Maharashtra State Board of Technical Education, Mumbai

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

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

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

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

Semester : Third — **Scheme - I**

S. N.	Course Title	Course Abbreviation	Course Code	Teaching Scheme			Credit (L+T+P)	Examination Scheme												Grand Total
								Theory						Practical						
								Exam Duration in Hrs.	ESE		PA		Total		ESE		PA		Total	
				L	T	P			Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	
1	Digital Techniques	DTE	22320	4	-	2	6	3	70	28	30*	00	100	40	25#	10	25	10	50	20	150
2	Applied Electronics	AEL	22329	4	-	4	8	3	70	28	30*	00	100	40	50#	20	50	20	100	40	200
3	Electronics Instruments and Measurements	EIM	22331	4	-	2	6	3	70	28	30*	00	100	40	25@	10	25	10	50	20	150
4	Industrial Measurements	IME	22335	3	-	2	5	3	70	28	30*	00	100	40	25@	10	25	10	50	20	150
5	Instrumentation Data Communication	IDC	22336	4	-	2	6	3	70	28	30*	00	100	40	25@	10	25	10	50	20	150
6	Programming in 'C'	PIC	22026	2	-	2	4	3	--	--	--	--	--	--	25@	10	25~	10	50	20	550
			Total	**21**	**-**	**14**	**35**	--	**280**	--	**120**	--	**400**	--	**210**	--	**190**	--	**400**	--	**850**

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

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

Abbreviations: ESE- End Semester Exam, PA- Progressive Assessment, L - Lectures, T - Tutorial, P - Practical

@ Internal Assessment, # External Assessment, *# On Line Examination, ^ Computer Based Assessment

