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							
				L	T	P		Exam Duration in Hrs.	ESE		PA		Total		ESE		PA		Total			
									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.**

MSBTE – Final Copy Dt. 20.04.2018

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.
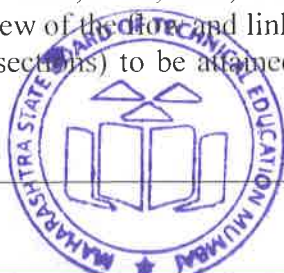
4.   TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme												
				Paper Hrs.	Theory						Practical					
L	T	P			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.
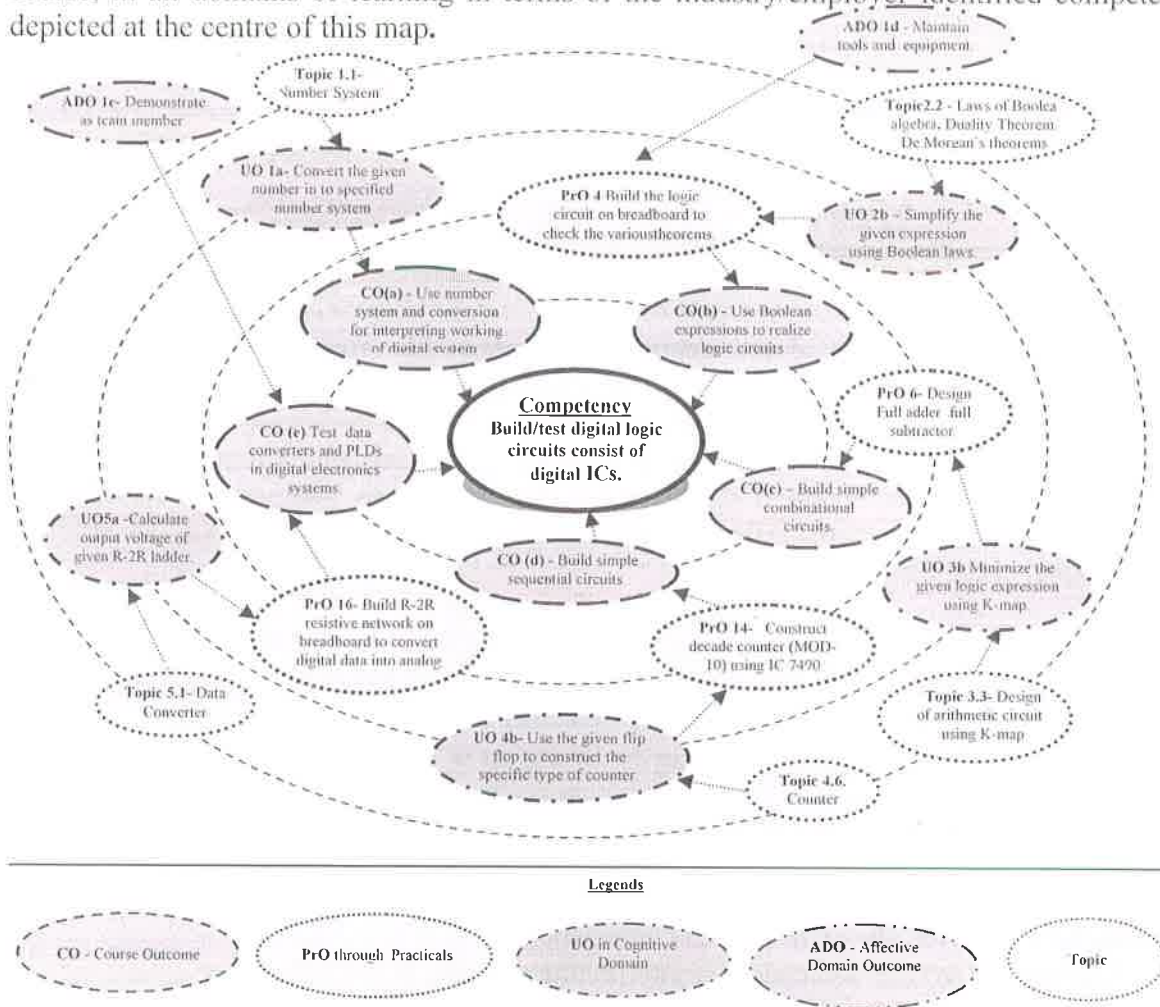

