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

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

Semester : **Third**

Course Title : **Electronic Instruments and Measurement**

Course Code : **22331**

1. RATIONALE

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

2. COMPETENCY

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

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

3. COURSE OUTCOMES (COs)

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

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

4. TEACHING AND EXAMINATION SCHEME

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

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

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

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

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

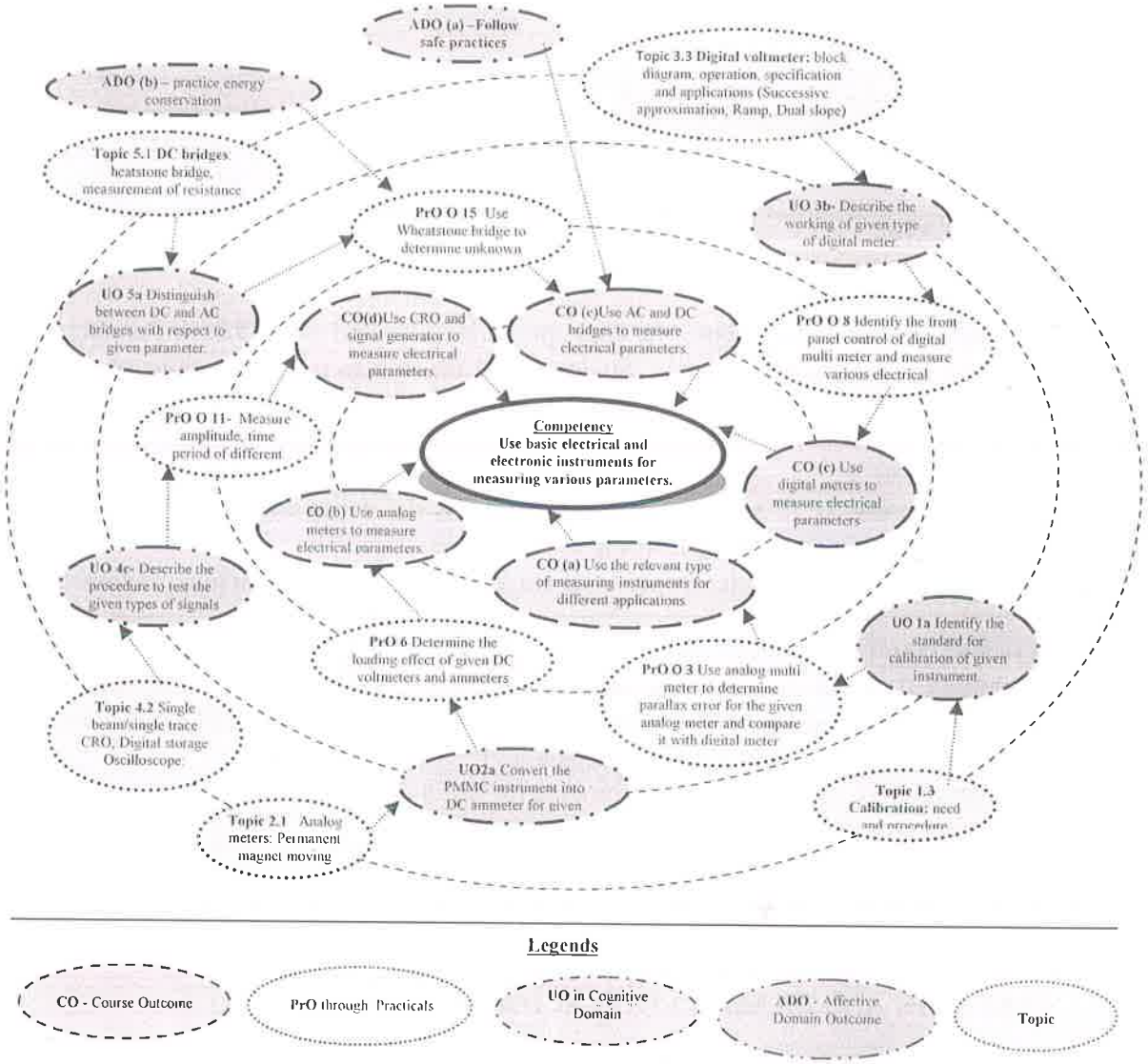

Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

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

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Use analog multi meter to determine accuracy, resolution and hysteresis.	I	02*
2	Calibrate the analog multi meter by comparing with given standard instrument.	I	02
3	Use analog multi meter to determine parallax error for the given analog meter and compare it with digital meter.	I	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
4	Convert basic PMMC movement of 1mA into DC voltmeter for measuring 5V, 10V, 15V.	II	02
5	Convert basic PMMC movement of 1mA into DC ammeter for measuring 10mA, 50mA, 100mA	II	02*
6	Determine the loading effect of given DC voltmeters and ammeters	II	02
7	Use LCR meter to calculate the value of resistance, Inductance, capacitance and compare those with component codes.	III	02
8	Identify the front panel control of digital multi meter and measure various electrical parameters using DMM	III	02*
9	Use analog multi meter to determine accuracy, resolution and hysteresis loop of given digital meter.	III	02
10	Identify the front panel control of logic Analyzer and Test the given digital circuit	III	02
11	Measure amplitude, time period of different signals generated by function generator using CRO.	IV	02*
12	Measure unknown frequency and phase difference with respect to given signal using Lissajous pattern	IV	02
13	Identify the front panel control of DSO and measure various parameters of applied signal	IV	02
14	Identify the front panel control of Spectrum Analyzer and determine frequency content of given signal.	IV	02
15	Use Wheatstone bridge to determine unknown resistance	V	02*
16	Use Maxwell Bridge to determine unknown inductance.	V	02
17	Use Schering Bridge to determine unknown capacitance.	V	02
18	Measure intensity of bulb available in the laboratory using Lux meter.	III	02
	Total		**36**

Note

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

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

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

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

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

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

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

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

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

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

8. UNDERPINNING THEORY COMPONENTS

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

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

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

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

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

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

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

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

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

10. SUGGESTED STUDENT ACTIVITIES

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

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

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

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

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

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

12. SUGGESTED MICRO-PROJECTS

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

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

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

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

13. SUGGESTED LEARNING RESOURCES

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

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

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

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