McGraw Hill , New Delhi, 2009,ISBN: 978-0070678200
3	Principal of Industrial Instrumentation	Patranabis D.	McGraw Hill , New Delhi, 2010,ISBN: 9780070699717
4	Instrumentation System and Devices	Sharma Rangan mani	McGraw Hill , New Delhi , 2011,ISBN: 9780074633502
5	Process Measurement Instrument Engineering Handbook	Bela Liptak; Kriszta Venczel	Chilton Book Co., New Delhi, 1982, ISBN: 978-0801969713
6	Electronic Measurement and Instrumentation	Rajput R.K. Er	S. CHAND , New Delhi , 2008,ISBN: 9788121929172

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. www.proprofs.com/webschool
b. www.en.wikipedia.org/wiki/Sensor
c. www.en.wikipedia.org/wiki/Tranducer
d. www.freestudy.co.uk/instrumentation/tutorial2.pdf
e. www.osvn.com
f. www.controlnet.com
g. www.youtube.com/(here type name of transducer /sensor/instrument)
h. www.freeideolecturers.com/course/2374/indusrial -instrumentation
i. www.ocw.mit.edu
j. www.mooc-list.com

Program Name : **Diploma in Digital Electronics Engineering**

Program Code : **DE**

Semester : **Third**

Course Title : **Electronics Simulation Software Practices**

Course Code : **22025**

1. RATIONALE

Industry expects a Diploma Engineer (technologist) to use modern day Electronic Design Automation (EDA) tool for analyzing, designing, and real time testing of analog, digital, Microcontroller(MCU), and mixed electronic circuits and their PCB layouts. These operations are useful in developing, fabricating and testing new prototype circuits. Using basic features of EDA tool prepares student for learning advanced aspects of the modern EDA tool such as using the simulation software for design of complex circuits.

2. COMPETENCY

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

- **Use different EDA tools to maintain the functioning of the basic analog and digital circuits.**

3. COURSE OUTCOMES (COs)

Student demonstrates the following industry oriented COs associated with the above mentioned competency:

a. Select relevant EDA tools.
b. Use EDA tools to analyze DC and AC circuit for various parameters.
c. Interpret time domain waveforms at various test points.
d. Use EDA tools to analyze digital circuit.
e. Use EDA tools to analyze Data acquisition system and power control 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	
-	-	4	4	--	--	--	--	--	--	--	25@	10	25~	10	50	20	

*(~[2]): For the **practical only courses,** the PA has two components under practical marks i.e. the assessment of practicals (seen in section 6) has a weightage of 60% (i.e.30 marks) and micro-project assessment (seen in section 12) has a weightage of 40% (i.e.20 marks). This is designed to facilitate attainment of COs holistically, as there is no theory ESE.*
***Legends:** L-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** - Practical; **C** – Credit, **ESE** - End Semester Examination; **PA** - Progressive Assessment.*

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.

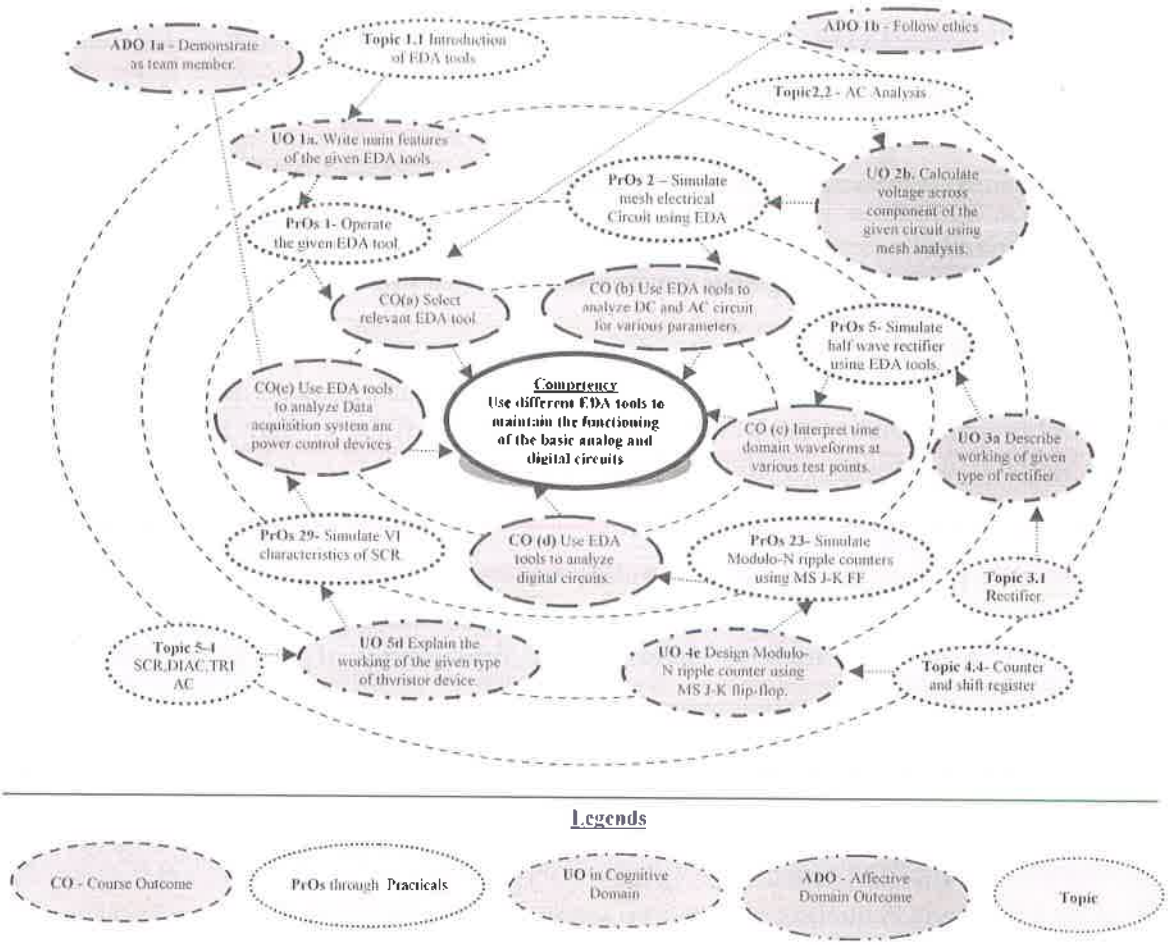

Figure 1 - Course Map

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	Operate the given EDA tool.	I	2*
2	Simulate the mesh electrical circuit using EDA tool.	II	2*
3	Simulate the nodal electrical circuit using EDA tool.	II	2
4	Simulate resonance characteristics of the given R-L-C circuit by varying L and C.	II	2
5	Simulate the half wave rectifier without filter using EDA tool.	III	2*
6	Simulate the half wave rectifier with filter using EDA tool.	III	2
7	Simulate the full wave centre tap/bridge rectifier without filter using EDA tool.	III	2
8	Simulate the full wave centre tap/bridge rectifier with filter using EDA tool.	III	2
9	Simulate the single stage amplifier using BJT to observe the frequency response using EDA tool.	III	2

S. No.	Practical Exercises(PrOs)	Unit No.	Approx. Hrs. required
10	Simulate the single stage amplifier using FET to observe the frequency response using EDA tool.	III	2
11	Simulate the single stage amplifier using MOSFET to observe the frequency response using EDA tool.	III	2
12	Interpret dc and transient analysis of two stage RC coupled/transformer coupled/ dc coupled amplifier using BJT/ JFET/MOSFET. Observe frequency response using virtual spectrum analyzer.	III	2
13	Interpret dc and transient analysis of two stage RC coupled/transformer coupled/ dc coupled amplifier using JFET. Observe frequency response using virtual spectrum analyzer.	III	2
14	Interpret dc and transient analysis of two stage RC coupled/transformer coupled/ dc coupled amplifier using MOSFET. Observe frequency response using virtual spectrum analyzer.	III	2
15	Interpret transient analysis of phase shift oscillator.	III	2
16	Interpret transient analysis of Wien bridge oscillator.	III	2
17	Interpret transient analysis of Colpitts oscillator.	III	2
18	Interpret transient analysis of Hartley oscillator.	III	2
19	Realize given Boolean expression using logic gates and verify its truth table by simulation software.	IV	2*
20	Simulate adder/subtractor and verify its truth table.	IV	2
21	Simulate multiplexer, demultiplexer/decoder and verify its truth table.	IV	2
22	Simulate R-S/J-K/MS J-K/D/T flip-flops and observe output on virtual logic analyzer,	IV	2
23	Simulate Modulo-N ripple counters using MS J-K FF and verify output using virtual logic analyzer.	IV	2
24	Simulate Modulo-N synchronous counters using MS J-K FF and verify output using virtual logic analyzer.	IV	2
25	Simulate four-bit shift universal register and verify output using virtual logic analyzer.	IV	2
26	Simulate R-2R resistive network DAC to convert given digital data into analog.	V	2
27	Measure temperature and display on 7 segment display.	V	2
28	Simulate Pressure to current converter for 4 to 20 mA	V	2*
29	Simulate VI characteristics of SCR	V	2
30	Simulate and control intensity of bulb using suitable Control rectifier .	V	2
31	Simulate VI characteristics of DIAC	V	2
32	Simulate VI characteristics of TRIAC	V	2
	Total		**64**

Note

*i. A suggestive list of **PrOs** is given in the above table. More such PrOs can be added to attain the COs and competency. A judicial mix of minimum 24 or more practical need to be performed, out of which, the practicals marked as '*' are compulsory, so that the student*

reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.

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

S. No.	Performance Indicators	Weightage in %
1.	Draw schematic circuit	20
2.	Neatness and appearances of drawing	10
3.	Answers to practical related questions	20
4.	Prepare journal report for all simulated practicals.	40
5.	Attendance and punctuality	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. Function as a team member.
d. Function as a team leader.
e. Follow ethics.

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 use in uniformity in conduct of experiments, as well as aid to procure equipment by administrators.

S. No.	Equipment Name with Broad Specifications	PrO. S.No.
1.	EDA tools like: eSim/ LTSPICE /TINA/OrCAD/MultiSim/SPICE/ /EasyEDA/ CircuitLogix/MicroCap /Scilab	All
2.	Personal Computer, 4GB RAM, 500GB HDD , i7 or higher Processor	All
3.	Laser Jet Printer.	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 EDA tool and File operation	1a. Write main features of the given EDA tool. 1b. Explain use of different windows to perform various operations of the given EDA tool. 1c. Explain procedure to perform the given file operation. 1d. Describe procedure to perform the given operation on schematic design windows of EDA tool.	1.1 EDA tools- eSim, Cadence, synopsis, spice, tina, scilab, lab view, multisim, orcad 1.2 Features of electronic design software. 1.3 Different editing windows 1.4 Different file operation 1.5 Drawing and editing schematic files
Unit– II Circuit Analysis	2a. Calculate current through component of the given circuit using Mesh analysis to verify the same through EDA simulation tool. 2b. Calculate voltage across component of the given circuit using Mesh analysis to verify the same through EDA simulation tool. 2c. Calculate current through and voltage across component of the given circuit using Nodal analysis to verify through EDA simulation tool. 2d. Calculate current through and voltage across component of the given RLC in ac circuit to verify the same through EDA tool.	2.1 DC analysis-Loop/ Mesh and Nodal 2.2 AC analysis-RL, RC and RLC circuit, peak value, rms value along with phase value.
Unit– III Transient Analysis of Analog Circuit	3a. Explain with sketches the working of the given type of rectifier. 3b. Explain with sketches the rectification of the given rectifiers circuit with and without filter. 3c. Select clipper or clamper for obtaining the given waveform with justification. 3d. Interpret the transient behavior of single/two stage RC coupled amplifier using the given transistor. 3e. Explain with sketches the frequency response of the given amplifier. 3f. Interpret the transient behavior of the given oscillator.	3.1 Rectifier:half wave rectifier, full wave rectifiers 3.2 Clipper and clamper circuits. 3.3 Single stage and multistage amplifier using BJT/JFET/MOSFET 3.4 Audio frequency and radio frequency oscillator.
Unit– IV Digital circuit	4a. Develop the given Boolean expression using logic gates and verify its truth table by simulation software. 4b. Draw MUX/DEMUX tree for the given number of input and output lines. 4c. Design the given simple flip-flops to verify output using virtual logic analyzer 4d. Use the given flip-flop to construct the specific type of counter. 4e. Use the given flip-flop to construct the	4.1 Combinational circuit-Logic gate, Boolean expressions. 4.2 Adder, subtractor, multiplexer, decoder, demultiplexer 4.3 Sequential circuit- Latch , flip-flops 4.4 Counters and shift register

	specific type of counter.	
Unit– V Measurement and power devices	5a. Explain with sketches the function of the given data converter. 5b. Explain with sketches the working principles of given temperature transducers. 5c. Explain with sketches the functions of the given components of Data acquisition system. 5d. Explain with sketches the working of the given type of thyristor device. 5e. Identify various power electronic devices for the specified application with justification.	5.1 ADC, DAC 5.2 Temperature transducers 5.3 Data acquisition system 5.4 SCR,DIAC,TRIAC

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 (INTERNAL) QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	EDA tool and File operation	03	--	--	02	02
II	Circuit Analysis	03	--	--	02	02
III	Transient Analysis of Analog Circuit	04	--	--	02	02
IV	Digital circuit	03	--	--	02	02
V	Measurement and power devices	03	--	--	02	02
Total		**16***	--	--	**10**	**10#**

**The hours utilize in conducting practical itself*

#PA = 50 (assesssment of pratical-20, microproject-20, internal theory test-10)

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 work diary based on simulated practicals performed in laboratory. Work diary consists of use of EDA tool, circuit drawing, simulated results, and date of performance with teacher signature.
b. Prepare journals consisting printouts of circuit diagram. Write simulation results of each practical in journal and precautions to be taken while using tools.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

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

a. Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b. ***'L' in item No. 4*** does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
c. About ***15-20% of the topics/sub-topics*** which is relatively simpler or descriptive in nature is to be given to the students for ***self-directed learning*** and assess the development of the COs through classroom presentations (see implementation guideline for details).
d. With respect to item No.10, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
e. Guide student(s) in undertaking micro-projects.
f. Arrange visit to nearby industries involved in research design and development of electronics hardware at circuit level.
g. Show video/animation films explaining application of simulation software.

12. SUGGESTED MICRO-PROJECTS

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

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

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

a. Build Circuit for D.C. motor to rotate in clockwise and anticlock wise direction using transistor.
b. Build on general purpose PCB to test circuit using opto-coupler for turn ON/OFF fan /light.
c. Build circuit using diodes and resistors to display numerals from 0 to 9 on seven segment display.
d. Build circuit to count 10 objects (pulses) for five times.
e. Build digital code lock using 16:1 MUX a digital code Switch turn on when input key code is 3,7,9,12 at output connect solenoid to operate the door.
f. Simulate and build circuit for water level controller using logic gates.
g. Simulate simple emergency light system using any EDA tool.
h. Simulate speed control of fan using TRIAC low power DC flasher using SCR.
i. Simulate pressure measurement system using appropriate EDA tool.
j. Simulate temperature measurement system using appropriate EDA tool.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Network Analysis and Synthesis	Ghosh, S.P.; Chakrabarti, A.K	McGraw Hill Education, New Delhi, 2010. ISBN: 978-0070144781
2	Electronics Devices and Circuit Theory	Boylestad, Robert L.	Pearson Publication, New Delhi, 2015. ISBN: 978-8131727003
3	Modern Digital Electronics	Jain, R.P.	McGraw Hill Education, New Delhi, 2009. ISBN: 978-0070669116
4	Power Electronics	Bimbhra, P.S.	KhannaPublishers, New Delhi, 2004, ISBN NO.81-7409-056-8
5	Power Electronics	Bimbhra, P.S.	Khanna Publishers, New Delhi ,2012 ISBN: 978-81-7409-279-3
6	Electrical & Electronics Measurement	Sawhney, A. H.	Dhanpat Rai and Sons, New Delhi, 2012, ISBN: 978-817001006

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. www.scilab.org
b. www.esim.fossee.in/
c. www.esim.fossee.in/resources/tutorials/KiCad
d. www.esim.fossee.in/resources/tutorials/Ngspice
e. www.spoken-tutorial.org/tutorial-search/?search_foss=Oscadandsearch language= English
f. www.linear.com/designtools/software/#LTspice
g. www.orcad.com/
h. www.linear.com/
i. www.easyeda.com/
j. www.circuitlogix.com/
k. www.spectrum-soft.com/
l. http://esim.fossee.in/resource/book/esimusermanual.pdf

Maharashtra State Board of Technical Education, Mumbai

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

Program Name : Diploma in Industrial Electronics

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

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

Semester : Third **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	Digital Techniques	DTE	22320	4	-	2	6	3	70	28	30*	00	100	40	25#	10	25	10	50	20	150
2	Fundamentals of Power Electronics	FPE	22326	4	-	2	6	3	70	28	30*	00	100	40	25@	10	25	10	50	20	150
3	Applied Electronics	AEL	22329	4	-	4	8	3	70	28	30*	00	100	40	50#	20	50	20	100	40	200
4	Electric Circuits and Networks	ECN	22330	3	2	2	7	3	70	28	30*	00	100	40	25@	10	25	10	50	20	150
5	Electronic Instruments and Measurements	EIM	22331	4	-	2	6	3	70	28	30*	00	100	40	25@	10	25	10	50	20	150
			Total	**19**	**2**	**12**	**33**	--	**350**	--	**150**	--	**500**	--	**150**	--	**150**	--	**300**	--	**800**

Student Contact Hours Per Week: **33 Hrs.** Medium of Instruction: **English**

Theory and practical periods of 60 minutes each. Total Marks : **800**

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 (5 marks each for Physics and Chemistry) to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the cognitive domain LOs required for the attainment of the COs.

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

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

Program Name : **Computer and Electronics Engineering Program Group**

Program Code : **CO/CM/CW/DE/EJ/ET/EN/EX/EQ/IE/IS/IC/MU**

Semester : **Third**

Course Title : **Digital Techniques**

Course Code : **22320**

1. RATIONALE

In the present scenario most of the electronic equipment like computers, mobiles, music systems, ATM, automation and control circuits and systems are based on digital circuits which the diploma electronic engineering passouts (also called technologists) have to test them. The knowledge of basic logic gates, combinational and sequential logic circuits using discrete gates as well as digital ICs will enable the students to interpret the working of equipment and maintain them. After completion of the course, students will be able to develop digital circuits based 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:

- **Build/ test digital logic circuits consist of digital ICs.**

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 number system and codes for interpreting working of digital system.
b. Use Boolean expressions to realize logic circuits.
c. Build simple combinational circuits.
d. Build simple sequential circuits.
e. Test data converters and PLDs in digital electronics systems.

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.

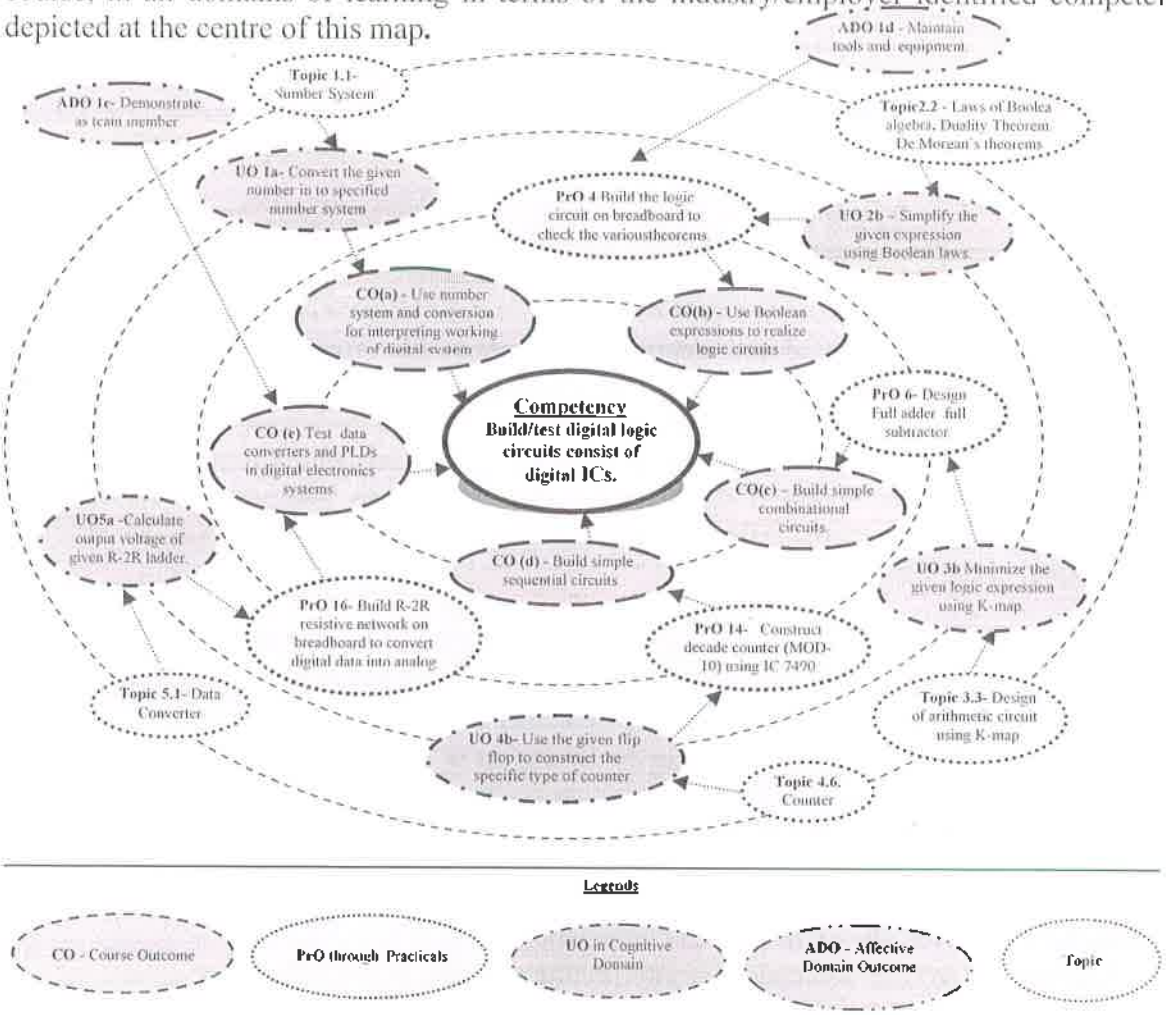

Figure 1 - Course Map

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	Test the functionality of specified logic gates using breadboard. (IC 7404, 7408, 7432, 7486)	II	02*
2	Test the functionality of NAND and NOR gate of using breadboard (IC 7400 and 7402)	II	02
3	Construct AND, OR, NOT gates using universal gates.	II	02
4	Build the logic circuit on breadboard to check the De Morgan's theorems.	II	02
5	Design Half adder and Half subtractor using Boolean expressions.	III	02*
6	Design Full adder and full subtractor.	III	02
7	Construct and test BCD to 7 segment decoder using IC 7447/ 7448.	III	02
8	Build / test function of MUX 74151/74150/any other equivalant.	III	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
9	Build / test function of DEMUX 74155/74154/any other equivalant.	III	02
10	Build / test function of RS flip flop using NAND Gate.	IV	02*
11	Build / test function of MS JK flip flop using 7476.	IV	02
12	Use IC 7476 to construct and test the functionality of D and T flip flop.	IV	02
13	Implement 4 bit ripple counter using 7476.	IV	02
14	Use IC 7490 to construct decade counter (MOD-10).	IV	02
15	Implement 4 bit universal shift register.	IV	02
16	Build R-2R resistive network on breadboard to convert given digital data into analog.	V	02*
		Total	**32**

Note

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

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

S. No.	Performance Indicators	Weightage in %
a.	Preparation of experimental 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

- '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. S. No.
1	Digital Multimeter: 3 and ½ digit with R, V, I measurements, diode and BJT testing.	All
2	CRO : Dual Channel, 4 Trace CRT / TFT based Bandwidth 20 MHz/30 MHz X10 magnification 20 ns max sweep rate, Alternate triggering Component tester and with optional features such as Digital Read out.	16
3	Pulse Generator: TTL pulse generator	10-15
4	DIGITAL IC tester: Tests a wide range of Analog and Digital IC's such as 74 Series, 40/45 Series of CMOS IC's.	1-15
5	Bread Board Development System: Bread Board system with DC power output 5V, +/-12V and 0-5V variable , digital voltmeter , ammeter, LED indicators 8 no, logic input switches 8 no, 7 segment display 2 no, clock generator, Manual pulser, Breadboard with about 1,600 points, Potentiometer, relay etc	1-15
6	Trainer kits for digital ICs: Trainer kit shall consists of digital ICs for logic gates, flop-flop, shift registers, counter along with toggle switches for inputs and bi-colour LED at outputs, built in power supply.	1-15
7	Regulated power supply: Floating DC Supply Voltages Dual DC : 2 x 0 -30V; 0-2 A Automatic Overload (Current Protection) Constant Voltage and Constant Current Operation Digital Display for Voltage and Current Adjustable Current Limiter Excellent Line and Load Regulation	1-16
8	Trainer kit for 4 bit Counter using Flip Flops: 4 bit ripple counter, Synchronous Counter, IC 7476 based circuit. Input given by switches and output indicated on LED. Facility to select MOD 8 or MOD 16 mode. Built in DC power supply and manual pulser with indicator.	13

8. UNDERPINNING THEORY COMPONENTS

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

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Number System and Codes	1a. Convert the given number into the specified number system. 1b. Perform the binary arithmetic operation on the given binary numbers. 1c. Convert the given coded number into the other specified code.	1.1 Number System: base or radix of number system, binary, octal, decimal and hexadecimal number system. 1.2 Binary Arithmetic: Addition, subtraction, multiplication, division. 1.3 Subtraction using 1's complement and 2's complement. Codes: BCD, Gray Code, Excess-3, and ASCII code.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	1d. Add the given two decimal numbers using BCD code.	1.5 BCD Arithmetic: BCD Addition
Unit – II Logic gates and logic families	2a. Develop the basic gates using the given NAND/NOR gate as universal gate. 2b. Simplify the given expression using Boolean laws. 2c. Develop logic circuits using the given Boolean expressions. 2d. Compare the salient characteristics of the given digital logic families.	2.1 **Logic gates**: Symbol, diode/ transistor switch circuit and logical expression , truth table of basic logic gates (AND, OR, NOT), Universal gates (NAND and NOR) and Special purpose gates (EX-OR, EX-NOR),Tristate logic 2.2 **Boolean algebra**: Laws of Boolean algebra, Duality Theorem, De-Morgan's theorems 2.3 **Logic Families**:Characteristics of logic families : Noise margin, Power dissipation, Figure of merit , Fan-in and fan-out, Speed of operation, Comparison of TTL, CMOS, types of TTL NAND gate
Unit– III Combinational Logic Circuits	3a. Develop logic circuits in standard SOP/ POS form for the given logical expression. 3b. Minimize the given logic expression using K-map. 3c. Use IC 7483 to design the given adder/ subtractor. 3d. Draw MUX/DEMUX tree for the given number of input and output lines. 3e. Write the specifications of the component for the given application. 3f. Develop the specified type of code converter.	3.1 **Standard Boolean representation:** Sum of Product (SOP) and Product of Sum(POS), Min-term and Max-term, conversion between SOP and POS forms, realization using NAND /NOR gates 3.2 **K-map reduction technique for the Boolean expression:** Minimization of Boolean functions up to 4 variables (SOP and POS form) 3.3 **Design of arithmetic circuits and code converter using K-map:** Half and full Adder, half and full Subtractor , gray to binary and binary to gray (up to 4 bits) 3.4 **Arithmetic circuits:** (IC 7483) Adder and Subtractor, BCD adder 3.5 **Encoder/Decoder:** Basics of encoder, decoder, comparison. (IC 7447) BCD to 7 segment decoder/driver 3.6 **Multiplexer and Demultiplexer:** working , truth table and applications of Multiplexers and Demultiplexures, MUX tree, IC 74151as MUX; DEMUX tree, DEMUX as decoder, IC 74155 as DEMUX 3.7 **Buffer:** Tristate logic, unidirectional and bidirectional buffer (IC 74LS244,74LS245)

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit– IV Sequential Logic Circuit	4a. Use relevant triggering technique for the given digital circuit. 4b. Use the given flip-flop to construct the specific type of counter. 4c. Use excitation table of the given flip-flop to design synchronous counter. 4d. Design the specified modulo-N counter using IC7490. 4e. Construct ring/ twisted ring counter using the given flip-flop.	4.1 **Basic memory cell**: RS-latch using NAND and NOR 4.2 **Triggering Methods:** Edge trigger and level trigger 4.3 **SR Flip Flops**: SR-flip flop, clocked SR flip flop with preset and clear, drawbacks of SR flip flop 4.4 **JK Flip Flops**: Clocked JK Flip flop with preset and clear, race around condition in JK flip flop, Master slave JK flip flop, D and T type flip flop Excitation table of flip flops, Block schematic and function table of IC-7474, 7475 4.5 **Shift Register**: Logic diagram of 4-bit Shift registers – Serial Input Serial Output, Serial Input Parallel Output, Parallel Input Serial Output, Parallel Input Parallel Output, 4 Bit Universal Shift register **4.6 Counters:** Asynchronous counter: 4 bit Ripple counter, 4 bit up/down Counter, modulus of counter Synchronous counter: Design of 4 bit synchronous up/down counter Decade counter: Block schematic of IC 7490 Decade counter, IC 7490 as MOD-N Counter, Ring counter, Twisted ring counter
Unit– V Data Converters and PLDs	5a. Calculate the output voltage of the R-2R ladder for the given specified digital input. 5b. Calculate the output voltage of the weighted resistor DAC for the given specified digital input. 5c. Explain with sketches the working principle of the given type of ADC. 5d. Explain with sketches the working principle of the given types of memories. 5e. Explain with basic block diagram the working principle of the given type of programmable logic device.	5.1 **Data Converter**: DAC: Types, weighted resistor circuit and R-2R ladder circuit, DAC IC 0808 specifications ADC: Block Diagram, types, and working of Dual slope ADC, SAR ADC, ADC IC 0808/0809, specification 5.2 **Memory**: RAM and ROM basic building blocks. read and write operation ,types of semiconductor memories 5.3 **PLD:** Basic building blocks and types of PLDs, PLA, PAL, GAL 5.4 CPLD: Basic Building blocks, functionality.

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	Number System	06	2	2	4	08
II	Logic gates and logic families	10	4	4	4	12
III	Combinational Logic Circuits	16	4	6	8	18
IV	Sequential Logic Circuit	16	4	6	8	18
V	Data Converters and PLDs	16	4	4	6	14
Total		**64**	**18**	**22**	**30**	**70**

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

10. SUGGESTED STUDENT ACTIVITIES

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

a. Prepare the survey report on the applications of different types of number system and code converters used in the design of digital system.
b. Compare technical specifications and applications of various types of memory, PLDs, CPLDs and Prepare report.
c. Test digital IC's using various testing equipment like digital IC tester, Digital multi-meter etc.
d. Give seminar on any course relevant topic.
e. Conduct library / internet survey regarding different data sheet and manuals.
f. Prepare power point presentation on digital circuits and their applications.
g. Undertake a market survey of different digital IC's required for different applications.
h. Search for video / animations / power point presentation on internet for complex topic related to the course and make a presentation.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

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

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

e. Guide student(s) in undertaking micro-projects.
f. PPTs/Animations may be used to explain the construction and working of electronic circuits.
g. Guide students for using data sheets / manuals.

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

a. Build a Digital IC tester circuit.
b. Build a 4bit parity generator and parity checker circuit.
c. Build a circuit to implement 4 bit adder.
d. Build a circuit to test 7 segment display.
e. Build a circuit to implement debounce switch.
f. Build a circuit for LED flasher.
g. Build a circuit for LED BAR display
h. Design and analyze digital arithmetic circuit

Note: *Use general purpose PCB for making micro projects*

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Modern Digital Electronics	Jain, R.P.	McGraw-Hill Publishing, New Delhi, 2009 ISBN: 9780070669116
2	Digital Circuits and Design	Salivahanan S.; Arivazhagan S.	Vikas Publishing House, New Delhi, 2013, ISBN: 9789325960411
3	Digital Electronics	Puri, V.K.	McGraw Hill , New Delhi, 2016, ISBN: 97800746331751
4	Digital Principles	Malvino, A.P.; Leach, D.P.; Saha G.	McGraw Hill Education, New Delhi, 2014, ISBN : 9789339203405
5	Digital Design	Mano, Morris; Ciletti, Michael D.	Pearson Education India, Delhi, 2007, ISBN: 9780131989245
6	Digital Electronics, Principles and Integrated Circuits	Maini, Anil K.	Wiley India, Delhi, 2007, ISBN: 9780470032145

S. No.	Title of Book	Author	Publication
7	Digital Fundamentals	Floyd, Thomas	Pearson Education India, Delhi, 2014, ISBN : 9780132737968

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. www.cse.yorku.ca/~mack/1011/01.NumberSystems.ppt
b. www.people.sju.edu/~ggrevera/arch/slides/binary-arithmetic.ppt
c. www.mathsisfun.com/binary-number-system.html
d. www.codesandtutorials.com/hardware/electronics/digital_codes-types.php
e. www.ee.surrey.ac.uk/Projects/Labview/gatesfunc/
f. www.ee.surrey.ac.uk/Projects/Labview/boolalgebra/
g. www.eng.auburn.edu/~strouce/class/elec2200/elec2200-8.pdf
h. www.maxwell.ict.griffith.edu.au/yg/teaching/dns/dns_module3_p3.pdf
i. www.scs.ryerson.ca/~aabhari/cps213Chapter5.ppt
j. www.eng.wayne.edu/~singhweb/seql.ppt
k. www.cs.sjsu.edu/faculty/lee/Ch2Problems2.ppt
l. www.rogtronics.net/files/datasheets/dac/SedraSmith.pdf
m. www-old.me.gatech.edu/mechatronics_course/ADC_F04.ppt
n. www.allaboutcircuits.com/vol_4/chpt_13/3.html
o. www.youtube.com/watch?v=5Wz5f3n5sjs
p. www.eee.metu.edu.tr/~cb/e447/Chapter%209%20-%20v2.0.pdf
q. www2.cs.siu.edu/~hexmoor/classes/CS315-S09/Chapter9-ROM.ppt
r. www.cms.gcg11.org/attachments/article/95/Memory2.ppt
s. www.cosc.brocku.ca/Offerings/3P92/seminars/Flash.ppt
t. www.webopedia.com/TERM/R/RAM.html
u. www.cs.sjsu.edu/~lee/cs147/Rahman.ppt

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

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

Semester : **Third**

Course Title : **Fundamentals of Power Electronics**

Course Code : **22326**

1. RATIONALE

Day by day the enhanced development in the industry is dynamic. The role of technicians (Diploma engineers) has changed over the years. Power electronic devices and circuits play a major role in nearly all industries. By virtue of their operating characteristics; for which study of these devices is very essential for the electrical and electronic technician to handle them. Hence they must be well conversant with the power electronic devices and their applications. This course aims to impart the knowledge and skills related to handling in terms of the applications and maintenance of these devices.