Figure 1 - Course Map

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 Combinati onal 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)
<u>*Note*</u>: *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 multimeter 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, POs, 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.
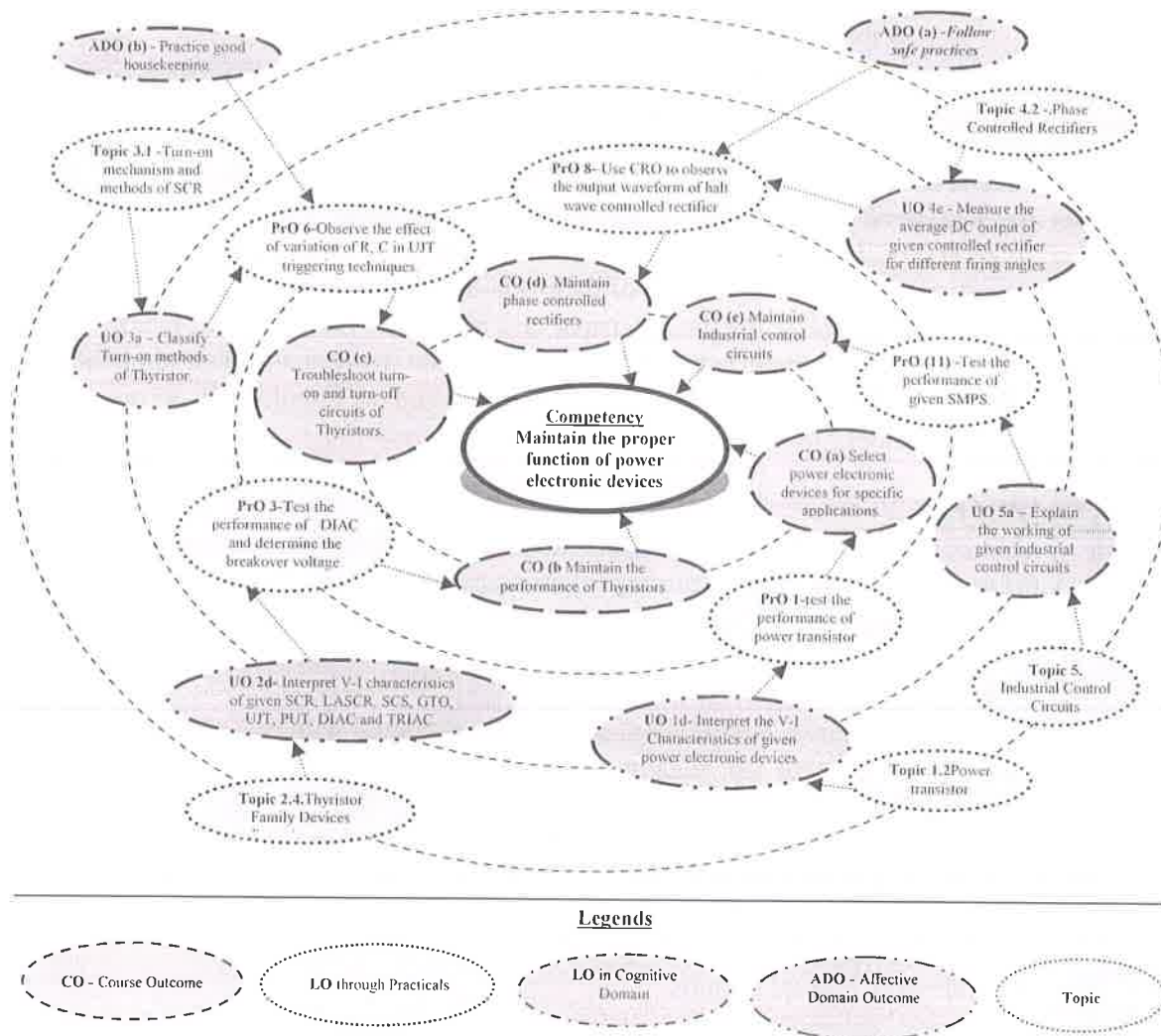

Figure 1 - Course Map

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.

