GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
Semester-III

Course Title: Electronic Measurements and Instruments
(Course Code: 4331102)

Diploma programme in which this course is offered	Semester in which offered
Electronics and Communication Engineering	Third

1. RATIONALE

Troubleshooting of electronic equipment is an essential skill required in service sector industry, which is growing very fast in our country. This course will help students to develop skills to become professional technicians with capability to measure various electrical, electronic and instrumentation parameters using instruments. By learning this course, students will be able to know the basics and use of various Instruments, transducers, sensors and working of electronic circuits used in electronic test and measuring instruments.

2. COMPETENCY

The course content should be taught and implemented with the aim to develop different types of skills leading to the achievement of following competency

Use various electronic test and measuring instruments for measurement process.

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with this competency are to be developed in the student to display the following COs:

a) Measure values of various passive components with proper accuracy, precision and resolution
b) Measure various electrical parameters using different electrical and electronic meters.
c) Measure various signal parameters using advanced electronic instruments.
d) Select appropriate transducer and sensor for measurement of physical quantity.
e) Use electronic instruments for specific testing, measurement and troubleshooting of electronic circuits.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
3	0	2	5	30	70	25	25	150

(*):Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment 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, **CA** - Continuous Assessment; **ESE** -End Semester Examination.*

5. SUGGESTED PRACTICAL EXERCISES

The following are the practical outcomes (PrOs) that are the subcomponents of the COs. *Some of the **PrOs** marked **'*'** are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain'.*

Sr. No	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
1	Measure voltage, current, and resistance using Digital Multimeter and analog millimeter and, and calculate error in the measurement.	1	2*
2	Measure the value of unknown resistor using Wheatstone bridge.	1	2*
3	Measure value of unknown inductor using Maxwell Bridge.	1	2
4	Measure quality Factor of given Inductor and Capacitor using LCR Q-Meter.	1	2*
5	Convert given PMMC galvanometer to DC/AC Volt-Meter.	2	2*
6	Convert the given PMMC galvanometer to DC current- meter.	2	2
7	Measure power using Digital wattmeter.	3	2
8	Measure Vrms , Vmax, Vp-p ,V average ,time and frequency of given signal using Analog oscilloscope	3	2*
9	Demonstrate features of digital storage oscilloscope and measure Vrms, Vmax, Vp-p, V average, time and frequency of given signal.	3	2*
10	Obtain characteristics of LVDT.	4	2*
11	Measure weight using strain gauge or load cell.	4	2*
12	Measure Temperature using Thermocouple.	4	2*
13	Measure temperature using RTD.	4	2*
14	Obtain characteristics of thermistor	4	2
15	Detection of Gas using a Gas sensor.	4	2

16	Measure Ph using a Ph sensor.	4	2
17	Measure Humidity using a Humidity Sensor.	4	2
18	Measure Frequency using Frequency Counter.	5	2*
19	Analyze sine, square, triangular and modulated waves in frequency domain using spectrum analyser.	5	2
20	Test various digital IC using I.C. Tester.	5	2
21	Demonstrate features of Harmonic distortion Analyzer.	5	2
22	Observe and draw output waveforms of rotary encoder	4	2
	Total		**28**

Note

*i. More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.*

*ii. The following are some **sample** 'Process' and 'Product' related skills(more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises** of this course required which are embedded in the COs and ultimately the competency..*

S. No.	Sample Performance Indicators for the PrOs	Weightage in %
1	Prepare of experimental setup	20
2	Operate the equipment setup or circuit	20
3	Follow safe practices measures	10
4	Record observations correctly	20
5	Interpret the result and conclude	30
Total		**100**

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

This major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to usher in uniformity of experiments in all institutions across the state.