2. COMPETENCY

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

- **Maintain the proper functioning of power electronic devices.**

3. COURSE OUTCOMES (COs)

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

a. Select power electronic devices for specific applications.
b. Maintain the performance of Thyristors.
c. Troubleshoot turn-on and turn-off circuits of Thyristors.
d. Maintain phase controlled rectifiers.
e. Maintain industrial control circuits.

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.

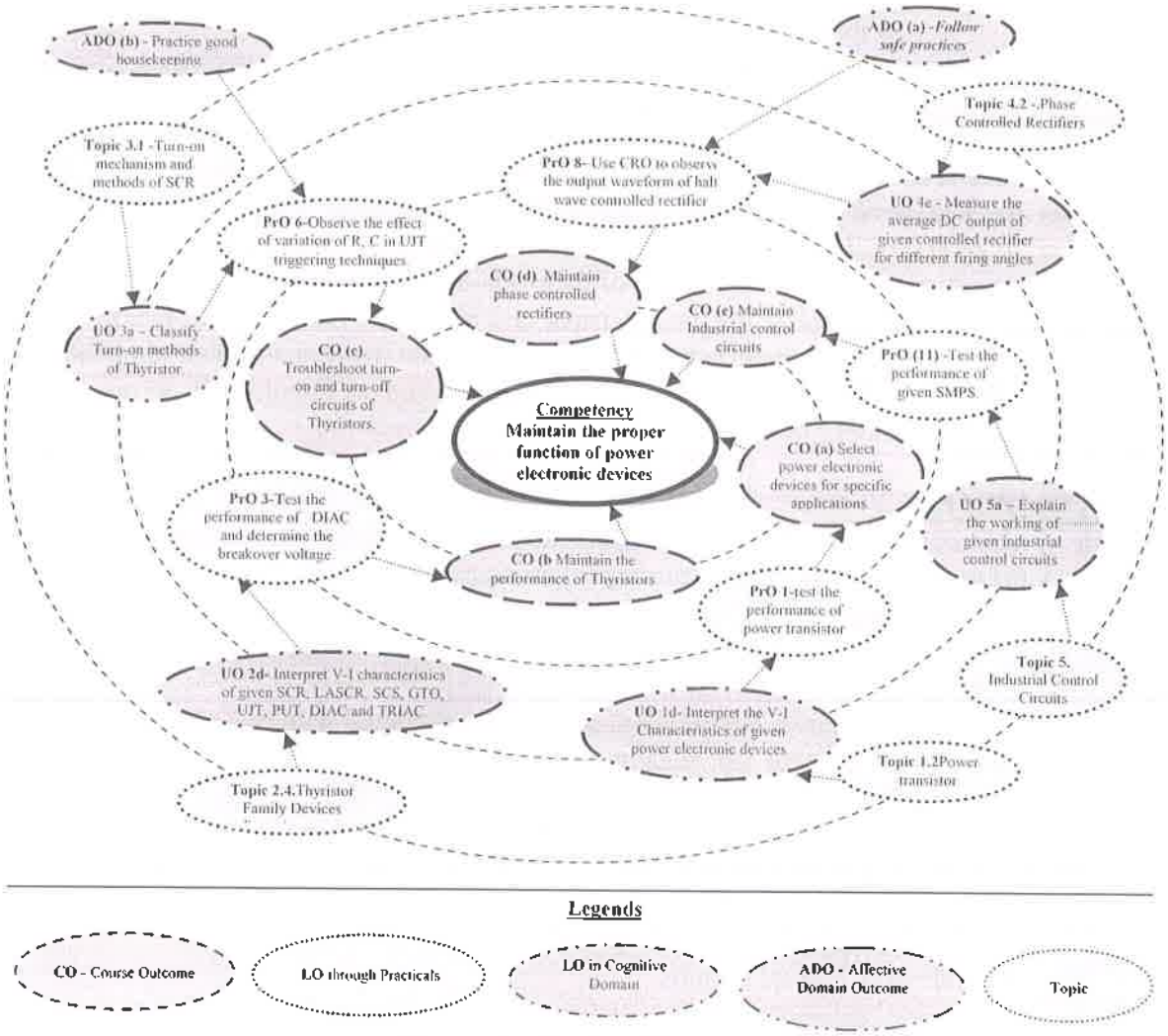

Figure 1 - Course Map

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	Test the proper functioning of power transistor.	I	02*
2	Test the proper functioning of IGBT.	I	02
3	Test the proper functioning of DIAC to determine the break over voltage.	II	02*
4	Determine the latching current and holding current using V-I characteristics of SCR.	II	02
5	Test the variation of R,C in R and RC triggering circuits on firing angle of SCR.	III	02*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
6	Test the effect of variation of R, C in UJT triggering technique.	III	02
7	Perform the operation of Class – A, B, C, turn off circuits.	III	02
8	Perform the operation of Class –D, E, F turn off circuits.	III	02
9	Use CRO to observe the output waveform of half wave controlled rectifier with resistive load and determine the load voltage.	IV	02*
10	Draw the output waveform of Full wave controlled rectifier with R load, RL load, freewheeling diode and determine the load voltage.	IV	02
11	Determine the firing angle using DIAC and TRIAC phase controlled circuit on output power under different loads such as lamp , motor or heater	V	02*
12	Simulate above firing angle control on SCILAB software	V	02*
13	Test the performance of given SMPS.	V	02
14	Test the performance of given UPS	V	02
15	Troubleshoot the Burglar's alarm.	V	02
16	Troubleshoot the Emergency light system.	V	02
17	Troubleshoot the Speed control system.	V	02
18	Troubleshoot the Temperature control system.	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 %
a.	Correctness of circuit diagrams	40
b.	Troubleshooting ability	20
c.	Quality of input and output displayed (observing , measuring, plotting and analysis of graph/characteristics/parameters)	10
d.	Answer to sample questions	20
e.	Submit 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
- 'Organising Level' in 2nd year
- 'Characterising Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTSREQUIRED

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

S. No.	Equipment Name with Broad Specifications	PrO. S. No.
1	Digital Multimeter: 3and1/2 digit 0-800Volts,0-10A , Micro-ammeters:0-100uA	All
2	Dual channel CRO: 25 MHz with isolation transformer OR Power scope , Attenuator probe for CRO	All
3	SCR, LASCR, SCS, GTO, UJT, PUT, DIAC and TRIAC – 5 each	All
4	DC Regulated Power Supply: 0-300 V,0- 10 A	1 to 7
5	Experimental kits related to Thyristors, connecting cords	All
6	Resistive load: (Lamp100W, heater coil 500W), Resistive-Inductive load: (single phase fractional ¼ HP, 60W,75W Motor)	8,9,10
7	Digital Tachometer with opto-coupler (phototechometer) 4000 RPM	15
8	SCILAB Software	10

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 Power Electronic Devices	1a. Explain with sketches the working of the given power electronic device(s). 1b. Describe with sketches the construction of the given power transistor. 1c. Interpret the V-I characteristics of the given power electronic device. 1d. Select suitable power electronic device for given situation with justification. 1e. Suggest suitable IGBT for given application. 1f. Describe the procedure to troubleshoot the given power	1.1 Power electronic devices 1.2 Power transistor: construction, working principle, V-I characteristics and uses. 1.3 IGBT: Construction, working principle, V-I characteristics and uses. 1.4 Concept of single electron transistor (SET) - aspects of Nano-technology.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	electronic device (s)	
Unit– II Thyristor Family Devices	2a. Classify given power semiconductor devices 2b. Identify given thyristors and triggering devices with justification 2c. Explain with sketches the working of the given type of thyristor 2d. Describe the procedure to troubleshoot the given type of thyristor.	2.1 SCR: construction, two transistor analogy, types, working and V-I characteristics. 2.2 SCR mounting and cooling. 2.3 Types of Thyristors: SCR, LASCR, SCS, GTO, UJT, PUT, DIAC and TRIAC 2.4 Thyristor family devices: symbol, construction, operating principle and V-I characteristics. 2.5 Protection circuits: over-voltage, over-current, Snubber, Crowbar.
Unit– III Turn-on and Turn-off Methods of Thyristors	3a. Explain with sketches the working of the given type of triggering circuit. 3b. Explain the role of pulse transformer in given triggering circuits. 3c. Explain with sketches the working of the given type of turn-on method. 3d. Describe the procedure to troubleshoot the given type of turn-on method. 3e. Explain with sketches the working of the given type of turn-off method. 3f. Describe the procedure to troubleshoot the given type of turn-off method.	3.1 SCR Turn-ON methods: High Voltage thermal triggering, Illumination triggering, dv/dt triggering, Gate triggering. 3.2 Gate trigger circuits – Resistance and Resistance-Capacitance circuits. 3.3 SCR triggering using UJT, PUT: Relaxation Oscillator and Synchronized UJT circuit. 3.4 Pulse transformer and opto-coupler based triggering. 3.5 SCR Turn-OFF methods: Class A-Series resonant commutation circuit, Class B-Shunt resonant commutation circuit, Class C-Complimentary Symmetry commutation circuit, Class D –Auxiliary commutation, Class E- External pulse commutation , Class F- Line or natural commutation.
Unit-IV Phase Controlled Rectifiers	4a. Explain with sketches the operation of the phase control. 4b. Calculate the average voltage of the given controlled rectifier. 4c. Interpret / draw the input-output waveforms of the power electronic circuit. 4d. Explain with sketches the operation of the given bridge configuration. 4e. Describe the procedure to troubleshoot the given phase controlled rectifier(s) circuit.	4.1 Phase control: firing angle, conduction angle. 4.2 Single phase half controlled, full controlled and midpoint controlled rectifier with R, RL load: Circuit diagram, working, input- output waveforms, equations for DC output and effect of freewheeling diode. 4.3 Different configurations of bridge controlled rectifiers: Full bridge, half bridge with common anode, common cathode, SCRs in one arm and diodes in another arm.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit –V Industrial Control Circuits	5a. Explain with sketches the working of given industrial control circuits. 5b. Describe the troubleshooting procedure of the given type of SMPS. 5c. Describe the troubleshooting procedure of the given type of online and offline UPS. 5d. Explain with sketches the working of the given type of SCR-based circuit breaker. 5e. Describe the procedure to troubleshoot phase controlled rectifier(s).	5.1 Applications: Burglar's alarm system, Battery charger using SCR, Emergency light system, Temperature controller using SCR and; Illumination control / fan speed control using TRIAC. 5.2 SMPS. 5.3 UPS: Offline and Online 5.4 SCR based AC and DC circuit breakers.

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	Power Electronic Devices	08	01	02	03	06
II	Thyristor Family Devices	16	03	06	08	17
III	Turn-on and Turn-off Methods of Thyristors	14	03	04	07	14
IV	Phase Controlled Rectifiers	18	02	06	10	18
V	Industrial Control Circuits	08	02	05	08	15
Total		**64**	**11**	**23**	**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 with respect to attainment of UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.*

10. SUGGESTED STUDENT ACTIVITIES

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

a. Visit the nearby power electronics based industry and observe the processes.
b. Take the market survey of various specifications of available Thyristors and submit the report of their uses.
c. Survey the market and submit the report of available circuit breakers, SMPS and different types of UPSs.

d. Survey the local market and identify the different types of fan regulator available in the market.

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).
a. With respect to item No.10, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
b. Guide student(s) in undertaking micro-projects
c. Use simulation software's for demonstrating the performance of different Thyristors.

12. SUGGESTED MICRO-PROJECTS

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

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

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

a. **Power Electronic Devices:** Build and test the circuit of electronic switch using power transistor and control the operation with wireless devices.
b. **Thyristor family devices:** Build and test the circuit of digital logic gates : AND , OR , NOT , NAND , NOR , Ex-OR , Ex-NOR using SCRs (any four).
c. **Turn-on and Turn-off methods:** Build and test the circuit of
   i) PUT and
   ii) UJT relaxation oscillator.
d. **Phase controlled rectifier:** Construct and test a circuit of fractional HP DC motor speed control (Open Loop) .
e. **Industrial control circuits:** Build and test circuit of
   i) fan regulator using TRIAC – DIAC or
   ii) SCR lamp flasher.
f. Any Other Micro Project: based on the curriculum suggested by the Teacher.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	An Introduction to Thyristors and their applications	Ramamoorty M.	East-West Press Pvt. Ltd., New Delhi, 1980, ISBN: 8185336679.
2	Thyristors: Theory and Applications	Sugandhi, Rajendra Kumar and Sugandhi, Krishna Kumar.	New Age International (P) ltd. Publishers, New Delhi, 2009, ISBN: 978-0-85226-852-0.
3	Fundamentals of Power Electronics	Bhattacharya, S.K.	Vikas Publishing House Pvt. Ltd. Noida. 2009,ISBN: 978-8125918530.
4	Power Electronics and its Applications	Jain, Alok	Penram International Publishing (India) Pvt. Ltd, Mumbai, 2006 ISBN: 978-8187972228.
5	Power Electronics Circuits Devices and Applications	Rashid , Muhammad, H.	Pearson Education India, Noida, 2014 ISBN: 978-0133125900.
6	Power Electronics	Singh, M. D. and Khanchandani, K.B.	Tata McGraw Hill Publishing Co. Ltd, New Delhi, 2008 ISBN: 9780070583894.
7	Industrial Electronics: A Text –Lab Manual	Zbar, Paul B.	McGraw Hill Publishing Co. Ltd. , New Delhi, 1990 ISBN: 978-0070728226.
8	SCR Manual	Grafham D.R.	General Electric Co., 1982 ISBN: 978-0137967711.
9	Understanding the Nanotechnology Revolution	Edward L Wolf and Manasa Mediconda	Wiley- VCH verlag GmbH and Co. kGaA, ISBN: 978-3527411092

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. www.nptel.ac.in/courses/108101038
b. www.ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-334-power-electronics-spring-2007
c. SCILab
d. www.nptelvideos.in/2012/11/power-electronics.html
e. www.coursera.org/learn/power-electronics
f. www.powerguru.org/power-electronics-videos/
g. www.youtube.com/watch?v=1Auay7ja2oY

Program Name : **Electronics Engineering, Digital Electronics and Instrumentation Engineering Program Group**

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

Semester : **Third**

Course Title : **Applied Electronics**

Course Code : **22329**

1. RATIONALE

Enhanced use of electronic gadgets has made electronics engineers to deal with the various types of electronic circuits which generate the required analog/digital output. Transistor has remarkably expanded the utility of electronic equipment. Discrete components are widely used in amplifiers and other electronic systems which the engineering diploma holders (also called as technologist) have to use or maintain. The learning of basic operating principles of electronic circuits will help the students to use the basic electronic equipment. This course is developed in such a way that, students will be able to apply the knowledge of basic electronic circuit working to solve broad based electronic engineering application problems.

2. COMPETENCY

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

- **Use discrete electronic devices and voltage regulators.**

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 transistor as low Power amplifier.
b. Use BJT as high Power amplifier.
c. Use BJT as feedback amplifier.
d. Use BJT as waveform generator.
e. Maintain IC voltage regulator and SMPS.

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	-	4	8	3	70	28	30*	00	100	40	50#	20	50	20	100	40

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

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

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

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

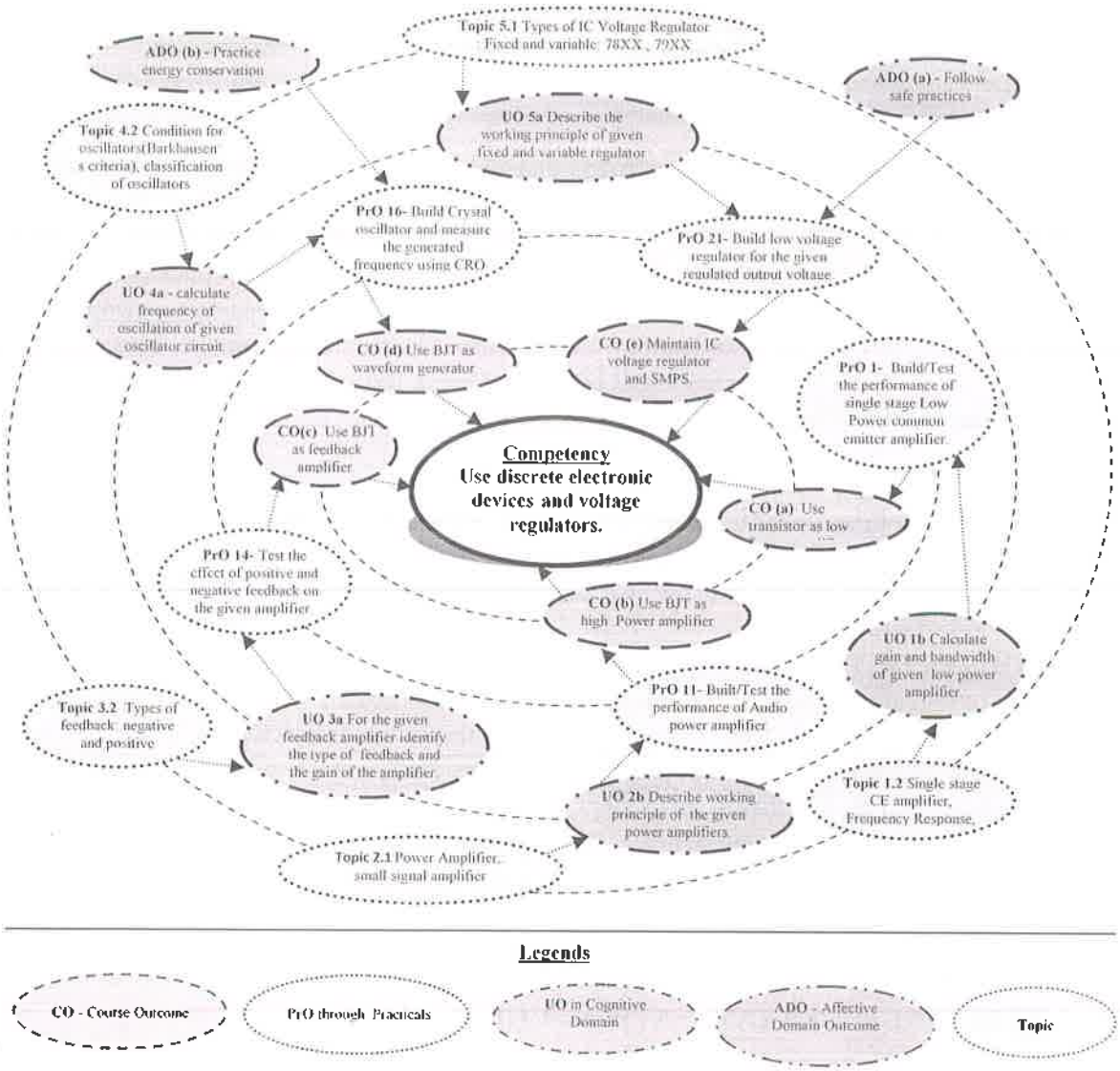

Figure 1 - Course Map

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.

** Use bread board for the following Practials (wherever applicable).*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Build/test the performance of single stage Low Power common emitter amplifier.	I	2*
2	Simulate / test out put Wave form of single stage common	I	2

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	emitter (CE) amplifier using simulation software(like spice, multisim).		
3	Simulate/test the output Wave form of single Stage common source FET amplifier using simulation software	I	2
4	Build/test the performance of single stage Common source FET amplifier.	I	2
5	Build/test the performance of two stage RC Coupled common emitter amplifier using transistor.	I	2*
6	Build/test the performance of two stage direct Coupled amplifier using transistor.	I	2
7	Build/Test the performance of transformer Coupled amplifier.(Part-I)	I	2*
8	Build/Test the performance of transformer Coupled amplifier.(Part-II)	I	2*
9	Build/test the performance of single tuned amplifier using transistor.	I	2
10	Build/test performance of double tuned common Emitter amplifier. (Part-I)	I	2
11	Build/test performance of double tuned common Emitter amplifier. (Part-II)	I	2
12	Build/test performance parameters of single stage class A power amplifier.	II	2
13	Build/test performance parameters of class B Push pull amplifier using transistor.	II	2
14	Build/test the performance of Audio power amplifier.	II	2*
15	Use transistor to build/ test voltage series Feedback amplifier parameters with and without feedback.	III	2
16	Use transistor to built/ test voltage shunt Feedback amplifier parameters with and without feedback.	III	2
17	Test the effect of positive and negative feedback on the given amplifier.(Part-I)	III	2*
18	Test the effect of positive and negative feedback on the given amplifier.(Part-II)	III	2*
19	Build RC phase shift oscillator and measure the generated frequency using CRO.	IV	2
20	Build Crystal oscillator and measure the generated frequency using CRO.	IV	2
21	Simulate Hartley oscillator using any relevant simulation software. (Like spice, multisim, Lab view, LTspice, Octeva).	IV	2*
22	Generate a waveform using Miller's sweep generator and measure sweep time and retrace time.	IV	2
23	Simulate dual voltage regulator using IC78XX and 79XX for the specified regulated output voltage	V	2*
24	Build dual voltage regulator for the specified Regulated output voltage.	V	2
25	Build low voltage regulator using IC723 for the given regulated output voltage. (2V to7V)	V	2*
26	Build high voltage regulator using IC723 for the given regulated output voltage.(7 V to 37 V)	V	2

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
27	Test the performance parameters of voltage regulator using IC LM317.	V	2*
	Total		**54**

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 %
1	Preparation of experimental set up	20
2	Setting and operation	20
3	Safety measures	10
4	Observations and Recording	10
5	Interpretation of result and conclusion	20
6	Answer to sample questions	10
7	Submission of report in time	10
Total		**100**

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

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

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

- 'Valuing Level' in 1st year
- '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. S. No.

S. No.	Equipment Name with Broad Specifications	PrO. S. No.
1	Variable DC power supply 0- 30V, 2A, SC protection	All
2	Dual Power supply 0- 30V, 2A	All
3	Cathode Ray Oscilloscope, Dual Trace 30Mhz and above, 1MegaΩ Input Impedance	1-16
4	Digital storage Oscilloscope, Dual Trace 20Mhz and above, 1MegaΩ Input Impedance	1-16
5	Function Generator 0-2 MHz with Sine, square and triangular output with variable frequency and amplitude	1-12
6	Digital Multimeter: 3and1/2 digit display, 9999 counts digital multimeter measures: V_{ac}, V_{dc} (1000V max) , A_{dc}, A_{ac} (10 amp max) , Resistance (0 - 100 MΩ) , Capacitance and diode .transistor tester	All
7	Electronic Work Bench : Bread Board 840 -1000 contact points, Positive and Negative power rails on opposite side of the board , 0-30 V , 2 Amp Variable DC power supply, Function Generator 0-2MHz, CRO 0-30MHz , Digital multimeter	All
8	LCR-Q meter, Test frequency standard 100 Hz / 1 kHz; Parameter L-Q, C-D, R-Q and Z-Q,Parameters L 100 Hz, 120 Hz 1 mH - 9999 H 1 KHz 0.1 mH - 999.9 Ht,C 100 Hz, 120Hz 1 pF - 9999 mF Range 1 KHz 0.1 pF - 999.9 mF,Terminals 4 terminals.	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 Low Power Amplifiers	1a. Explain with sketches the working principle of the given type of amplifier. 1b. Calculate gain and bandwidth of the given low power amplifier. 1c. Compare performance parameters of the given types of amplifier coupling. 1d. Select relevant tuned amplifier for the given frequency band with justification. 1e. Describe the environment employed for the given simulation work with justification.	1.1 Classification of Amplifiers, BJT as an amplifier . 1.2 Single stage CE amplifier, frequency response, gain, bandwidth 1.3 Multistage amplifier: General Multistage amplifier BJT based. 1.4 Type of BJT amplifier coupling: Circuit diagram , operation, frequency response and applications of RC, transformer and direct coupling 1.5 FET Amplifier: Common Source amplifier, working principle and applications 1.6 Tuned Amplifier: Need of tuned amplifier, basic tuned circuit, circuit diagram, operating principle and frequency response of Single tuned, Double tuned and stagger tuned amplifiers

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit– II High Power Amplifiers	2a. Explain with sketches the working of the given type of power amplifier. 2b. Select the relevant power amplifier for the given application with justification. 2c. Calculate efficiency of the given power amplifier. 2d. Compare the performance parameters of the given types of power amplifiers. 2e. Prepare the specifications of the given type of amplifier.	2.1 Power Amplifier: Comparison between small signal amplifier and power amplifier, performance parameter of power amplifier like : bandwidth, gain, frequency band, efficiency 2.2 Classification: Class A, Class B, Class AB and Class C 2.3 Circuit, operation, input /output waveforms, efficiency and power equations of Single Stage Class A, Class B, Class AB and Class C Power amplifier.
Unit III Feedback Amplifiers	3a. Calculate the gain of the amplifier for the given type of feedback amplifier. 3b. Explain effect of negative feedback on the given type of amplifier performance. 3c. Calculate Gain, Bandwidth, Input and Output resistance of the given feedback amplifier. 3d. Compare the performance of given types of negative feedback amplifiers.	3.1 Principle of feedback Amplifier 3.2 Types of feedback: negative and positive feedback, advantages and disadvantages of negative feedback 3.3 Types of feedback connections, voltage shunt, voltage series, current series and current shunt: block diagram, circuit diagram, and operation
Unit IV Wave form Generators	4a. Calculate frequency of oscillation for the given type of oscillator circuit. 4b. Select the relevant oscillator to obtain the given range of frequency with justification. 4c. Choose the relevant sweep generator to obtain the specified saw tooth waveform with justification. 4d. Prepare the specifications of the given oscillator.	4.1 Oscillators: Need, oscillator and amplifier 4.2 Condition for oscillation (Barkhausen's criteria), classification of oscillators 4.3 Sine wave Oscillator : RC Phase shift oscillator and crystal oscillator , concept , working and applications 4.4 Sweep generator: Miller sweep, Bootstrap circuit, current time base generator
Unit– V IC Voltage Regulators and SMPS	5a. Explain with sketches the working principle of given type of voltage regulator IC. 5b. Compare the working of the given types of regulators. 5c. Design voltage regulator for the specified output voltage. 5d. Interpret the working of given block of the SMPS.	5.1 Types of IC Voltage Regulator: Fixed and variable: 78XX, 79XX, specification, series and LM723, LM317, line and load regulation. 5.2 SMPS : Block diagram, working principle, specifications, special features, advantages , disadvantages and applications. Use of heat sink for regulated power supply.

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	Low Power Amplifiers	14	4	6	6	16
II	High Power Amplifiers	18	4	6	8	18
III	Feedback Amplifiers	12	4	4	4	12
IV	Waveform Generators	12	4	4	6	14
V	IC voltage Regulators and SMPS	08	2	4	4	10
Total		**64**	**18**	**24**	**28**	**70**

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

10. SUGGESTED STUDENT ACTIVITIES

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

a. Undertake micro-projects.
b. Give seminar on any relevant topic.
c. Library survey regarding different electronics circuits and voltage regulators.
d. Prepare power point presentation for electronic circuits.
e. Undertake a market survey of different electronics circuits and voltage regulators

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

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

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

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. Construct a doorbell using transistor.
b. Using transistor construct a clap switch.
c. Construct audio amplifier using.(IC810 or equivalent IC).
d. Construct power amplifier for FM receiver output.
e. Drive a 4Ω speaker using class A amplifier which is directly coupled and test its performance parameters.
f. Using ClassAB push pull amplifier drive (4Ω/8Ω) speaker, test its performance parameters.
g. IC regulators: Build a circuit of Dual regulated power supply on general purpose PCB to obtain +/- 15 V, 500mA using IC 78XX & 79XX series.
h. IC regulators: Build a regulated power supply on general purpose PCB to obtain + 5V, 500mA using IC 78XX series. Drive suitable load with regulated output.
i. IC regulators: Build a regulated power supply on general purpose PCB to obtain -20V, 500mA using IC 79XX series. Use suitable heat sink .Drive suitable load with regulated output.
j. IC Regulators: Build a constant current regulator on general purpose PCB for output current of 125mA using IC 317.
k. IC Regulators : Construct low voltage regulator on general purpose PCB for output voltage 5V using LM IC 723.Drive any 5v operated load.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Applied Electronics	Sedha, R.S.	S.Chand. New Delhi, 2015 ISBN:9788121927833
2	Principles of Electronics	Mehta, V.K. Mehta, Rohit	S.Chand, New Delhi, 2014 ISBN:8121924502
3	Electronic Devices and Circuit Theory	Boylestead, Robert, Neshelsky, Louis	Pearson Education, New Delhi, 2014, ISBN: 9780132622264
4	Fundamental of Electronic Devices and	Bell ,David	Oxford University Press, New Delhi, 2015, ISBN:9780195425239

S. No.	Title of Book	Author	Publication
	Circuits		
5	Electronic Devices and Circuits	Millman, Jacob Halkias, C. Christos Jit, Satyabrata	Mc Graw Hill Education, New Delhi 2015, ISBN:9789339219550
6	Modern Power Electronics	Sen, P.C.	S.Chand, New Delhi, 2015 ISBN:9788121924252

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. www.eng.uokufa.edu.iq/staff/alikassim/lectures/CH-4.pdf
b. www.electronics-tutorials.ws/amplifier/amp_1.html
c. www.colorado.edu/ physics/phys3330/PDF/Experiment7.pdf
d. www.alldatasheet.com/view.jsp?Searchword=Bc147
e. www.williamson-labs.com
f. www.futurlec.com
g. www.learnerstv.com/video/Free-video-Lecture-870-Engineering.htm
h. www.electronicspost.com/discuss-the-essentials-of-a-transistor-oscillator-explain-the-action-of-tuned-collector-oscillator-colpitts-oscillator-and-hartley-oscillator/
i. www.radio-electronics.com/info/power-management/switching-mode-power-supply/basics-tutorial.php
j. www.circuitstoday.com/ic-723-voltage-regulators
k. www.onsemi.com/pub_link/Collateral/LM317-D.PDF

Program Name : **Electronics Engineering, Digital Electronics and Instrumentation Engineering Program Group**

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

Semester : **Third**

Course Title : **Electric Circuits and Networks**

Course Code : **22330**

1. RATIONALE

In industry, to build and test electronic/electrical circuits in different situations knowledge of electric circuits and networks is very important. This course is intended to develop the skills to diagnose and rectify the electric network and circuit related problems in the industry. The concept and principles of circuit analysis lays the foundation to understand courses of higher level.

2. COMPETENCY

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

- **Diagonose the electrical and electronic circuits problems**.

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. Check the working of single phase a.c. circuits.
b. Check the resonance condition of electric/electronic circuits.
c. Check the functionality using the principles of circuit analysis.
d. Use network theorems to determine the various parameters in circuits.
e. Use two port networks to determine the circuit parameters.

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	2	7	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.