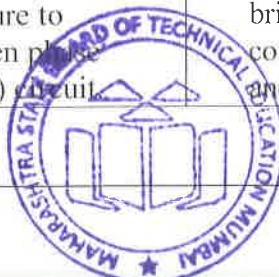| S. No.	Equipment Name with Broad Specifications	PrO. S. No.
1	Digital Multimeter: 3and1/2 digit 0-800Volts,0-10A , Micro-ammeters:0-100uA	All
2	Dual channel CRO: 25 MHz with isolation transformer OR Power scope , Attenuator probe for CRO	All
3	SCR, LASCR, SCS, GTO, UJT, PUT, DIAC and TRIAC – 5 each	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											
				Paper Hrs.	Theory						Practical					
L	T	P			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.
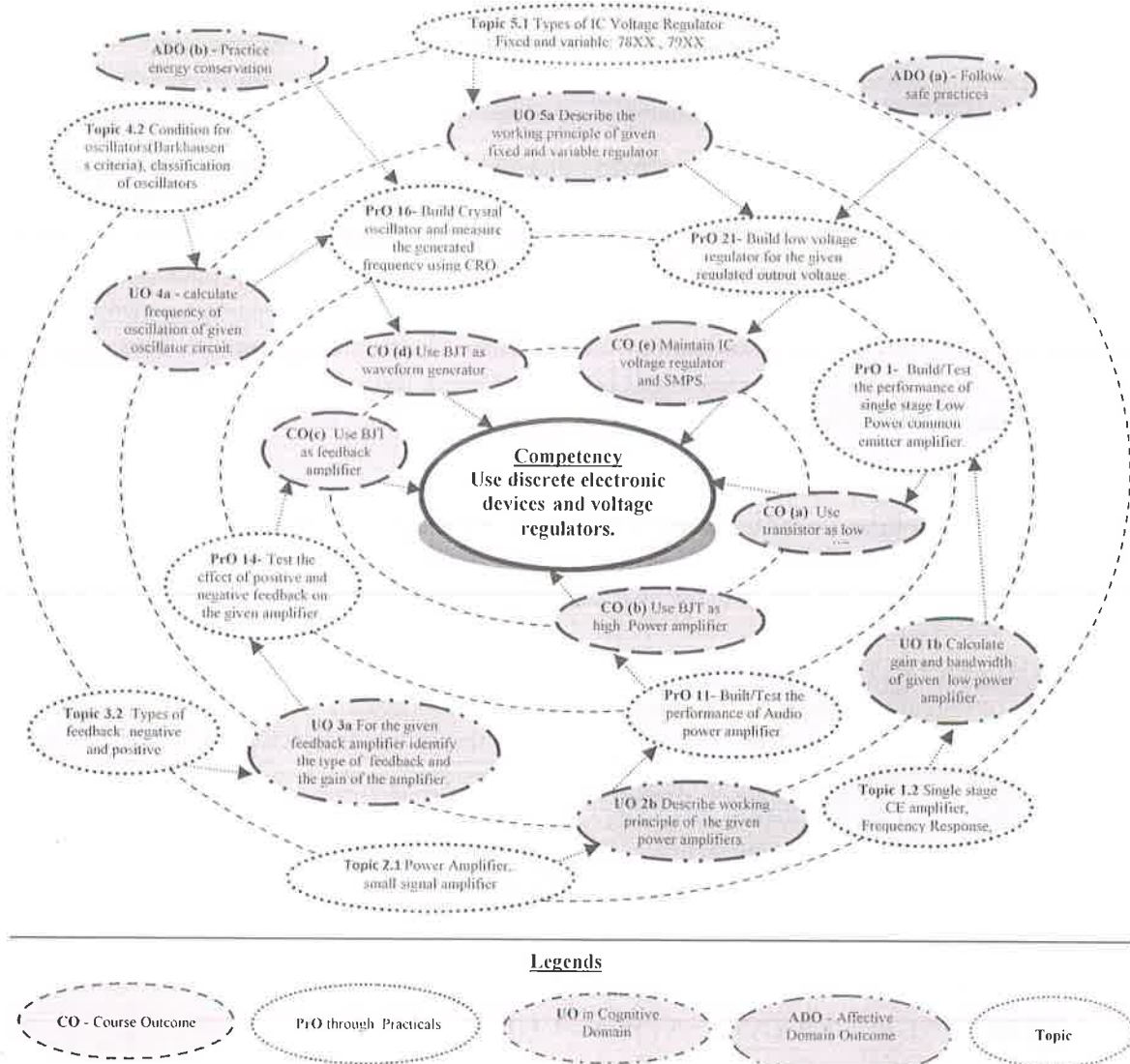