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

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

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

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

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

Semester : **Third**

Course Title : **Digital Techniques**

Course Code : **22320**

1. RATIONALE

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

2. COMPETENCY

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

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

3. COURSE OUTCOMES (COs)

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

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

4. TEACHING AND EXAMINATION SCHEME

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

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

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

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

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

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

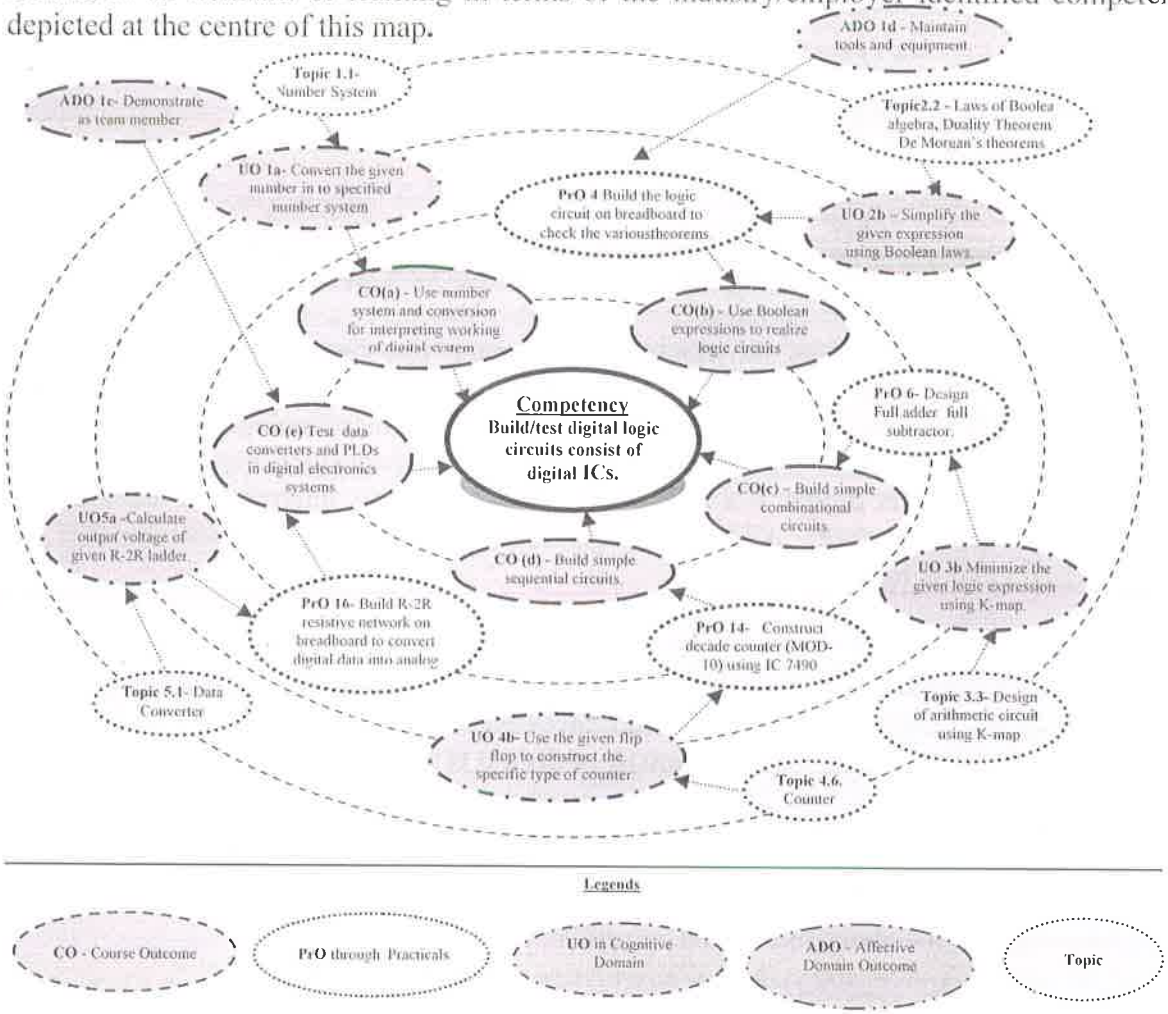

Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

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

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
1	Test the functionality of specified logic gates using breadboard. (IC 7404, 7408, 7432, 7486)	II	02*
2	Test the functionality of NAND and NOR gate of using breadboard (IC 7400 and 7402)	II	02
3	Construct AND, OR, NOT gates using universal gates.	II	02
4	Build the logic circuit on breadboard to check the De Morgan's theorems.	II	02
5	Design Half adder and Half subtractor using Boolean expressions.	III	02*
6	Design Full adder and full subtractor.	III	02
7	Construct and test BCD to 7 segment decoder using IC 7447/ 7448.	III	02
8	Build / test function of MUX 74[illegible]/74150/any other equivalant.	III	02

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

Note

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

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

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

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

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

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

- 'Valuing Level' in 1st year

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

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

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

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

8. UNDERPINNING THEORY COMPONENTS

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

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

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

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

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

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Number System	06	2	2	4	08
II	Logic gates and logic families	10	4	4	4	12
III	Combinational Logic Circuits	16	4	6	8	18
IV	Sequential Logic Circuit	16	4	6	8	18
V	Data Converters and PLDs	16	4	4	6	14
Total		**64**	**18**	**22**	**30**	**70**

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

10. SUGGESTED STUDENT ACTIVITIES

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

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

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

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

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

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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

