GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2022 (COGC-2021)
Semester-IV

Course Title: Engineering Metrology & Instrumentation Control
(Course Code: 4345501)

Diploma programmer in which this course is offered	Semester in which offered
Fabrication Technology	4th Semester

1. RATIONALE

This course provides the knowledge and practice regarding measurement and inspection of different types of fabricated items, process piping, structural items and mechanical parts. The course develops skills for using and calibrating different measuring instruments used in fabrication & process industries. As you know the exact and precise measurements are the basic need of the manufacturing industries. This course of engineering metrology & instrumentation control therefore provides necessary knowledge and skills for accurate & precise measurements for manufacturing and creates quality consciousness. This course may build confidence among the students for developing employable skills required in fabrication industries.

2. COMPETENCY

The course content should be taught and with the aim to develop different types of skills so that students are able to acquire following competency:

- Select and use appropriate analog and digital measuring and gauging instruments for inspecting various parameters in fabrication and process industry such as linear dimensions, angular, roughness, straightness, flatness, pressure, temperature, flow etc.

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with the identified competency are to be developed in the student for the achievement of the following COs:

a) Measure the given job using appropriate linear measuring instrument.
b) Measure the given job using appropriate angular measuring instrument.
c) Use different types of gauges for inspecting given job.
d) Describe the temperature, pressure and flow measuring instruments.
e) Perform inspection of various elements of given process equipment.

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	
4	0	4	6	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 practical outcomes (PrOs) are the sub-components of the COs.*These PrOs need to be attained to achieve COs.*

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Measure length, width, diagonal length & thickness of plate by using 3 meter measure - tap.	1	2
2	Measure Length of given job using Vernier Calliper.	1	2
3	Measure OD of given job using Vernier Calliper.	1	2
4	Measure ID of given job using Vernier Calliper.	1	2
5	Measure Depth of blind hole of given job using Vernier Calliper	1	2
6	Measure OD of given job using Outside Micrometer.	1	2
7	Measure Straightness of given job using dial gauge / sprit level.	1	2
8	Measure Flatness of given job using dial gauge / sprit level.	1	2
9	Measure Roundness of given job using dial gauge.	1	2
10	Calibrate Vernier caliper and micrometer screw.	1	2
11	Prepare set of Slip Gauges for given dimension using M112 slip gauge set.	1	4
12	Calculate a set of Angle Gauges for given angle using angle gauge set.	2	4
13	Measure angle of given job using Universal Bevel Protractor.	2	2
14	Measure angle between two planes with the help of sine bar.	2	2
15	Demonstrate Indirect measuring methods with instruments for surface roughness measurement.	2	2

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
16	Measure a given job using snap/ring gauge.	3	2
17	Measure a given job using plug gauge.	3	2
18	Measures a Thread of given job by using thread gauge.	3	2
19	Demonstrate use of temperature measuring instruments.	4	2
20	Demonstrate use of pressure measuring instruments.	4	2
21	Demonstrate use of flow measuring instruments.	4	2
22	Perform inspection of welded joint for Process Equipment.	5	2
23	Prepare inspection report of process equipment.	5	8
Total Hours			**56**

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. *Boiler suit, safety shoes and necessary tools & instruments are compulsory while attending laboratory and has to be brought by students (Annexure-1).*

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.

Sr. No.	Sample Performance Indicators for the PrOs	Weightage in %
For PrOs no: 1,2,3,4,5,6,7,8,9,10,11,13,14,16,17,18,22,23		
1	Knowledge of experiment	20
2	Performance	30
3	Procedure followed	30
4	Quality of report	10
5	Punctuality	10
Total		**100**

Sr. No.	Sample Performance Indicators for the PrOs	Weightage in %
For PrOs no: 12,15,19,20,21		
1	Knowledge of experiment	30
2	Quality of report	30
3	Participation	20
4	Punctuality	10
5	Originality	10
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 user in uniformity of practical's in all institutions across the state.