Figure 1 - Course Map

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 $(4\Omega/8\Omega)$ 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											
				Paper Hrs.	Theory						Practical					
L	T	P			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.
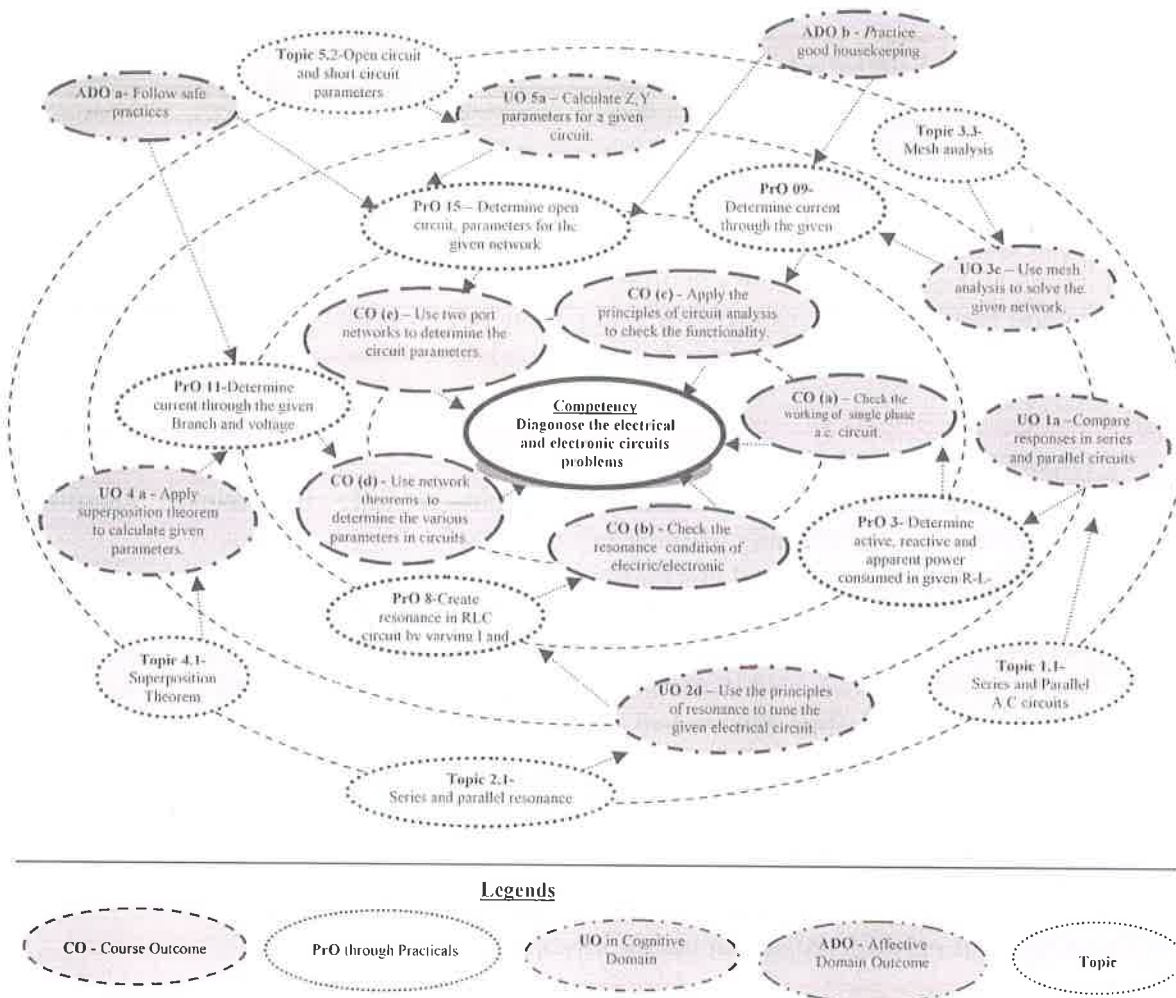