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

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

Semester : **Third**

Course Title : **Applied Electronics**

Course Code : **22329**

1. RATIONALE

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

2. COMPETENCY

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

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

3. COURSE OUTCOMES (COs)

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

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

4. TEACHING AND EXAMINATION SCHEME

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

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

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

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

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

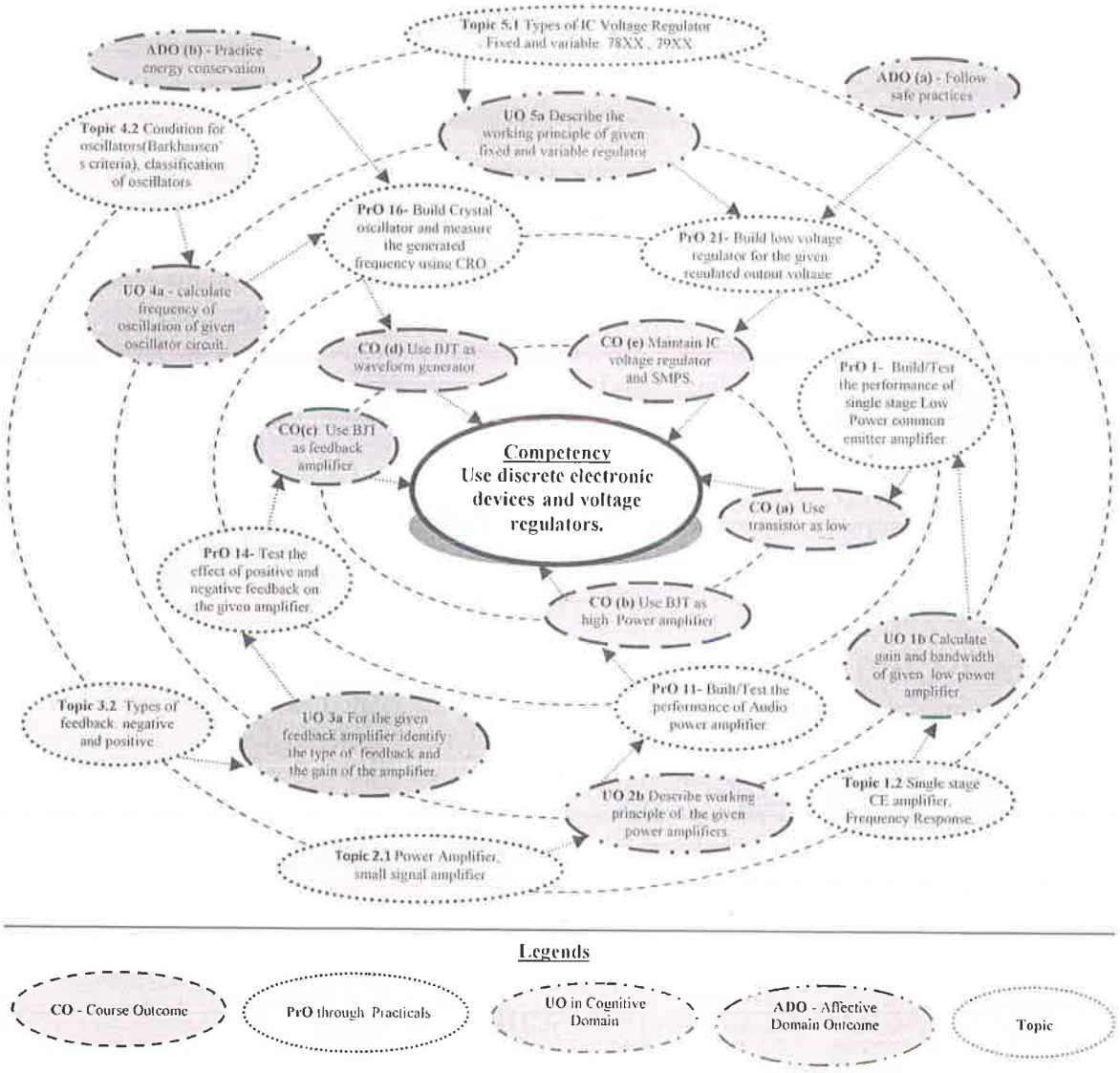

Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

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

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

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

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	emitter (CE) amplifier using simulation software(like spice, multisim).		
3	Simulate/test the output Wave form of single Stage common source FET amplifier using simulation software	I	2
4	Build/test the performance of single stage Common source FET amplifier.	I	2
5	Build/test the performance of two stage RC Coupled common emitter amplifier using transistor.	I	2*
6	Build/test the performance of two stage direct Coupled amplifier using transistor.	I	2
7	Build/Test the performance of transformer Coupled amplifier.(Part-I)	I	2*
8	Build/Test the performance of transformer Coupled amplifier.(Part-II)	I	2*
9	Build/test the performance of single tuned amplifier using transistor.	I	2
10	Build/test performance of double tuned common Emitter amplifier. (Part-I)	I	2
11	Build/test performance of double tuned common Emitter amplifier. (Part-II)	I	2
12	Build/test performance parameters of single stage class A power amplifier.	II	2
13	Build/test performance parameters of class B Push pull amplifier using transistor.	II	2
14	Build/test the performance of Audio power amplifier.	II	2*
15	Use transistor to build/ test voltage series Feedback amplifier parameters with and without feedback.	III	2
16	Use transistor to built/ test voltage shunt Feedback amplifier parameters with and without feedback.	III	2
17	Test the effect of positive and negative feedback on the given amplifier.(Part-I)	III	2*
18	Test the effect of positive and negative feedback on the given amplifier.(Part-II)	III	2*
19	Build RC phase shift oscillator and measure the generated frequency using CRO.	IV	2
20	Build Crystal oscillator and measure the generated frequency using CRO.	IV	2
21	Simulate Hartley oscillator using any relevant simulation software. (Like spice, multisim, Lab view, LTspice, Octeva).	IV	2*
22	Generate a waveform using Miller's sweep generator and measure sweep time and retrace time.	IV	2
23	Simulate dual voltage regulator using IC78XX and 79XX for the specified regulated output voltage	V	2*
24	Build dual voltage regulator for the specified Regulated output voltage.	V	2
25	Build low voltage regulator using IC723 for the given regulated output voltage. (2V to7V)	V	2*
26	Build high voltage regulator using IC 723 for the given regulated output voltage.(7 V to 37 V)	V	2

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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

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

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

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Low Power Amplifiers	14	4	6	6	16
II	High Power Amplifiers	18	4	6	8	18
III	Feedback Amplifiers	12	4	4	4	12
IV	Waveform Generators	12	4	4	6	14
V	IC voltage Regulators and SMPS	08	2	4	4	10
Total		**64**	**18**	**24**	**28**	**70**

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

10. SUGGESTED STUDENT ACTIVITIES

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

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

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

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

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

12. SUGGESTED MICRO-PROJECTS

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

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

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

13. SUGGESTED LEARNING RESOURCES

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

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

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

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

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

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

Semester : **Third**

Course Title : **Electronic Instruments and Measurement**

Course Code : **22331**

1. RATIONALE

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

2. COMPETENCY

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

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

3. COURSE OUTCOMES (COs)

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

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

4. TEACHING AND EXAMINATION SCHEME

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

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

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

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

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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.