Sr. No.	Equipment Name with Broad Specifications	PrO. No.
1.	3 meter measure tap	1
2.	Simple vernier calliper, dial vernier calliper, digital vernier calliper, Vernier height gauge	2,3,4,5,10
3.	Outside micrometer, inside micrometer, depth micrometer	6,10
4.	Slip gauge set	11
5.	Angle gauge set	12
6.	Dial gauge with magnetic stand and V- blocks	7,8,9
7.	Bevel protractor	13
8.	Sprit level	7,8
9.	Surface plate	7,8,9
10.	Sine bar	14
11.	Indirect measuring instruments for surface roughness measurement	15
12.	Sample of various surface texture and different surface roughness.	15
13.	Plug gauge, ring gauge, snap gauge, standard wire gauge, taper gauge, thread gauge, Weld gauge etc.	16,17,18,22,23
14.	Dead weight piston gauge	20
15.	Temperature, Pressure and flow and measuring instruments.	19,20,21

7. AFFECTIVE DOMAIN OUTCOMES

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

a) Follow safety practices in laboratory.
b) Practice good housekeeping.
c) Work as a leader/a team member.
d) Maintain tools/equipment
e) Follow ethical practices

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 & 4th year.

8. UNDERPINNING THEORY

The major underpinning theory is given below based on the higher level UOs of *Revised Bloom's taxonomy* that are formulated for development of the COs and competency. If required, more such UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
Unit-I **Linear measurement**	1a. Describe concept and objectives of metrology 1b. Select suitable linear measuring instruments and check for errors. 1c. Calibrate linear measuring instrument	1.1 Definition, concept and objectives of metrology 1.2 Principles, process and methods of measurement 1.3 Need, importance and types of standards 1.4 Interchangeability and selective assembly 1.5 Fundamental linear measuring unit and their conversion 1.6 Concept of computer aided inspection 1.7 Static characteristics of measuring instrument 1.8 Direct and indirect measuring instruments 1.9 Construction, working principle, leastcount of various linear measuring instruments. 1.10 Errors in measurements 1.11 Working and use of dial indicator. 1.12 Selection of measuring instrument. 1.13 Straightness, flatness, squareness and roundness measurement 1.14 Calibration of measuring instrument vernier caliper

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
		& micrometer
Unit– II **Angular and surface roughness measurement**	2a. Describe working principle and calculate least count of angular measuring Instruments. 2b. Select suitable angular measuring instruments and measure dimensions of a given job. 2c. Define various terms related with surface roughness measurement. 2d. Measure surface roughness and compute profile by using given data.	2.1 Construction, working principle, leastcount of various angular measuring instruments. 2.2 Optical angular measuring instruments, clinometers, auto collimator, angle dekker etc. 2.3 Surface roughness terminology 2.4 Direct and indirect surface roughness measuring system 2.5 measurement of surface roughness and computation of profile 2.6 Relationship of machining process and surface texture
Unit-III **Limit gauges & transducers**	3a. Select and check the given dimension by using various types of gauge. 3b. Select proper gauge material 3c. Describe instruments used in process industries and Various transducers.	3.1 Concept of gauging, 3.2 Measurement VS gauges 3.3 Advantages, limitation and classification of gauges 3.4 Application of limit gauge 3.5 Weld gauge - classification, Sketch and its applications. 3.6 Gauges material 3.7 Introduction, advantages and Classification of Transducers. 3.8 Concept of generalize measuring System
Unit-IV **Instrumentation control in process industries**	4a. Select and measure the temperature, pressure and flow by using appropriate measuring devices. 4b. Calibrate pressure and Temperature & flow measuring devices	4.1 Temperature measurement 4.2 Pressure measurement 4.3 Flow measurement 4.4 Calibration of pressure gauge, temperature measuring device
Unit- V	5a. Explain roles, responsibilities and	5.1 Need of inspection in industry 5.2 Types of inspection