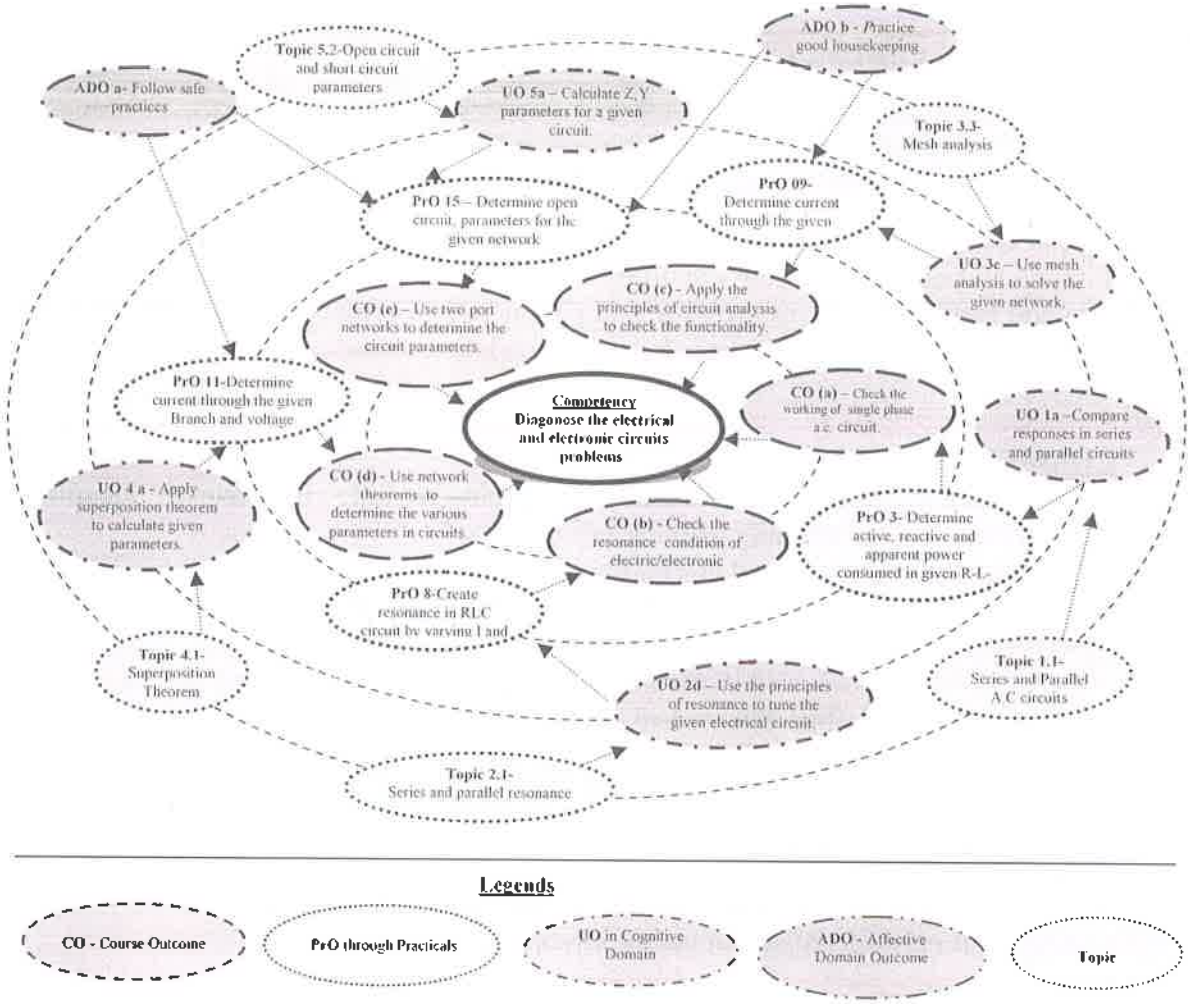

Figure 1 - Course Map

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	Determine active, reactive and apparent power consumed in given R-L series circuit and draw phasor diagram.	I	02*
2	Determine active, reactive and apparent power consumed in given R-C series circuit and draw phasor diagram.	I	02
3	Determine active, reactive and apparent power consumed in given R-L-C series circuit and draw phasor digram.	I	02*
4	a. Measure currents in R-C parallel A. C. circuit. b. Determine p.f., active, reactive and apparent power in R-C parallel a.c. circuit.	I	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
5	a. Measure currents in each branch of given R-L-C parallel a. c. circuit. b. Determine p.f., active, reactive and apparent power for given R-L-C Parallel circuit with series connection of resistor and inductor in parallel with capacitor.	I	02
6	Determine initial and final voltage across the capacitor at $t=0^-$ and $t=0^+$.	I	02
7	Determine initial and final current through the inductive coil at $t=0^-$ and $t=0^+$	I	02
8	Create resonance in given R-L-C circuit by varying L and C or by using variable frequency supply.	II	02*
9	Determine current through the given branch of a electric network by applying mesh analysis.	III	02
10	Determine voltage at the particular node and current through any given branch of the network by applying nodal analysis.	III	02*
11	Determine current through the given branch and voltage across the given element of circuit by applying superposition theorem .	IV	02*
12	Determine equivalent circuit parameter in a given circuit by applying Thevenin's and Norton's theorem .	IV	02
13	Determine load resistance for maximum power transfer for a given circuit by applying maximum power transfer theorem .	IV	02
14	Test the response of the given circuit by applying reciprocity theorem.	IV	02
15	Determine open circuit (Z) parameters for the given network.	V	02*
16	Determine short circuit (Y) parameters for the given network.	V	02
17	Determine transmission (ABCD) parameters for the given network.	V	02
	Total		**34**

Note

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

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

S. No.	Performance Indicators	Weightage in %
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	Ammeters MI Type: AC/DC, 0-1Amp,0-1.5 Amp,0-2.5Amp,0-5Amp.	1 to 17
2	Voltmeter MI Type: AC/DC, 0-150/300V, 0-250/500V,0-75/150V.	1 to 17
3	Ammeters PMMC Type: DC, 0-1.5/3Amp, 0-2.5/5 Amp, 0-5/10Amp.	1 to 17
4	Voltmeter PMMC Type: DC, 0-150/300V, 0-250/500V,0-75/150V.	1 to 17
5	Wattmeter: Single phase 2.5/5Amp, 200/400V, Single phase 5/10Amp, 250/500V	1 to 17
6	Low power factor wattmeter : Single phase, 5/10Amp, 250/500V.	1 to 5
7	Wattmeter: Dynamometer type, single phase, 5Amp, 250V.	1 to 5
8	Power factor meters: AC, 230V,45-50-55 Hz , single phase, 5-10 Amp, 250V.	1 to 5
9	Digital storage oscilloscope 50MHz.	6 ,7
10	Trainer kit for all theorems.	9 to 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 Single Phase A.C. Circuits	1a. Compare the A.C. responses in the given type of series and parallel circuits. 1b. Explain with sketches the phasor diagram of the given AC circuit. 1c. Calculate active, reactive, apparent	1.1 Series A.C. circuits: R-L, R-C and R-L-C circuits, impedance, reactance, phasor diagram, impedance triangle, power factor, active(real) power, apparent power , reactive power, power triangle

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	power and power factor for the specified circuit. 1d. Suggest the power factor improve technique for the given situation with justification. 1e. Calculate admittance,conductance and susceptance for the given circuit. 1f. Determine the equivalent impedance and admittance for the given circuit. 1g. Interpret the working of the given R,L, and C component using initial and final condition.	1.2 AC Series circuit by using complex algebra 1.3 Parallel AC circuits: Resistance in parallel with pure inductance and capacitance, series combination of resistance and inductance in parallel with capacitance 1.4 Concept of admittance, conductance and susceptance 1.5 Concept of initial and final conditions in switching circuits, Meaning of t = 0 -, t = 0+ and t = ∞. R, L and C at initial and final conditions
Unit-II Resonance in Series and Parallel Circuits	2a. Find the resonance condition for the specified series and parallel circuits. 2b. Calculate current, voltage and frequency for the given resonant circuit. 2c. Determine bandwidth and quality factor(Q) for the given series and parallel resonant circuit. 2d. Describe the procedure to tune the given electrical circuit using the principles of resonance.	2.1 Series and parallel resonance 2.2 Impedance and phase angle of a Series and parallel resonant circuits 2.3 Voltage and current in a series and parallel resonant circuit 2.4 Bandwidth of a RLC circuit(series and parallel resonance) 2.5 Quality factor (Q) and its effect on bandwidth (series and parallel resonance) 2.6 Magnification in series and parallel resonance circuits
Unit– III Principles of Circuit Analysis	3a. Use source transformation techniques for the given circuit. 3b. Convert the given star connection to delta connection and vice versa. 3c. Use mesh analysis to solve the given network. 3d. Solve the given network using nodal analysis. 3e. Diagnose the fault in the given circuit using the relevant technique(s).	3.1 Source transformation 3.2 Star/delta and delta/star transformations 3.3 Mesh analysis 3.4 Node analysis
Unit– IV Network Theorems	4a. Use superposition theorem to calculate the given parameters in the given circuit. 4b. Apply Thevenin's theorem to calculate the given parameters in the given circuit. 4c. Use Norton's theorem to calculate the given parameters in the given circuit.	4.1 Superposition theorem for both AC voltage and DC source 4.2 Thevenin's theorem 4.3 Norton's theorem 4.4 Maximum power transfer theorem 4.5 Reciprocity theorem 4.6 Superposition theorem

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	4d. Calculate load impedance using maximum power transfer theorem for the given circuit. 4e. Use reciprocity theorem to analyse the given circuit.	
Unit –V Two Port Networks	5a. Calculate Z, Y, parameters for the given circuit. 5b. Find the ABCD parameters for the given circuit. 5c. Sketch the phasor diagram for the given T and π circuit with justification. 5d. Calculate Z and Y parameters to test whether the given circuit is reciprocal or symmetrical two port network .	5.1 Significance of two port network 5.2 Open circuit(Z) and short circuit(Y) Parameters 5.3 Transmission (ABCD) parameter 5.4 T and π representation of circuits 5.5 Reciprocal and symmetrical two port network(no derivation)

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	Single Phase A.C. Circuits	10	04	04	06	14
II	Resonance in Series and Parallel Circuits	10	02	06	06	14
III	Principles of Circuit Analysis	10	04	04	06	14
IV	Network Theorems	12	04	06	08	18
V	Two port networks	06	02	04	04	10
Total		**48**	**16**	**24**	**30**	**70**

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

10. SUGGESTED STUDENT ACTIVITIES

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

a. Prepare journals based on practical performed in laboratory.
b. Follow the safety precautions.
c. Use various meters to test electric/electronic equipment and component.
d. Library /Internet survey of electrical circuits and network.

e. Prepare power point presentation or animation for understanding different circuits behaviour.

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. Use Flash/Animations to explain various theorems in circuit analysis
f. Guide student(s) in undertaking micro-projects

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably be ***individually*** undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should ***not exceed three.***
The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than ***16 (sixteen) student engagement hours*** during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs. Micro project report may be of four to five pages.

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

a. **Single Phase A.C. series and parallel Circuits:** Prepare series and parallel circuit using variable R, L and C combination on the bread board. Measure the response and draw vector diagram. Also calculate power factor for the circuit. Write report on the same.
b. **Resonance in series and Parallel Circuits:** Prepare series RLC circuit using variable R, L and C combination on the bread board. Tune the circuit for resonance condition. Measure the responses and calculate band width and Q-factor for the circuit. Write report on the same.
c. **Resonance in Series and parallel Circuits:** Prepare parallel RLC circuit using variable R, L and C combination on the bread board. Tune the circuit for resonance condition. Measure the response and calculate band width and Q-factor for the circuit. Write report on the same.

d. **Principles of circuit analysis:** Prepare power point presentation on source transformation, star delta transformation, mesh and nodal analysis and give presentation in the class room.
e. **Network Theorems:** Select suitable components for the given circuit and prepare the same on the bread board. Verify the following network theorem theoretically and practically.
   i. Superposition Theorem
   ii. Maximum power transfer theorem
   iii. Thevenin's theorem
   iv. Norton's theorem.
f. **Two Port Networks:** Design and prepare two port network on bread board for given values of open circuit Z parameter.
g. **Two Port Networks:** Design and prepare two port network on bread board for given values of short circuit Y parameter.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Basic Electrical Engineering	Mittle, V.N. ; Mittle, Arvind	McGraw Hill Education, Noida, 2005, ISBN: 9780070593572
2	A Text Book of Electrical Technology Vol-I	Theraja, B. L. ; Theraja, A. K.	S. Chand and Co., New Delhi, 2006 ISBN: 978-81-219-2440-5
3	Fundamentals of Electrical Engineering	Saxena, S.B.; Dasgupta, K.	Cambridge university press pvt. Ltd., New Delhi, 2016, ISBN : 9781107464353
4	Circuit and network	Sudhakar, A. ; Palli Shyammohan, S.	McGraw Hill, New Delhi, 2006 ISBN : 978-0-07-340458-5
5	Electric Circuits	Bell, David A.	Oxford University Press New Delhi, 2009 ISBN: 9780195425246
6	Electric Circuit Analysis	Paranjothi, S.R.	New Age Publisher, New Delhi, 2011, ISBN: 978-81-224-3154-4
7	Fundamentals of Electrical Networks	Gupta, B.R ; Singhal, Vandana	S.Chand and Co., New Delhi, 2005 ISBN: 978-81-219-2318-7
8	Schaum's Outline of Electric Circuits	Edminister,Joseph A. Nahvi,Mahmood	McGraw Hill, New Delhi, 2013 ISBN: 9780070189997
9	Introductory circuit Analysis.	Boylested, R.L.	Wheeler, New Delhi , 2013 ISBN: 978-0023131615

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. www.cesim.com/simulations
b. www.scilab.org/scilab
c. www.ni.com/multisim
d. www.youtube.com /electric circuits
e. www.dreamtechpress.com /ebooks
f. www.nptelvideos.in/electrical engineering/ circuit theory
g. www.learnerstv.com/free-engineering
h. electronicsforu.com/category/electronics-for-tech

Program Name : **Digital Electronics, Medical Electronics and Instrumentation Engineering Program Group**

Program Code : **DE/IE/IS/IC/MU**

Semester : **Third**

Course Title : **Electronic Instruments and Measurement**

Course Code : **22331**

1. RATIONALE

Diploma pass outs (also called as technologists) should be able to measure various electrical and electronic parameters in industry using relevant instruments. This course is designed to provide the basic understanding about the concepts, principles and procedures of analog and digital electronic measuring instruments. Students will be able to use the various electronic measuring instruments for fault finding in the industry.

2. COMPETENCY

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

- **Use basic electrical and electronic instruments for measuring various parameters.**

3. COURSE OUTCOMES (COs)

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

a. Use relevant type of measuring instruments for different applications.
b. Use analog meters to measure electrical parameters.
c. Use digital meters to measure electrical parameters.
d. Use CRO and signal generator to measure electrical parameters.
e. Use AC and DC bridges to measure electrical parameters.

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.

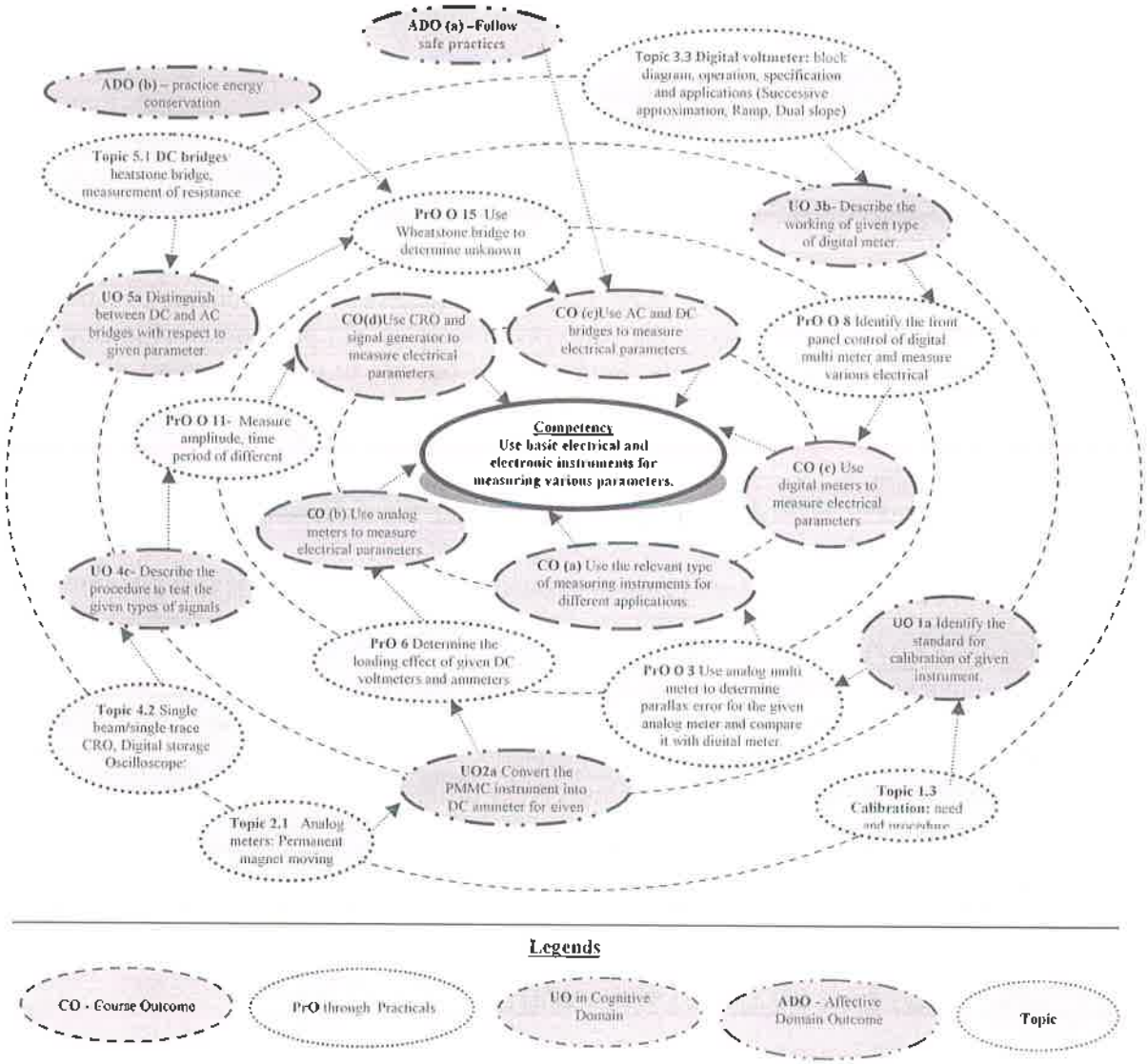

Figure 1 - Course Map

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 analog multi meter to determine accuracy, resolution and hysteresis.	I	02*
2	Calibrate the analog multi meter by comparing with given standard instrument.	I	02
3	Use analog multi meter to determine parallax error for the given analog meter and compare it with digital meter	I	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
4	Convert basic PMMC movement of 1mA into DC voltmeter for measuring 5V, 10V, 15V.	II	02
5	Convert basic PMMC movement of 1mA into DC ammeter for measuring 10mA, 50mA, 100mA	II	02*
6	Determine the loading effect of given DC voltmeters and ammeters	II	02
7	Use LCR meter to calculate the value of resistance, Inductance, capacitance and compare those with component codes.	III	02
8	Identify the front panel control of digital multi meter and measure various electrical parameters using DMM	III	02*
9	Use analog multi meter to determine accuracy, resolution and hysteresis loop of given digital meter.	III	02
10	Identify the front panel control of logic Analyzer and Test the given digital circuit	III	02
11	Measure amplitude, time period of different signals generated by function generator using CRO.	IV	02*
12	Measure unknown frequency and phase difference with respect to given signal using Lissajous pattern	IV	02
13	Identify the front panel control of DSO and measure various parameters of applied signal	IV	02
14	Identify the front panel control of Spectrum Analyzer and determine frequency content of given signal.	IV	02
15	Use Wheatstone bridge to determine unknown resistance	V	02*
16	Use Maxwell Bridge to determine unknown inductance.	V	02
17	Use Schering Bridge to determine unknown capacitance.	V	02
18	Measure intensity of bulb available in the laboratory using Lux meter.	III	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 setup	20
2.	Setting and operation	20
3.	Safety measures	10
4.	Observation and recording	10
5.	Interpretation of result and conclusion	20
6.	Answer to sample questions	10
7.	Submission of report in time	10
	Total	**100**

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

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

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

- 'Valuing Level' in 1st year
- 'Organising Level' in 2nd year
- 'Characterising Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specification mentioned here will use 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	Analog multi meter 1mA, 500 ohms.	1,2,3
2	Digital Multi meter 4 ½ digit display	2,3,8,9
3	Voltmeter 0-10V,0-50V,0-100V,0-300V	3,4,6
4	Ammeter 0-100mA, 0-50μA,0-1mA	3,5
5	LCR meter 20Hz – 2MHz	5
6	Cathode ray Oscilloscope single beam dual trace 0-30 MHz	11,12
7	Function generator 0-2MHz, 0-3MHz	11,12, 14,16, 17
8	Digital Storage Oscilloscope 60 MHz bandwidth	13
9	Logic Analyzer: 32 channel	10
10	Spectrum Analyzer: Heterodyne type 3GHz	14
11	Lux Meter range 400.0/4000 lux sensor diameter 2 to 2 inch, Accuracy 5%, memory 16000 reading, resolution 100 lux, foot candle resolution 0.1 fc. Display type- numeric	18

8. UNDERPINNING THEORY COMPONENTS

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

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Fundamentals of measure	1a. Identify the standard for calibration of the given instrument with justification. 1b. Classify the given measuring instruments.	1.1 Measurement: Concept , units of measurement of fundamental quantities, standard and their classification, Static and

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
ments	1c. Determine static and dynamic characteristics of the measuring instruments with the given data. 1d. Explain with sketches the generalized procedure for calibration of the given device.	dynamic characteristics, types of errors 1.2 Classification of instruments: (i) absolute and secondary instruments, (ii) analog and digital instruments, (iii) mechanical, electrical and electronic instruments 1.3 Calibration: need and procedure
Unit– II Analog meters	2a. Explain with sketches the construction and working principle of the given permanent magnet moving coil (PMMC) instrument with sketches. 2b. Describe with sketches the procedure to convert the PMMC instrument into DC ammeter for the given range. 2c. Describe with sketches the procedure to convert the PMMC instrument into DC voltmeter for the given range. 2d. Explain with sketches the working of given type of ohm meter. 2e. Explain with sketches the working of given type of AC voltmeter. 2f. Prepare specification for given analog meters.	2.1 Permanent magnet moving coil (PMMC) and Permanent magnet moving iron (PMMI) meter their construction, principle, working, salient features 2.2 DC Ammeter: Basic, Multi range, Universal shunt/Ayrton, simple numerical based on R_{sh} 2.3 DC Voltmeter: Basic, Multi range, simple numerical based on R_s, concept of loading effect and sensitivity 2.4 Ohm meter: Series and shunt 2.5 AC voltmeter: Rectifier type (half wave and full wave)
Unit– III Digital Meters	3a. Determine resolution, sensitivity and accuracy of the given digital display. 3b. Explain with sketches the working of given type of digital meter. 3c. Explain with sketches the construction and working of the given types of digital meters. 3d. Describe with sketches the procedure to measure the given electric parameter using the relevant type of digital meter. 3e. Describe with sketches the procedure to test the given digital circuits using logic analyser. 3f. Prepare specification for given digital instrument.	3.1 Resolution, sensitivity and accuracy of digital Instruments. 3.2 Digital frequency meter, Digital multi meter, LCR-Meter, Lux Meter, Logic Analyser: block diagram, operation, specification and applications 3.3 Digital voltmeter: block diagram, operation, specification and applications (Successive approximation, Ramp, Dual slope)
Unit-IV CRO and signal generato	4a. Describe the given blocks and working of given type of oscilloscope with sketches. 4b. Describe with sketches the procedure to measure the given parameter using the	4.1 Single beam/single trace CRO, Digital storage Oscilloscope: Basic block diagram, working, Cathode ray tube, electrostatic deflection, vertical amplifier.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
rs	CRO. 4c. Describe with sketches the working of given type of type of signal/function generator with sketches. 4d. Describe with sketches the procedure to test the given type of signal using the relevant type of function generator/signal generator/CRO. 4e. Select CRO/ DSO, Spectrum analyzer and function generator for the given application. 4f. Prepare specification for given instrument.	time base generator, horizontal amplifier, attenuator, delay line and specifications. 4.2 CRO Measurements: voltage, time period, frequency, phase angle, Lissajous pattern. 4.3 Signal generator: need, working and Basic block diagram 4.4 Function generator: need, working and basic block diagram and specifications. 4.5 Spectrum analyzer: Basic block diagram, operation , specification and applications.
Unit –V DC and AC bridges	5a. Explain with sketches the the working of the given type of bridge with sketches. 5b. Describe with sketches the procedure to measure given unknown resistance using the relevant type of bridge with sketches 5c. Describe with sketches the procedure to measure given unknown capacitance using relevant type of bridge with sketches. 5d. Describe with sketches the procedure to measure given unknown inductance value using relevant type of bridge with sketches.	5.1 DC bridges: Wheatstone bridge, measurement of resistance 5.2 AC bridges: Use of Schering bridge, Maxwell bridge, Hays bridge

***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 measurements	08	02	02	04	08
II	Analog meters	16	04	06	08	18
III	Digital meters	14	02	06	10	18
IV	CRO and Signal generator	18	02	06	10	18
V	DC and AC bridges	08	02	02	04	08
Total		**64**	**12**	**22**	**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. Compile broad specification of DSO, LCR meter, logic analyzer, Spectrum analyser using data sheets and handbook.
b. Develop a report after performing market survey of electronic instruments used in the laboratory.
c. Prepare a chart of static and dynamic characteristics of the instrument/equipment available in the laboratory.
d. Prepare chart to display types of Units.
e. Prepare chart to display front panel control of DSO, LCR meter, Logic analyser and Spectrum analyser
f. Visit nearby institutes, exhibition and industries to collect information about electronic instruments.
g. Assist to the technicians who are doing repair or maintenance work of electronic instruments.
h. Prepare instruction chart for safe handling of electronic instruments

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

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

a. Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b. ***'L' in item No. 4*** does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
c. About ***15-20% of the topics/sub-topics*** which is relatively simpler or descriptive in nature is to be given to the students for ***self-directed learning*** and assess the development of the COs through classroom presentations (see implementation guideline for details).
d. With respect to item No.10, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
e. Guide student(s) in undertaking micro-projects.
f. Video programs/YouTube may be used to teach various topics and sub topics.
g. Demonstrate set-up arrangement to the students thoroughly before they start doing the practical.
h. Encourage students to refer different book and websites to have deeper understanding of the subject.
i. Observe continuously and monitor the performance of students in Lab.
j. Encourage students to use front/rear panel control of electronic instruments.
k. Encourage students to visit nearby electronic instruments repair workshop units or manufacturing industries.

l. Instruct students to safety concern of handling electronic instruments and also to avoid any damage to the electronic instruments.

12. SUGGESTED MICRO-PROJECTS

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

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

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

a. Prepare a report on market survey of Dual beam CRO, Dual trace CRO, Sampling Oscilloscope, DSO, function generator, logic analyzer and LCR meter.(technical specification and manufacturers).
b. Build and test given power supply using CRO and DMM.
c. Build, test and commission Wheatstone bridge using LDR / thermistor / RTD / potentiometer.
d. Find the fault in the given laboratory electronic measuring instrument.
e. Build, test and commission Schering Bridge using LDR / thermistor / RTD / potentiometer.
f. Build the circuit of LED bulb using white LED arrays and measure its intensity using lux meter.
g. Take two similar circuit board. One is faulty another is in working condition. Test both circuit boards using component test function on CRO/DSO and find out the faulty component in faulty circuit.
h. Take laminated copper wire and construct inductor and measure inductance using LCR meter. Now change the number of turns and test different inductors.
i. Take copper clad and form capacitor by etching copper clad and measure the capacitance using LCR meter.
j. Construct voltage Doubler /trippler circuit and measure voltage at every capacitor using CRO.
k. Build and test function generator using IC (eg.ICL8038, MAX038, XR2206 etc.).

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Electronic Instrumentation	Kalsi, H.S.	Mc Graw Hill Education, New Delhi, 2010 ISBN:9780070702066
2	Electronic Measurement and instrumentation	Sedha, R.S.	S Chand and Company, New Delhi , 2013 ISBN: 9788121997751
3	Electronic instruments and	Anand, M.M.S.	PHI Learning., New Delhi,2004

S. No.	Title of Book	Author	Publication
	instrumentation Technology		ISBN: 9788120324541
4	A course in electrical and electronic measurement and instrumentation	Sawhney, A.K.	Dhanpat Rai and Company, New Delhi, 2005 ISBN-13: 978-8177000160
5	Electronic Measurement and instrumentation	Rajput, R.K.	S Chand and Company, New Delhi , 2008 ISBN: 9788121929172
6	Electronic instrumentation and Measurement	Khurana, Rohit.	Vikas Publications House. New Delhi, ISBN: 9789325990203
7	Electronic instrumentation and Measurement	Bell, David A.	Oxford University Press, New Delhi, 2013; ISBN: 9780195696141
8	Elements of electronic instrumentation and measurements	Carr, Joseph J.	Pearson Education ,New Delhi, 2003 ISBN: 9788131712115

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. www.nptel.iitg.ernet.in/courses/Elec.engg/IIT%20Bombay/electrical/%20and
b. www.electrical4u.com/permanent-magnet-moving-coil-instrument/
c. www.electrical4u.com/digital-frequency-meter/
d. www.electrical4u.com/digital-multimeter/
e. www.electrical4u.com/wheatstone-bridge-circuit-theory-and-principle/
f. www.electrical4u.com/maxwell-bridge-inductance-capacitance-bridge/
g. www.electrical4u.com/hays-bridge-circuit-theory-phasor-diagram-advantages-applications/
h. www.electrical4u.com/schering-bridge-measurement-of-capacitance-using-schering-bridge/
i. www.electrical4u.com/cathode-ray-oscilloscope-cro/
j. www.nprcet.org/eee/document/MI.pdf
k. web.mst.edu/~cottrell/ME240/Resources/basic_inst/Basic_Instrumentation.pdf

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 : Third — **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	Digital Techniques	DTE	22320	4	-	2	6	3	70	28	30*	00	100	40	25#	10	25	10	50	20	150
2	Applied Electronics	AEL	22329	4	-	4	8	3	70	28	30*	00	100	40	50#	20	50	20	100	40	200
3	Electronics Instruments and Measurements	EIM	22331	4	-	2	6	3	70	28	30*	00	100	40	25@	10	25	10	50	20	150
4	Industrial Measurements	IME	22335	3	-	2	5	3	70	28	30*	00	100	40	25@	10	25	10	50	20	150
5	Instrumentation Data Communication	IDC	22336	4	-	2	6	3	70	28	30*	00	100	40	25@	10	25	10	50	20	150
6	Programming in 'C'	PIC	22026	2	-	2	4	3	--	--	--	--	--	--	25@	10	25~	10	50	20	550
			Total	**21**	**-**	**14**	**35**	--	**280**	--	**120**	--	**400**	--	**210**	**--**	**190**	--	**400**	--	**850**

Student Contact Hours Per Week: **35 Hrs.** Medium of Instruction: **English**

Theory and practical periods of 60 minutes each. Total Marks : **850**

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 (5 marks each for Physics and Chemistry) to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the cognitive domain LOs required for the attainment of the COs.

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

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

Program Name : **Computer and Electronics Engineering Program Group**

Program Code : **CO/CM/CW/DE/EJ/ET/EN/EX/EQ/IE/IS/IC/MU**

Semester : **Third**

Course Title : **Digital Techniques**

Course Code : **22320**

1. RATIONALE

In the present scenario most of the electronic equipment like computers, mobiles, music systems, ATM, automation and control circuits and systems are based on digital circuits which the diploma electronic engineering passouts (also called technologists) have to test them. The knowledge of basic logic gates, combinational and sequential logic circuits using discrete gates as well as digital ICs will enable the students to interpret the working of equipment and maintain them. After completion of the course, students will be able to develop digital circuits based 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:

- **Build/ test digital logic circuits consist of digital ICs.**

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 number system and codes for interpreting working of digital system.
b. Use Boolean expressions to realize logic circuits.
c. Build simple combinational circuits.
d. Build simple sequential circuits.
e. Test data converters and PLDs in digital electronics systems.

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.

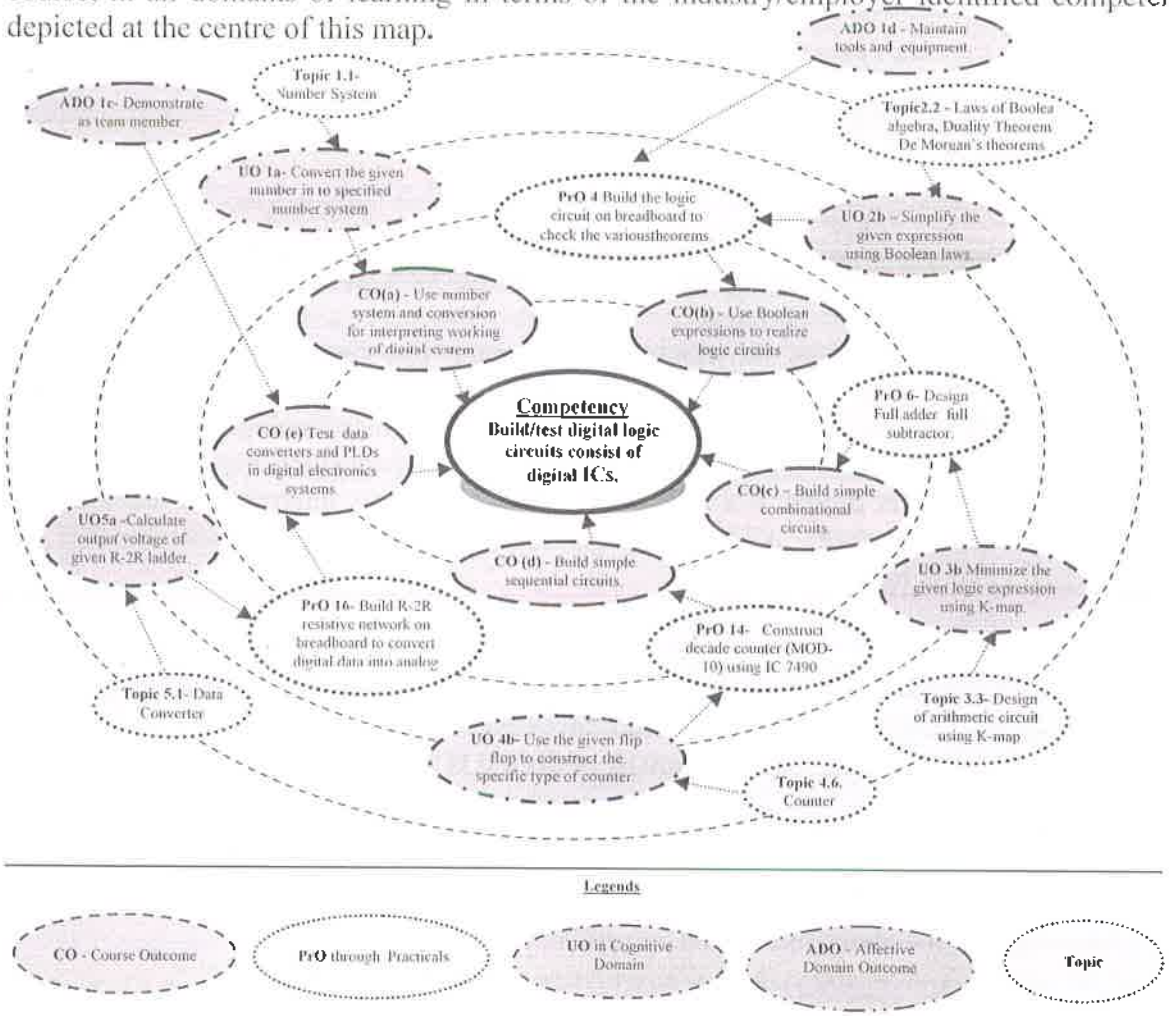

Figure 1 - Course Map

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	Test the functionality of specified logic gates using breadboard. (IC 7404, 7408, 7432, 7486)	II	02*
2	Test the functionality of NAND and NOR gate of using breadboard (IC 7400 and 7402)	II	02
3	Construct AND, OR, NOT gates using universal gates.	II	02
4	Build the logic circuit on breadboard to check the De Morgan's theorems.	II	02
5	Design Half adder and Half subtractor using Boolean expressions.	III	02*
6	Design Full adder and full subtractor.	III	02
7	Construct and test BCD to 7 segment decoder using IC 7447/ 7448.	III	02
8	Build / test function of MUX 74[illegible]/74150/any other equivalant.	III	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
9	Build / test function of DEMUX 74155/74154/any other equivalant.	III	02
10	Build / test function of RS flip flop using NAND Gate.	IV	02*
11	Build / test function of MS JK flip flop using 7476.	IV	02
12	Use IC 7476 to construct and test the functionality of D and T flip flop.	IV	02
13	Implement 4 bit ripple counter using 7476.	IV	02
14	Use IC 7490 to construct decade counter (MOD-10).	IV	02
15	Implement 4 bit universal shift register.	IV	02
16	Build R-2R resistive network on breadboard to convert given digital data into analog.	V	02*
		Total	**32**

Note

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

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

S. No.	Performance Indicators	Weightage in %
a.	Preparation of experimental 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

- '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: S. No.
1	Digital Multimeter: 3 and ½ digit with R, V, I measurements, diode and BJT testing.	All
2	CRO : Dual Channel, 4 Trace CRT / TFT based Bandwidth 20 MHz/30 MHz X10 magnification 20 ns max sweep rate, Alternate triggering Component tester and with optional features such as Digital Read out.	16
3	Pulse Generator: TTL pulse generator	10-15
4	DIGITAL IC tester: Tests a wide range of Analog and Digital IC's such as 74 Series, 40/45 Series of CMOS IC's.	1-15
5	Bread Board Development System: Bread Board system with DC power output 5V, +/-12V and 0-5V variable , digital voltmeter , ammeter, LED indicators 8 no, logic input switches 8 no, 7 segment display 2 no, clock generator, Manual pulser, Breadboard with about 1,600 points, Potentiometer, relay etc	1-15
6	Trainer kits for digital ICs: Trainer kit shall consists of digital ICs for logic gates, flop-flop, shift registers, counter along with toggle switches for inputs and bi-colour LED at outputs, built in power supply.	1-15
7	Regulated power supply: Floating DC Supply Voltages Dual DC : 2 x 0 -30V; 0-2 A Automatic Overload (Current Protection) Constant Voltage and Constant Current Operation Digital Display for Voltage and Current Adjustable Current Limiter Excellent Line and Load Regulation	1-16
8	Trainer kit for 4 bit Counter using Flip Flops: 4 bit ripple counter, Synchronous Counter, IC 7476 based circuit. Input given by switches and output indicated on LED. Facility to select MOD 8 or MOD 16 mode. Built in DC power supply and manual pulser with indicator.	13

8. UNDERPINNING THEORY COMPONENTS

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

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Number System and Codes	1a. Convert the given number into the specified number system. 1b. Perform the binary arithmetic operation on the given binary numbers. 1c. Convert the given coded number into the other specified code.	1.1 Number System: base or radix of number system, binary, octal, decimal and hexadecimal number system. 1.2 Binary Arithmetic: Addition, subtraction, multiplication, division. 1.3 Subtraction using 1's complement and 2's complement. Codes: BCD, Gray Code, Excess-3, and ASCII code.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	1d. Add the given two decimal numbers using BCD code.	1.5 BCD Arithmetic: BCD Addition
Unit – II Logic gates and logic families	2a. Develop the basic gates using the given NAND/NOR gate as universal gate. 2b. Simplify the given expression using Boolean laws. 2c. Develop logic circuits using the given Boolean expressions. 2d. Compare the salient characteristics of the given digital logic families.	2.1 **Logic gates**: Symbol, diode/ transistor switch circuit and logical expression , truth table of basic logic gates (AND, OR, NOT), Universal gates (NAND and NOR) and Special purpose gates (EX-OR, EX-NOR),Tristate logic 2.2 **Boolean algebra**: Laws of Boolean algebra, Duality Theorem, De-Morgan's theorems 2.3 **Logic Families**:Characteristics of logic families : Noise margin, Power dissipation, Figure of merit , Fan-in and fan-out, Speed of operation, Comparison of TTL, CMOS, types of TTL NAND gate
Unit– III Combinational Logic Circuits	3a. Develop logic circuits in standard SOP/ POS form for the given logical expression. 3b. Minimize the given logic expression using K-map. 3c. Use IC 7483 to design the given adder/ subtractor. 3d. Draw MUX/DEMUX tree for the given number of input and output lines. 3e. Write the specifications of the component for the given application. 3f. Develop the specified type of code converter.	3.1 **Standard Boolean representation:** Sum of Product (SOP) and Product of Sum(POS), Min-term and Max-term, conversion between SOP and POS forms, realization using NAND /NOR gates 3.2 **K-map reduction technique for the Boolean expression:** Minimization of Boolean functions up to 4 variables (SOP and POS form) 3.3 **Design of arithmetic circuits and code converter using K-map:** Half and full Adder, half and full Subtractor , gray to binary and binary to gray (up to 4 bits) 3.4 **Arithmetic circuits:** (IC 7483) Adder and Subtractor, BCD adder 3.5 **Encoder/Decoder:** Basics of encoder, decoder, comparison, (IC 7447) BCD to 7 segment decoder/driver 3.6 **Multiplexer and Demultiplexer:** working , truth table and applications of Multiplexers and Demultiplexures, MUX tree, IC 74151as MUX; DEMUX tree, DEMUX as decoder, IC 74155 as DEMUX 3.7 **Buffer:** Tristate logic, unidirectional and bidirectional buffer (IC74LS244,74LS245)

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit– IV Sequential Logic Circuit	4a. Use relevant triggering technique for the given digital circuit. 4b. Use the given flip-flop to construct the specific type of counter. 4c. Use excitation table of the given flip-flop to design synchronous counter. 4d. Design the specified modulo-N counter using IC7490. 4e. Construct ring/ twisted ring counter using the given flip-flop.	4.1 **Basic memory cell**: RS-latch using NAND and NOR 4.2 **Triggering Methods:** Edge trigger and level trigger 4.3 **SR Flip Flops**: SR-flip flop, clocked SR flip flop with preset and clear, drawbacks of SR flip flop 4.4 **JK Flip Flops**: Clocked JK Flip flop with preset and clear, race around condition in JK flip flop, Master slave JK flip flop, D and T type flip flop Excitation table of flip flops, Block schematic and function table of IC-7474, 7475 4.5 **Shift Register**: Logic diagram of 4-bit Shift registers – Serial Input Serial Output, Serial Input Parallel Output, Parallel Input Serial Output. Parallel Input Parallel Output, 4 Bit Universal Shift register 4.6 **Counters:** Asynchronous counter: 4 bit Ripple counter, 4 bit up/down Counter, modulus of counter Synchronous counter: Design of 4 bit synchronous up/down counter Decade counter: Block schematic of IC 7490 Decade counter, IC 7490 as MOD-N Counter, Ring counter, Twisted ring counter
Unit– V Data Converters and PLDs	5a. Calculate the output voltage of the R-2R ladder for the given specified digital input. 5b. Calculate the output voltage of the weighted resistor DAC for the given specified digital input. 5c. Explain with sketches the working principle of the given type of ADC. 5d. Explain with sketches the working principle of the given types of memories. 5e. Explain with basic block diagram the working principle of the given type of programmable logic device.	5.1 **Data Converter**: DAC: Types, weighted resistor circuit and R-2R ladder circuit, DAC IC 0808 specifications ADC: Block Diagram, types, and working of Dual slope ADC, SAR ADC, ADC IC 0808/0809, specification 5.2 **Memory**: RAM and ROM basic building blocks, read and write operation ,types of semiconductor memories 5.3 **PLD:** Basic building blocks and types of PLDs, PLA, PAL, GAL 5.4 CPLD: Basic Building blocks, functionality.