Sr. No.	Equipment Name with Instrument / trainer Broad Specifications	PrO. No.
1	Variable DC source, Dual channel (0-30 V, 0-2 A, with digital display)	1
2	PMMC galvanometer , 1 mA/ 100 micro ampere	5
3	Moving iron meters , 0-300 Vac/dc ,0-10 amp ac/dc	1
4	Digital Multimeter (LCD display, 3999 or 9999 or 19999 count , hand held, battery operated)	1
5	Wheatstone bridge	2
6	Maxwell bridge	3
7	Q-meter	4
8	Digital wattmeter	7
7	Analog CRO (0-20 or 50 MHz)	8
8	Digital storage oscilloscope (0-20 MHz , 100 Ms/sec)	9
10	LVDT trainer kit , 0 to +-25 mm.	10
11	Weight measurement using strain gauge/ load cell trainer kit 0-5 Kg.	11
12	Temperature measurement using Thermocouple trainer kit. 0-300 degree Celsius	12
13	Temperature measurement using RTD trainer kit. 0-300 degree Celsius	13
14	Thermistor characteristics trainer	14
15	Gas sensor trainer	15
16	Trainer for Measurement of Ph using a Ph sensor.	16
17	Trainer for Measurement of Humidity using a Humidity Sensor.	17
18	Frequency Counter. 0-10 MHz	18
19	spectrum analyzer 0-500 MHz	19
20	Digital I.C. Tester. Test CMOS , TTL ,HCMOS With test , multiple test and unknown IC finding facility	20

21	Harmonic distortion Analyzer. Type : Digital Distortion Meter Range : 2%-100% Accuracy : ± 2% Frequency : 20Hz to 20KHz Voltage Range : 50mV to 10.0V	21
22	Digital clip-on (Clamp) meter 0-20,200 amp AC	7
23	Digital wattmeter	7
24	Absolute Optical encoder trainer	22

7.**AFFECTIVE DOMAIN OUTCOMES**

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the above mentioned COs and PrO s. More could be added to fulfill the development of this competency.

a) Work as a leader /a team member.
b) Follow safety practices while using electrical appliances.
c) Practice environment friendly methods and processes. (Environment related issues like disposal of E-waste items like instruments and trainer kits)

The ADOs are best developed through the laboratory/field based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

i. 'Valuing Level' in 1st year
ii. 'Organization Level' in 2nd year.
iii. 'Characterization Level' in 3rd year.

8.**UNDERPINNING THEORY**

Only the major Underpinning Theory is formulated as higher level UOs of *Revised Bloom's taxonomy* in order development of the COs and competency is not missed out by the students and teachers. If required, more such higher level UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	**Unit Outcomes (UOs)** (4 to 6 UOs at Application and above level)	**Topics and Sub-topics**

Unit – I **Characteristic of Measurement and Bridges**	1a. Define Instrument, Error, Accuracy, Reproducibility, and Repeatability. Precision, Sensitivity, Resolution, Linearity, Response time 1b. Describe types of Error & Limiting of errors 1c. Explain working and applications of AC and DC Bridge. 1d .Explain principle and Working of Q Meter.	1.1 Definition of Instrument and it's characteristics such as rror, Accuracy, Reproducibility, Repeatability. Precision, Sensitivity, Resolution, Linearity, Response time 1.2 Types of errors & Limiting of errors 1.3 Wheatstone bridge , it's working and limitations 1.4 Basic concept of AC bridge 1.5 Maxwell's bridge 1.5 Schering bridge 1.6 Principle of Q meter 1.7 Practical Q Meter.
Unit – II **Basic Electrical Parameter measurement**	2a. Differentiate between moving iron and moving coil type instruments. 2b. Measure DC and AC voltage and current using an analogue meter. 2c. Extend the measuring range of the meters. 2d. Explain working of electronic multimeter 2e. Explain working and advantages of DVM. 2f. Explain working of clamp on Ammeter, Electronic Wattmeter and energy meter.	2.1 Introduction to Moving coil and moving iron type instruments 2.2 DC and AC voltmeter and current meter 2.3 Electronic Multimeter and its advantages 2.4 DVM Types - Integrating type, and successive approximation type DVM 2.5 Clamp on Meter 2.6 Electronic Watt Meter 2.7 Electronic Energy Meter

