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

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

Semester : **Third**

Course Title : **Electronics Measurements and Instrumentation**

Course Code : **22333**

1. RATIONALE

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

2. COMPETENCY

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

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

3. COURSE OUTCOMES (COs)

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

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

4. TEACHING AND EXAMINATION SCHEME

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

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

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

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

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

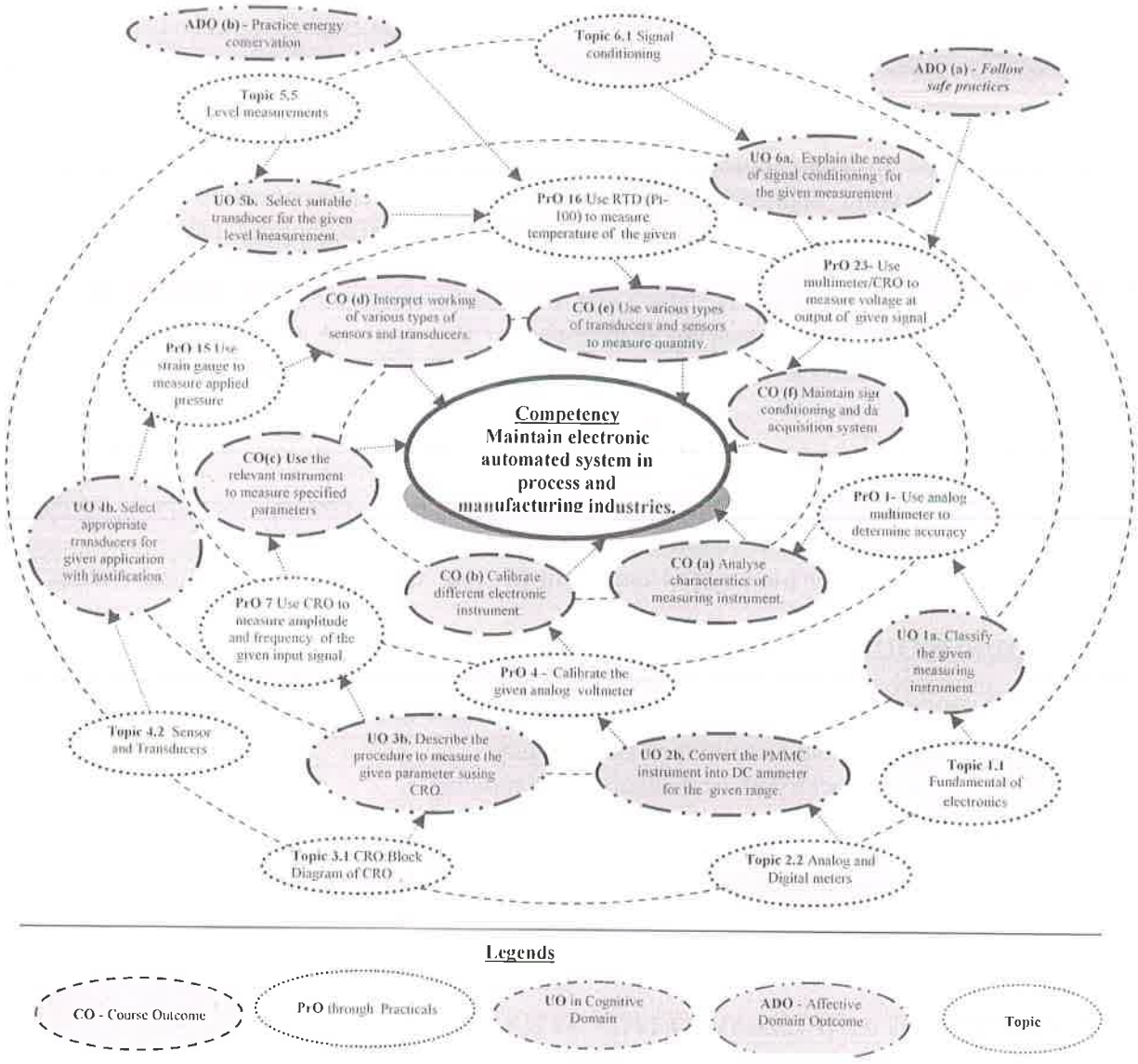

Figure 1 - Course Map

6. SUGGESTED PRACTICALS/EXERCISES

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

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Use analog multimeter to determine accuracy, resolution and hysteresis for specified measured quantity.	I	02*

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

Note

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

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

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

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

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

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

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

7. MAJOR EQUIPMENT/INSTRUMENTS REQUIRED

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

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

8. UNDERPINNING THEORY COMPONENTS

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

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

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

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

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

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Fundamental of electronics measurements	08	02	02	04	8
II	Analog and Digital meters	14	02	06	06	14
III	Oscilloscope,Function generator and Spectrum analyzer	14	02	04	08	14
IV	Sensors and transducers	10	02	04	06	12
V	Applications of sensor and transducers	12	02	04	06	12
VI	Signal conditioning and Data acquisition system	06	02	02	06	10
Total		**64**	**12**	**22**	**36**	**70**

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

10. SUGGESTED STUDENT ACTIVITIES

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

a. Prepare journals based on practical performed in laboratory.
b. Test different components using CRO.
c. Give seminar on any latest Test and measuring Instruments used in the Industry.
d. Library survey regarding different data books of different instruments and manuals.
e. Prepare power point presentation to demonstrate operation of DSO.
f. Undertake a market survey of different electronic instrument.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES

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

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

12. SUGGESTED MICRO-PROJECTS

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

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

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

13. SUGGESTED LEARNING RESOURCES

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

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

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