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
Inspection	ethical requirement of welding / fabrication industry inspector. 5b. Develop qualities of good inspector for fabrication industry 5c. Carryout inspection of process / fabrication equipment	5.3 Centralized and decentralized inspection system 5.4 Ethical and essential requirement of welding inspector 5.5 Responsibilities of welding inspector 5.6 Inspection of process equipment 5.7 Welding inspection operation 5.8 Role of third party inspection agencies in field of fabrication 5.9 Inspection VS quality control

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	Linear measurement	18	7	7	7	21
II	Angular and surface roughness measurement	10	3	4	7	14
III	Limit gauges & transducers	6	3	3	0	6
IV	Instrumentation control in process industries	14	11	7	0	18
V	Inspection	8	4	7	0	11
	TOTAL	**56**	**28**	**28**	**14**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*
Note: *This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks and 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 perform following activities in group and prepare reports of about 5 pages for each activity. They should also collect/record physical evidences for their (student's) portfolio which may be useful for their placement interviews:

a) Prepare solutions of different assignments given by subject faculty.
b) Prepare a list of specifications for various measuring instruments used in fabrication or process industries.

c) Download videos showing correct practices for used of various measuring instruments used in fabrication or process industries.
d) Visit at local manufacturing/fabrication/process industries place and prepare the report on it.
e) Prepare report on inspection for process equipments.

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.10***, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.

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-projects are group-based (group of 3 to 5). However, **in the fifth and eighth semesters**, 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 duration of the micro project should be about **14-16** ***(fourteen to sixteen) student engagement hours*** during the course. The students ought to submit micro-project by the end of the semester to develop the industry-oriented COs.

A suggestive list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

a) Chart making: Student has to prepare a chart on construction of various measuring instruments given by the subject teacher.
b) Video Preparation: Student has to prepare his/her video on demonstrating different measuring instruments given by the subject teacher.
c) E-learning projects: Students have to use internet and other online resources for preparation of report and/or download video on the topic given by the subject teacher within the syllabus or beyond the syllabus.

d) **Report preparation:** Student has to use different books, technical magazine, journals etc. for preparation of a report on the topic given by the subject teacher within the syllabus or beyond the syllabus.

e) **Power point presentation**: Students has to prepare a power point presentation of 10 to 15 slides on the topic given by the subject teacher within the syllabus or beyond the syllabus. In the end of presentation student has to ask at least 3 to 5 MCQ based question to identify the gain of listeners at the end presentation.

13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
1	A textbook of metrology	M. Mahajan	Dhanpat rai & co.
2	Engg. metrology	R. K. Jain	Khanna Publishers, Delhi
3	Mechanical measurement & instrument	R. K. Rajput	S. K. Kataria & Sons
4	Mechanical measurement	Dr. D. S.Kumar	Metropolitan Book Pub.
5	Mechanical measurement	R. K. Jain	Khanna publishers
6	Statistical Quality Control	M. Mahajan	Dhanpat rai & co.
7	Industrial Instrumentation & Control	S K Singh	Tata McGrawHill
8	Practical Engineering Metrology	K.W.B.Sdarp	Pitman

14. SOFTWARE/LEARNING WEBSITES

- **https://youtu.be/3nio_KKMbnU**
- **https://youtu.be/BqAmLOI8uzs**
- **https://youtu.be/u8UW9O1UHCw**
- **https://youtu.be/VtMBICpCfew**
- **https://youtu.be/xPUjQAtre7Q**
- **https://youtu.be/vkPlzmalvN4**
- **https://youtu.be/vMgKQegeV24**
- **https://youtu.be/saoOUXYXde0**
- **https://youtu.be/qwEB0wEfQTg**
- **https://youtu.be/dzhh82H2Nuk**
- **https://youtu.be/As5kzxkyT24**
- **https://youtu.be/uWX5layyDY4**
- **https://youtu.be/sHmjE21Fp9w**
- **https://youtu.be/9VpimWrPTaM**