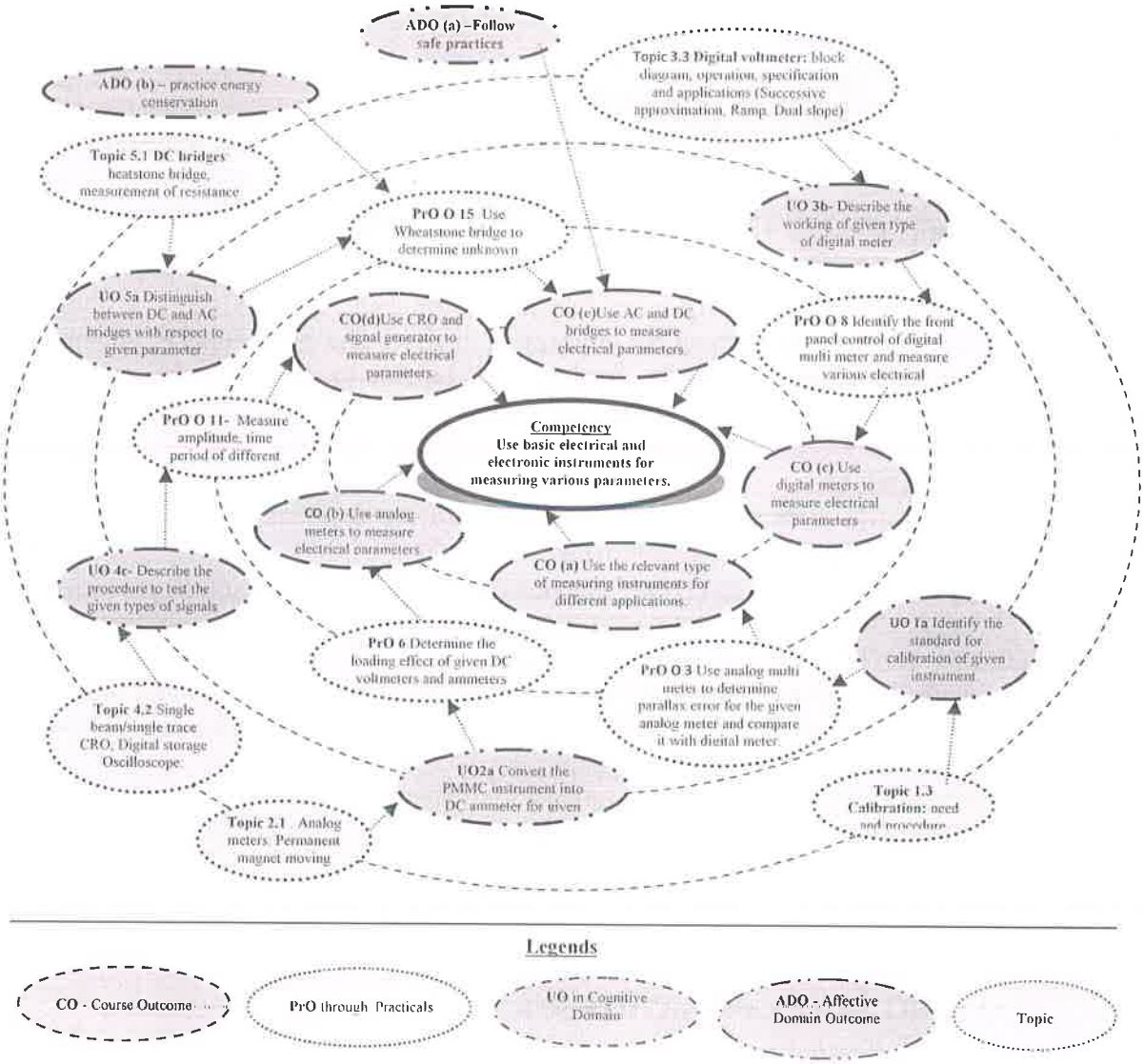

Figure 1 - Course Map

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**

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

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

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

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

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

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

S. No.	Equipment Name with Broad Specifications	Pro.S. No.
1	Analog multi meter 1mA, 500 ohms.	1,2,3
2	Digital Multi meter 4 ½ digit display	2,3,8,9
3	Voltmeter 0-10V,0-50V,0-100V,0-300V	3,4,6
4	Ammeter 0-100mA, 0-50μA,0-1mA	3,5
5	LCR meter 20Hz – 2MHz	5
6	Cathode ray Oscilloscope single beam dual trace 0-30 MHz	11,12
7	Function generator 0-2MHz. 0-3MHz	11,12, 14,16, 17
8	Digital Storage Oscilloscope 60 MHz bandwidth	13
9	Logic Analyzer: 32 channel	10
10	Spectrum Analyzer: Heterodyne type 3GHz	14
11	Lux Meter range 400.0/4000 lux sensor diameter 2 to 2 inch, Accuracy 5%, memory 16000 reading, resolution 100 lux, foot candle resolution 0.1 fc. Display type- numeric	18