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	Number System	06	2	2	4	08
II	Logic gates and logic families	10	4	4	4	12
III	Combinational Logic Circuits	16	4	6	8	18
IV	Sequential Logic Circuit	16	4	6	8	18
V	Data Converters and PLDs	16	4	4	6	14
Total		**64**	**18**	**22**	**30**	**70**

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

10. SUGGESTED STUDENT ACTIVITIES

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

a. Prepare the survey report on the applications of different types of number system and code converters used in the design of digital system.
b. Compare technical specifications and applications of various types of memory, PLDs, CPLDs and Prepare report.
c. Test digital IC's using various testing equipment like digital IC tester, Digital multi-meter etc.
d. Give seminar on any course relevant topic.
e. Conduct library / internet survey regarding different data sheet and manuals.
f. Prepare power point presentation on digital circuits and their applications.
g. Undertake a market survey of different digital IC's required for different applications.
h. Search for video / animations / power point presentation on internet for complex topic related to the course and make a presentation.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

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

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

e. Guide student(s) in undertaking micro-projects.
f. PPTs/Animations may be used to explain the construction and working of electronic circuits.
g. Guide students for using data sheets / manuals.

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

a. Build a Digital IC tester circuit.
b. Build a 4bit parity generator and parity checker circuit.
c. Build a circuit to implement 4 bit adder.
d. Build a circuit to test 7 segment display.
e. Build a circuit to implement debounce switch.
f. Build a circuit for LED flasher.
g. Build a circuit for LED BAR display
h. Design and analyze digital arithmetic circuit

Note: *Use general purpose PCB for making micro projects*

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Modern Digital Electronics	Jain, R.P.	McGraw-Hill Publishing, New Delhi, 2009 ISBN: 9780070669116
2	Digital Circuits and Design	Salivahanan S.; Arivazhagan S.	Vikas Publishing House, New Delhi, 2013, ISBN: 9789325960411
3	Digital Electronics	Puri, V.K.	McGraw Hill , New Delhi, 2016, ISBN: 97800746331751
4	Digital Principles	Malvino, A.P.; Leach, D.P.; Saha G.	McGraw Hill Education, New Delhi, 2014, ISBN : 9789339203405
5	Digital Design	Mano, Morris; Ciletti, Michael D.	Pearson Education India, Delhi, 2007, ISBN: 9780131989245
6	Digital Electronics, Principles and Integrated Circuits	Maini, Anil K.	Wiley India, Delhi, 2007, ISBN: 9780470032145

S. No.	Title of Book	Author	Publication
7	Digital Fundamentals	Floyd, Thomas	Pearson Education India, Delhi, 2014, ISBN : 9780132737968

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. www.cse.yorku.ca/~mack/1011/01.NumberSystems.ppt
b. www.people.sju.edu/~ggrevera/arch/slides/binary-arithmetic.ppt
c. www.mathsisfun.com/binary-number-system.html
d. www.codesandtutorials.com/hardware/electronics/digital_codes-types.php
e. www.ee.surrey.ac.uk/Projects/Labview/gatesfunc/
f. www.ee.surrey.ac.uk/Projects/Labview/boolalgebra/
g. www.eng.auburn.edu/~strouce/class/elec2200/elec2200-8.pdf
h. www.maxwell.ict.griffith.edu.au/yg/teaching/dns/dns_module3_p3.pdf
i. www.scs.ryerson.ca/~aabhari/cps213Chapter5.ppt
j. www.eng.wayne.edu/~singhweb/seql.ppt
k. www.cs.sjsu.edu/faculty/lee/Ch2Problems2.ppt
l. www.rogtronics.net/files/datasheets/dac/SedraSmith.pdf
m. www-old.me.gatech.edu/mechatronics_course/ADC_F04.ppt
n. www.allaboutcircuits.com/vol_4/chpt_13/3.html
o. www.youtube.com/watch?v=5Wz5f3n5sjs
p. www.eee.metu.edu.tr/~cb/e447/Chapter%209%20-%20v2.0.pdf
q. www2.cs.siu.edu/~hexmoor/classes/CS315-S09/Chapter9-ROM.ppt
r. www.cms.gcg11.org/attachments/article/95/Memory2.ppt
s. www.cosc.brocku.ca/Offerings/3P92/seminars/Flash.ppt
t. www.webopedia.com/TERM/R/RAM.html
u. www.cs.sjsu.edu/~lee/cs147/Rahman.ppt

Program Name : **Electronics Engineering, Digital Electronics and Instrumentation Engineering Program Group**

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

Semester : **Third**

Course Title : **Applied Electronics**

Course Code : **22329**

1. RATIONALE

Enhanced use of electronic gadgets has made electronics engineers to deal with the various types of electronic circuits which generate the required analog/digital output. Transistor has remarkably expanded the utility of electronic equipment. Discrete components are widely used in amplifiers and other electronic systems which the engineering diploma holders (also called as technologist) have to use or maintain. The learning of basic operating principles of electronic circuits will help the students to use the basic electronic equipment. This course is developed in such a way that, students will be able to apply the knowledge of basic electronic circuit working to solve broad based electronic engineering application problems.

2. COMPETENCY

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

- **Use discrete electronic devices and voltage regulators.**

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 transistor as low Power amplifier.
b. Use BJT as high Power amplifier.
c. Use BJT as feedback amplifier.
d. Use BJT as waveform generator.
e. Maintain IC voltage regulator and SMPS.

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	-	4	8	3	70	28	30*	00	100	40	50#	20	50	20	100	40

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

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

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

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

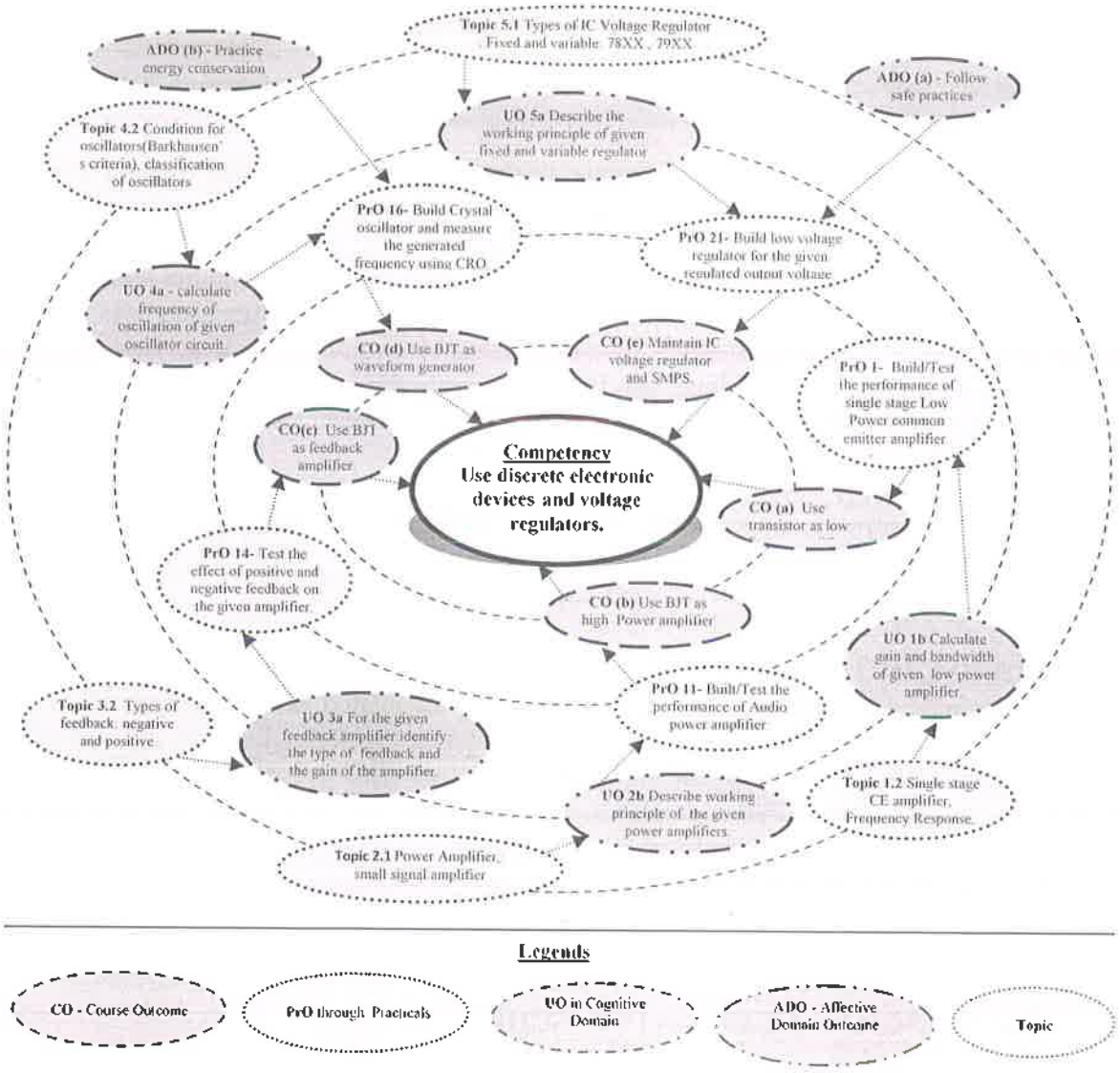

Figure 1 - Course Map

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.

**** Use bread board for the following Practials (wherever applicable).***

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Build/test the performance of single stage Low Power common emitter amplifier.	I	2*
2	Simulate / test out put Wave form of single stage common	I	2

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	emitter (CE) amplifier using simulation software(like spice, multisim).		
3	Simulate/test the output Wave form of single Stage common source FET amplifier using simulation software	I	2
4	Build/test the performance of single stage Common source FET amplifier.	I	2
5	Build/test the performance of two stage RC Coupled common emitter amplifier using transistor.	I	2*
6	Build/test the performance of two stage direct Coupled amplifier using transistor.	I	2
7	Build/Test the performance of transformer Coupled amplifier.(Part-I)	I	2*
8	Build/Test the performance of transformer Coupled amplifier.(Part-II)	I	2*
9	Build/test the performance of single tuned amplifier using transistor.	I	2
10	Build/test performance of double tuned common Emitter amplifier. (Part-I)	I	2
11	Build/test performance of double tuned common Emitter amplifier. (Part-II)	I	2
12	Build/test performance parameters of single stage class A power amplifier.	II	2
13	Build/test performance parameters of class B Push pull amplifier using transistor.	II	2
14	Build/test the performance of Audio power amplifier.	II	2*
15	Use transistor to build/ test voltage series Feedback amplifier parameters with and without feedback.	III	2
16	Use transistor to built/ test voltage shunt Feedback amplifier parameters with and without feedback.	III	2
17	Test the effect of positive and negative feedback on the given amplifier.(Part-I)	III	2*
18	Test the effect of positive and negative feedback on the given amplifier.(Part-II)	III	2*
19	Build RC phase shift oscillator and measure the generated frequency using CRO.	IV	2
20	Build Crystal oscillator and measure the generated frequency using CRO.	IV	2
21	Simulate Hartley oscillator using any relevant simulation software. (Like spice, multisim, Lab view, LTspice, Octeva).	IV	2*
22	Generate a waveform using Miller's sweep generator and measure sweep time and retrace time.	IV	2
23	Simulate dual voltage regulator using IC78XX and 79XX for the specified regulated output voltage	V	2*
24	Build dual voltage regulator for the specified Regulated output voltage.	V	2
25	Build low voltage regulator using IC723 for the given regulated output voltage. (2V to7V)	V	2*
26	Build high voltage regulator using IC723 for the given regulated output voltage.(7 V to 37 V)	V	2

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
27	Test the performance parameters of voltage regulator using IC LM317.	V	2*
	Total		**54**

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 %
1	Preparation of experimental set up	20
2	Setting and operation	20
3	Safety measures	10
4	Observations and Recording	10
5	Interpretation of result and conclusion	20
6	Answer to sample questions	10
7	Submission of report in time	10
	Total	**100**

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

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

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

- 'Valuing Level' in 1st year
- '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. S. No.

S. No.	Equipment Name with Broad Specifications	PrO. S. No.
1	Variable DC power supply 0- 30V, 2A, SC protection	All
2	Dual Power supply 0- 30V, 2A	All
3	Cathode Ray Oscilloscope, Dual Trace 30Mhz and above, 1MegaΩ Input Impedance	1-16
4	Digital storage Oscilloscope, Dual Trace 20Mhz and above, 1MegaΩ Input Impedance	1-16
5	Function Generator 0-2 MHz with Sine, square and triangular output with variable frequency and amplitude	1-12
6	Digital Multimeter: 3and1/2 digit display, 9999 counts digital multimeter measures: V_{ac}, V_{dc} (1000V max) , A_{dc}, A_{ac} (10 amp max) , Resistance (0 - 100 MΩ) , Capacitance and diode ,transistor tester	All
7	Electronic Work Bench : Bread Board 840 -1000 contact points, Positive and Negative power rails on opposite side of the board , 0-30 V , 2 Amp Variable DC power supply, Function Generator 0-2MHz, CRO 0-30MHz , Digital multimeter	All
8	LCR-Q meter, Test frequency standard 100 Hz / 1 kHz; Parameter L-Q, C-D, R-Q and Z-Q,Parameters L 100 Hz, 120 Hz 1 mH - 9999 H 1 KHz 0.1 mH - 999.9 Ht,C 100 Hz, 120Hz 1 pF - 9999 mF Range 1 KHz 0.1 pF - 999.9 mF,Terminals 4 terminals.	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 Low Power Amplifiers	1a. Explain with sketches the working principle of the given type of amplifier. 1b. Calculate gain and bandwidth of the given low power amplifier. 1c. Compare performance parameters of the given types of amplifier coupling. 1d. Select relevant tuned amplifier for the given frequency band with justification. 1e. Describe the environment employed for the given simulation work with justification.	1.1 Classification of Amplifiers, BJT as an amplifier . 1.2 Single stage CE amplifier, frequency response. gain, bandwidth 1.3 Multistage amplifier: General Multistage amplifier BJT based. 1.4 Type of BJT amplifier coupling: Circuit diagram , operation, frequency response and applications of RC, transformer and direct coupling 1.5 FET Amplifier: Common Source amplifier, working principle and applications 1.6 Tuned Amplifier: Need of tuned amplifier. basic tuned circuit, circuit diagram. operating principle and frequency response of Single tuned, Double tuned and stagger tuned amplifiers

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit– II High Power Amplifiers	2a. Explain with sketches the working of the given type of power amplifier. 2b. Select the relevant power amplifier for the given application with justification. 2c. Calculate efficiency of the given power amplifier. 2d. Compare the performance parameters of the given types of power amplifiers. 2e. Prepare the specifications of the given type of amplifier.	2.1 Power Amplifier: Comparison between small signal amplifier and power amplifier, performance parameter of power amplifier like : bandwidth, gain, frequency band, efficiency 2.2 Classification: Class A, Class B, Class AB and Class C 2.3 Circuit, operation, input /output waveforms, efficiency and power equations of Single Stage Class A, Class B, Class AB and Class C Power amplifier.
Unit III Feedback Amplifiers	3a. Calculate the gain of the amplifier for the given type of feedback amplifier. 3b. Explain effect of negative feedback on the given type of amplifier performance. 3c. Calculate Gain, Bandwidth, Input and Output resistance of the given feedback amplifier. 3d. Compare the performance of given types of negative feedback amplifiers.	3.1 Principle of feedback Amplifier 3.2 Types of feedback: negative and positive feedback, advantages and disadvantages of negative feedback 3.3 Types of feedback connections, voltage shunt, voltage series, current series and current shunt: block diagram, circuit diagram, and operation
Unit IV Wave form Generators	4a. Calculate frequency of oscillation for the given type of oscillator circuit. 4b. Select the relevant oscillator to obtain the given range of frequency with justification. 4c. Choose the relevant sweep generator to obtain the specified saw tooth waveform with justification. 4d. Prepare the specifications of the given oscillator.	4.1 Oscillators: Need, oscillator and amplifier 4.2 Condition for oscillation (Barkhausen's criteria), classification of oscillators 4.3 Sine wave Oscillator : RC Phase shift oscillator and crystal oscillator , concept , working and applications 4.4 Sweep generator: Miller sweep, Bootstrap circuit, current time base generator
Unit– V IC Voltage Regulators and SMPS	5a. Explain with sketches the working principle of given type of voltage regulator IC. 5b. Compare the working of the given types of regulators. 5c. Design voltage regulator for the specified output voltage. 5d. Interpret the working of given block of the SMPS.	5.1 Types of IC Voltage Regulator: Fixed and variable: 78XX, 79XX, specification, series and LM723, LM317, line and load regulation. 5.2 SMPS : Block diagram, working principle, specifications, special features, advantages , disadvantages and applications. 5.3 Use of heat sink for regulated power supply.

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	Low Power Amplifiers	14	4	6	6	16
II	High Power Amplifiers	18	4	6	8	18
III	Feedback Amplifiers	12	4	4	4	12
IV	Waveform Generators	12	4	4	6	14
V	IC voltage Regulators and SMPS	08	2	4	4	10
Total		**64**	**18**	**24**	**28**	**70**

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

10. SUGGESTED STUDENT ACTIVITIES

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

a. Undertake micro-projects.
b. Give seminar on any relevant topic.
c. Library survey regarding different electronics circuits and voltage regulators.
d. Prepare power point presentation for electronic circuits.
e. Undertake a market survey of different electronics circuits and voltage regulators

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

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

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

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. Construct a doorbell using transistor.
b. Using transistor construct a clap switch.
c. Construct audio amplifier using.(IC810 or equivalent IC).
d. Construct power amplifier for FM receiver output.
e. Drive a 4Ω speaker using class A amplifier which is directly coupled and test its performance parameters.
f. Using ClassAB push pull amplifier drive (4Ω/8Ω) speaker, test its performance parameters.
g. IC regulators: Build a circuit of Dual regulated power supply on general purpose PCB to obtain +/- 15 V, 500mA using IC 78XX & 79XX series.
h. IC regulators: Build a regulated power supply on general purpose PCB to obtain + 5V, 500mA using IC 78XX series. Drive suitable load with regulated output.
i. IC regulators: Build a regulated power supply on general purpose PCB to obtain -20V, 500mA using IC 79XX series. Use suitable heat sink .Drive suitable load with regulated output.
j. IC Regulators: Build a constant current regulator on general purpose PCB for output current of 125mA using IC 317.
k. IC Regulators : Construct low voltage regulator on general purpose PCB for output voltage 5V using LM IC 723.Drive any 5v operated load.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Applied Electronics	Sedha, R.S.	S.Chand, New Delhi, 2015 ISBN:9788121927833
2	Principles of Electronics	Mehta, V.K. Mehta, Rohit	S.Chand, New Delhi, 2014 ISBN:8121924502
3	Electronic Devices and Circuit Theory	Boylestead, Robert, Neshelsky, Louis	Pearson Education, New Delhi, 2014, ISBN: 9780132622264
4	Fundamental of Electronic Devices and	Bell ,David	Oxford University Press, New Delhi, 2015, ISBN:9780195425239

S. No.	Title of Book	Author	Publication
	Circuits		
5	Electronic Devices and Circuits	Millman, Jacob Halkias, C. Christos Jit, Satyabrata	Mc Graw Hill Education, New Delhi 2015, ISBN:9789339219550
6	Modern Power Electronics	Sen, P.C.	S.Chand, New Delhi, 2015 ISBN:9788121924252

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. www.eng.uokufa.edu.iq/staff/alikassim/lectures/CH-4.pdf
b. www.electronics-tutorials.ws/amplifier/amp_1.html
c. www.colorado.edu/ physics/phys3330/PDF/Experiment7.pdf
d. www.alldatasheet.com/view.jsp?Searchword=Bc147
e. www.williamson-labs.com
f. www.futurlec.com
g. www.learnerstv.com/video/Free-video-Lecture-870-Engineering.htm
h. www.electronicspost.com/discuss-the-essentials-of-a-transistor-oscillator-explain-the-action-of-tuned-collector-oscillator-colpitts-oscillator-and-hartley-oscillator/
i. www.radio-electronics.com/info/power-management/switching-mode-power-supply/basics-tutorial.php
j. www.circuitstoday.com/ic-723-voltage-regulators
k. www.onsemi.com/pub_link/Collateral/LM317-D.PDF

Program Name : **Digital Electronics, Medical Electronics and Instrumentation Engineering Program Group**

Program Code : **DE/IE/IS/IC/MU**

Semester : **Third**

Course Title : **Electronic Instruments and Measurement**

Course Code : **22331**

1. RATIONALE

Diploma pass outs (also called as technologists) should be able to measure various electrical and electronic parameters in industry using relevant instruments. This course is designed to provide the basic understanding about the concepts, principles and procedures of analog and digital electronic measuring instruments. Students will be able to use the various electronic measuring instruments for fault finding in the industry.

2. COMPETENCY

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

- **Use basic electrical and electronic instruments for measuring various parameters.**

3. COURSE OUTCOMES (COs)

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

a. Use relevant type of measuring instruments for different applications.
b. Use analog meters to measure electrical parameters.
c. Use digital meters to measure electrical parameters.
d. Use CRO and signal generator to measure electrical parameters.
e. Use AC and DC bridges to measure electrical parameters.

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.

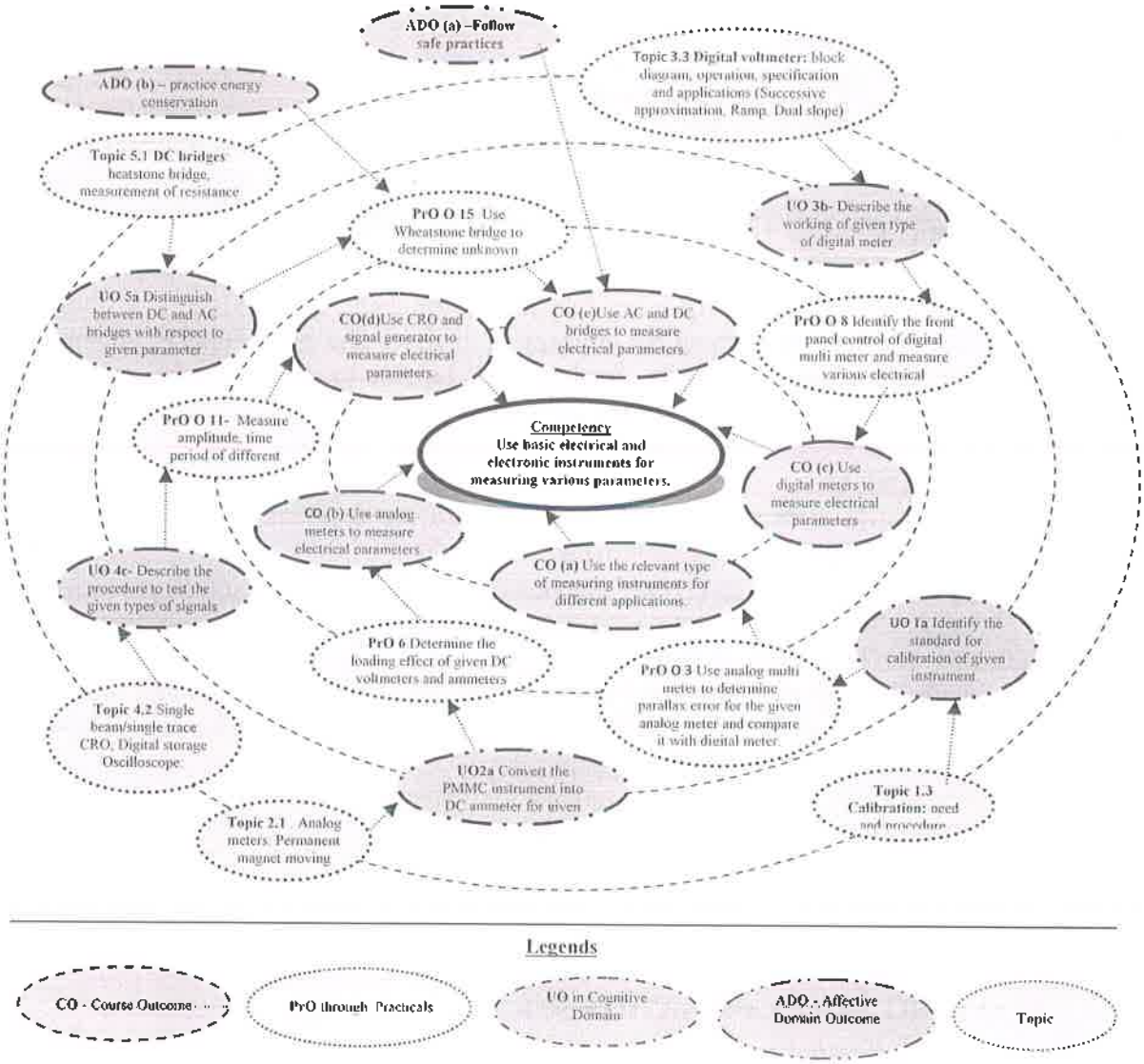

Figure 1 - Course Map

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 analog multi meter to determine accuracy, resolution and hysteresis.	I	02*
2	Calibrate the analog multi meter by comparing with given standard instrument.	I	02
3	Use analog multi meter to determine parallax error for the given analog meter and compare it with digital meter.	I	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
4	Convert basic PMMC movement of 1mA into DC voltmeter for measuring 5V, 10V, 15V.	II	02
5	Convert basic PMMC movement of 1mA into DC ammeter for measuring 10mA, 50mA, 100mA	II	02*
6	Determine the loading effect of given DC voltmeters and ammeters	II	02
7	Use LCR meter to calculate the value of resistance, Inductance, capacitance and compare those with component codes.	III	02
8	Identify the front panel control of digital multi meter and measure various electrical parameters using DMM	III	02*
9	Use analog multi meter to determine accuracy, resolution and hysteresis loop of given digital meter.	III	02
10	Identify the front panel control of logic Analyzer and Test the given digital circuit	III	02
11	Measure amplitude, time period of different signals generated by function generator using CRO.	IV	02*
12	Measure unknown frequency and phase difference with respect to given signal using Lissajous pattern	IV	02
13	Identify the front panel control of DSO and measure various parameters of applied signal	IV	02
14	Identify the front panel control of Spectrum Analyzer and determine frequency content of given signal.	IV	02
15	Use Wheatstone bridge to determine unknown resistance	V	02*
16	Use Maxwell Bridge to determine unknown inductance.	V	02
17	Use Schering Bridge to determine unknown capacitance.	V	02
18	Measure intensity of bulb available in the laboratory using Lux meter.	III	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 setup	20
2.	Setting and operation	20
3.	Safety measures	10
4.	Observation and recording	10
5.	Interpretation of result and conclusion	20
6.	Answer to sample questions	10
7.	Submission of report in time	10
	Total	**100**

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

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

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

- 'Valuing Level' in 1st year
- 'Organising Level' in 2nd year
- 'Characterising Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specification mentioned here will use 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	Analog multi meter 1mA, 500 ohms.	1,2,3
2	Digital Multi meter 4 ½ digit display	2,3,8,9
3	Voltmeter 0-10V,0-50V,0-100V,0-300V	3,4,6
4	Ammeter 0-100mA, 0-50μA,0-1mA	3,5
5	LCR meter 20Hz – 2MHz	5
6	Cathode ray Oscilloscope single beam dual trace 0-30 MHz	11,12
7	Function generator 0-2MHz. 0-3MHz	11,12, 14,16, 17
8	Digital Storage Oscilloscope 60 MHz bandwidth	13
9	Logic Analyzer: 32 channel	10
10	Spectrum Analyzer: Heterodyne type 3GHz	14
11	Lux Meter range 400.0/4000 lux sensor diameter 2 to 2 inch, Accuracy 5%, memory 16000 reading, resolution 100 lux, foot candle resolution 0.1 fc. Display type- numeric	18

8. UNDERPINNING THEORY COMPONENTS

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

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – 1 Fundamentals of measure	1a. Identify the standard for calibration of the given instrument with justification. 1b. Classify the given measuring instruments.	1.1 Measurement: Concept , units of measurement of fundamental quantities, standard and their classification, Static and

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
ments	1c. Determine static and dynamic characteristics of the measuring instruments with the given data. 1d. Explain with sketches the generalized procedure for calibration of the given device.	dynamic characteristics, types of errors 1.2 Classification of instruments: (i) absolute and secondary instruments, (ii) analog and digital instruments, (iii) mechanical, electrical and electronic instruments 1.3 Calibration: need and procedure
Unit– II Analog meters	2a. Explain with sketches the construction and working principle of the given permanent magnet moving coil (PMMC) instrument with sketches. 2b. Describe with sketches the procedure to convert the PMMC instrument into DC ammeter for the given range. 2c. Describe with sketches the procedure to convert the PMMC instrument into DC voltmeter for the given range. 2d. Explain with sketches the working of given type of ohm meter. 2e. Explain with sketches the working of given type of AC voltmeter. 2f. Prepare specification for given analog meters.	2.1 Permanent magnet moving coil (PMMC) and Permanent magnet moving iron (PMMI) meter their construction, principle, working, salient features 2.2 DC Ammeter: Basic, Multi range, Universal shunt/Ayrton, simple numerical based on R_{sh} 2.3 DC Voltmeter: Basic, Multi range, simple numerical based on R_s, concept of loading effect and sensitivity 2.4 Ohm meter: Series and shunt 2.5 AC voltmeter: Rectifier type (half wave and full wave)
Unit– III Digital Meters	3a. Determine resolution, sensitivity and accuracy of the given digital display. 3b. Explain with sketches the working of given type of digital meter. 3c. Explain with sketches the construction and working of the given types of digital meters. 3d. Describe with sketches the procedure to measure the given electric parameter using the relevant type of digital meter. 3e. Describe with sketches the procedure to test the given digital circuits using logic analyser. 3f. Prepare specification for given digital instrument.	3.1 Resolution, sensitivity and accuracy of digital Instruments. 3.2 Digital frequency meter, Digital multi meter, LCR-Meter, Lux Meter, Logic Analyser: block diagram, operation, specification and applications 3.3 Digital voltmeter: block diagram, operation, specification and applications (Successive approximation, Ramp, Dual slope)
Unit-IV CRO and signal generato	4a. Describe the given blocks and working of given type of oscilloscope with sketches. 4b. Describe with sketches the procedure to measure the given parameter using the	4.1 Single beam/single trace CRO, Digital storage Oscilloscope: Basic block diagram, working, Cathode ray tube, electrostatic deflection, vertical amplifier,

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
rs	CRO. 4c. Describe with sketches the working of given type of type of signal/function generator with sketches. 4d. Describe with sketches the procedure to test the given type of signal using the relevant type of function generator/signal generator/CRO. 4e. Select CRO/ DSO, Spectrum analyzer and function generator for the given application. 4f. Prepare specification for given instrument.	time base generator, horizontal amplifier, attenuator, delay line and specifications. 4.2 CRO Measurements: voltage, time period, frequency, phase angle, Lissajous pattern. 4.3 Signal generator: need, working and Basic block diagram 4.4 Function generator: need, working and basic block diagram and specifications. 4.5 Spectrum analyzer: Basic block diagram, operation , specification and applications.
Unit –V DC and AC bridges	5a. Explain with sketches the the working of the given type of bridge with sketches. 5b. Describe with sketches the procedure to measure given unknown resistance using the relevant type of bridge with sketches 5c. Describe with sketches the procedure to measure given unknown capacitance using relevant type of bridge with sketches. 5d. Describe with sketches the procedure to measure given unknown inductance value using relevant type of bridge with sketches.	5.1 DC bridges: Wheatstone bridge, measurement of resistance 5.2 AC bridges: Use of Schering bridge, Maxwell bridge, Hays bridge

Note: To attain the CUs 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 measurements	08	02	02	04	08
II	Analog meters	16	04	06	08	18
III	Digital meters	14	02	06	10	18
IV	CRO and Signal generator	18	02	06	10	18
V	DC and AC bridges	08	02	02	04	08
Total		64	**12**	**22**	**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. Compile broad specification of DSO, LCR meter, logic analyzer, Spectrum analyser using data sheets and handbook.
b. Develop a report after performing market survey of electronic instruments used in the laboratory.
c. Prepare a chart of static and dynamic characteristics of the instrument/equipment available in the laboratory.
d. Prepare chart to display types of Units.
e. Prepare chart to display front panel control of DSO, LCR meter, Logic analyser and Spectrum analyser
f. Visit nearby institutes, exhibition and industries to collect information about electronic instruments.
g. Assist to the technicians who are doing repair or maintenance work of electronic instruments.
h. Prepare instruction chart for safe handling of electronic instruments

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

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

a. Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b. ***'L' in item No. 4*** does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
c. About ***15-20% of the topics/sub-topics*** which is relatively simpler or descriptive in nature is to be given to the students for ***self-directed learning*** and assess the development of the COs through classroom presentations (see implementation guideline for details).
d. With respect to item No.10, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
e. Guide student(s) in undertaking micro-projects.
f. Video programs/YouTube may be used to teach various topics and sub topics.
g. Demonstrate set-up arrangement to the students thoroughly before they start doing the practical.
h. Encourage students to refer different book and websites to have deeper understanding of the subject.
i. Observe continuously and monitor the performance of students in Lab.
j. Encourage students to use front/rear panel control of electronic instruments.
k. Encourage students to visit nearby electronic instruments repair workshop units or manufacturing industries.

l. Instruct students to safety concern of handling electronic instruments and also to avoid any damage to the electronic instruments.