Unit– III **Oscilloscopes**	3a. Explain block diagram of CRO. 3b. Explain CRO Screen, Graticules. 3c. Measure various parameters using CRO. 3d. Explain Construction, Block diagram, working and advantage of DSO.	3.1 Block diagram of Analog C.R.O. and working of each block in brief 3.2 Various probes for CRO 3.3 Measurement of Voltage , Frequency, Time delay and Phase angle 3.4 Digital storage oscilloscope(DSO) , construction ,features and advantages
Unit– IV **Transducers and Sensors**	4a. Differentiate active, passive, primary and secondary transducers. 4b. Explain Working of strain Gauge and Load cell. 4d. Describe working of LVDT and inductive transducer. 4e. Explain working of Capacitive, Inductive, and temperature transducers. 4f. Explain the working principle of temperature, Gas, Humidity, Proximity, Pollution and PH sensors. 4g. Explain absolute and incremental type of Optical encoder.	4.1 Classification of transducers(active ,passive, primary , secondary , resistive ,capacitive ,inductive) 4.2 Strain Gauge (without mathematical derivation of gauge factor), construction of load Cell ,applications of strain gauge 4.3 LVDT 4.4 Inductive Transducer 4.5 Capacitive Transducer. Pressure measurement using capacitive transducer 4.6 Temperature Transducers. RTD, Thermistor, Thermocouple Semiconductor Temperature Sensor LM35 4.7 Gas Sensor MQ2 4.8 Humidity Sensor Hygrometer 4.9 Proximity Sensor 4.10 PH Sensor 4.11 Absolute Optical encoder and it's A ,B , C waveform output

Unit– V **Test And Measuring Instruments**	5a. Describe working principle of function generator. 5b. Describe the working principle of the basic frequency counter. 5c. Describe working of Digital IC tester. 5d. Describe working of Spectrum Analyzer. 5e Describe working of Harmonic distortion analyzer.	5.1 Function generator 5.2 Basic frequency Counter 5.3 Digital IC Tester 5.4 Spectrum Analyzer 5.5 Harmonic Distortion analyzer

***Note**: The UOs need to be formulated at the 'Application Level' and above of Revised Bloom's Taxonomy' to accelerate the attainment of the COs and the competency.*

9. SUGGESTED SPECIFICATION TABLE FOR QUESTIONPAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A	Total Marks
I	Characteristic of Measurement and Bridges	6	3	4	3	10
II	Basic Parameter measurement	8	4	5	6	15
III	Oscilloscopes	9	4	5	6	15
IV	Transducers and Sensors	12	4	12	4	20
V	Test And Measuring Instruments	7	2	4	4	10
Total		**42**	**17**	**30**	**23**	**70**

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

***Note**: This specification table provides general guidelines to assist student for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions assess the attainment of the UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary slightly 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 specification of electronics instruments.
b) Give seminars on DSO, MSO, Various transducers and sensors.
c) Undertake a market survey of different electronics instruments.
d) Prepare plan for disposal of E-waste of old and non-use electronics instruments as per GPCB and CPCB guidelines.

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) Guide student(s) in undertaking micro-projects.

c) ***'L' in section No. 4*** means different types of teaching methods that are to be employed by teachers to develop the outcomes.

d) About ***20% of the topics/sub-topics*** which are relatively simpler or descriptive in nature is to be given to the students for ***self-learning***, but to be assessed using different assessment methods.

e) With respect to ***section No.11***, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.