8. UNDERPINNING THEORY COMPONENTS

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

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

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

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

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

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Fundamentals of measurements	08	02	02	04	08
II	Analog meters	16	04	06	08	18
III	Digital meters	14	02	06	10	18
IV	CRO and Signal generator	18	02	06	10	18
V	DC and AC bridges	08	02	02	04	08
Total		64	**12**	**22**	**36**	**70**

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

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

10. SUGGESTED STUDENT ACTIVITIES

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

a. Compile broad specification of DSO, LCR meter, logic analyzer, Spectrum analyser using data sheets and handbook.
b. Develop a report after performing market survey of electronic instruments used in the laboratory.
c. Prepare a chart of static and dynamic characteristics of the instrument/equipment available in the laboratory.
d. Prepare chart to display types of Units.
e. Prepare chart to display front panel control of DSO, LCR meter, Logic analyser and Spectrum analyser
f. Visit nearby institutes, exhibition and industries to collect information about electronic instruments.
g. Assist to the technicians who are doing repair or maintenance work of electronic instruments.
h. Prepare instruction chart for safe handling of electronic instruments

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

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

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

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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

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

Program Code : **IS / IC**

Semester : **Third**

Course Title : **Industrial Measurement**

Course Code : **22335**

1. RATIONALE

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

2. COMPETENCY

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

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

3. COURSE OUTCOMES (COs)

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

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

4. TEACHING AND EXAMINATION SCHEME

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

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

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

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

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

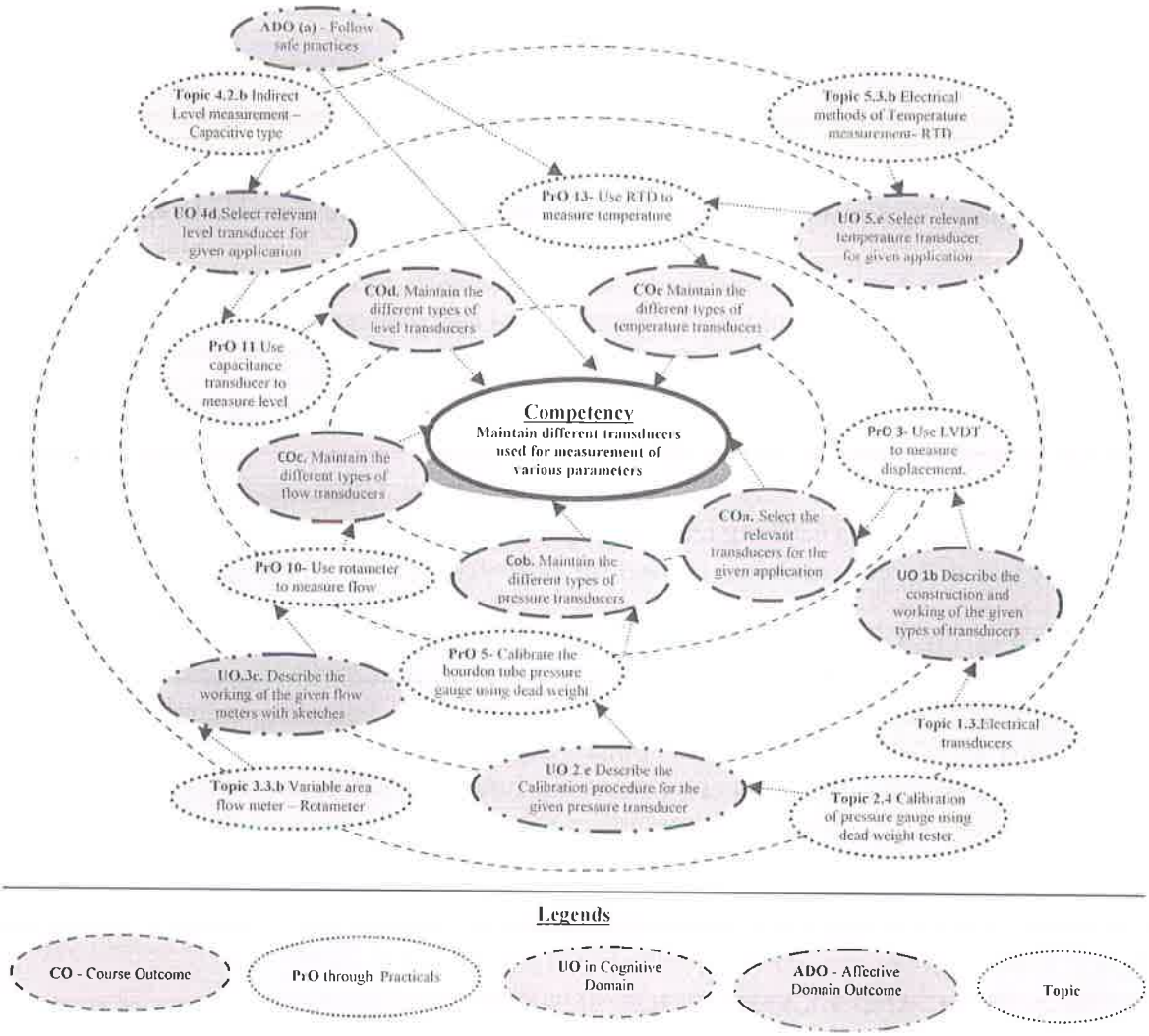

Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

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

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

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

Note

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

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

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

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