12. SUGGESTED MICRO-PROJECTS

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

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

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

a. Prepare a report on market survey of Dual beam CRO, Dual trace CRO, Sampling Oscilloscope, DSO, function generator, logic analyzer and LCR meter.(technical specification and manufacturers).
b. Build and test given power supply using CRO and DMM.
c. Build, test and commission Wheatstone bridge using LDR / thermistor / RTD / potentiometer.
d. Find the fault in the given laboratory electronic measuring instrument.
e. Build, test and commission Schering Bridge using LDR / thermistor / RTD / potentiometer.
f. Build the circuit of LED bulb using white LED arrays and measure its intensity using lux meter.
g. Take two similar circuit board. One is faulty another is in working condition. Test both circuit boards using component test function on CRO/DSO and find out the faulty component in faulty circuit.
h. Take laminated copper wire and construct inductor and measure inductance using LCR meter. Now change the number of turns and test different inductors.
i. Take copper clad and form capacitor by etching copper clad and measure the capacitance using LCR meter.
j. Construct voltage Doubler /trippler circuit and measure voltage at every capacitor using CRO.
k. Build and test function generator using IC (eg.ICL8038, MAX038, XR2206 etc.).

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Electronic Instrumentation	Kalsi, H.S.	Mc Graw Hill Education, New Delhi, 2010 ISBN:9780070702066
2	Electronic Measurement and instrumentation	Sedha, R.S.	S Chand and Company, New Delhi , 2013 ISBN: 9788121997751
3	Electronic instruments and	Anand, M.M.S.	PHI Learning., New Delhi,2004

S. No.	Title of Book	Author	Publication
	instrumentation Technology		ISBN: 9788120324541
4	A course in electrical and electronic measurement and instrumentation	Sawhney, A.K.	Dhanpat Rai and Company, New Delhi, 2005 ISBN-13: 978-8177000160
5	Electronic Measurement and instrumentation	Rajput, R.K.	S Chand and Company, New Delhi , 2008 ISBN: 9788121929172
6	Electronic instrumentation and Measurement	Khurana, Rohit.	Vikas Publications House. New Delhi, ISBN: 9789325990203
7	Electronic instrumentation and Measurement	Bell, David A.	Oxford University Press, New Delhi, 2013; ISBN: 9780195696141
8	Elements of electronic instrumentation and measurements	Carr, Joseph J.	Pearson Education ,New Delhi, 2003 ISBN: 9788131712115

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. www.nptel.iitg.ernet.in/courses/Elec.engg/IIT%20Bombay/electrical/%20and
b. www.electrical4u.com/permanent-magnet-moving-coil-instrument/
c. www.electrical4u.com/digital-frequency-meter/
d. www.electrical4u.com/digital-multimeter/
e. www.electrical4u.com/wheatstone-bridge-circuit-theory-and-principle/
f. www.electrical4u.com/maxwell-bridge-inductance-capacitance-bridge/
g. www.electrical4u.com/hays-bridge-circuit-theory-phasor-diagram-advantages-applications/
h. www.electrical4u.com/schering-bridge-measurement-of-capacitance-using-schering-bridge/
i. www.electrical4u.com/cathode-ray-oscilloscope-cro/
j. www.nprcet.org/eee/document/MI.pdf
k. web.mst.edu/~cottrell/ME240/Resources/basic_inst/Basic_Instrumentation.pdf

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

Program Code : **IS / IC**

Semester : **Third**

Course Title : **Industrial Measurement**

Course Code : **22335**

1. RATIONALE

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

2. COMPETENCY

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

- **Maintain different transducers used for measurement of various parameters.**

3. COURSE OUTCOMES (COs)

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

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

4. TEACHING AND EXAMINATION SCHEME

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

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

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

5. COURSE MAP (with sample COs, POs, PSOs, ADOs and topics)

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

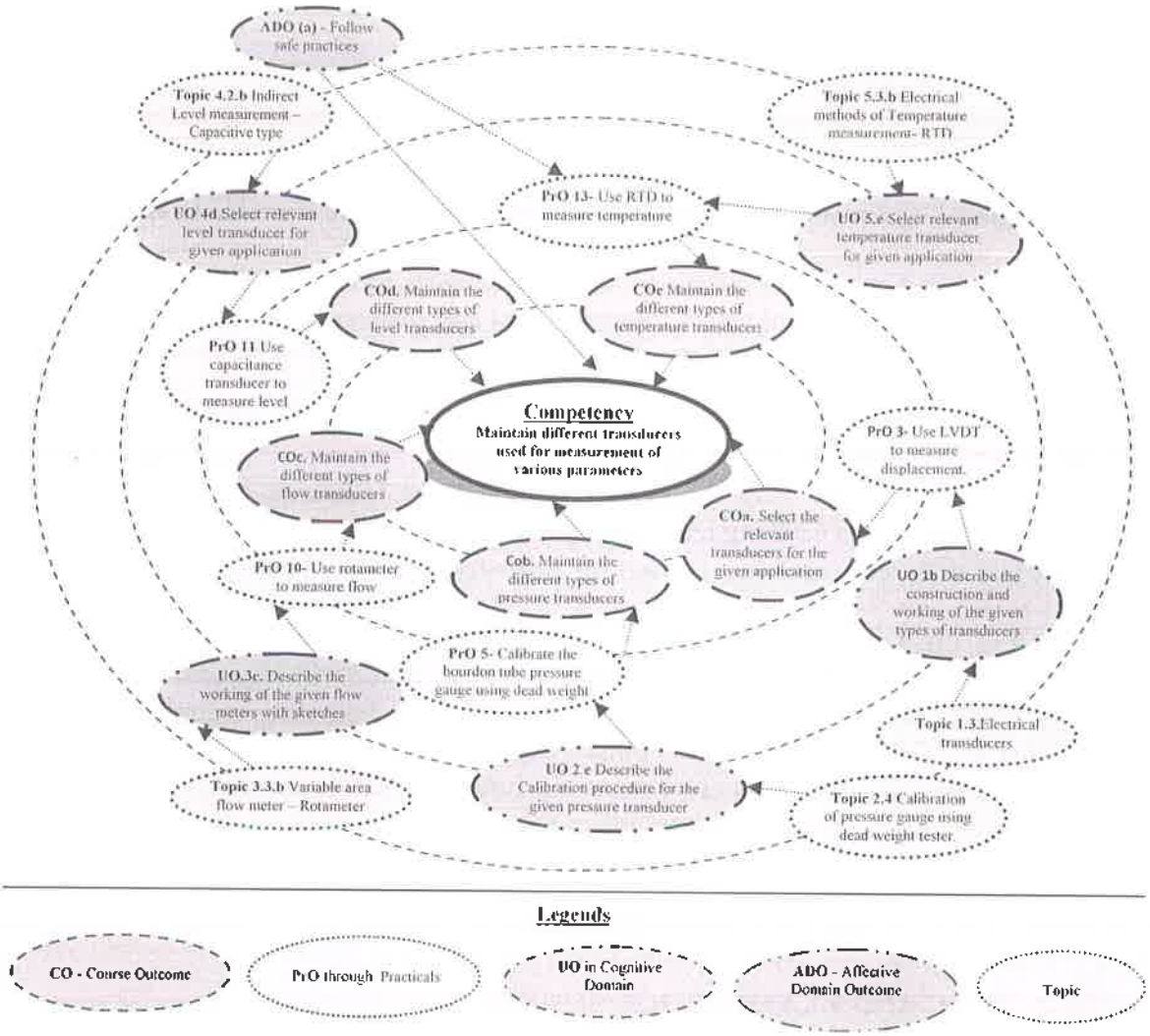

Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

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

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Use the potentiometer to measure the linear displacement	I	02*
2	Use the potentiometer to measure the angular displacement	I	02
3	Use LVDT to measure displacement.	I	02
4	Use the strain gauge to measure weights.	I	02
5	Use Bourdon tube pressure gauge to measure pressure	II	02*
6	Calibrate the bourdon tube pressure gauge using dead weight tester	II	02
7	Assemble/dismantle digital pressure measurement system	II	02
8	Use orifice meter for flow measurement	III	02*

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

Note

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

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

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

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

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

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

- 'Valuing Level' in 1st year
- 'Organizing Level' in 2nd year
- 'Characterizing Level' in 3rd year

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specification mentioned here will 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	**LVDT trainer kit**- Displacement range +/- 20 mm. Accuracy of +/- 2% Primary Excitation 4 KHZ and 1 Volt, RMS Output : Digital display of +/- 20mm	3
2	**Strain gauge trainer kit**: Strain gages of 350 ohms, Accuracy: +/- 1% Power Supply 230 Vac, maximum of 5-kg load, Digital indication	4
3	**Bourdon tube pressure gauge**: Input pressure range 0 – 50 psi. Accuracy of +/- 2%. Dial gauge indication in the range 0 to 50 psi.	5
4	**Dead weight tester :** Input range 0-10 kg, Output on dial gauge 0 – 10kg/cm^2	6
5	**Orifice meter measurement setup:** 1''line size, concentric type, MOC-SS, U tube manometer 400 mm height, Range 0-1000LPH, Digital display	8
6	**Ventury flow measurement setup:** 1''line size, MOC-SS, U tube manometer 400 mm height, Range 0-1000LPH, Digital display	9
7	**Rotameter flow measurement setup:** Range 0-1000 LPH, Glass tube body, Bob Material-SS, connection 1'', Mounting inlet bottom top outlet.	10
8	**Capacitance level measurement:** Input range 0-500 mm, power supply 230 V ac , 2 wire capacitance type, top mounted, Digital display indication of 0 – 500mm.	11
9	**Air purge level measurement:** Level tank ,height 0-500mm ,air pressure regulator ¼" valve ,air compressor with ¼" connection and pressure gauge power supply 230 Vac, Level indication	12
10	**RTD temperature measurement:** Temp range 0-100 ^{0}C digital, temp bath, RTD Type pt100,accuracy +/- 1% , power supply 230v ac,	13
11	**Thermocouple temperature measurement:** Temp range 0-200^0 c, temp bath, Thermocouple K Type ,accuracy of +/- 1% , power supply 230v ac, digital indication of temp	14

8. UNDERPINNING THEORY COMPONENTS

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

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Applications of Transducers	1a. Describe with sketches function of the given components used in instrumentation system. 1b. Explain with sketches the construction and working of the given type (s) of transducer(s). 1c. Differentiate the working of the given types of transducers with sketches.	1.1 Function of each block of Instrumentation system. 1.2 Transducer: Need, Classification - Active and Passive, Analog and Digital, Primary and Secondary, Mechanical and Electrical. 1.3 Electrical Transducers: Resistive transducers- Linear and Angular potentiometers, strain gauge, types, gauge factor. Capacitive transducer.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	1d. Select relevant transducer for given application with justification. 1e. Prepare the specification of given transducer.	1.5 Inductive transducer –LVDT, RVDT 1.6 Piezoelectric transducer, photo electric transducer-LDR, photo voltaic cell. 1.7 Selection criteria of transducers.
Unit– II Pressure measurement	2a. Describe with sketches the construction of the given type of pressure transducer. 2b. Explain with sketches the working of the given type of pressure transducer with sketches. 2c. Select the relevant pressure transducer for the given application with justification 2d. Describe with sketches the calibration procedure for the given pressure transducer. 2e. Prepare the specification of the given pressure transducer. 2f. Describe with sketches the procedure to troubleshoot the given type of pressure transducer.	2.1 Pressure and its units, Types - Absolute, Gauge, Atmospheric, Vacuum. 2.2 Classification of Pressure measuring devices: a. Manometer-U tube, Inclined Tube, Well type manometer b. Elastic pressure transducer: Bourdon Tube Bellows, Diaphragm, Capsule c. Electrical pressure transducers: Bourdon tube with LVDT, Bellow with LVDT Diaphragm with Strain gauge. 2.3 Specification of electrical pressure transducer. 2.4 Calibration of pressure gauge using dead weight tester.
Unit– III Flow measurement	3a. Describe with sketches the construction of the given type of flow transducer with sketches. 3b. Explain with sketches the working of the given type of flow transducer with sketches. 3c. Differentiate the salient features of the given type of flow transducers. 3d. Select relevant flow transducer for the given application with justification. 3e. Prepare the specification of given flow transducer. 3f. Describe with sketches the procedure to troubleshoot the given type of flow transducer.	3.1 Flow and its units, Types of Flow – Laminar, turbulent, Reynolds number 3.2 Classification of flow measuring transducers: a. Variable head flow meter: Venturimeter, orifice plate meter, flow nozzle, pitot tube b. Variable area flow meter – Rotameter c. Electrical flow meter: Turbine flow meter, Electromagnetic Flow meter, Ultrasonic flow meter- Time difference and Doppler Type, Hot wire anemometer, Vortex flow meter 3.3 Positive displacement meter-nutating disc type. 3.4 Coriolis Mass flow meter 3.5 Typical specifications of various flow meters.
Unit-IV Level measurement	4a. Describe with sketches the construction of the given type of level transducer.	4.1 Level and its units, Classification of level measurement methods: a. Direct methods- Hook type, Sight

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

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

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Applications of transducers	8	02	04	06	12
II	Pressure Measurement	10	02	04	08	14
III	Flow Measurement	12	02	04	10	16
IV	Level Measurement	8	02	04	08	14
V	Temperature Measurement	10	02	04	08	14
Total		**48**	**10**	**20**	**40**	**70**

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

10. SUGGESTED STUDENT ACTIVITIES

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

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

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES

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

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

12. SUGGESTED MICRO-PROJECTS

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

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

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

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

13. SUGGESTED LEARNING RESOURCES

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

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

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

h. www.isa.org


MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION MUMBAI

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

Program Code : **IS / IC**

Semester : **Third**

Course Title : **Instrumentation Data Communication**

Course Code : **22336**

1. RATIONALE

Now- a –days, process industries are being automated by advanced **instrumentation** devices/ systems to measure and control various process variables like temperature, pressure, flow and liquid level. The instruments used in the field and control room require communication of data from field to control room and vice versa. Diploma Engineers should therefore be able to select, classify, install, troubleshoot and maintain different industrial data communication networks for automation.

2. COMPETENCY

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

- **Maintain instrumentation data communication hardware networks.**

3. COURSE OUTCOMES (COs)

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

a. Use the relevant mode of data communications.
b. Maintain data communication systems.
c. Choose the network models required for data communication applications.
d. Install physical medium for given data transmission.
e. Troubleshoot industrial network and field bus.

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..

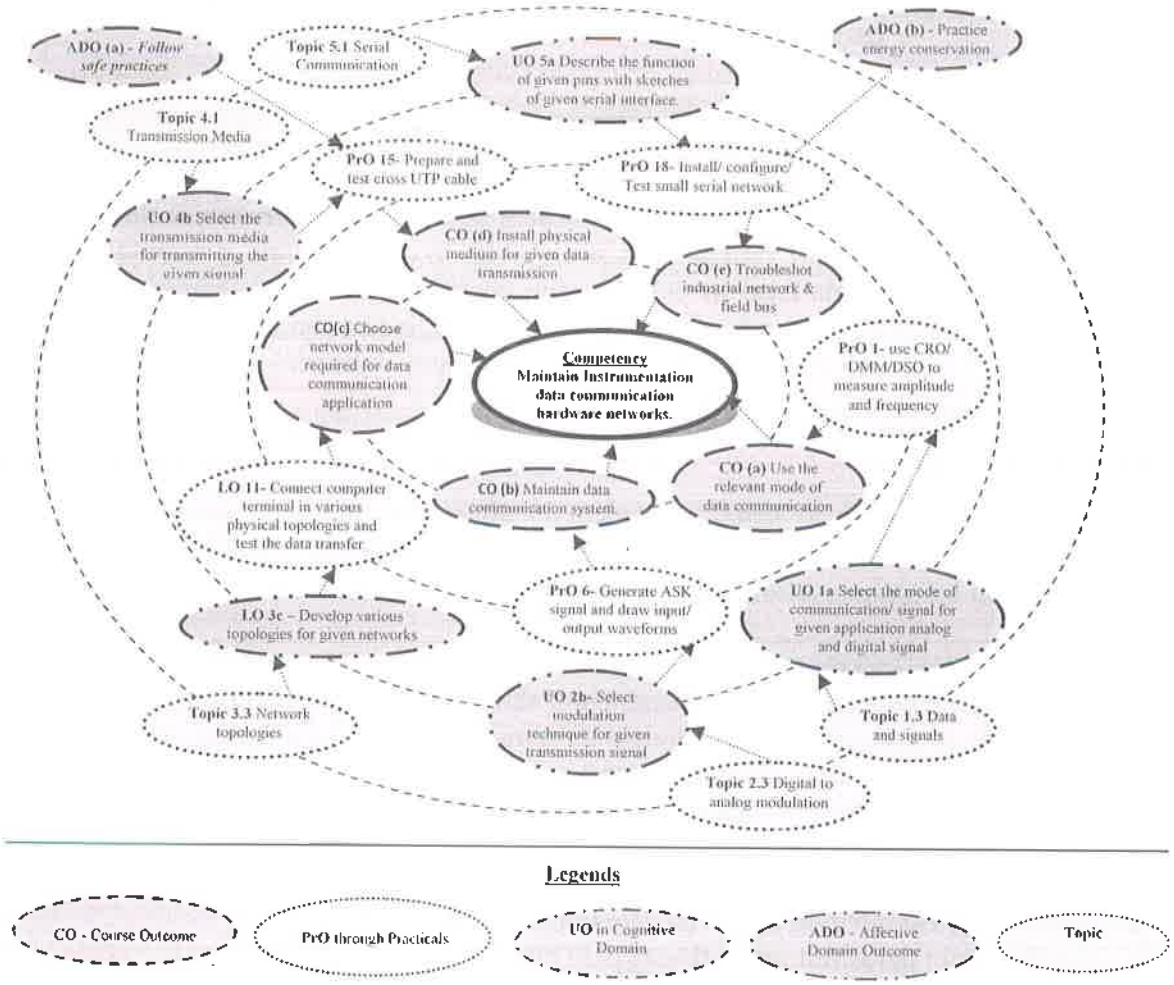

Figure 1 - Course Map

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	Use CRO/ DMM /DSO to measure amplitude and frequency of the given analog signal.	I	02*
2	Use CRO/ DMM/DSO to measure amplitude and frequency of the given digital signal.	I	02
3	Generate PAM signal and draw input/output waveforms.	II	02*
4	Generate PWM signal and draw input/output waveforms.	II	02
5	Generate PPM signal and draw input/output waveforms.	II	02
6	Generate ASK signal and draw input/output waveforms.	II	02
7	Generate FSK signal and draw input/output waveforms.	II	02
8	Generate PSK signal and draw input/output waveforms.	II	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
9	Generate PCM signal and draw input/output waveforms.	II	02
10	Prepare detailed report of existing LAN in the Department/Institute.	III	02*
11	Connect computer terminal in various physical topologies and test the data transfer.	III	02
12	Install/configure/Test Peer to Peer LAN and sharing of resources.	III	02
13	Configure/Test Internet connectivity.	III	02
14	Prepare/Test Straight UTP Cable.	IV	02*
15	Prepare/Test cross UTP Cable.	IV	02
16	Prepare/Test Cross CAT5, CAT6 Cable.	IV	02
17	Install/configure/Test LAN using Hub/switch.	IV	02
18	Install/configure/Test serial network.	V	02
19	Configure the fieldbus wiring.	V	02
20	Prepare the termination for Foundation Fieldbus.	V	02
21	Select appropriate cable for Foundation Fieldbus and Profibus network.	V	02
22	Test the operational Fieldbus Network using Fieldbus tester.	V	02*
23	Transmit 8 bit digital signal superimposed on 4-20mA analog signal using HART FSK technique	V	02
24	Install /Configure HART point-to-point communication Network	V	02
25	Connect HART handheld communicator to HART network	V	02
	Total		**50**

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 setup.	20
2	Setting and operation.	20
3	Safety measures.	10
4	Observation and recording.	10
5	Interpretation of result and conclusion.	20
6	Answer to sample questions.	10
7	Submission of report in time.	10
Total		**100**

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

a. Follow safety practices.
b. Practice good housekeeping.

c. Demonstrate working as a leader/a team member.
d. Maintain tools and equipment.
e. Follow ethical Practices.

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

- 'Valuing Level' in 1st year
- 'Organizing Level' in 2nd year
- 'Characterizing Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

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

S. No.	Equipment Name with Broad Specifications	PrO. S. No.
1	**20MHz Dual Trace CRO** ; Deflection Factor- 5 mV/div to 5 V/div, Magnification- 5x, Accuracy- ±3%, Bandwidth (referenced to 5 divisions at 50 kHz)- DC to 25 MHz (at -3 dB); DC to 10 MHz (at -3 dB) on 1 mV/div range	1 to 9
2	31/2 Digit Digital Multimeter	1 to 9, 14-16
3	**Signal Generator** ; 0.3Hz to 3MHz Frequency Output, Sine, Square, Triangle, Ramp, Pulse and DC Outputs, Standard AM, Balance AM, FM, ASK, FSK, PWM Modulation and Sweep Mode,	1 to 9
4	**Digital Storage Oscilloscope** ; 60MHz/100MHz/200MHz bandwidth, 500MS/s to 1GS/s real-time sample rate, 50GS/s sample rate for repetitive waveforms, High resolution color LCD display	1 to 9
5	**Computer system;** Operating System: Windows 10 or higher **Memory:** minimum of 8 GB RAM, Processor Speed: minimum of Intel Core i5 or equivalent, Hard Drive: 320 GB or larger, DVD Drive: DVD +/- RW Dual Layer Burner or Mac Super Drive, Wireless: Any card that supports 802.11 g/n protocols and WPA2 Enterprise, Ethernet: 10/100/1000 (gigabit). Monitor (Desktop): 19" Monitor or larger	10-13
6	'Computer Hub 8/ 16 node with console port	10-13,17
7	Router/ Wireless Router	13,17
8	Modem	13
9	Ethernet Switch 4/8/16/24/32	10-13,17
10	LAN Cable (CAT6, CAT5)	16
11	Coaxial Cable, UTP Cable, STP Cable, Fiber Optic Cable	14-16
12	**Profibus PA starter KIT;** Profibus enable controller, devices, cable, connector, power supply.	Micro project
13	**ModBus Trainer Kit;** Modbus enable controller/ PC, Modbus Enable device, Modbus cable, Power Supply	Micro project
14	**HART starter KIT;** HART driver software, Host computer, HART enable device, HART enable Controller, HART Handheld Communicator	23-25

S. No.	Equipment Name with Broad Specifications	PrO. S. No.
	(optional)	
15	**Foundation Fieldbus Trainer Kit;** Controller with Ethernet enable module, Host computer and OPC server, Stratix 8000 switch, linking device, Power conditioner, Field devices, 24V DC power supply, Network terminator	18-22
16	**Devicenet trainer kit;** Devicenet power supply, cable, connector, taps, devicenet enable field device, devicenet adapter, PLC system.	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 Basics of Communication	1a. Select the mode of communication/signal for the given application. 1b. Describe the given type of transmission with sketches for the given application. 1c. Select relevant signal standard for the given data communication system. 1d. Describe with sketches the function of the components in the given communication system. 1e. Justify the need of modulation in the given communication system.	1.1 **Communication Modes**: Simplex, Half Duplex, and Full Duplex. 1.2 **Data Transmission**: Synchronous, Asynchronous, Serial, Parallel; Frame formats for each. 1.3 **Data and Signals**: Analog and digital-data, signal; Digital Standard signals, Analog standard Signals. 1.4 **Transmission Characteristics**: Signaling rate, data rate, bit rate. 1.5 Basic block diagram of Communication system. 1.6 **Noise**: sources of noise, Effects of noise, Signal to Noise Ratio, Factor affecting signal propagation. 1.7 **Modulation and Demodulation**: Need for Modulation.
Unit– II Digital Communication	2a. Calculate bandwidth for transmission of the given signal. 2b. Select modulation techniques for the given transmission signal. 2c. Compare the principle of working for the given signal multiplexing methods. 2d. Encode the given data stream using data encoding techniques.	2.1 **Bandwidth**: Definition, Unit. 2.2 **Analog to digital Modulation**: Working principle, waveform and applications of PAM, PWM, PPM, and PCM. 2.3 **Digital to Analog Modulation:** Working principle, waveform and applications of ASK, FSK, BPSK, QPSK. 2.4 **Multiplexing:** Need for multiplexing, Schematic diagram, principle, application of TDM, FDM, and WDM. 2.5 **Data Encoding techniques:** Coding method, waveforms of: Unipolar- NRZ, RZ; Polar - NRZ, RZ; Biphase - Manchester, Differential Manchester; Bipolar- AMI, Pseudo ternary.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit– III Communication standards	3a. Describe the functions of the given layer of OSI Reference model. 3b. Describe the function of the given layer of TCP/IP Reference model. 3c. Develop the topology(s) for the given networks. 3d. Describe salient features of the given network. 3e. Explain functions of the given VPN. 3f. Classify computer networks based on the given parameter(s).	3.1 **ISO OSI reference model:** Layered architecture, Functions of various layers. 3.2 **TCP/IP Model**: Layered architecture, Functions of various layers. 3.3 **Network topologies**: Schematic diagram, working, advantages, disadvantages, applications of Mesh, Star, Bus, Ring topology. 3.4 **Network Classification Based on Transmission Technologies**: Point to-point, broadcast based on scale: LAN, WAN, MAN, VPN, Internet Based on Architecture: Peer to Peer, Client Server, advantages of Client Sever over Peer-to-Peer Model.
Unit-IV Transmission Media and Accessories	4a. Select characteristics of the given transmission media for the transmission of the given signal. 4b. Select the transmission media for transmitting the given signal. 4c. Describe the construction of the given cable with labeled sketches. 4d. Explain with sketches the working of the given type of electronic device. 4e. Describe the function of the given connecting devices.	4.1 **Transmission Media**: Unguided and Guided media, Wired and Wireless, UTP, Coaxial and Fiber optical cable. 4.2 **Optical Fiber Cable**: Total internal reflection, acceptance angle and numerical aperture; Propagation of energy in fiber optics. 4.3 **Optical transmitter**: LED, LASER Diode, Optical Receiver: P-i-N Photo diode and Avalanche photo diode. 4.4 **Types of Connectors**: RJ-45, RJ-11, BNC, BNC –T, BNC Terminator, Fiber optic connectors: Subscriber Channel (SC), Straight Tip (ST), Mechanical transfer – registered jack (MT-RJ) connectors. 4.5 **Connecting Device**: Concept of Hubs, repeater, router, and gateway.
Unit –V Industrial Networks and Field buses	5a. Describe the function of the given pins with sketches of given serial interface. 5b. Describe the features of the given industrial network protocol. 5c. Describe the features of the given aspect of the field bus. 5d. Describe with sketches the features of the given aspect of HART/ Devicenet.	5.1 **Serial Communication**: RS232, RS485: Overview, 9 Pin configurations, Interface Standard. 5.2 **Ethernet** IEEE802.3, CSMA/CD 5.3 **MODBUS**: General Overview, Modbus ASCII, RTU, TCP/IP, Protocol Structure 5.4 **Profibus**: Overview, profibus protocol stack: Physical layer, Data Link layer, Application layer. 5.5 **Foundation Field Bus**: Architecture, Physical layer, Data Link layer, Application layer, User layer.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
		5.6 **HART**: HART networks, working, communication modes, silent features, benefits, wireless HART. 5.7 **Devicenet**: Features, layer structure, Topology.

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

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Basics of Communication	08	02	02	04	08
II	Digital Communication	12	-	06	08	14
III	Communication standards	14	02	04	10	16
IV	Transmission Media and Accessories	12	02	06	06	14
V	Industrial Network and Field buses	18	04	02	12	18
Total		**64**	**10**	**20**	**40**	**70**

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

10. SUGGESTED STUDENT ACTIVITIES

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

a. Prepare specifications of a given communication medium.
b. Encode the given data stream using various encoding techniques.
c. Identify the various losses in a fiber optic cable and evaluate the extent of loss
d. Identify various components of serial network.
e. Identify various components of Modbus network.
f. Identify various components of Profibus network.
g. Identify various components of devicenet network.
h. Prepare specification of various components of serial network.
i. Prepare specification of various components of Modbus network.
j. Prepare specification of various components of Profibus network.
k. Prepare specification of various components of devicenet network.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

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

a. Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b. ***'L' in item No. 4*** does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
c. About ***15-20% of the topics/sub-topics*** which is relatively simpler or descriptive in nature is to be given to the students for ***self-directed learning*** and assess the development of the COs through classroom presentations (see implementation guideline for details).
d. With respect to item No.10, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***..
e. Video programs/YouTube may be used to teach various topics and sub topics.
f. Demonstrate students thoroughly before they start doing the practice.
g. Encourage students to refer different book and websites to have deeper understanding of the subject.
h. Observe continuously and monitor the performance of students in Lab.
i. Encourage students to use front/rear panel control of electronic instruments.
j. Encourage students to visit nearby electronic instruments repair workshop units or manufacturing industries.
k. Instruct students to safety concern of handling electronic instruments and also to avoid any damage to the electronic instruments.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student assigned to him/her in the ***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. Setup an analog signal current loop and test it.
b. Setup a LAN network for your laboratory.
c. Prepare a cable trainer kit.
d. Setup and test a serial network.
e. Setup and test Modbus network.
f. Setup and test Profibus network.
g. Setup and test devicenet network.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication

S. No.	Title of Book	Author	Publication
1	Data Communication and Networking	Forouzan, Behrouz A	McGraw Hill, Education New Delhi, 2015; ISBN 9780072967753
2	Optical Fibre Communication	Senior, John M	PHI Learning, New Delhi, 2015; ISBN 9788131732663
3	Computer Networks	Tannebaum, Andrew S; Wetherall, David J.	Pearson, New Delhi, 5th Edition, 2011; ISBN 9788177581652
4	Practical Data Communications for Instrumentation and Control	Park, John; Mackay, Steve; Wright, Edwin	Newnes An imprint of Elsevier Linacre House, Jordan Hill, Oxford Wheeler Road, Burlington, MA 01803 ; ISBN 97807506 57979
5	Computer Networks	Trivedi, Bhushan	Oxford University Press, New Delhi 2013; ISBN9780198066774
6	Practical Industrial Data Networks: Design, Installation and Troubleshooting	Mackay, Steve; Wright, Edwin; Reynders, Deon; Park, John	Newnes An imprint of Elsevier, Linacre House, Jordan Hill, Oxford Wheeler Road, Burlington, MA 01803 ; ISBN-9780750658072
7	Data Communication Networks	Sharma, Sanjay	S.K.Kataria and Sons, New Delhi ; 2015; ISBN-9788189757427

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. www.pacontrol.com
b. www.ourinstrumentation.com
c. www.profibus.com
d. www.siemens.com
e. sine.ni.com/nips/cds/view/p/lang/en/nid/208382
f. www.prosoft-technology.com/Products/Schneider-Electric-Inchassis/PROFIBUS-DP-Master-Network-Interface-Module-for-Quantum
g. www.profibus.com/uploads/media/PROFIBUS_Planning_8012_V10_Aug09.pdf
h. www.rotork.com
i. www.ti.com
j. www.fieldbus.org/
k. www.automation.com/pdf_articles/fieldbus.pdf
l. www.yokogawa.com
m. www.mtl-inst.com
n. www.ni.com/pdf/manuals/370729a.pdf
o. www.fieldbus-international.com
p. ab.rockwellautomation.com/Networks-andCommunications/Process/ FOUNDATION-Field bus
q. www.murrelektronik.com
r. literature.rockwellautomation.com/idc/groups/literature/documents/um/dnet-um072_-en-p.pdf
s. literature.rockwellautomation.com/idc/groups/literature/documents/um/1757-um012_-en-p.pdf
t. literature.rockwellautomation.com/idc/groups/literature/documents/rm/proces-rm010_-en-p.pdf
u. www.fieldbusinc.com
v. www.cisco.com

Program Name : **Diploma in Instrumentation**

Program Code : **IS**

Semester : **Third**

Course Title : **Programming in 'C'**

Course Code : 22026

1. RATIONALE

The electrical and electronics related specialised branches deal with microcontrollers and embedded systems, in many applications. To interface with such devices, knowledge of programming language is required. The 'C' language is very helpful to develop and enhance skills of programming. 'C' is used to develop device drivers, operating systems, system software and applications. This course will enable students to learn developing programming logic as well as debug, compile and execute 'C' program on different operating systems.