- https://youtu.be/RARjXXaFEQ0
- https://youtu.be/gByrUkZUnKo
- https://youtu.be/3zmF7qRb9pI
- https://youtu.be/b12XN3G4GaU
- https://youtu.be/pG3UFnIYSeI
- https://youtu.be/fXYdSEli88Y
- https://youtu.be/oI1iWsgbGAE
- https://youtu.be/iwasC3G141w

15. PO-COMPETENCY-CO MAPPING

Semester IV	Engineering Metrology & Instrumentation Control (Course Code: 4345501)						
	POs						
Competency & Course Outcomes	**PO 1 Basic & Discipline specific knowledge**	**PO 2 Problem Analysis**	**PO 3 Design/ develop-ment of solutions**	**PO 4 Engineering Tools, Experimen-tation & Testing**	**PO 5 Engineering practices for society, sustainability & environment**	**PO 6 Project Manage-ment**	**PO 7 Life-long learning**
Competency	Select and use appropriate analog and digital measuring and gauging instruments for inspecting various parameters in fabrication and process industry such as linear dimensions, angular, roughness, straightness, flatness, pressure, temperature, flow etc.						
Course Outcomes CO1) Measure the given job using appropriate linear measuring instrument.	2	1		3			2
CO2) Measure the given job using appropriate angular measuring instrument.	2	1		3			2
CO3) Use different types of gauges for inspecting given job.	2			3			2
CO4) Describe the temperature, pressure and flow measuring instruments.	2			2	1		1
CO5) Perform inspection of various elements of given process equipment.	3			2			2

*Legend: '**3**' for high, '**2**' for medium, '**1**' for low and '**-**' for no correlation of each CO with PO.*

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

Sr. No.	Name and Designation	Institute	Contact No.	Email
1.	Mr.Samirbhai Y.Merchant I/C H.O.D Fabrication Technology Department	Sir Bhavsinhji Polytechnic Institute Bhavnagar	9428408314	Symerchant72@gmail.com
2.	Mr. Rohankumar B. Zapadiya Lecturer in Fabrication Technology	Sir Bhavsinhji Polytechnic Institute Bhavnagar	9033219351	rohan.zapadiya@gmail.com

ANNEXURE-1

❖ SAMPLE SEFATY CONTRACT:

(To be filled by the students and submitted to concerned faculty/staff)

-- Use for reference purposes only --

1. You have to read and sign the safety contract.
2. The safety contract says that you understand that safety is your responsibility.
3. The safety contract to be signed before you carry out any work in the laboratory and if you don't observe and obey the safety rules, you will not be allowed in the laboratory.

::

Safety Contract

Date: _____

Name of Institute: _____

Name of Course with Code: Engineering metrology & Instrumentation Control (4345501)

Name of Faculty/Staff with Designation: 1. _____

2. _____

3. _____

I RECOGNIZE THAT:

1. Safety is my responsibility when using a tool.
2. Safety regulations have been provided to me.
3. The possibility of accident and injury increases if I do not follow all the safety guidelines.
4. I must act responsibly to ensure my own safety & the safety of others in the work area.

I AGREE TO:

1. Never work in the shop without my faculty's/ Instructor's supervision.
2. Read and practice all the safety regulations that have been distributed to me in this course or have been posted in the work areas.
3. Act in a responsible manner at all times in the laboratory.
4. Follow all instructions given by the faculty/Instructor.
5. Immediately report any unsafe condition or activity to my faculty/Instructor.
6. Wear eye protection at all times when working with tools or working anywhere near someone who is using tools.
8. Cut or Tie back long hair, remove jewellery, secure loosed clothing, and wear boiler suit & safety shoes in the laboratory.
9. Clean all work areas and put equipment away before leaving the laboratory.

I, _____, have read and agree with all the safety instructions.

Particulars:

Programme: _____ Student Signature

Batch No.: _____ _____

Enrolment No.: _____