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

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

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

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

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

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

8. UNDERPINNING THEORY COMPONENTS

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

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

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

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

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

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

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

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

10. SUGGESTED STUDENT ACTIVITIES

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

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

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES

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

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

12. SUGGESTED MICRO-PROJECTS

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

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

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

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

13. SUGGESTED LEARNING RESOURCES

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

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

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

h. www.isa.org


MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION MUMBAI

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

Program Code : **IS / IC**

Semester : **Third**

Course Title : **Instrumentation Data Communication**

Course Code : **22336**

1. RATIONALE

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

2. COMPETENCY

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

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

3. COURSE OUTCOMES (COs)

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

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

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme												
				Theory							Practical					
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 CO's, PrOs, UOs, ADOs and topics)

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

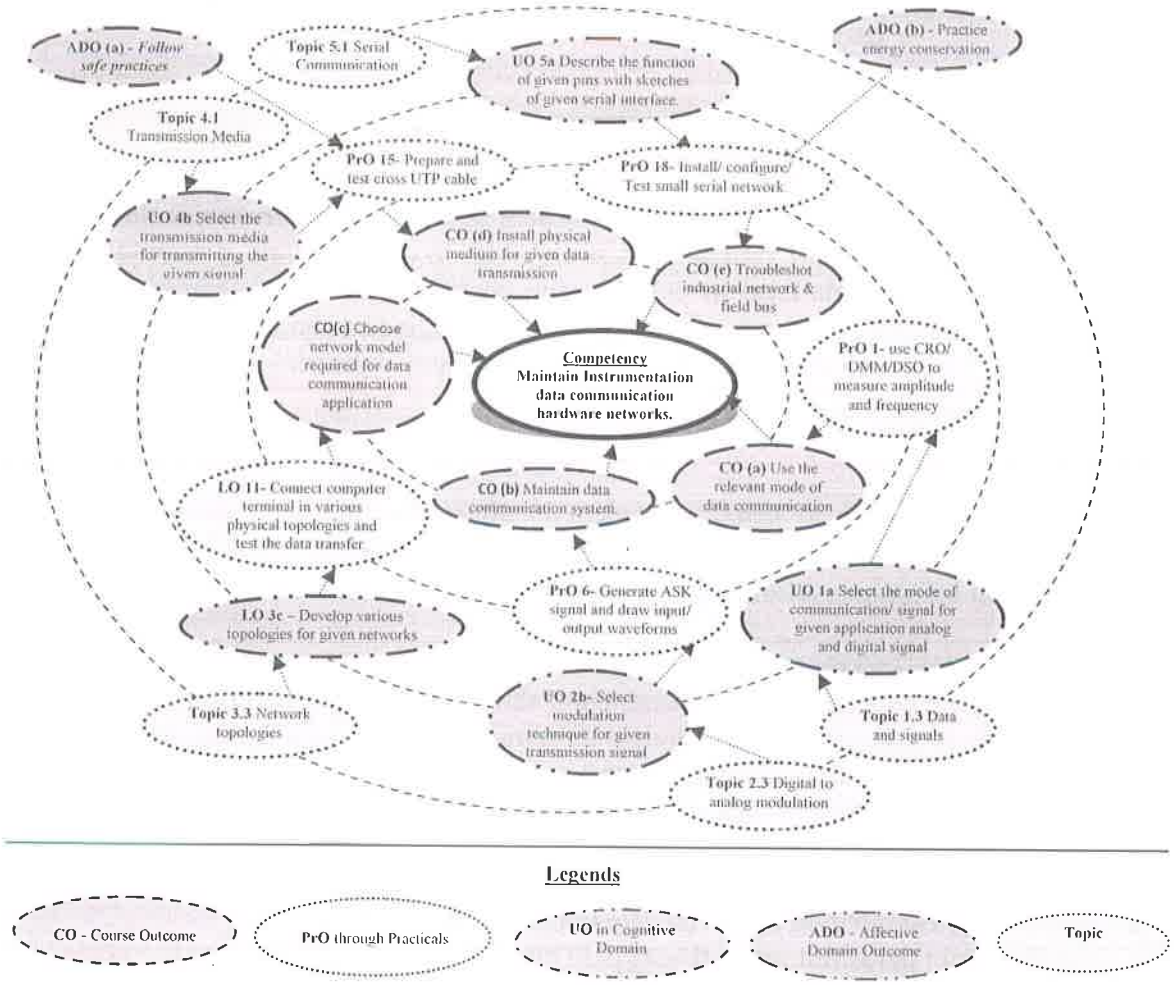

Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

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

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Use CRO/ DMM /DSO to measure amplitude and frequency of the given analog signal.	I	02*
2	Use CRO/ DMM/DSO to measure amplitude and frequency of the given digital signal.	I	02
3	Generate PAM signal and draw input/output waveforms.	II	02*
4	Generate PWM signal and draw input/output waveforms.	II	02
5	Generate PPM signal and draw input/output waveforms.	II	02
6	Generate ASK signal and draw input/output waveforms.	II	02
7	Generate FSK signal and draw input/output waveforms.	II	02
8	Generate PSK signal and draw input/output waveforms.	II	02