2. COMPETENCY

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

- **Develop 'C' programs to solve engineering problems.**

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. Write simple 'C' programs using arithmetic expressions.
b. Use control structures in 'C' program.
c. Develop 'C' programs using array.
d. Develop 'C' programs using functions for modular programming approach.
e. Develop 'C' programs using structure and union.
f. Create graphics employing 'C' functions.

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.30 marks) and micro-project assessment (seen in section 12) has a weightage of 40% (i.e.20 marks). This is designed to facilitate attainment of COs holistically, as there is no theory ESE.*

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

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.

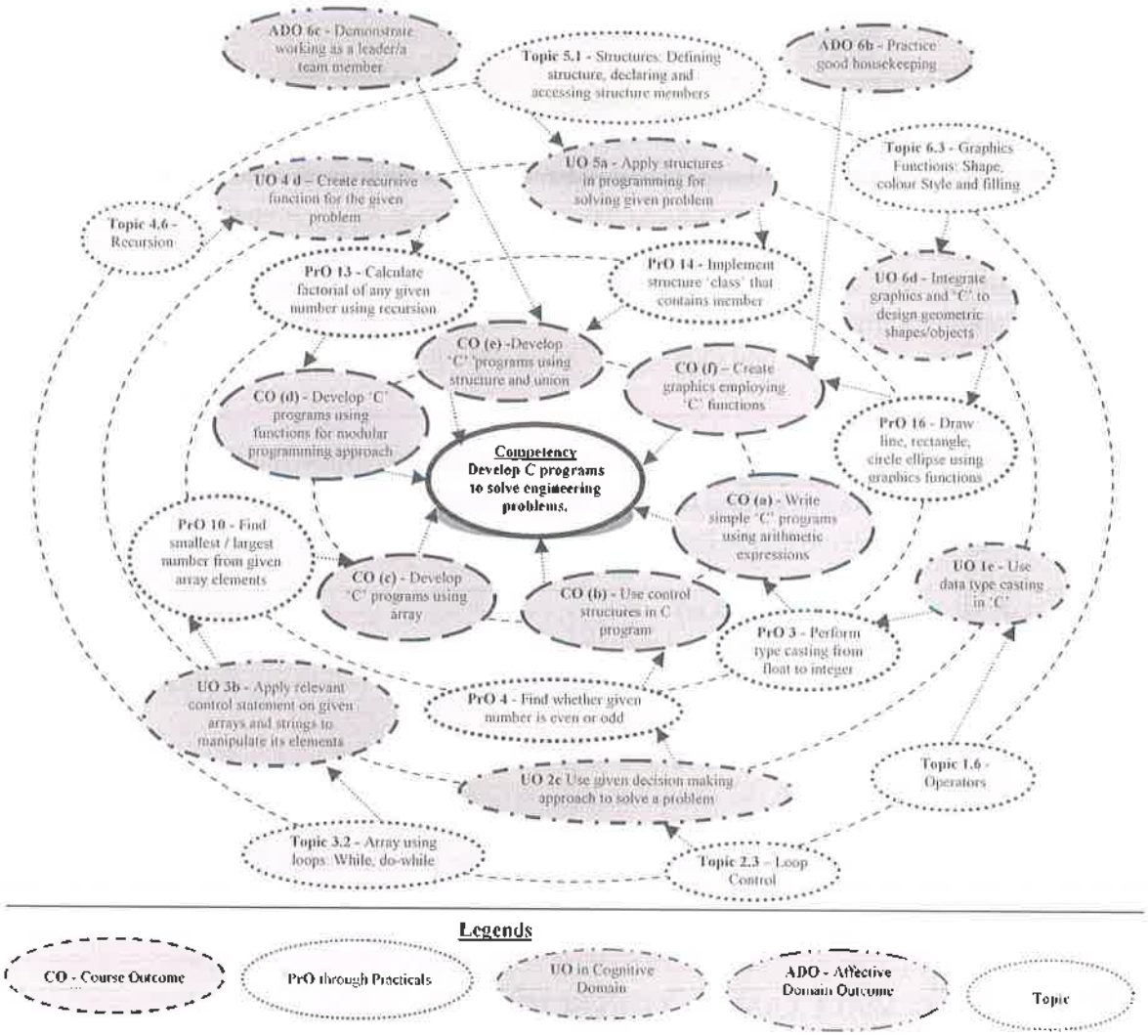

Figure 1 - Course Map

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
	Construct flowchart, algorithm and develop a 'C' program to do the following:		
1	a. Display "Hello World" on computer screen. b. Display your name, address and college name on screen.	I	02*
2	a. Display square, cube of given number on computer screen. b. Calculate area of triangle, square and circle	I	02
3	a. Perform type casting from float to integer. b. Demonstrate use of format specifiers.	I	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
4	a. Find whether given number is even or odd. b. Find greatest and smallest of 3 numbers.	II	02*
5	a. Convert a given decimal number to binary and hexadecimal number. b. Convert a binary number to decimal number.	II	02
6	Display pass class, second class, first class, distinction according to the marks entered using switch case.	II	02
7	Display menu to perform- • Addition • Subtraction • Multiplication • Division and Based on user's choice execute it using switch case.	II	02
8	a. Display Fibonacci series of length 5. b. Display following pattern 1 2 2 3 3 3 4 4 4 4	II	02
9	a. Print ASCII tables of alphabets (use continue statements). b. Print prime numbers from 1 to 100 (use break statement).	II	02
10	a. Find smallest / largest number from given array elements. b. Find sum of first 10 elements of array.	III	02*
11	a. Enter elements for 3X3 matrix and display them. b. Calculate addition and subtraction of 2 dimensional matrix.	III	02
12	a. Calculate length of String "Digital India". b. Replace word 'Digital' from above string with 'Incredible'. c. Concatenate "Incredible India" and "Campaign" as a one string. d. Check if given string is palindrome or not.	III	02
13	a. Calculate area of circle, triangle and rectangle using function. b. Calculate factorial of any given number using recursion.	IV	02*
14	Implement a structure named 'class' that contains following member variables: Roll No, Name, Marks of three subjects Read the information from keyboard calculate percentage of total marks and print Roll No, Name, Marks of three subjects and percentage marks on screen.	V	02*
15	Implement union 'Book' that contains following member variables: Book title, Author's name, Book price Read the information from keyboard and print same on screen	V	02
16	Draw line, rectangle, circle and ellipse using graphics functions.	VI	02*
17	Draw a smiley using graphics functions.	VI	02
	Total		**34**

Note

i. A suggestive list of PrOs is given in the above table. More such PrOs can be added to attain the COs and competency. A faculty must ensure 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	Ability to prepare flowchart	20
2	Ability to develop algorithm	20
3	Compile, debug and run 'C' programs	40
5	Answer to oral questions	10
6	Submission of program print-out in time	10
	Total	**100**

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

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

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

- 'Valuing Level' in 1st year.
- 'Organizing Level' in 2nd year.
- 'Characterizing Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

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

S. No.	Equipment Name with Broad Specifications	Exp. S. No.
1	Desktop computer with optimum configuration	All
2	'C' compiler	

8. UNDERPINNING THEORY COMPONENTS

The following topics/subtopics is to be taught and assessed in order to develop UOs for achieving the COs to attain the identified competency.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Fundamentals of 'C'	1a. Interpret working of the given system software in the execution of 'C' program. 1b. Explain the feature of the given data types in 'C'. 1c. Explain use of the given operators in 'C' with example. 1d. Describe the given formatting procedure in 'C'. 1e. Describe the use of the given data type casting in 'C' with example.	1.1 Applications and functions of system software: Assembler, compiler, interpreter, debugger, linker 1.2 Basic concepts of 'C': Evolution, building components of C, Features, advantages, structure of 'C' program 1.3 Constants, variables and data types, character set, keywords, constants, variables, declaration initializations and assigning values of variables, data type and their size, formatting characters 1.4 Operators (arithmetic, Logical, assignment, relational, increment and decrement, conditional, bit wise, special operators),operator precedence, expressions, formatted input and output, type conversion
Unit– II Loops in C- Decision Making	2a. Describe the procedure to construct flowcharts for given problem. 2b. Describe the procedure to develop algorithm for the given problem. 2c. Use given decision making approach to solve a problem. 2d. Explain the procedure of using the given loop statement with examples.	2.1 Fundamentals of algorithm and flowcharts 2.2 Decision making and branching: If statement (if, if-else, if-else-if ladder, nested if-else),switch statement 2.3 Loop Control: Loop concepts, use of loops, pre test and post test loops, while, do-while and for loops, nested loops, break and continue statement
Unit– III Arrays and Strings	3a. Write statements to read, write the given array. 3b. Apply relevant control statement on the given arrays and strings to manipulate its elements. 3c. Explain use of numerical arrays in the given mathematical application with examples. 3d. Describe the procedure for string operations in 'C' for the given data.	3.1 Arrays: declaration, initialization of one dimensional, two dimensional arrays, size of array, memory allocation of array 3.2 Array operations using control structures: while, do-while and for 3.3 Multi dimensional array 3.4 Declaration and initialization of string variables.
Unit-IV	4a. Use the given built-in C function.	4.1 Concept of Functions, benefits of

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Functions	4b. Develop relevant user defined functions for the given problem. 4c. Write program to pass the given function parameters using "call by value" and "call by reference" approach. 4d. Create recursive function for the given problem.	using functions, Built in functions from C library: Math, character/string, miscellaneous functions 4.2 User defined Function, Function declaration, definition and call 4.3 Return values and their types, function with return values 4.4 Internal and external variables, scope and lifetime of variables 4.5 Function call, passing arguments to functions (call by value, call by reference) 4.6 Recursion
Unit –V Structure and Union	5a. Apply structures in programming for solving the given problem. 5b. Differentiate the given structure and union with examples. 5c. Apply union to solve the given problem. 5d. Explain the memory utilization by member variables in the given structures/Union.	5.1 Structures: Defining structure, declaring and accessing structure members, initialization of structure 5.2 Arrays of structure 5.3 Union: Definition of union, declaring and accessing union members, difference between structure and union
Unit-VI Graphics in C	6a. Explain the given graphics component in 'C' with examples. 6b. Describe the use of the given graphics driver in C programming. 6c. Describe the use of the given in-built graphics functions in 'C'. 6d. Integrate graphics and 'C' to design the given geometric shapes/ objects.	6.1 Computer graphics overview 6.2 Graphics drivers and graphics mode definition, declaration 6.3 Graphics functions: Shape, colour, style and filling

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:

a. List any five major scientific and medical applications based on 'C' programming.
b. List any five major commercial applications based on 'C' programming.
c. Illustrate various languages based on the concepts of 'C'.

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. Arrange group discussion of students on live day-to- ay problems leading to useful 'C' programming.
g. Arrange spoken tutorial on 'C' programming.
h. Evaluate programming skills through multiple choice questions on 'C' programming.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student assigned to him/her in the beginning of the semester. S/he ought to submit it by the end of the semester to develop the industry oriented COs. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. 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.

In the first four semesters, the micro-project could be group-based. However, in higher semesters, it should 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. A suggestive list is given here. Similar micro-projects could be added by the concerned faculty:

a. **Modern Periodic Table using 'C'** - Prepare a periodic table using functions:
Void add() and Void show()
b. **Simple Calculator** - Prepare a menu driven program to perform any five mathematical operations.
c. **Employee Record System** - Prepare a menu driven program to perform following operations :
   i. Add record
   ii. List record.
d. **Digital clock using 'C'**
e. **String Manipulation project** - Prepare a menu driven program to perform following operations (any five) :
   i. Substrings
   ii. Palindromes
   iii. Comparison
   iv. Reverse string
   v. String to integer
   vi. Sort a string.

f. **Matrix Operations** - Prepare a menu driven program to perform following operations:
   i. Matrix addition
   ii. Matrix multiplication
   iii. Matrix transpose
   iv. Sum of diagonal of a matrix.

g. **Basic mathematic functions** - Prepare a menu driven program to perform following operations:
   i. Pascal triangle
   ii. Armstrong No.
   iii. Floyd's triangle
   iv. HCF and LCM.

h. **Patterns** - Prepare a menu driven program to obtain following patterns :

```
1          1          *          1
121        12         **         2 2
12321      123        ***        3 3 3
1234321    1234       **         4 4 4 4
                      *
```

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Programming in 'C'	Balguruswamy, E.	Tata Mc-Graw Hill, New Delhi, 2008, ISBN: 978-0070648227
2	Let Us 'C'	Kanetkar, Yashwant P.	BPB Publications 13th Edition, 2016, ISBN: 978-8183331630
3	Programming in 'C': A Practical Approach	Mittal, Ajay	Pearson Education India, New Delhi, 2010, ISBN: 978-8131729342
4	Programming with 'C' (Schaum's Outlines Series)	Gottfried, Byron; Chhabra Jitender	McGraw Hill Education, 2010, ISBN: 978-0070145900
5	'C' Programming Absolute Beginner's Guide	Perry Greg	Pearson Education, 1st edition, 2014, ISBN: 978-9332539570
6	'C': The Complete Reference	Schildt, Herbert	Tata Mc-Graw Hill, New York 2000, ISBN: 978-00072121247

14. SOFTWARE/LEARNING WEBSITES

a. Turbo C Editor
b. Dosbox
c. www.tutorialspoint.com/cprogramming
d. www.cprogramming.com
e. www.programiz.com/c-programming
f. www.w3schools.in/c-tutorial
g. www.fresh2refresh.com/c-programming
h. www.programming-techniques.com
i. www.learn-c.org
j. www.spoken-tutorial.org
k. www.cplus.about.com
l. www.computer.howstuffworks.com/c.htm
m. www.indiastudycenter.com/studyguides/cs/default.asp

Maharashtra State Board of Technical Education, Mumbai

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

Program Name : Diploma in Medical Electronics

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

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

Semester : Third **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	Digital Techniques	DTE	22320	4	-	2	6	3	70	28	30*	00	100	40	25#	10	25	10	50	20	150
2	Electronics Instruments and Measurements	EIM	22331	4	-	2	6	3	70	28	30*	00	100	40	25@	10	25	10	50	20	150
3	Electronics Devices and Circuits	EDC	22346	3	-	4	7	3	70	28	30*	00	100	40	50@	20	50	20	100	40	200
4	Human Anatomy and Physiology	HAP	22347	4	-	2	6	3	70	28	30*	00	100	40	25#	10	25	10	50	20	150
5	Bio-Sensors	BIO	22348	3	2	2	7	3	70	28	30*	00	100	40	25@	10	25	10	50	20	150
6	Computer Hardware and Networking	CHN	22029	1	-	2	3	--	--	--	--	--	--	--	25@	10	25~	10	50	20	50
			Total	**19**	**2**	**14**	**35**	--	**350**	--	**150**	--	**500**	--	**175**	--	**175**	--	**350**	--	**850**

Student Contact Hours Per Week: **35 Hrs.** Medium of Instruction: **English**

Theory and practical periods of 60 minutes each. Total Marks : **850**

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.**

MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION MUMBAI

Program Name : **Computer and Electronics Engineering Program Group**

Program Code : **CO/CM/CW/DE/EJ/ET/EN/EX/EQ/IE/IS/IC/MU**

Semester : **Third**

Course Title : **Digital Techniques**

Course Code : **22320**

1. RATIONALE

In the present scenario most of the electronic equipment like computers, mobiles, music systems, ATM, automation and control circuits and systems are based on digital circuits which the diploma electronic engineering passouts (also called technologists) have to test them. The knowledge of basic logic gates, combinational and sequential logic circuits using discrete gates as well as digital ICs will enable the students to interpret the working of equipment and maintain them. After completion of the course, students will be able to develop digital circuits based 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:

- **Build/ test digital logic circuits consist of digital ICs.**

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 number system and codes for interpreting working of digital system.
b. Use Boolean expressions to realize logic circuits.
c. Build simple combinational circuits.
d. Build simple sequential circuits.
e. Test data converters and PLDs in digital electronics systems.

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 teaching 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.

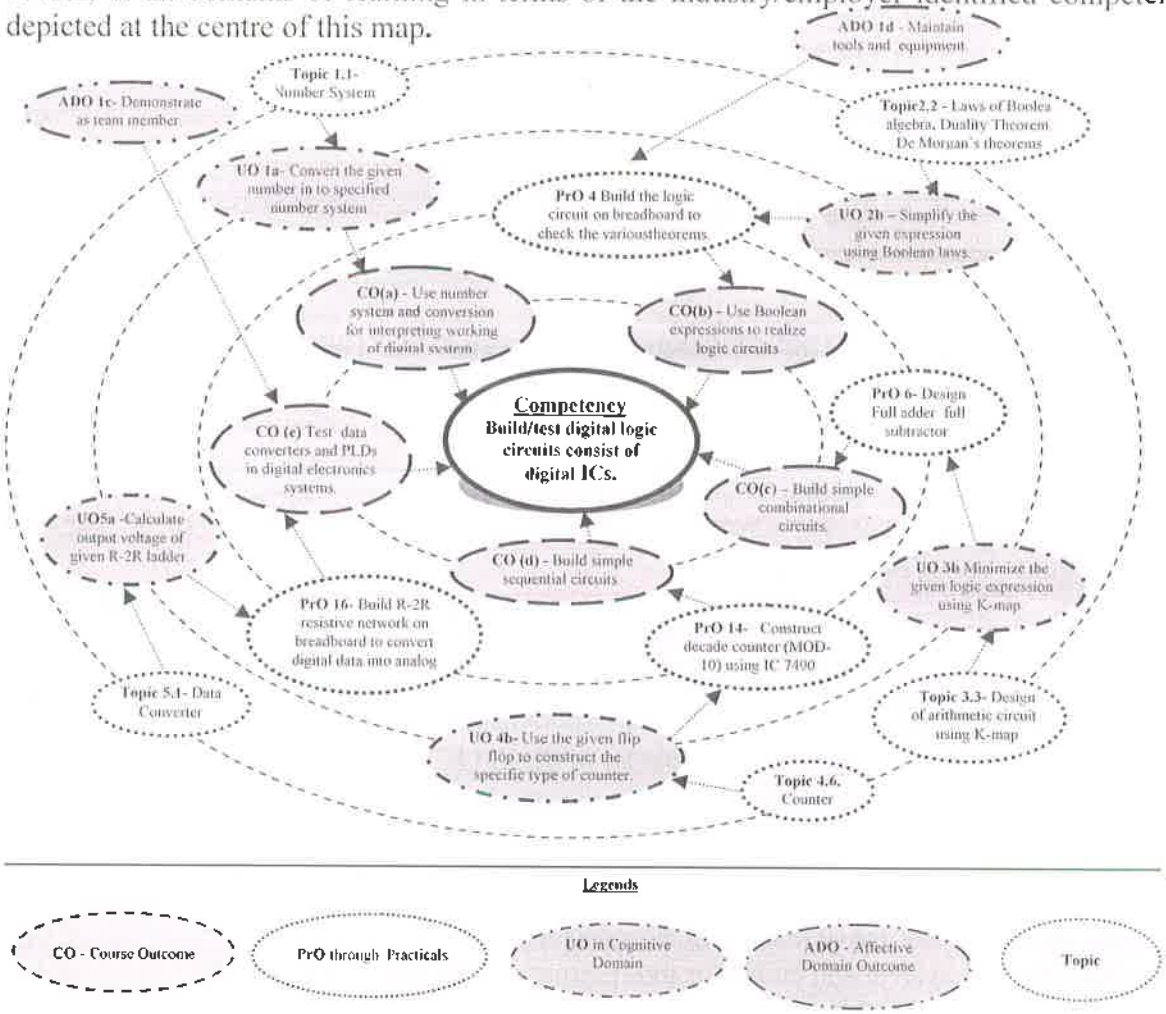

Figure 1 - Course Map

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	Test the functionality of specified logic gates using breadboard. (IC 7404, 7408, 7432, 7486)	II	02*
2	Test the functionality of NAND and NOR gate of using breadboard (IC 7400 and 7402)	II	02
3	Construct AND, OR, NOT gates using universal gates.	II	02
4	Build the logic circuit on breadboard to check the De Morgan's theorems.	II	02
5	Design Half adder and Half subtractor using Boolean expressions.	III	02*
6	Design Full adder and full subtractor.	III	02
7	Construct and test BCD to 7 segment decoder using IC 7447/ 7448.	III	02
8	Build / test function of MUX 74151/74153 any other equivalant.	III	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
9	Build / test function of DEMUX 74155/74154/any other equivalant.	III	02
10	Build / test function of RS flip flop using NAND Gate.	IV	02*
11	Build / test function of MS JK flip flop using 7476.	IV	02
12	Use IC 7476 to construct and test the functionality of D and T flip flop.	IV	02
13	Implement 4 bit ripple counter using 7476.	IV	02
14	Use IC 7490 to construct decade counter (MOD-10).	IV	02
15	Implement 4 bit universal shift register.	IV	02
16	Build R-2R resistive network on breadboard to convert given digital data into analog.	V	02*
		Total	**32**

Note

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

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

S. No.	Performance Indicators	Weightage in %
a.	Preparation of experimental 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

- '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. S. No.
1	Digital Multimeter: 3 and ½ digit with R, V, I measurements, diode and BJT testing.	All
2	CRO : Dual Channel, 4 Trace CRT / TFT based Bandwidth 20 MHz/30 MHz X10 magnification 20 ns max sweep rate, Alternate triggering Component tester and with optional features such as Digital Read out.	16
3	Pulse Generator: TTL pulse generator	10-15
4	DIGITAL IC tester: Tests a wide range of Analog and Digital IC's such as 74 Series, 40/45 Series of CMOS IC's.	1-15
5	Bread Board Development System: Bread Board system with DC power output 5V, +/-12V and 0-5V variable , digital voltmeter , ammeter, LED indicators 8 no, logic input switches 8 no, 7 segment display 2 no, clock generator, Manual pulser, Breadboard with about 1,600 points, Potentiometer, relay etc	1-15
6	Trainer kits for digital ICs: Trainer kit shall consists of digital ICs for logic gates, flop-flop, shift registers, counter along with toggle switches for inputs and bi-colour LED at outputs, built in power supply.	1-15
7	Regulated power supply: Floating DC Supply Voltages Dual DC : 2 x 0 -30V; 0-2 A Automatic Overload (Current Protection) Constant Voltage and Constant Current Operation Digital Display for Voltage and Current Adjustable Current Limiter Excellent Line and Load Regulation	1-16
8	Trainer kit for 4 bit Counter using Flip Flops: 4 bit ripple counter, Synchronous Counter, IC 7476 based circuit. Input given by switches and output indicated on LED. Facility to select MOD 8 or MOD 16 mode. Built in DC power supply and manual pulser with indicator.	13

8. UNDERPINNING THEORY COMPONENTS

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

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Number System and Codes	1a. Convert the given number into the specified number system. 1b. Perform the binary arithmetic operation on the given binary numbers. 1c. Convert the given coded number into the other specified code.	1.1 Number System: base or radix of number system, binary, octal, decimal and hexadecimal number system. 1.2 Binary Arithmetic: Addition, subtraction, multiplication, division. 1.3 Subtraction using 1's complement and 2's complement. 1.4 Codes: BCD, Gray Code, Excess-3, and ASCII code.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	1d. Add the given two decimal numbers using BCD code.	1.5 BCD Arithmetic: BCD Addition
Unit – II Logic gates and logic families	2a. Develop the basic gates using the given NAND/NOR gate as universal gate. 2b. Simplify the given expression using Boolean laws. 2c. Develop logic circuits using the given Boolean expressions. 2d. Compare the salient characteristics of the given digital logic families.	2.1 **Logic gates**: Symbol, diode/ transistor switch circuit and logical expression , truth table of basic logic gates (AND, OR, NOT), Universal gates (NAND and NOR) and Special purpose gates (EX-OR, EX-NOR),Tristate logic 2.2 **Boolean algebra**: Laws of Boolean algebra, Duality Theorem, De-Morgan's theorems 2.3 **Logic Families**:Characteristics of logic families : Noise margin, Power dissipation, Figure of merit , Fan-in and fan-out, Speed of operation, Comparison of TTL, CMOS, types of TTL NAND gate
Unit– III Combinational Logic Circuits	3a. Develop logic circuits in standard SOP/ POS form for the given logical expression. 3b. Minimize the given logic expression using K-map. 3c. Use IC 7483 to design the given adder/ subtractor. 3d. Draw MUX/DEMUX tree for the given number of input and output lines. 3e. Write the specifications of the component for the given application. 3f. Develop the specified type of code converter.	3.1 **Standard Boolean representation:** Sum of Product (SOP) and Product of Sum(POS), Min-term and Max-term, conversion between SOP and POS forms, realization using NAND /NOR gates 3.2 **K-map reduction technique for the Boolean expression:** Minimization of Boolean functions up to 4 variables (SOP and POS form) 3.3 **Design of arithmetic circuits and code converter using K-map:** Half and full Adder, half and full Subtractor , gray to binary and binary to gray (up to 4 bits) 3.4 **Arithmetic circuits:** (IC 7483) Adder and Subtractor, BCD adder 3.5 **Encoder/Decoder:** Basics of encoder, decoder, comparison, (IC 7447) BCD to 7 segment decoder/driver 3.6 **Multiplexer and Demultiplexer:** working , truth table and applications of Multiplexers and Demultiplexures, MUX tree, IC 74151as MUX; DEMUX tree, DEMUX as decoder, IC 74155 as DEMUX 3.7 **Buffer:** Tristate logic, unidirectional and bidirectional buffer (74LS244,74LS245)

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit– IV Sequential Logic Circuit	4a. Use relevant triggering technique for the given digital circuit. 4b. Use the given flip-flop to construct the specific type of counter. 4c. Use excitation table of the given flip-flop to design synchronous counter. 4d. Design the specified modulo-N counter using IC7490. 4e. Construct ring/ twisted ring counter using the given flip-flop.	4.1 **Basic memory cell**: RS-latch using NAND and NOR 4.2 **Triggering Methods:** Edge trigger and level trigger 4.3 **SR Flip Flops**: SR-flip flop, clocked SR flip flop with preset and clear, drawbacks of SR flip flop 4.4 **JK Flip Flops**: Clocked JK Flip flop with preset and clear, race around condition in JK flip flop, Master slave JK flip flop, D and T type flip flop Excitation table of flip flops, Block schematic and function table of IC-7474, 7475 4.5 **Shift Register**: Logic diagram of 4-bit Shift registers – Serial Input Serial Output, Serial Input Parallel Output, Parallel Input Serial Output, Parallel Input Parallel Output, 4 Bit Universal Shift register **4.6 Counters:** Asynchronous counter: 4 bit Ripple counter, 4 bit up/down Counter, modulus of counter Synchronous counter: Design of 4 bit synchronous up/down counter Decade counter: Block schematic of IC 7490 Decade counter, IC 7490 as MOD-N Counter, Ring counter, Twisted ring counter
Unit– V Data Converters and PLDs	5a. Calculate the output voltage of the R-2R ladder for the given specified digital input. 5b. Calculate the output voltage of the weighted resistor DAC for the given specified digital input. 5c. Explain with sketches the working principle of the given type of ADC. 5d. Explain with sketches the working principle of the given types of memories. 5e. Explain with basic block diagram the working principle of the given type of programmable logic device.	5.1 **Data Converter**: DAC: Types, weighted resistor circuit and R-2R ladder circuit, DAC IC 0808 specifications ADC: Block Diagram, types, and working of Dual slope ADC, SAR ADC, ADC IC 0808/0809, specification 5.2 **Memory**: RAM and ROM basic building blocks, read and write operation ,types of semiconductor memories 5.3 **PLD:** Basic building blocks and types of PLDs. PLA, PAL, GAL 5.4 CPLD: Basic Building blocks, functionality.

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	Number System	06	2	2	4	08
II	Logic gates and logic families	10	4	4	4	12
III	Combinational Logic Circuits	16	4	6	8	18
IV	Sequential Logic Circuit	16	4	6	8	18
V	Data Converters and PLDs	16	4	4	6	14
Total		**64**	**18**	**22**	**30**	**70**

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

10. SUGGESTED STUDENT ACTIVITIES

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

a. Prepare the survey report on the applications of different types of number system and code converters used in the design of digital system.
b. Compare technical specifications and applications of various types of memory, PLDs, CPLDs and Prepare report.
c. Test digital IC's using various testing equipment like digital IC tester, Digital multi-meter etc.
d. Give seminar on any course relevant topic.
e. Conduct library / internet survey regarding different data sheet and manuals.
f. Prepare power point presentation on digital circuits and their applications.
g. Undertake a market survey of different digital IC's required for different applications.
h. Search for video / animations / power point presentation on internet for complex topic related to the course and make a presentation.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

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

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

e. Guide student(s) in undertaking micro-projects.
f. PPTs/Animations may be used to explain the construction and working of electronic circuits.
g. Guide students for using data sheets / manuals.

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

a. Build a Digital IC tester circuit.
b. Build a 4bit parity generator and parity checker circuit.
c. Build a circuit to implement 4 bit adder.
d. Build a circuit to test 7 segment display.
e. Build a circuit to implement debounce switch.
f. Build a circuit for LED flasher.
g. Build a circuit for LED BAR display
h. Design and analyze digital arithmetic circuit

Note: *Use general purpose PCB for making micro projects*

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Modern Digital Electronics	Jain, R.P.	McGraw-Hill Publishing, New Delhi, 2009 ISBN: 9780070669116
2	Digital Circuits and Design	Salivahanan S.; Arivazhagan S.	Vikas Publishing House, New Delhi, 2013, ISBN: 9789325960411
3	Digital Electronics	Puri, V.K.	McGraw Hill , New Delhi, 2016, ISBN: 97800746331751
4	Digital Principles	Malvino, A.P.; Leach, D.P.; Saha G.	McGraw Hill Education, New Delhi, 2014, ISBN : 9789339203405
5	Digital Design	Mano, Morris; Ciletti, Michael D.	Pearson Education India, Delhi, 2007, ISBN: 9780131989245
6	Digital Electronics, Principles and Integrated Circuits	Maini, Anil K.	Wiley India, Delhi, 2007, ISBN: 9780470032145

S. No.	Title of Book	Author	Publication
7	Digital Fundamentals	Floyd, Thomas	Pearson Education India, Delhi, 2014, ISBN : 9780132737968

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. www.cse.yorku.ca/~mack/1011/01.NumberSystems.ppt
b. www.people.sju.edu/~ggrevera/arch/slides/binary-arithmetic.ppt
c. www.mathsisfun.com/binary-number-system.html
d. www.codesandtutorials.com/hardware/electronics/digital_codes-types.php
e. www.ee.surrey.ac.uk/Projects/Labview/gatesfunc/
f. www.ee.surrey.ac.uk/Projects/Labview/boolalgebra/
g. www.eng.auburn.edu/~strouce/class/elec2200/elec2200-8.pdf
h. www.maxwell.ict.griffith.edu.au/yg/teaching/dns/dns_module3_p3.pdf
i. www.scs.ryerson.ca/~aabhari/cps213Chapter5.ppt
j. www.eng.wayne.edu/~singhweb/seql.ppt
k. www.cs.sjsu.edu/faculty/lee/Ch2Problems2.ppt
l. www.rogtronics.net/files/datasheets/dac/SedraSmith.pdf
m. www-old.me.gatech.edu/mechatronics_course/ADC_F04.ppt
n. www.allaboutcircuits.com/vol_4/chpt_13/3.html
o. www.youtube.com/watch?v=5Wz5f3n5sjs
p. www.eee.metu.edu.tr/~cb/e447/Chapter%209%20-%20v2.0.pdf
q. www2.cs.siu.edu/~hexmoor/classes/CS315-S09/Chapter9-ROM.ppt
r. www.cms.gcg11.org/attachments/article/95/Memory2.ppt
s. www.cosc.brocku.ca/Offerings/3P92/seminars/Flash.ppt
t. www.webopedia.com/TERM/R/RAM.html
u. www.cs.sjsu.edu/~lee/cs147/Rahman.ppt

Program Name : **Digital Electronics, Medical Electronics and Instrumentation Engineering Program Group**

Program Code : **DE/IE/IS/IC/MU**

Semester : **Third**

Course Title : **Electronic Instruments and Measurement**

Course Code : **22331**

1. RATIONALE

Diploma pass outs (also called as technologists) should be able to measure various electrical and electronic parameters in industry using relevant instruments. This course is designed to provide the basic understanding about the concepts, principles and procedures of analog and digital electronic measuring instruments. Students will be able to use the various electronic measuring instruments for fault finding in the industry.

2. COMPETENCY

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

- **Use basic electrical and electronic instruments for measuring various parameters.**

3. COURSE OUTCOMES (COs)

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

a. Use relevant type of measuring instruments for different applications.
b. Use analog meters to measure electrical parameters.
c. Use digital meters to measure electrical parameters.
d. Use CRO and signal generator to measure electrical parameters.
e. Use AC and DC bridges to measure electrical parameters.

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, ELOs 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.