f) Guide students on how to address issues on environment and sustainability

g) Guide students for using specification and data manuals of different 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, 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 a dated work diary consisting of individual contributions 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 a micro-project by the end of the semester to develop the industry oriented COs.
A suggestive list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

a) Build a small circuit for 30 V DC measurement using PMMC meter
b) Build a simple circuit to measure DC voltage using ICL 7107 or MAX07
c) Build a small circuit for 300 V ac measurement using PMMC meter
d) Build a simple counter circuit for measuring line frequency (50 Hz)
e) Build a simple circuit for measurement of displacement using optical encoder
f) Build a simple circuit for measurement of room temperature using LM35
g) Build a simple circuit of function generator using IC 8038 or XR2206
h) Disposal of old instruments
– Prepare a chart or report on handling, recycling and disposal of old instruments with figures, tables and comparative charts and strategies used or suggested.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	Electronic Instruments and Measurement Techniques	Cooper, W.D. Halfrick, A.B.	PHI Learning, New Delhi, latest edition
2	Electrical and Electronic Measurements	Sahani, A.K.	Dhanpat Rai, New Delhi, latest edition
3	Elements of Electronic Instrumentation and Measurement	Joseph, J.Carr	Pearson, New Delhi, latest edition
4	Electronic Instrumentation and Measurements	David, Bell	PHI New Delhi, latest edition
5	Electronic Measurements and Instrumentation	Kishor, K Lal	Pearson, New Delhi, latest edition
6	Electronic Instrumentation and Measurements	H S Kalsi	McGraw Hill

14. SOFTWARE/LEARNING WEBSITES

1. www.nptel.iitm.ac.in
2. www.khanacademy.org
3. https://phet.colorado.edu/

4. https://ndl.iitkgp.ac.in
5. www.electrical4u.com
6. www.vlab.co.in
7. www.techtronics.in
8. www.scientificindia.com
9. www.agilent.com
10. www.sensorland.com/HowPage037.html
11. www.elprocus.com/category/sensors/
12. https://www.electronicscomp.com/
13. https://onlinecourses.nptel.ac.in/noc19_ee44/preview
14. https://thinkrobotics.in/

15. PO-COMPETENCY- CO MAPPING

Semester -III	**Electronics Instruments and Measurements (Course Code: .....)**						
	POs						
Competency & Course Outcomes	**PO 1 Basic & Discipline specific knowledge**	**PO 2 Problem Analysis**	**PO 3 Design/ development of solutions**	**PO 4 Engineering Tools, Experimentation &Testing**	**PO 5 Engineering practices for society, sustainability & environment**	**PO 6 Project Management**	**PO 7 Life-long learning**
Competency Use **various electronic tests and measuring instruments for measurement process**							
CO a) Measure values of various passive components with proper accuracy, precision and resolution	3	2	2	2	-	-	1
CO b) Measure various electrical parameters using different electrical and electronic meters.	3	2	-	3	2	-	1
CO c) Measure various signal parameters using electronic instruments.	3	-	-	3	-	-	1
CO d) Select appropriate transducer /sensor for measurement of physical quantity.	3	2	3	3	2	1	2
CO e) Use electronic instruments for measurement, testing and troubleshooting of electronic circuits.	3	2	-	3	-	-	1

Legend: '**3**' for high, '**2**' for medium, **'1'** for low or **'-'** for the relevant correlation of each competency, CO, with PO/ PSO

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

Sr. No.	Name and Designation	Institute	Contact No.	Email
1	Bhadreshkumar B. Renuka	A.V.P.T.I. , Rajkot	9426783082	renukasir@gmail.com
2	Ketan S. Patel	B.B.I.T., VVNagar	9825581051	kspatel@bbit.ac.in

BoS Resource Persons

Sr. No.	Name and Designation	Institute	Contact No.	Email
1.	Dr. A S Pandya, Principal BoS Chairman Electrical & Allied Branches	AVPTI, Rajkot	9426201171	aspandya22@rediffmail.com
2.	Dr. S N Sampat i/c Principal BoS Member-EC	GGP, Surat	9033777389	snsampat@gmail.com
3.	Shri U V Buch, LEC BoS Member-EC	GP A'bad	9825346922	uvbuch@gmail.com