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

Note

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

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

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

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

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

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

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

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

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

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

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

S. No.	Equipment Name with Broad Specifications	PrO. S. No.
	(optional)	
15	**Foundation Fieldbus Trainer Kit;** Controller with Ethernet enable module, Host computer and OPC server, Stratix 8000 switch, linking device, Power conditioner, Field devices, 24V DC power supply, Network terminator	18-22
16	**Devicenet trainer kit;** Devicenet power supply, cable, connector, taps, devicenet enable field device, devicenet adapter, PLC system.	Micro project

8. UNDERPINNING THEORY COMPONENTS

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

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Basics of Communication	1a. Select the mode of communication/signal for the given application. 1b. Describe the given type of transmission with sketches for the given application. 1c. Select relevant signal standard for the given data communication system. 1d. Describe with sketches the function of the components in the given communication system. 1e. Justify the need of modulation in the given communication system.	1.1 **Communication Modes**: Simplex, Half Duplex, and Full Duplex. 1.2 **Data Transmission**: Synchronous, Asynchronous, Serial, Parallel; Frame formats for each. 1.3 **Data and Signals**: Analog and digital-data, signal; Digital Standard signals, Analog standard Signals. 1.4 **Transmission Characteristics**: Signaling rate, data rate, bit rate. 1.5 Basic block diagram of Communication system. 1.6 **Noise**: sources of noise, Effects of noise, Signal to Noise Ratio, Factor affecting signal propagation. 1.7 **Modulation and Demodulation**: Need for Modulation.
Unit– II Digital Communication	2a. Calculate bandwidth for transmission of the given signal. 2b. Select modulation techniques for the given transmission signal. 2c. Compare the principle of working for the given signal multiplexing methods. 2d. Encode the given data stream using data encoding techniques.	2.1 **Bandwidth**: Definition, Unit. 2.2 **Analog to digital Modulation**: Working principle, waveform and applications of PAM, PWM, PPM, and PCM. 2.3 **Digital to Analog Modulation:** Working principle, waveform and applications of ASK, FSK, BPSK, QPSK. 2.4 **Multiplexing:** Need for multiplexing, Schematic diagram, principle, application of TDM, FDM, and WDM. 2.5 **Data Encoding techniques:** Coding method, waveforms of: Unipolar- NRZ, RZ; Polar - NRZ, RZ; Biphase - Manchester, Differential Manchester; Bipolar- AMI, Pseudo ternary.

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

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

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

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

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

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

10. SUGGESTED STUDENT ACTIVITIES

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

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

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

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

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

12. SUGGESTED MICRO-PROJECTS

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

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

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

a. Setup an analog signal current loop and test it.
b. Setup a LAN network for your laboratory.
c. Prepare a cable trainer kit.
d. Setup and test a serial network.
e. Setup and test Modbus network.
f. Setup and test Profibus network.
g. Setup and test devicenet network.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication

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

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

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

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Program Name : **Diploma in Instrumentation**