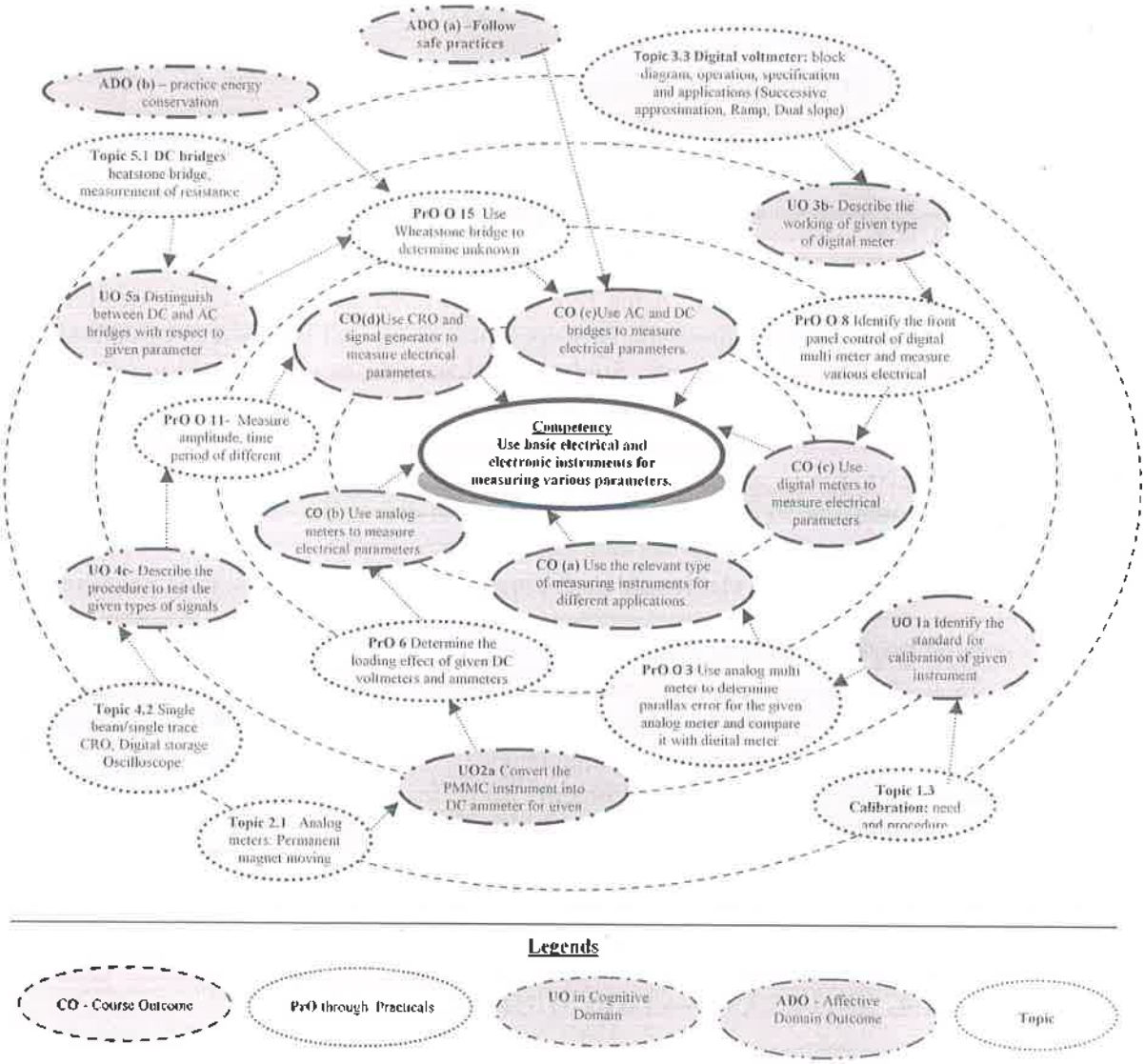

Figure 1 - Course Map

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 analog multi meter to determine accuracy, resolution and hysteresis.	I	02*
2	Calibrate the analog multi meter by comparing with given standard instrument.	I	02
3	Use analog multi meter to determine parallax error for the given analog meter and compare it with digital meter	I	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
4	Convert basic PMMC movement of 1mA into DC voltmeter for measuring 5V, 10V, 15V.	II	02
5	Convert basic PMMC movement of 1mA into DC ammeter for measuring 10mA, 50mA, 100mA	II	02*
6	Determine the loading effect of given DC voltmeters and ammeters	II	02
7	Use LCR meter to calculate the value of resistance, Inductance, capacitance and compare those with component codes.	III	02
8	Identify the front panel control of digital multi meter and measure various electrical parameters using DMM	III	02*
9	Use analog multi meter to determine accuracy, resolution and hysteresis loop of given digital meter.	III	02
10	Identify the front panel control of logic Analyzer and Test the given digital circuit	III	02
11	Measure amplitude, time period of different signals generated by function generator using CRO.	IV	02*
12	Measure unknown frequency and phase difference with respect to given signal using Lissajous pattern	IV	02
13	Identify the front panel control of DSO and measure various parameters of applied signal	IV	02
14	Identify the front panel control of Spectrum Analyzer and determine frequency content of given signal.	IV	02
15	Use Wheatstone bridge to determine unknown resistance	V	02*
16	Use Maxwell Bridge to determine unknown inductance.	V	02
17	Use Schering Bridge to determine unknown capacitance.	V	02
18	Measure intensity of bulb available in the laboratory using Lux meter.	III	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 setup	20
2.	Setting and operation	20
3.	Safety measures	10
4.	Observation and recording	10
5.	Interpretation of result and conclusion	20
6.	Answer to sample questions	10
7.	Submission of report in time	10
	Total	**100**

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

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

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

- 'Valuing Level' in 1st year
- 'Organising Level' in 2nd year
- 'Characterising Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specification mentioned here will use 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	Analog multi meter 1mA, 500 ohms.	1,2,3
2	Digital Multi meter 4 ½ digit display	2,3,8,9
3	Voltmeter 0-10V,0-50V,0-100V,0-300V	3,4,6
4	Ammeter 0-100mA, 0-50μA,0-1mA	3,5
5	LCR meter 20Hz – 2MHz	5
6	Cathode ray Oscilloscope single beam dual trace 0-30 MHz	11,12
7	Function generator 0-2MHz, 0-3MHz	11,12, 14,16, 17
8	Digital Storage Oscilloscope 60 MHz bandwidth	13
9	Logic Analyzer: 32 channel	10
10	Spectrum Analyzer: Heterodyne type 3GHz	14
11	Lux Meter range 400.0/4000 lux sensor diameter 2 to 2 inch, Accuracy 5%, memory 16000 reading, resolution 100 lux, foot candle resolution 0.1 fc. Display type- numeric	18

8. UNDERPINNING THEORY COMPONENTS

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

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Fundamentals of measure	1a. Identify the standard for calibration of the given instrument with justification. 1b. Classify the given measuring instruments.	1.1 Measurement: Concept , units of measurement of fundamental quantities, standard and their classification, Static and

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
ments	1c. Determine static and dynamic characteristics of the measuring instruments with the given data. 1d. Explain with sketches the generalized procedure for calibration of the given device.	dynamic characteristics, types of errors 1.2 Classification of instruments: (i) absolute and secondary instruments, (ii) analog and digital instruments, (iii) mechanical, electrical and electronic instruments 1.3 Calibration: need and procedure
Unit– II Analog meters	2a. Explain with sketches the construction and working principle of the given permanent magnet moving coil (PMMC) instrument with sketches. 2b. Describe with sketches the procedure to convert the PMMC instrument into DC ammeter for the given range. 2c. Describe with sketches the procedure to convert the PMMC instrument into DC voltmeter for the given range. 2d. Explain with sketches the working of given type of ohm meter. 2e. Explain with sketches the working of given type of AC voltmeter. 2f. Prepare specification for given analog meters.	2.1 Permanent magnet moving coil (PMMC) and Permanent magnet moving iron (PMMI) meter their construction, principle, working, salient features 2.2 DC Ammeter: Basic, Multi range, Universal shunt/Ayrton, simple numerical based on R_{sh} 2.3 DC Voltmeter: Basic, Multi range, simple numerical based on R_s, concept of loading effect and sensitivity 2.4 Ohm meter: Series and shunt 2.5 AC voltmeter: Rectifier type (half wave and full wave)
Unit– III Digital Meters	3a. Determine resolution, sensitivity and accuracy of the given digital display. 3b. Explain with sketches the working of given type of digital meter. 3c. Explain with sketches the construction and working of the given types of digital meters. 3d. Describe with sketches the procedure to measure the given electric parameter using the relevant type of digital meter. 3e. Describe with sketches the procedure to test the given digital circuits using logic analyser. 3f. Prepare specification for given digital instrument.	3.1 Resolution, sensitivity and accuracy of digital Instruments. 3.2 Digital frequency meter, Digital multi meter, LCR-Meter, Lux Meter, Logic Analyser: block diagram, operation, specification and applications 3.3 Digital voltmeter: block diagram, operation, specification and applications (Successive approximation, Ramp, Dual slope)
Unit-IV CRO and signal generato	4a. Describe the given blocks and working of given type of oscilloscope with sketches. 4b. Describe with sketches the procedure to measure the given parameter using the	4.1 Single beam/single trace CRO, Digital storage Oscilloscope: Basic block diagram, working, Cathode ray tube, electrostatic deflection, vertical amplifier,

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
rs	CRO. 4c. Describe with sketches the working of given type of type of signal/function generator with sketches. 4d. Describe with sketches the procedure to test the given type of signal using the relevant type of function generator/signal generator/CRO. 4e. Select CRO/ DSO, Spectrum analyzer and function generator for the given application. 4f. Prepare specification for given instrument.	time base generator, horizontal amplifier, attenuator, delay line and specifications. 4.2 CRO Measurements: voltage, time period, frequency, phase angle, Lissajous pattern. 4.3 Signal generator: need, working and Basic block diagram 4.4 Function generator: need, working and basic block diagram and specifications. 4.5 Spectrum analyzer: Basic block diagram, operation , specification and applications.
Unit –V DC and AC bridges	5a. Explain with sketches the the working of the given type of bridge with sketches. 5b. Describe with sketches the procedure to measure given unknown resistance using the relevant type of bridge with sketches 5c. Describe with sketches the procedure to measure given unknown capacitance using relevant type of bridge with sketches. 5d. Describe with sketches the procedure to measure given unknown inductance value using relevant type of bridge with sketches.	5.1 DC bridges: Wheatstone bridge, measurement of resistance 5.2 AC bridges: Use of Schering bridge, Maxwell bridge, Hays bridge

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 measurements	08	02	02	04	08
II	Analog meters	16	04	06	08	18
III	Digital meters	14	02	06	10	18
IV	CRO and Signal generator	18	02	06	10	18
V	DC and AC bridges	08	02	02	04	08
Total		**64**	**12**	**22**	**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. Compile broad specification of DSO, LCR meter, logic analyzer, Spectrum analyser using data sheets and handbook.
b. Develop a report after performing market survey of electronic instruments used in the laboratory.
c. Prepare a chart of static and dynamic characteristics of the instrument/equipment available in the laboratory.
d. Prepare chart to display types of Units.
e. Prepare chart to display front panel control of DSO, LCR meter, Logic analyser and Spectrum analyser
f. Visit nearby institutes, exhibition and industries to collect information about electronic instruments.
g. Assist to the technicians who are doing repair or maintenance work of electronic instruments.
h. Prepare instruction chart for safe handling of electronic instruments

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

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

a. Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b. ***'L' in item No. 4*** does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
c. About ***15-20% of the topics/sub-topics*** which is relatively simpler or descriptive in nature is to be given to the students for ***self-directed learning*** and assess the development of the COs through classroom presentations (see implementation guideline for details).
d. With respect to item No.10, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
e. Guide student(s) in undertaking micro-projects.
f. Video programs/YouTube may be used to teach various topics and sub topics.
g. Demonstrate set-up arrangement to the students thoroughly before they start doing the practical.
h. Encourage students to refer different book and websites to have deeper understanding of the subject.
i. Observe continuously and monitor the performance of students in Lab.
j. Encourage students to use front/rear panel control of electronic instruments.
k. Encourage students to visit nearby electronic instruments repair workshop units or manufacturing industries.

l. Instruct students to safety concern of handling electronic instruments and also to avoid any damage to the electronic instruments.

12. SUGGESTED MICRO-PROJECTS

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

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

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

a. Prepare a report on market survey of Dual beam CRO, Dual trace CRO, Sampling Oscilloscope, DSO, function generator, logic analyzer and LCR meter.(technical specification and manufacturers).
b. Build and test given power supply using CRO and DMM.
c. Build, test and commission Wheatstone bridge using LDR / thermistor / RTD / potentiometer.
d. Find the fault in the given laboratory electronic measuring instrument.
e. Build, test and commission Schering Bridge using LDR / thermistor / RTD / potentiometer.
f. Build the circuit of LED bulb using white LED arrays and measure its intensity using lux meter.
g. Take two similar circuit board. One is faulty another is in working condition. Test both circuit boards using component test function on CRO/DSO and find out the faulty component in faulty circuit.
h. Take laminated copper wire and construct inductor and measure inductance using LCR meter. Now change the number of turns and test different inductors.
i. Take copper clad and form capacitor by etching copper clad and measure the capacitance using LCR meter.
j. Construct voltage Doubler /trippler circuit and measure voltage at every capacitor using CRO.
k. Build and test function generator using IC (eg.ICL8038, MAX038, XR2206 etc.).

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Electronic Instrumentation	Kalsi, H.S.	Mc Graw Hill Education, New Delhi, 2010 ISBN:9780070702066
2	Electronic Measurement and instrumentation	Sedha, R.S.	S Chand and Company, New Delhi , 2012 ISBN: 9788121997751
3	Electronic instruments and	Anand, M.M.S.	PHI Learning., New Delhi.2004

S. No.	Title of Book	Author	Publication
	instrumentation Technology		ISBN: 9788120324541
4	A course in electrical and electronic measurement and instrumentation	Sawhney, A.K.	Dhanpat Rai and Company, New Delhi, 2005 ISBN-13: 978-8177000160
5	Electronic Measurement and instrumentation	Rajput, R.K.	S Chand and Company, New Delhi , 2008 ISBN: 9788121929172
6	Electronic instrumentation and Measurement	Khurana, Rohit.	Vikas Publications House. New Delhi, ISBN: 9789325990203
7	Electronic instrumentation and Measurement	Bell, David A.	Oxford University Press, New Delhi, 2013; ISBN: 9780195696141
8	Elements of electronic instrumentation and measurements	Carr, Joseph J.	Pearson Education ,New Delhi, 2003 ISBN: 9788131712115

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. www.nptel.iitg.ernet.in/courses/Elec.engg/IIT%20Bombay/electrical/%20and
b. www.electrical4u.com/permanent-magnet-moving-coil-instrument/
c. www.electrical4u.com/digital-frequency-meter/
d. www.electrical4u.com/digital-multimeter/
e. www.electrical4u.com/wheatstone-bridge-circuit-theory-and-principle/
f. www.electrical4u.com/maxwell-bridge-inductance-capacitance-bridge/
g. www.electrical4u.com/hays-bridge-circuit-theory-phasor-diagram-advantages-applications/
h. www.electrical4u.com/schering-bridge-measurement-of-capacitance-using-schering-bridge/
i. www.electrical4u.com/cathode-ray-oscilloscope-cro/
j. www.nprcet.org/eee/document/MI.pdf
k. web.mst.edu/~cottrell/ME240/Resources/basic_inst/Basic_Instrumentation.pdf

Program Name : **Diploma in Medical Electronics**

Program Code : **MU**

Semester : **Third**

Course Title : **Electronic Devices and Circuits**

Course Code : **22346**

1. RATIONALE

The past decades have witnessed several exciting technological developments in the field of medical electronics. Large numbers of solid state devices have been used to design various circuits in medical electronics. For learners this course imparts a sound understanding of electronic devices and circuits like amplifiers, oscillators, regulators and plays a vital role in developing skills needed to become a medical electronics professional in healthcare industry.

2. COMPETENCY

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

- **Maintain regulated power supplies, amplifiers and oscillator 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. Select the relevant configuration of transistor.
b. Use the relevant biasing circuit in the transistorised amplifier circuit.
c. Use transistor(s) for amplification of signals
d. Troubleshoot oscillator/ amplifier circuits.
e. Build various wave shaping circuits.
f. Troubleshoot voltage regulator circuits.

4. TEACHING AND EXAMINATION SCHEME

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

(*): 10 marks of theory PA is for micro-project assessment to facilitate attainment of COs and the remaining 10 marks for tests and assignments given by the teacher.
***Legends:** L-Lecture; T – Tutorial/Teacher Guided Theory Practice; P -Practical; C – Credit, ESE -End Semester Examination; PA - Progressive Assessment*

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

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

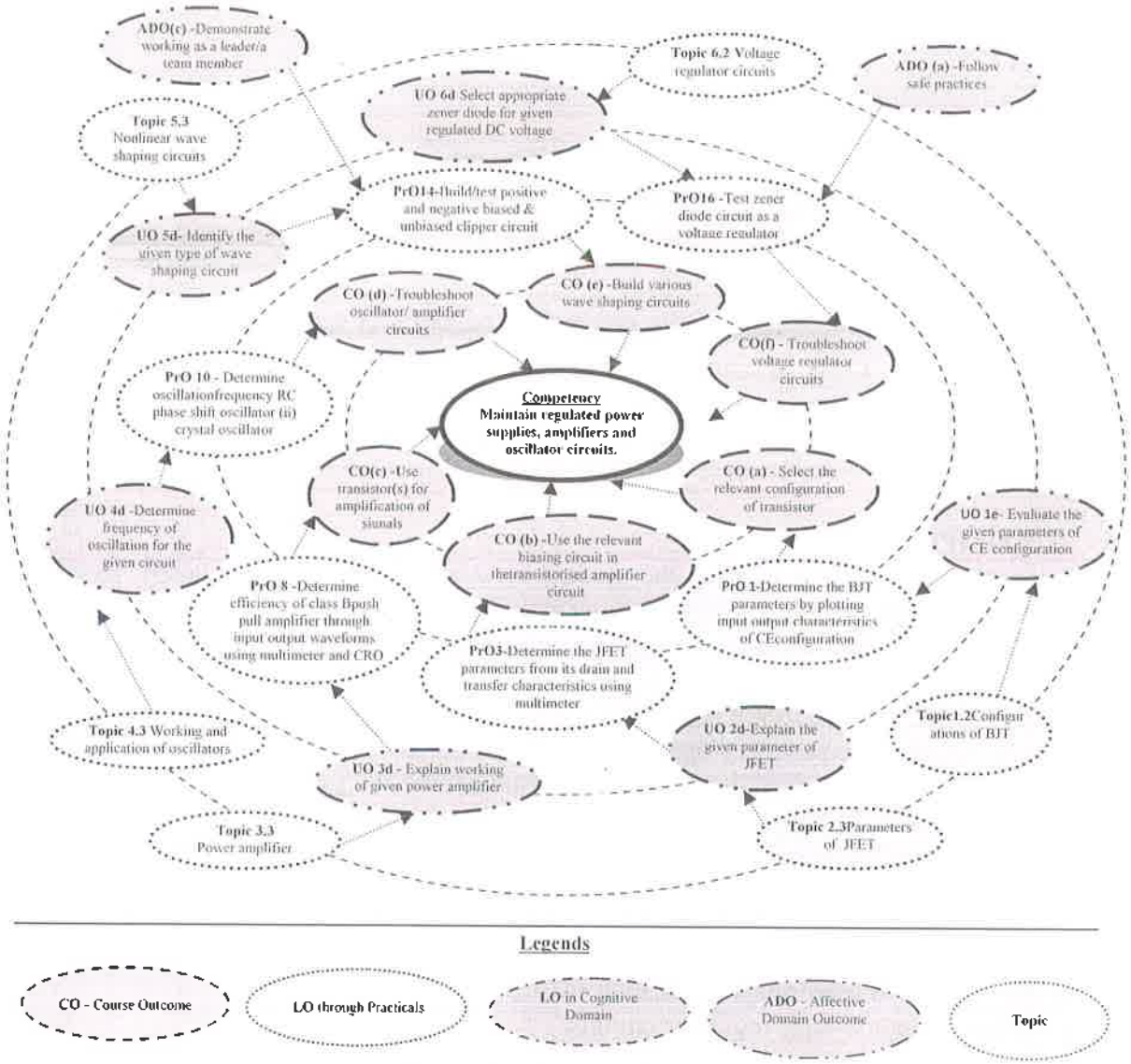

Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

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

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Determine the BJT parameters by plotting input output characteristics of common emitter configuration – Part I	I	02*
2	Determine the BJT parameters by plotting input output characteristics of common emitter configuration.– Part II	I	02
3	Use BJT as a switch to turn on/off LED,	I	02
4	Determine the JFET parameters from its drain and transfer characteristics using multimeter. – Part I	II	02*
5	Determine the JFET parameters from its drain and transfer characteristics using multimeter. – Part II	II	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
6	Determine the EMOSFET parameters from its drain and transfer characteristics using multimeter. – Part I	II	02*
7	Determine the EMOSFET parameters from its drain and transfer characteristics using multimeter. – Part II	II	02
8	Identify the negative resistance region by plotting V-I characteristics of UJT using multimeter.	II	02
9	Determine gain and bandwidth of amplifier by plotting frequency response of single stage CE amplifier using CRO and function generator.– Part I	III	02*
10	Determine gain and bandwidth of amplifier by plotting frequency response of single stage CE amplifier using CRO and function generator. – Part II	III	02
11	Use CRO and function generator to Determine gain and bandwidth of two stage RC coupled BJT amplifier from its frequency response. – Part I	III	02
12	Use CRO and function generator to Determine gain and bandwidth of two stage RC coupled BJT amplifier from its frequency response.– Part II	III	02
13	Usemultimeter and CRO to Determine efficiency of class B push pull amplifier through input and output waveforms. – Part I	III	02
14	Usemultimeter and CRO Determine efficiency of class B push pull amplifier through input and output waveforms. – Part II	III	02
15	UseCRO and function generatorto Compare bandwidth of amplifier with and without negative feedback from frequency response. – Part I	IV	02*
16	UseCRO and function generatorto Compare bandwidth of amplifier with and without negative feedback from frequency response. – Part II	IV	02
17	Determine oscillation frequency practically of (i) RC phase shift oscillator (ii) crystal oscillator and compare with theoretical value.	IV	02*
18	Determine frequency of UJT relaxation oscillator to verify with theoretical value.	IV	02
19	Build/test RC Integrator circuit for square wave input. – Part I	V	02*
20	Build/test RC Differentiator circuit for square wave input. – Part II	V	02
21	Build/Test positive and negative biased and unbiased clipper circuit.– Part I	V	02*
22	Build/Test positive and negative biased and unbiased clipper circuit.– Part II	V	02
23	Build/Test positive and negative biased and unbiased clamper circuit.– Part I	V	02*
24	Build/Test positive and negative biased and unbiased clamper circuit. – Part II	V	02
25	Test zener diode circuit as a voltage regulator. – Part I	VI	02*
26	Test zener diode circuit as a voltage regulator. – Part II	VI	02
27	Determine the line and load regulation of series voltage regulator	VI	02*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	using multimeter. – Part I		
28	Determine the line and load regulation of series voltage regulator using multimeter. – Part II	VI	02
29	Check Load and Line regulation characteristics of fixed regulator circuit using IC 78XX. – Part I	VI	02*
30	Check Load and Line regulation characteristics of fixed regulator circuit using IC 78XX. – Part II	VI	02
31	Build dual voltage regulator and test input-output voltage. – Part I	VI	02*
32	Build dual voltage regulator and test input-output voltage. – Part II	VI	02
Total			**64**

Note:

i. *A suggestive list of PrOs is given in the above table. More such PrOs can be added to attain the COs and competency. A judicial mix of minimum 24 or more practical need to be performed, out of which, the practicals marked as '*' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.*

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

S. No.	Performance Indicators	Weightage in %
1.	Selection of suitable component(s), device(s) and instrument(s)	10
2.	Preparation of experimental set up	20
3.	Setting and operation	20
4.	Observations and Recording	10
5.	Interpretation of result and Conclusion	20
6.	Answer to sample questions	10
7.	Submission of report in time	10
Total		**100**

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

a. Follow safety practices.
b. Practice good housekeeping.
c. Demonstrate working as a leader/a team member.
d. Maintain equipment and designed circuits.
e. Follow ethical practices.

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

- 'Valuing Level' in 1st year

- 'Organising Level' in 2nd year
- 'Characterising Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTSREQUIRED

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

S. No.	Equipment Name with Broad Specifications	PrO.S.No.
1	Digital multimeter: 3 1/2 digit display, 9999 counts, measures: V_{ac},V_{dc} (1000V max), A_{dc}, A_{ac}(10 amp max),Hz, resistance (0 - 100 MΩ) , capacitance and temperature	1,2,3,4,5, 8, 16, 17, 18 and 19
2	Variable DC power supply: 0- 30V, 2A, short circuit protection, display for voltage and current	1 to11and 14 to19
3	Cathode Ray Oscilloscope: Dual Trace 20 MHz, 1 megaohm input impedance	2 and 6 to 15
4	Function Generator: 0-2 MHz with sine, square and triangular output with variable frequency and voltage	2, 6,7,8,9,12,13, 14and15
5	Electronic Test Bench: Bread Board 840 -1000 contact points, positive and negative power rails on opposite side of the board, 0-30 V, 2 Amp variable DC power supply, Function Generator 0-2 MHz, CRO 0-30 MHz, digital multimeter	All

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 – 1 Bipolar Junction Transistor	1a. Identify terminals of the given BJTfigure with justification. 1b. Compare different configurations of BJT with respect to circuit diagram, and amplification factor. 1c. Evaluate the given parameter of CE configuration. 1d. Select thebiasing circuit of BJT forthe given application with justification. 1e. Determine numerically current amplification factor for the given data of the amplifier.	1.1 Fundamentals of BJT:Types of BJT, construction, symbol and operation 1.2 Configurations of BJT: CB,CE ,CC and their current amplification factors,input output characteristics of CE with their parameters, BJT as switch 1.3 BJT biasing: DC loadline, biasing, stabilization,thermal runaway,biasing circuits: i. Fixed bias ii. Voltage divider bias

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit– II FET and UJT	2a. Compare the given parmenters/features of the BJT with FET 2b. Describe with sketches the construction of agiven type of FET. 2c. Explain with sketches the working principle of the given type of transistor. 2d. Explain with sketches the given parameter of the JFET. 2e. Use the relevant FET biasing circuit for the given application. 2f. Explain with sketches the working principle of the given transistor in order to understand its application.	2.1 Field Effect Transistors:Types,construction and applications 2.2 Working principle and characteristics of: JFET,EMOSFET, DMOSFET, ISFET and UJT 2.3 Parameters of JFET:DC drain resistance.amplification factor,transconductance 2.4 FET biasing : i. Self-bias ii. Voltage divider bias
Unit– III Amplifier	3a. Explain with sketches operation of the given type of transistor as small signal amplifier. 3b. Explain with sketches working of the given type of power amplifier. 3c. Determine the gain and bandwidth of thegiven type amplifier circuit from the frequency response. 3d. Identify the relevant type of amplifier for the given use with justification.	3.1 Small signal amplifier: Amplifier concept, single stage BJT CE amplifier, FET CS amplifier,frequency response 3.2 Multistage amplifier: Types of coupling:RC coupling, Transformer coupling, Direct coupling 3.3 Power amplifiers:Class A,class B, class AB and class C 3.4 Operation: Class A transformer coupled amplifier,class B push pull amplifier
Unit-IV Feedback Amplifiers and Oscillators	4a. Identify the type of feedback connections for the given circuit with justification. 4b. Derive the gain expression for the given feedback amplifier. 4c. Select a particular type of oscillator for the given application with justification. 4d. Determinefrequency of oscillation for the given circuit.	4.1 Types of feedback: Gain expression with block diagram 4.2 Types of feedback connections:Voltage shunt,voltage series, current shunt and current series 4.3 Oscillator concept: Barkhausen's criteria for sustained oscillation 4.4 Working and application: RC phase shift oscillator, crystal oscillator(using BJT),UJT relaxation oscillator.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit –V Wave Shaping Circuit	5a. Design the circuit to generate the desired waveform. 5b. Compare the salient features of the given type ofintegrator anddifferentiator. 5c. Identify the given type ofwave shaping circuit in the given figure with justification. 5d. Sketch the output waveform of wave shaping circuit for the given input.	5.1 Wave shaping circuits: Need,comparison between linear and non-linear circuits 5.2 Linear wave shaping circuits: RC integrator and differentiator 5.3 Non linear wave shaping circuits: clippers and clampers
Unit-VI DC Voltage Regulator	6a. Select relevantzenerdiode for the given regulated DC voltage. 6b. Distinguish between transistorised shunt and series voltage regulator on the basis of given criteria. 6c. Design the regulated power supply using using IC 78XX and 79XX for a given value of voltage. 6d. Design zener diode as a voltage regulator for the given value of voltage.	6.1 Regulators:Block diagram of regulated power supply,load and line regulation 6.2 Voltage regulator circuits: Zener diode as voltage regulator, transistorised shunt and series voltage regulator 6.3 Regulator ICs: Fixed and variable DC voltage regulators using IC 78XX and 79XX

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 FORQUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Bipolar Junction Transistor	10	04	06	04	14
II	FET and UJT	08	02	04	04	10
III	Amplifier	10	02	04	08	14
IV	Feedback Amplifiers and Oscillators	06	02	04	04	10
V	Wave Shaping Circuit	08	02	04	06	12
VI	DC Voltage Regulator	06	02	04	04	10
Total		**48**	**14**	**26**	**30**	**70**

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

10. SUGGESTED STUDENT ACTIVITIES

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

a. Prepare power point presentation or animation showing working of transistors, amplifiers, oscillators and regulators.
b. Simulate simple amplifier, oscillator and regulator circuits using open source software.
c. Undertake a market survey of different devices covered in curriculum based on the following points:
    i. Manufacturer
    ii. Specifications/ratings
    iii. Salient features
    iv. Applications

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. Encourage students to refer different websites to have deeper understanding of the course.
b. Observe continuously and monitor the performance of students in Lab.
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. Use animations to explain the construction and working ofelectronic devices.
e. In respect of item no.10 above, the teachers need to create opportunities and pursue students for the effectiveness of such co-curricular activities.
f. MOOCs (Massive Open Online Courses) may be used to teach various topics and sub-topics.

12. SUGGESTED MICRO-PROJECTS

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

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

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

a. Prepare an Electronic device board with specifications of each.

b. Build and Testan audio amplifier circuit.
c. Build automatic darkness detector circuit using LDR sensor and BJT as a switch
d. Build a basic remote tester using transistor and IR sensor.
e. Design and build dual voltage regulator for different voltage range.
f. Build a simple touch switch/ touch alarm /rain alarm sensor.

For the micro-project undertaken, the student should also simulate and develop the PCB layout in any open source software like evaluation versionof Multisim, Microcap, and Proteus etc. during building and testing of the circuit. This will also help him/her to develop competence in using CAD tools.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	A Textbook of Applied Electronics	Sedha, R.S.	S.Chand Publishing, New Delhi, 2014, ISBN: 978-8121927833
2	A Textbook of Electrical Technology	Theraja,B.L ; Theraja, A.K.	S.Chand Publishing, New Delhi, 2015, ISBN:978-8121926676
3	Electronics Devices and Circuit Theory	Boylestead, Robert L.;Neshelsky, Louis	Pearson, 11th edition, 2012, New Delhi, ISBN: 978-0132622264
4	Basic Electronics	Mandal,Soumitra Kumar	Mc Graw Hill,New Delhi,2013,ISBN: 978-1259006586
5	Fundamentals of Electronic Devices and Circuits	Bell, David	Oxford University Press, New Delhi, 2015, ISBN: 978-0195425239

14. SUGGESTED SOFTWARES/LEARNING WEBSITES

a. www.en.m.wikipedia.org/wiki/ISFET
b. www.nptel.ac.in/courses/117103063/
c. www.electronics-tutorials.ws/category/amplifier
d. www.electronics-tutorials.ws/category/transistor
e. www.ni.com/multisim/try/
f. www.labcenter.com/downloads/
g. www.spectrum-soft.com/download.shtm

Program Name : **Diploma in Medical Electronics**

Program Code : **MU**

Semester : **Third**

Course Title : **Human Anatomy and Physiology**

Course Code : **22346**

1. RATIONALE

Human anatomy and physiology is a core course that deals with normal structure, shape, size and location and functions of various organs of human body. By studying this course. students will be able to become familiar with anatomical and physiological terms, understand general anatomy of major systems, their importance in design of biomedical devices and correlate the knowledge of anatomy and functionality of human body systems in operating medical instruments. This course is a prerequisite for all courses of Medical Electronics, thereby vital for their career in Medical Electronics Field.

2. COMPETENCY

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

- **Correlate the use of medical instruments with respect to human body organ functions.**

3. COURSE OUTCOMES (COs)

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

a. Interpret the functioning of the cell, tissues and skeleton system of the body.
b. Choose the equipment relevant to cardiac disease.
c. Relate the instrument to measure the respiratory parameters.
d. Select the equipment related to digestive & urinary system.
e. Interpret the effect of hormones on human body.
f. Identify the instruments related to function of nervous systems parts and special senses in human body.

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 of theory PA is for micro-project assessment to facilitate attainment of COs and the remaining 20 marks is for tests and assignments given by the teacher.