Figure 1 - Course Map

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, appa	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 $t = \infty$. 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 networks

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	: **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												
				Paper Hrs.	Theory						Practical					
					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.
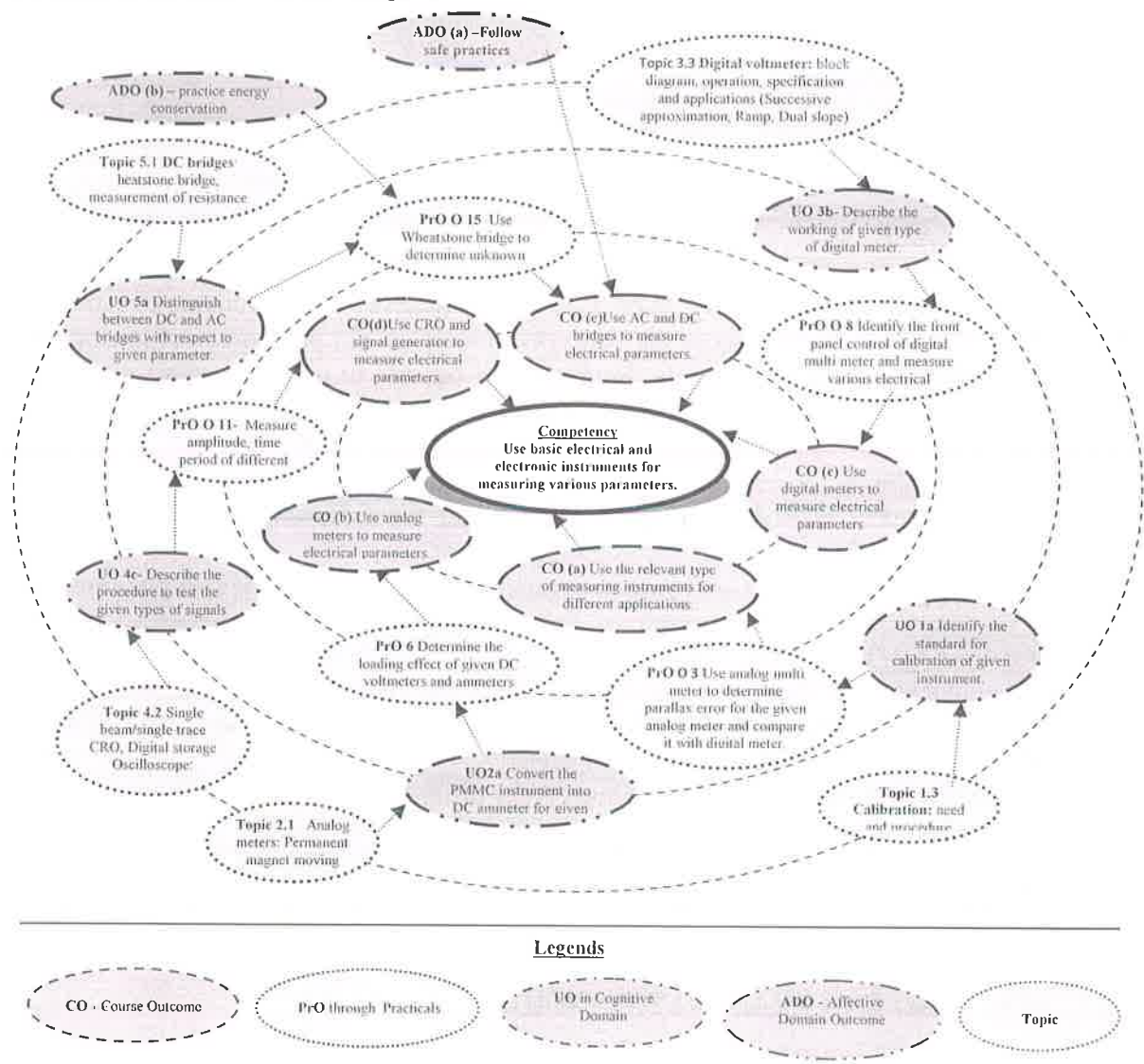

Figure 1 - Course Map

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 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 Fundame ntals 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 ssification, 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