Program Code : **IS**

Semester : **Third**

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

Course Code : **22026**

1. RATIONALE

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

2. COMPETENCY

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

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

3. COURSE OUTCOMES (COs)

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

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

4. TEACHING AND EXAMINATION SCHEME

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

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

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

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

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

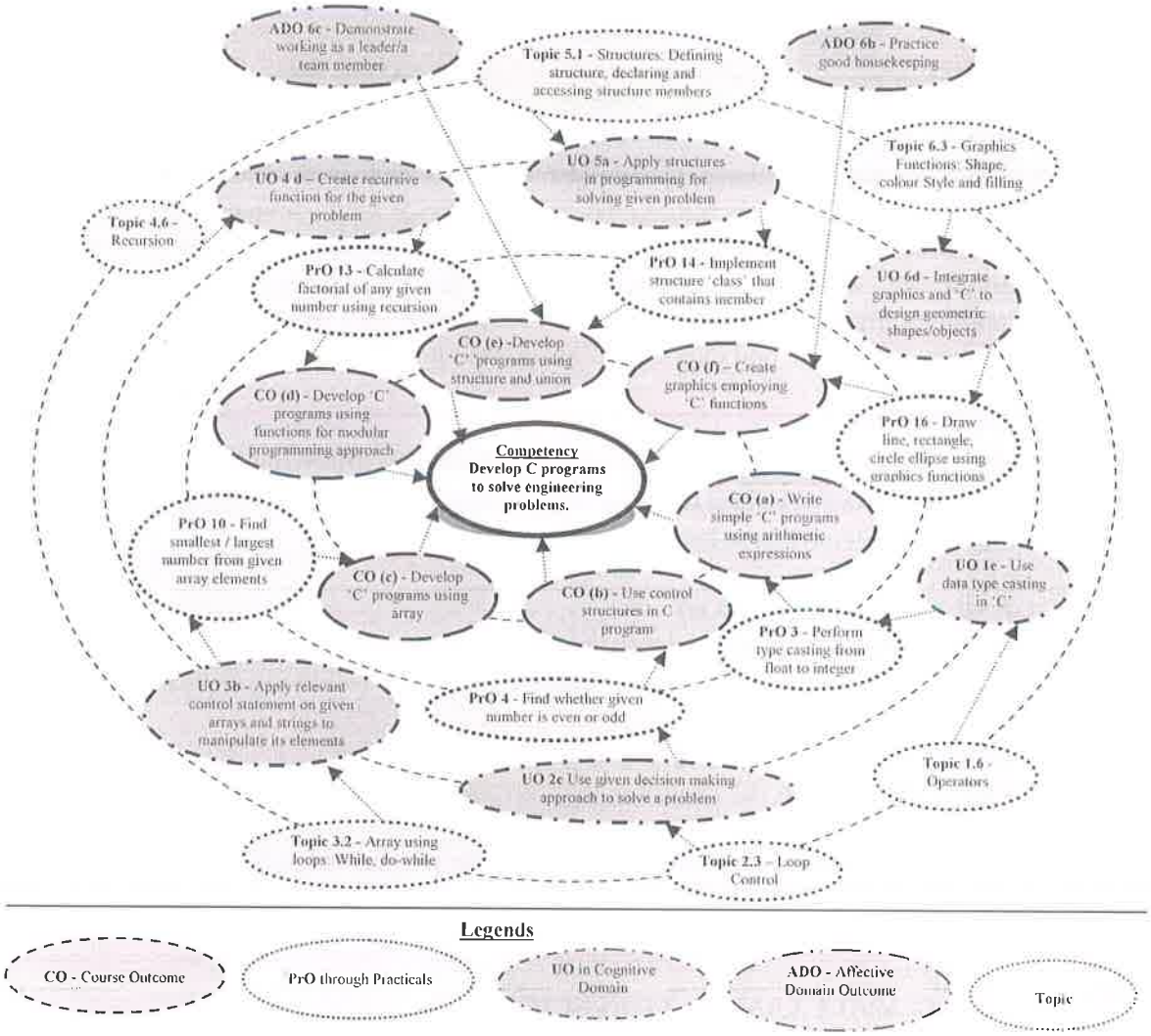

Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

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

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	Construct flowchart, algorithm and develop a 'C' program to do the following:		
1	a. Display "Hello World" on computer screen. b. Display your name, address and college name on screen.	I	02*
2	a. Display square, cube of given number on computer screen. b. Calculate area of triangle, square and circle	I	02
3	a. Perform type casting from float to integer. b. Demonstrate use of format specifiers.	I	02

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

Note

i. A suggestive list of PrOs is given in the above table. More such PrOs can be added to attain the COs and competency. A faculty must ensure minimum 12 or more practical need to be

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performed, out of which, the practicals marked as '' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.*

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

S. No.	Performance Indicators	Weightage in %
1	Ability to prepare flowchart	20
2	Ability to develop algorithm	20
3	Compile, debug and run 'C' programs	40
5	Answer to oral questions	10
6	Submission of program print-out in time	10
	Total	**100**

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

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

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

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

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

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

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

8. UNDERPINNING THEORY COMPONENTS

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

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

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

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

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

-Not applicable -

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course:

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

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

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

a. Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b. ***'L' in item No. 4*** does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
c. About ***15-20% of the topics/sub-topics*** which is relatively simpler or descriptive in nature is to be given to the students for ***self-directed learning*** and assess the development of the COs through classroom presentations (see implementation guideline for details).
d. With respect to item No.10, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
e. Guide student(s) in undertaking micro-projects.
f. Arrange group discussion of students on live day-to- ay problems leading to useful 'C' programming.
g. Arrange spoken tutorial on 'C' programming.
h. Evaluate programming skills through multiple choice questions on 'C' programming.

12. SUGGESTED MICRO-PROJECTS

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

In the first four semesters, the micro-project could be group-based. However, in higher semesters, it should be individually undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. A suggestive list is given here. Similar micro-projects could be added by the concerned faculty:

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

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

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

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

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

13. SUGGESTED LEARNING RESOURCES

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

14. SOFTWARE/LEARNING WEBSITES

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