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

5. COURSE MAP (with sample COs, POs, UOs, ALMs and topics)

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

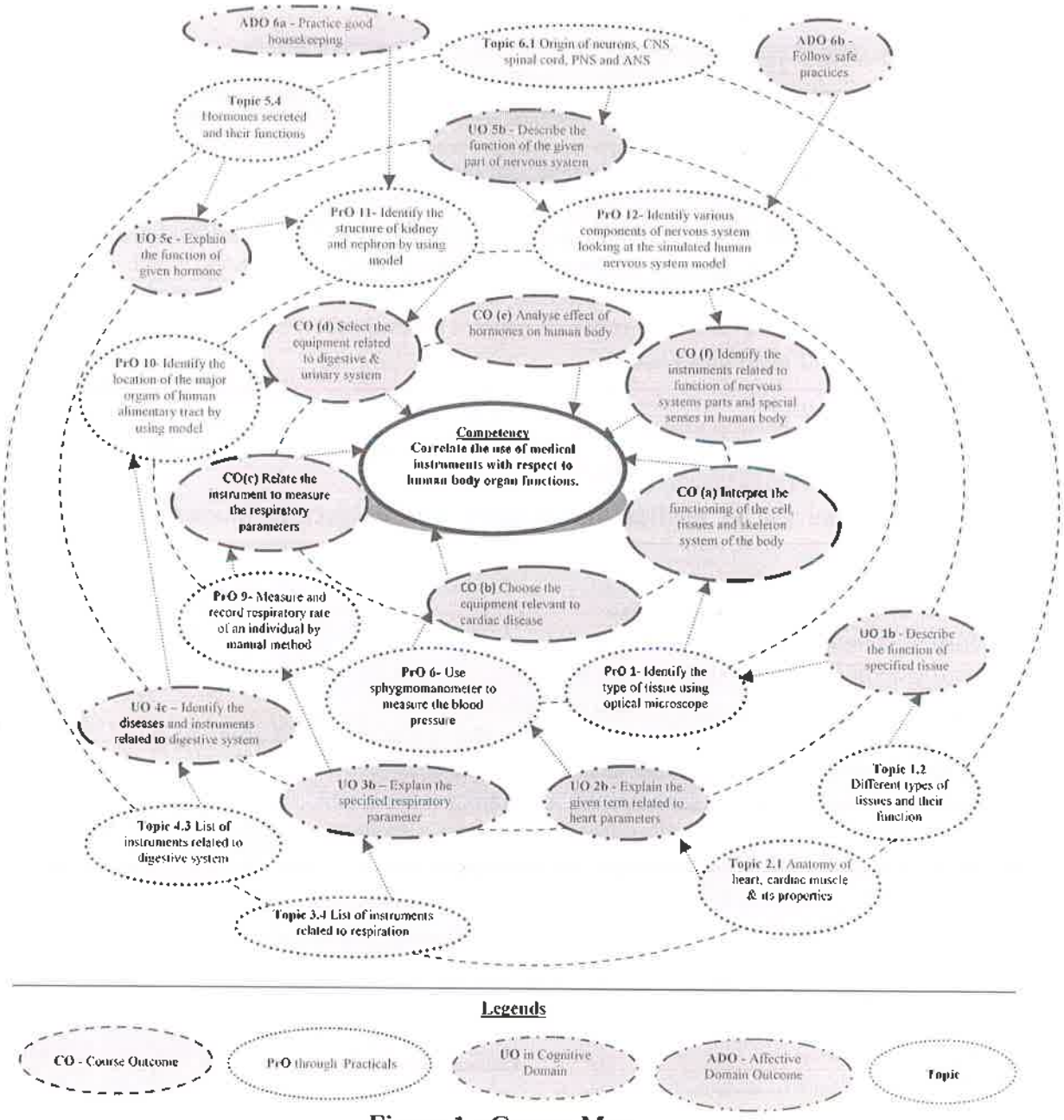

Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

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

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Identify the type of tissue using optical microscope	I	02

2	Identify the blood group of given blood sample. – Part I	I	02*
3	Identify the blood group of given blood sample. – Part II	I	02
4	Determine haemoglobin content of the given blood sample. – Part I	I	02*
5	Determine haemoglobin content of the given blood sample. – Part II	I	02
6	Determine the bleeding time of a patient.	I	02
7	Determine the clotting time of the given blood sample.	I	02
8	Use sphygmomanometer to measure the blood pressure. – Part I	II	02*
9	Use sphygmomanometer to measure the blood pressure. – Part II	II	02
10	Identify heart sound using stethoscope.	II	02*
11	Determine pulse rate by manual method using radial pulse and carotid pulse. – Part I	II	02*
12	Determine pulse rate by manual method using radial pulse and carotid pulse. – Part II	II	02
13	Measure and record respiratory rate of an individual by manual method.	III	02*
14	Identify the location of the major organs of human alimentary tract by using model.	IV	02*
15	Identify the structure of kidney and nephron by using model.	IV	02
16	Identify various components of nervous system looking at the simulated human nervous system model.	VI	02
17	Identify various components of special senses looking at the simulated special senses model. – Part I	VI	02*
18	Identify various components of special senses looking at the simulated special senses model. – Part II	VI	02
Total			**36**

Note

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

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

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

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

a. Follow safety practices.
b. Practice good housekeeping.
c. 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
- '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	Stethoscope: Diaphragm diameter 2.0"(51cm), diaphragm material: polyurethane –coated silicon, Length 27"(69cm)	1
2	Sphygmomanometer: Measuring range 0-300mm Hg, mercury type, Accuracy 3mm Hg, Glass tube 3.5 to 4.0mm	2
3	Microscope: Eyepiece Magnification 10X, Illuminator 50W halogen & 130W mercury, Magnification range 10X to 1500X	1

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 Cell, Tissues and Skeleton System	1a. Explain with sketches the structure and function of the given cell organelle. 1b. Describe with sketches the function of the specified tissue. 1c. Explain with sketches the functions of blood and its' given components. 1d. Identify the type of joint in the specified body location with justification.	1.1 Structure and function of cell organelles 1.2 Different types of tissues and their function 1.3 Composition of blood, cellular contents, blood function, blood groups 1.4 Classification of bone, joints and muscles, function of bone, joints and skeletal muscle
Unit – II Cardiovascular System	2a. Describe with sketches the function of the specified part of the conduction system of heart. 2b. Explain with sketches the given term related to heart parameters.	2.1 Anatomy of heart, cardiac muscle and its properties 2.2 Blood vessels and circulation of blood, conduction system 2.3 Blood pressure, blood flow, cardiac

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	2c. Identify the parts of the cardiovascular system with justification. 2d. Select the relevant instrument for the given application with justification.	output, heart rate and pulse rate 2.4 Diseases related to cardiovascular system 2.4 Instruments related to heart
Unit – III Respiratory System	3a. Describe with sketches the function of the given part of respiratory system. 3b. Explain with sketches the features of the specified respiratory parameter. 3c. Describe the systems of the specified disease related to the respiratory system and the instruments related to it. 3d. Select the relevant type of instrument required for the respiratory system with justification.	3.1 Anatomy of respiratory system, nose, pharynx, larynx, trachea, bronchi and lungs 3.2 Mechanism of respiration, gases exchange, respiratory parameters: lung volumes and capacities 3.3 Diseases related to respiratory system 3.4 Instruments related to respiration
Unit – IV Digestive and Excretory System	4a. Explain with sketches the function of given digestive organ. 4b. Identify the diseases and instruments related to the given body system. 4c. Identify the diseases related to the given excretory system with justification. 4d. Explain with sketches the structure of skin.	4.1 Organs of digestive system, juices secreted by various digestive organs and their functions 4.2 Diseases related digestive system 4.3 Instruments related to digestive system and urinary system 4.4 Anatomy of urinary system –kidney, ureter, urinary bladder, urethra, formation of urine & function of kidney 4.5 Diseases related to urinary system 4.6 Structure and function of skin
Unit– V Reproductive System and endocrine system	5a. Describe with sketches the function of the specified part of male/female reproductive system. 5b. Identify the hormones secreted by male/female reproductive system. 5c. Describe the function of the given type of hormone. 5d. Identify the location of the specified gland with justification. 5e. Correlate the given endocrine	5.1 Male reproductive system 5.2 Hormones secreted by male reproductive system and their functions 5.3 Female reproductive system 5.4 Hormones secreted by female reproductive system and their functions 5.5 Structure, position and function of endocrine glands

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	gland with the hormones in human body.	
Unit-VI Nervous System and special senses	6a. Describe with sketches the function of the given part of the nervous system along with labelled sketch. 6b. Identify the diseases and instruments related to the given body system. 6c. Describe with sketches the mechanism of a human being. 6d. Identify the specified part of eye along with its function	6.1 Origin neurons, central nervous system (CNS), brain, spinal cord, peripheral nervous system (PNS), autonomic nervous system (ANS) 6.2 Diseases related to nervous system, instruments related to nervous system 6.3 Anatomy of ear and its function, hearing mechanism 6.4 Anatomy of eye and its function, image formation

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

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Cell, Tissues and Skeleton System	11	04	02	04	10
II	Cardiovascular System	10	02	04	04	10
III	Respiratory System	10	02	04	04	10
IV	Digestive and Excretory System	12	02	08	04	14
V	Reproductive System and Endocrine System	08	04	02	04	10
VI	Nervous System and Special Senses	13	02	08	06	16
Total		**64**	**16**	**28**	**26**	**70**

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

10. SUGGESTED STUDENT ACTIVITIES

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

a. Prepare a presentation on functions of Cell/tissues/blood/kidney.
b. Prepare a chart of organ system of human body.
c. Collect information of instruments related to human body.

d. Collect the videos or animation to give presentation of given human system.
e. Visit a genetic lab and prepare a report.

11. SPECIAL INSTRUCTIONAL STRATEGIES (if any)

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

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

12. SUGGESTED MICRO-PROJECTS

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

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

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

a. Prepare a model of circulatory system.
b. Prepare a chart to demonstrate respiratory system.
c. Prepare a model of digestive/ urinary system.
d. Prepare a brief report to analyse the effect of endocrine glands on human body.
e. Prepare a report on market survey of medical instruments, with respect to aspects like manufacturing company, advancements, cost, technical specification and applications.
f. Prepare a report containing details on heart.
g. Prepare a report on vitamins and classification with its importance.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Ross and Wilson Anatomy and Physiology in Health and Illness	Waugh Anne; Grant Allison	Churchil Livingstone Elsevier, U.K, 12th Edition, 2014, ISBN:978-0702032288
2	Essentials of Human Anatomy and Physiology	Marieb Elaine N.	Pearson International Edition, 11th Edition, 2014, ISBN:0321919009
3	Biology	Campbell Neil; Reece Jane	Pearson Education, 7th Edition, ISBN: 978-8131724095
4	Human Anatomy and Physiology and Health Education	Jayaveera K.N.; Vrushabendra Swamy B.M.	S. Chand, 1st Edition, 2010 ISBN: 978-8121933575

14. SUGGESTED SOFTWARE AND LEARNING WEBSITES

a. www.innerbody.com
b. www.getbodysmart.com
c. www.visiblebody.com
d. www.argosymedical.com

Program Name : **Diploma in Medical Electronics**

Program Code : **MU**

Semester : **Third**

Course Title : **Biosensors**

Course Code : **22348**

1. RATIONALE

Human body generates different physiological signals. These signals are further electronically processed for diagnosis, monitoring or therapeutic patient management. This course deals with the acquisition of bio-signals from human body using various transducers/ sensors and processing of these signals. Biosensor is the pre-requisite for all the courses related to patient's management in the respect of diagnosis, monitoring and therapy.

2. COMPETENCY

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

- **Use relevant transducers to measure bio-signals.**

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 sensors and transducers for different medical applications.
b. Use displacement and pressure transducers for biomedical applications.
c. Use temperature, optical and radiation transducers for biomedical applications.
d. Select flow and electrochemical transducers for different biomedical applications.
e. Use bio- potential electrodes for medical applications.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme											
				Theory							Practical					
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
3	2	2	7	3	70	28	30*	00	100	40	25@	10	25	10	50	20

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

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

5. COURSE MAP (with sample COs, 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.

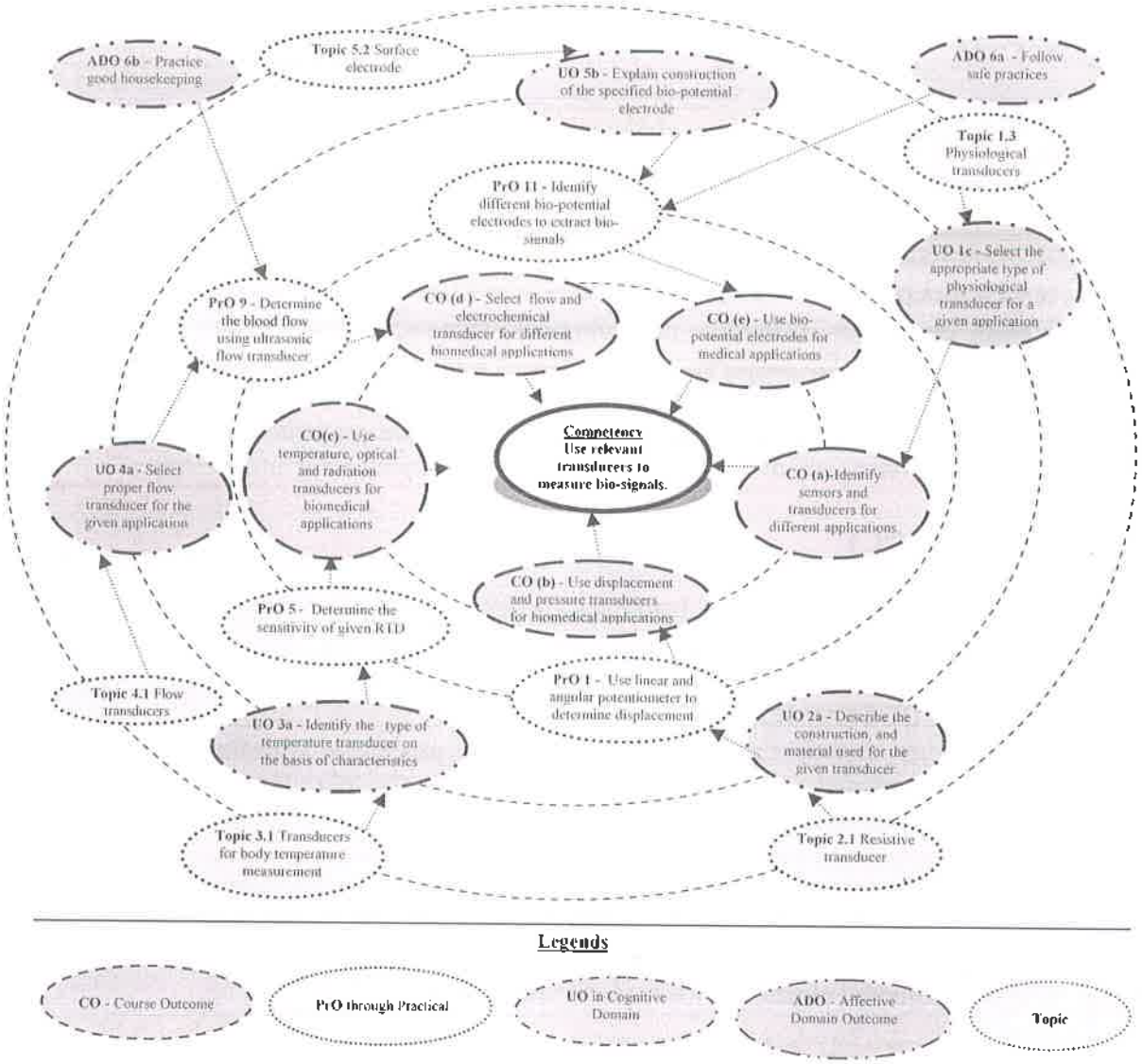

Figure 1 - Course Map

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 linear and angular potentiometer to determine displacement. - Part I	II	02*
2	Use linear and angular potentiometer to determine displacement. - Part II	II	02
3	Use given LVDT to determine linear displacement.	II	02
4	Use strain gauge to determine the weight of unknown object.	II	02*
5	Use strain gauge to determine the weight of unknown object. - Part II	II	02
6	Measure the pressure by using Burdon tube.	II	02
7	Measure the pressure by using Bellows.	II	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
8	Measure the pressure by using piezoelectric transducer.	II	02*
9	Identify the type of thermister and determine its' sensitivity.	III	02*
10	Determine the sensitivity of given RTD.	III	02
11	Identify the type of thermocouple and determine its sensitivity. - Part I	III	02
12	Identify the type of thermocouple and determine its sensitivity. - Part II	III	02
13	Calibrate the given PH electrode and measure the pH level of the given solution. - Part I	IV	02*
14	Calibrate the given PH electrode and measure the pH level of the given solution. - Part II	IV	02
15	Measure blood glucose level by using glucometer.	IV	02*
16	Determine the blood flow using ultrasonic flow transducer. - Part I	IV	02
17	Determine the blood flow using ultrasonic flow transducer. - Part II	IV	02
18	Identify and connect the different types of bio-potential electrode to extract the bio-signals and suggest application area. - Part I	V	02*
19	Identify and connect the different types of bio-potential electrode to extract the bio-signals and suggest application area. - Part II	V	02
Total			**38**

Note

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

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

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

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

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

e. Follow ethical practices.

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

- 'Valuing Level' in 1st year
- 'Organizing Level' in 2nd year
- 'Characterizing Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

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

S. No.	Equipment Name with Broad Specifications	Pro. S. No.
1	Digital multimeter : 3 1/2 digit display, 9999 counts digital millimeter measures: V_{ac}, V_{dc} (1000V max), A_{dc}, A_{ac} (10 amp max) , Hz , Resistance (0 - 100 MΩ) , capacitance and temperature	1, 2, 3, 4, 5, 6,11
2	Linear and angular potentiometer set-up: Linear Rheostat from 25 Ω to 50 Ω; Angular Potentiometer of different values from 10K Ω to 100K Ω	1
3	LVDT set- up trainer kit consists of industrial grade: LVDT of +/- 20 mm with instrumentation, Micrometer with resolution of 0.1 mm, Digital indicator in terms of voltage, Built in Excitation signal, DC regulated power supply, facility to vary excitation frequency and amplitude	2
4	Strain gauge set-up, trainer kit consisting of Wheatstone bridge, cantilever type loading arrangement on which strain gauges are mounted, weights up to 2Kg, DC amplifier, digital indicator in terms of grams, facility to select quarter and half bridge mode, inbuilt DC regulated power supply	3
5	Temperature measurement set- up trainer kit suitable to measure the temperature using K type Cr-Al Thermocouple housed in S.S. type industrial housing, heater which can go up to 200 deg C with facility to vary heater power, 3 1/2 digit digital indicator of temperature, in built DC regulated power supply etc.	6
6	Trainer kit suitable to measure the temperature using thermister set up should be provided with Heater which can go up to 200 deg C with facility to vary heater power, constant current source with amplifier, 3 ½ digit digital indicator of temperature, In built DC regulated power supply etc.	4
7	Trainer kit suitable to measure the temperature using PT 100 type R.T.D. housed in S.S. type industrial housing. Set up should be provided with Heater which can go up to 200 deg C with facility to vary heater power, constant current source with amplifier, 3½ digit digital indicator of temperature, In built DC regulated power supply	5
8	pH meter: pH electrode with at least three different buffer solutions	7
9	Glucose-meter : Digital type, high data storage around 400 measurements , sample volume 1.2 µL, Time to glucose result 6 s , connectivity, Battery	8

S. No.	Equipment Name with Broad Specifications	Pro. S. No.
	specification..3V lithium button battery	
10	Ultrasonic flow transducer: 1MHz /5 MHz ultrasonic sensor	9
11	Pressure measurement set- up : 1 MHz piezoelectric crystal with measuring accessories, Bourdon tube pressure measurement setup Bellows pressure measurement setup	10
12	Different biomedical electrodes	11

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 Medical Instrumentation System and Introduction to Physiological Transducers	1a. Identify the use of a given physiological biomedical signal with justification. 1b. Explain with sketches the function of specified component of Man Instrumentation System. 1c. Select the appropriate type of physiological transducer for a given application with justification. 1d. Identify the type of the specified transducer on the basis of the given performance characteristics with justification.	1.1 Overview of physiological biomedical signals 1.2 Block diagram and specifications of Man Instrumentation System (MIS), General constraints in design of MIS 1.3 Physiological transducers, classification of transducers: active and passive transducers, primary and secondary transducers based on process used, based on physical or chemical principle used, based on applications, Performance characteristics of transducers, static characteristics, dynamic characteristics
Unit– II Displacement and Pressure Transducers	2a. Describe with sketches the construction, and material used for the given type of transducer. 2b. Explain with sketches the working principle of the specified transducer. 2c. Identify the type of the specified displacement/ pressure transducers on the basis of the characteristics with justification. 2d. Select relevant displacement/ pressure transducer for the given application with justification. 2e. Calculate different parameters	2.1 Resistive transducer - Linear and angular potentiometers, bonded and unbounded strain gauge 2.2 Inductive transducers- Linear Variable Differential Transformer (LVDT) 2.3 Capacitive transducers, Piezoelectric transducers 2.4 Pressure transducers Diaphragm - Flat, corrugated, capsule, Bellows, Bourdon tube - C shape, spiral, helical, Twisted

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	on the basis of formulae for the given transducers.	
Unit– III Temperature, Optical and Radiation Transducers	3a. Identify the type of temperature transducer on the basis of the characteristics with justification. 3b. Explain with sketches construction and material used for the given temperature transducers. 3c. Identify the type of optical transducers on the basis of the characteristics with justification. 3d. Select relevant radiation transducer for the given application with justification.	3.1 Transducers for body temperature measurement : Thermistor, thermocouple, RTD 3.2 Optical transducers: Fiber optic sensors, photomultiplier tube 3.3 Radiation thermometry
Unit-IV Flow and Electro Chemical Transducers	4a. Select proper flow transducer for the given application with justification. 4b. Identify the type of chemical transducer with justification. 4c. Describe with sketches the construction along with its principle of operation of the specified flow transducer. 4d. Explain with sketches the operating principle of the given electrochemical transducer along with sketches. 4e. Select the relevant electrochemical transducer for the given application with justification.	4.1 Flow transducers: Plethysmography, ultrasonic flow transducers, electromagnetic transducers, flow measurement by indicator dilution, flow measurement by thermal convection 4.2 Chemical transducers: Reference electrode, pH electrode, PO_2 electrode, PCO_2 electrode, blood glucose sensor
Unit –V Bio-potential electrodes and advanced biosensors	5a. Compare polarizable and non-polarizable electrodes using concept of electrode electrolyte interference. 5b. Explain with sketches the construction of the specified bio-potential electrode. 5c. Identify electrodes for the given biomedical operation with justification. 5d. Explain with sketches the concept of carbon	5.1 Electrode electrolyte interference, polarizable and non-polarizable electrodes, electrode and skin interface, motion artifact, classification of electrodes 5.2 Surface electrodes: Metal plate electrode, metal disc disposable, suction electrode, floating electrodes, flexible electrode 5.3 Internal electrode-Needle electrodes, wire electrodes 5.4 Micro electrodes: Metal

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	Nanotube as a biosensor with reference to the specified application. 5e. Describe with sketches the given application for the given Bio-MEMS.	microelectrodes, supported microelectrodes, micropipette 5.5 Advanced biosensor: Carbon nanotube biosensor, fiber optic biosensor, wireless biosensor network, Bio MEMS-Biomedical Micro Electro Mechanical Systems.

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

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Medical Instrumentation System and Introduction to Physiological Transducers	08	02	04	04	10
II	Displacement and Pressure Transducers	10	04	04	06	14
III	Temperature, Optical and Radiation Transducers	10	02	08	08	18
IV	Flow and Electro Chemical Transducers	10	02	08	08	18
V	Bio Potential Electrodes and advanced biosensors	10	02	04	04	10
Total		**48**	**12**	**28**	**30**	**70**

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

10. SUGGESTED STUDENT ACTIVITIES

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

a. Prepare chart of different electronic transducer based on their construction, working, specifications and application.
b. Collect and understand datasheets of different types of transducers.
c. Give seminar on any relevant topic to this course.
e. Prepare display chart of different types of advance biosensors.
d. Prepare power point presentation on animation for showing different types transducers.

e. Develop a report after undertaking a market survey of different transducers and electrodes on the following points.
   i. Construction
   ii. Properties
   iii. Applications

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

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

a. Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b. ***'L' in item No. 4*** does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
c. About ***15-20% of the topics/sub-topics*** which is relatively simpler or descriptive in nature is to be given to the students for ***self-directed learning*** and assess the development of the COs through classroom presentations (see implementation guideline for details).
d. With respect to item No.10, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
e. Guide student(s) in undertaking micro-projects.
f. Use Flash/Animations to explain the construction and working of different 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 a bridge circuit using RTD and measure the output by varying the temperature.
b. Build a bridge circuit using thermister and measure the output by varying the temperature.
c. Build a simple application based on load cell.
d. Design digital thermometer to measure body temperature.
e. Design and construct LVDT for displacement measurement.
f. Market survey of different types of biomedical electrodes and prepare a report.
g. Prepare report on applications of different biosensors by visiting hospital/diagnostic center/pathology lab.

h. Make a display using available pressure measuring transducers from different sources and prepare a report.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Medical Instrumentation Application and Design	Webster John G.	Wiley India, Fourth Edition, ISBN 13 : 978-81265553792
2	A Handbook of Biomedical Instrumentation	Khandpur R.S.	Mc Graw Hill Education, Third Edition, ISBN: 978-9339205430
3	Biomedical Instrumentation and Measurements	Cromwell Leslie, Weibell Fred J., Pfeiffer Erich A.	PHI learning Pvt. Ltd. Second Edition; ISBN 13: 978-0130764485
4	Biomedical Instrumentation and Measurements	Ananadnatarajan R.	PHI learning Pvt. Ltd. ISBN 13: 978-8120342279

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. www.transducersdirect.com/DSLibrary.asp
b. www.multitrode.com/assets/datasheets/mtpt-pressure-transducer-datasheet.pdf
c. www.d-flow.com/sites/default/files/media/transducer_data_sheet.pdf
d. www.journals.elsevier.com/biosensors-and-bioelectronics
e. www.medcraveonline.com/IJBSBE/
f. www.Bio-MEMS/Wikipedia.html

Program Name : **Diploma in Medical Electronics**

Program Code : **MU**

Semester : **Third**

Course Title : **Computer Hardware and Networking**

Course Code : 22029

1. RATIONALE

Medical electronics diploma engineers have to deal with computers and with current trends of development in medical electronics field, this is only going to increase. Skills to use and maintain computers especially with reference to its various areas of applications such as networking, networking components and various peripherals are essential. Emphasis on practical approach while undergoing this course will help in diagnosing and troubleshooting computer along with peripheral related problems in medical electronics domain. The course will help the students understand various protocols required to set up and configure the basic network as well as troubleshoot connectivity problems.

2. COMPETENCY

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

- **Maintain computer hardware and networking devices.**

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. Assemble/Disassemble a computer.
b. Perform hard disk management operations.
c. Maintain computer peripherals.
d. Maintain the computer networks in laboratory environment.
e. Troubleshoot computer networks.

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
1	-	2	3	--	--	--	--	--	--	--	25@	10	25~	10	50	20

*(#): No theory Exam; (~): 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*

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

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

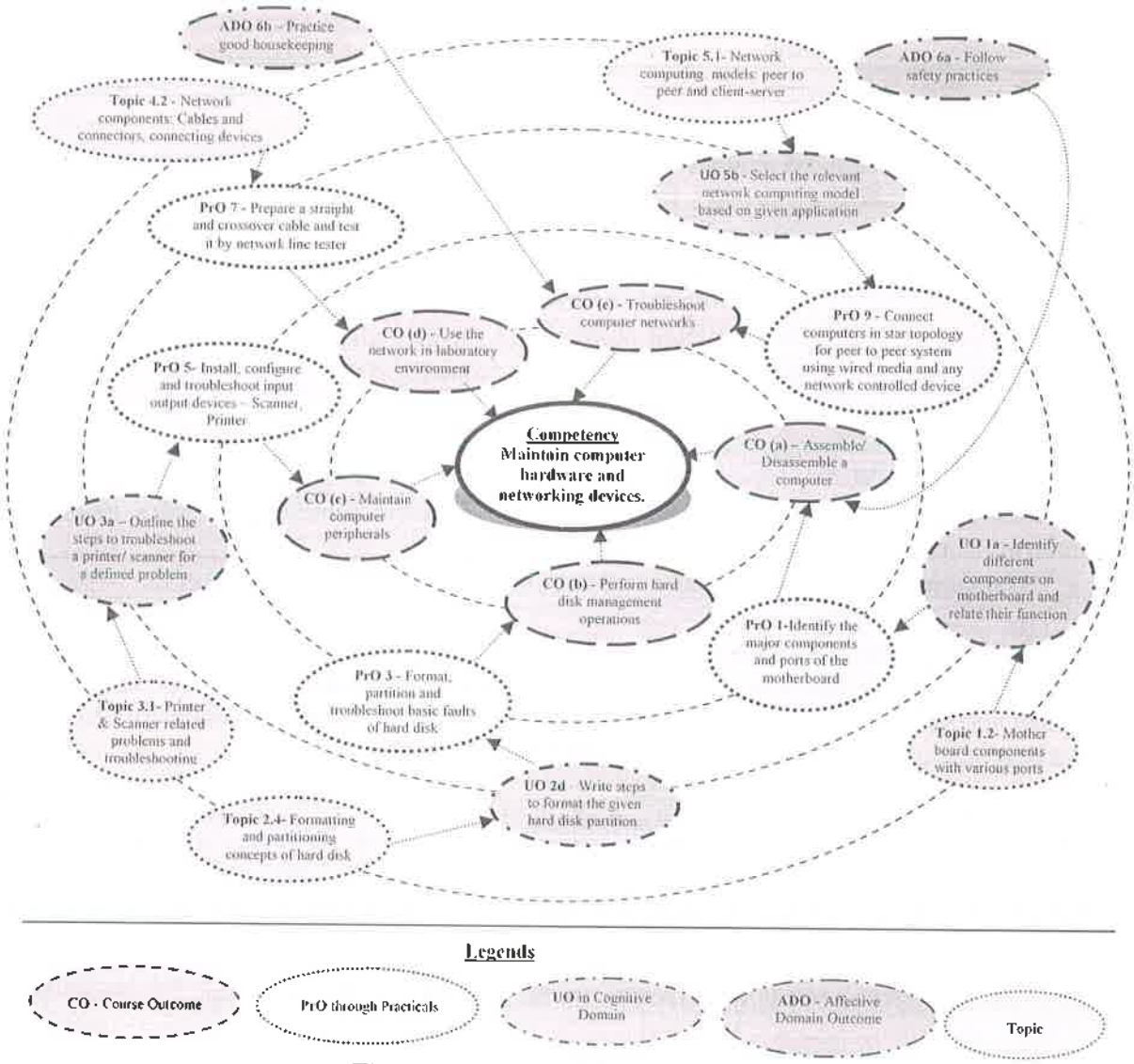

Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

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

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Identify the major components and ports of the motherboard.	I	02*
2	Dismantle a computer system.	I	02*
3	Configure various BIOS settings.	I	02
4	Format, partition and troubleshoot basic faults of hard disk. – Part I	II	02*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
5	Format, partition and troubleshoot basic faults of hard disk. – Part I	II	02
6	Install, configure and troubleshoot input output devices – Scanner, Printer.	III	02*
7	Install, configure and troubleshoot input output devices – Scanner, Printer.	III	02
8	Backup and restore files and settings using backup utility.	III	02
9	Identify various networking cables.	IV	02*
10	Prepare a straight and crossover cable and test it by network line tester.	IV	02*
11	Configure IP related properties.	V	02*
12	Configure IP related properties.	V	02
13	Connect computers in star topology for peer to peer system using wired media and any network controlled device.	V	02*
14	Connect computers in star topology for peer to peer system using wired media and any network controlled device.	V	02
15	Share printer and folder in network.	IV	02
16	Troubleshoot the network using basic TCP/IP network commands and utility software.	V	02*
17	Troubleshoot the network using basic TCP/IP network commands and utility software.	V	02
18	Form a Piconet using Bluetooth devices and transfer data.	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	Ability to perform practical using appropriate tools	30
2	Complete the practical in stipulated time	30
3	Quality of output achieved	10
4	Answer to oral questions	20
5	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. Ensure tools are in proper working conditions.

e. Follow ethical practices.

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

- 'Valuing Level' in 1st year
- 'Organising Level' in 2nd year
- 'Characterising Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

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

S. No.	Equipment Name with Broad Specifications	Exp. No.
1	Motherboard of a Desktop Computer	1
2	Desktop Computer (Intel core i3/ i7/ RAM 16 GB/ HDD)	All except 1,6,7,12
3	Crimping tool, Cables –UTP, Connectors –RJ45, Network Line tester	7,9
4	Scanner – A4 size	4
5	Printer – LaserJet 30 ppm, 16 MB RAM, 1200 dpi or equivalent	4
6	Ethernet Hub/Switch - 8/16/24 port	9
7	Bluetooth enabled devices like laptop, mobile.	12

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 Motherboard and major components	1a. Identify the given component on motherboard and relate its function. 1b. Describe with sketches the construction of specified peripheral. 1c. Illustrate with sketches the working of specified peripheral with its connection to computer. 1d. Describe with sketches the configuration of BIOS setting for the given functionality aspect.	1.1 Computer system and its peripherals 1.2 Mother board components with various ports 1.3 Motherboard configuration and assembling a computer 1.4 BIOS basics
Unit– II Storage Devices	2a. Describe with sketches the construction and working of specified type of hard disk. 2b. Write steps to connect the given type of hard disk to a computer.	2.1 Concept and use of cache memory 2.2 Construction, working of hard disk 2.3 Types of hard disks – SATA,

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	2c. Write steps to partition a hard disk as per given specification. 2d. Write steps to format the given hard disk partition.	PATA, USB and their connection to computer 2.4 Formatting, Partitioning concepts of hard disk
Unit– III Troubleshooting and Maintenance	3a. Describe with sketches the steps to troubleshoot a printer/scanner for a defined problem. 3b. Write steps to perform a specified maintenance procedure of PC. 3c. Write major steps to perform the maintenance of specified peripheral device used in medical application. 3d. Write steps to create a specified type of backup/restoration of files.	3.1 Printer & Scanner related problems and Troubleshooting 3.2 PC and peripheral maintenance, active maintenance, passive maintenance 3.3 Backup utility – Types of backups and their application: full, incremental, differential backups,concept of driver
Unit-IV Basic Network Concepts	4a. Describe the steps to perform sharing of a specified resource in a network. 4b. Describe with sketches the salient features of a given type of network cable. 4c. Describe with sketches the salient features of given network connecting device. 4d. Explain with sketches the characteristics of given network topology.	4.1 Objective of networking: Managing resources- printer share and folder, device share 4.2 Network components: Cables and connectors, connecting devices 4.3 Network topology-Star, Bus, Ring, Mesh
Unit-V Networking Devices and Reference Models	5a. Describe with sketches the procedure to configure IP address of computer/network device as per the required type of IP protocol. 5b. Select the relevant network computing model based on given application with justication. 5c. Outline the steps for creating blue tooth connection for data transfer between two devices. 5d. Outline the troubleshooting steps for a given network problem. 5e. Write steps to perform given type of security settings using firewall	5.1 TCP/IP fundamentals, TCP/IP addressing – IP addresses, IPv4, IPv6 5.2 Network computing models: peer to peer and client-server 5.3 Ethernet(IEEE 802.3),Wireless(802.11) 5.4 Ad-hoc network using Blue tooth 5.5 Troubleshooting and maintaining the network – using TCP/IP commands 5.6 Network Security: Firewalls and proxies

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. Identify the different beep codes generated while assembling and troubleshooting.
b. Collect information about various probes used in medical field and its interfaces.
c. Collect specification of the latest computer and its advanced features.
d. Prepare a network diagram of your laboratory and list its specifications & features.
e. Collect Information regarding the IP addressing and sub-netting in the laboratory.
f. Prepare a presentation showing the concept of cache memory and its types.

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. Guide the students in undertaking micro-projects.
b. Arrange video sessions to demonstrate the various procedures for maintenance and troubleshooting computers and networks.
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. Arrange group discussion of students on use of networking in medical field.
e. Guide the students to prepare and present the micro-project through PPT. They should also submit a report which is limited to 4-5 pages.
f. Take quiz/MCQ on various topics.
g. MOOCs (Massive Open Online Courses) may be used to teach various topics and sub-topics.

12. SUGGESTED MICRO-PROJECTS

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

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of 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. Assemble a computer using given components.
b. Partition and format the hard disk into logical drives as C:, D:, E:, in the percentage of 40%, 40% and 20%. Install operating system, Antivirus software, update and report a summary.
c. Select a computerized system in your institute such as admission system, payroll system, student record keeping or any other. Develop a backup plan. Create following type of backup of the selected system:
    i. Daily Backup at specified time
    ii. Incremental backup
    iii. Differential backup
d. Configure and use VoIP to communicate with people at different location.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Upgrading and Repairing PCs	Mueller, Scott	Pearson Education, Inc. U.S., 2011, ISBN: 978-0789747105
2	The Complete PC Upgrade and Maintenance Guide	Minasi, Mark	Willey Publication, U.S. , 2005, ISBN: 978-8126506279
3	Managing and Troubleshooting Networks	Meyers, Mike	Tata McGraw Hill Education Private Limited, New Delhi, 2009, ISBN: 978-0070677272
4	Data Communications and Networks	Godbole, Achyut; Kahate, Atul	McGraw Hill Education, New Delhi, 2011, ISBN: 978-0071077705

14. SUGGESTED SOFTWARE/ LEARNING WEBSITES

a. www.tutorialspoint.com/computer_fundamentals/computer_hardware.htm
b. www.techiwarehouse.com/engine/3b8fc18b/Basics-of-Computer-Hardware-Maintenance
c. www.bleepingcomputer.com/tutorials/hardware
d. www.windowsnetworking.com/articles-tutorials