GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

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

Course Title: Process Instrumentation and Maintenance
(Course Code: 4342304)

Diploma programme in which this course is offered	Semester in which offered
Plastics Engineering (Sandwich Pattern)	4th Semester

1. RATIONALE

Plastic engineering machineries and processes are now very much automated. And hence, the knowledge of instruments is essential for a plastic engineer. This subject provides the knowledge of measurement and control of plastic processing parameters. Moreover, the subject also deals with maintenance methods for machinery and helps plastic diploma holders in appreciating safety rules and does the routine maintenance. Hence this course has been designed to develop this competency and its associated cognitive, practical and affective domain learning outcomes.

2. COMPETENCY

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

- Troubleshoot and maintain different plant machineries and various instruments safely.
- Able to use all safety precautions in plant.

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) Utilize various measuring and controlling instruments.
b) Understand the fundamentals of servomechanism and PLC systems
c) Practice various types of plant maintenance such as preventive, schedule and break-down maintenance.
d) Manage the maintenance activities for different equipment's.
e) Develop newer lubricating methods for prevention of wear, corrosion.

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	4	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. *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	Demonstrate working principle and constructional features of Bi-metallic thermometer	**II**	02
2	Calibrate a given thermocouple.	**II**	02
3	Calibrate an RTD.	**II**	02
4	Carryout plant maintenance of Moulds	**VI**	02
5	Carryout plant maintenance of Hydraulic & pneumatic systems	**VI**	02
6	Prepare list of activities of preventive maintenance.	**VI**	02
7	Perform preventive maintenance of Injection molding machine	**VI**	02
8	Find and resolve the problems in Injection molding machine.	**IV**	02
9	Apply lubrication to Injection Molding Machine, extruder.	**V**	02
10	Carryout plant maintenance of extrusion plant.	**VI**	02
11	Carryout plant maintenance of Injection molding machine	**VI**	02
	Total		**22**

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 practical's in all institutions across the state.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	Thermocouple experimental setup	1,2
2	RTD experimental setup	1,2
3	Transducer experimental setup	1,2
4	Safety related precautions	3,4
5	Planning and scheduling of maintenance activity	3,4
6	Maintenance activity observation and record keeping	4,5

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 competency.

a) Work as a leader/a team member.
b) Follow ethical practices.
c) Practice environmentally friendly methods and processes to avoid metal waste.

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 Instrumentation fundamentals	1a. Select appropriate measuring instrument 1b. Rectify the instrumental errors. 1c. Draw the diagram of instrument system	1.1 Introduction to instrumentation 1.2 Selection of measuring instruments 1.3 Errors in instruments 1.4 Block diagram of instrumentation system
Unit– II Process Instrumentation	2a. Differentiate between measuring instruments. 2b. Utilize various measuring instruments. 2c. Calibrate various instruments. 2d. Use the transducers	2.1 Temperature measurement instruments and scales 2.1.1 Solid thermometer 2.1.2 Liquid thermometer 2.1.3 Gas thermometer 2.2 Thermocouple & resistance thermometer or Resistance Temperature Detector (RTD) 2.3 Pressure measurement instruments 2.3.1 Linear variable differential transformer (LVDT) 2.3.2 Pressure measurement instruments with the help of LVDT & Burdon tube 2.4 Classification of Transducers
Unit– III Servo mechanisms & PLC system	3a. Differentiate open and close loop controls systems 3b. Apply servomotors 3c. Describe the working of PLC systems	3.1 Open & close loop control system 3.2 Regulators & servo-mechanism 3.3 Servomotors 3.4 PLC control system
Unit – IV Plant maintenance	4a. Classify various maintenances 4b. Prevent equipment's from beak down 4c. Manage maintenance schedules 4d. Repair the machine	4.1 Types of maintenance 4.2 Fault finding methods 4.3 Planning & Scheduling of maintenance work 4.4 Maintenance cost and economy 4.5 Service life of equipment's

Unit	**Unit Outcomes (UOs)** (4 to 6 UOs at Application and above level)	**Topics and Sub-topics**
Unit – V Wear, Corrosion & Lubrication	5a. Apply various techniques to reduce wear 5b. Select appropriate preventive material for corrosion 5c. Predict the quantity lubricants. 5d. Apply the lubrication methods.	5.1 Wear types and reduction techniques 5.2 Corrosion and its types 5.3 Corrosion prevention techniques 5.4 Function and types of Lubricants 5.5 Lubrication methods
Unit – VI Maintenance of Plastics processing machines	6a. Organize maintenance activities for any plastic Processing plant. 6b. Prepare maintenance chart. 6c. Identify the faults.	6.1 Maintenance of an Injection Molding machine 6.2 Maintenance of Moulds 6.3 Maintenance of Hydraulic & pneumatic systems
Unit – VII Safety	7a. Appreciate the need of safety 7b. Apply safely rules 7c. Organize various safety awareness programs 7d. Prevent accidents 7e. Use various protective equipment	7.1 Importance of safety 7.2 Major safety measures in plastics processing plants 7.3 Management responsibilities 7.4 Accidents and its prevention 7.5 Activities related to promotion of safety 7.6 Safety awareness measures 7.7 Personal Protection Equipment

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

8. 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	**Instrumentation fundamentals**	04	02	03	00	05
II	**Process Instrumentation**	10	05	05	05	15
III	**Servo mechanisms & PLC system**	06	05	05	00	10
IV	**Plant maintenance**	06	02	02	06	15
V	**Wear, Corrosion & Lubrication**	06	05	03	02	10
VI	**Maintenance of Plastics processing machines**	06	03	02	05	05
VII	**Safety**	04	03	03	04	10
Total		**42**	**25**	**23**	**22**	**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.*

9. 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:

1. Students will measurement of pressure and temperature.
2. Students will calibrate instruments.
3. Students will be greasing machines
4. Students will remove rust from machines, molds, dies.

10. 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) Visit to nearby industries.
h) Video/animation films on working of an injection molding machine.
i) Video/animation films on remedies to overcome defects found in an injection molded products.

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

a) Activities during Mold maintenance: Detailed statement indicating activities during maintenance of molds.
b) Fault finding method: Draw a decision tree and find out faulty parts.
c) Lubrication: Greasing and oiling of require parts.
d) Safety: Keep all safety precautions during plant activity.

13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
1.	Industrial Instrumentation & Control	S.K.Singh	Publication: Tata McGraw Hill ISBN:10- 0070262225 Year:2010
2.	Industrial Instrumentation	Donald P.Eckman	Publication: Wiley Eastern Ltd ISBN: 9780852262061 Year:1950
3.	Hand Book of Instrumentation and control	H.P.Kallen	Publication: Tata McGraw Hill ISBN:10- 0070332355 Year:1961
4.	Plastics Industry Safety Hand Book	Dominick V.Rosato & John R. Lawrence	Publication: Van Nostrand Reinhold ISBN:10- 084361207X Year:1973
5.	Industrial safety, Health and Environment Management system	R. K. Jain & Sunil S. Rao	Publication: Khanna publishers ISBN:10- 8174092102 Year:2000

14. SOFTWARE/LEARNING WEBSITES

1. www.processinst.com
2. www.automation.siemens.com/mcms/automation/en/sensor-systems/process-instrumentation/Pages/Default.aspx
3. www.scribd.com/doc/62796183/Instrumentation-Presentation
4. http://pc-education.mcmaster.ca/Instrumentation/go_inst.htm

15. PO-COMPETENCY-CO MAPPING

Semester IV	PROCESS INSTRUMENTATION AND MAINTENANCE (Course Code: 4342304)									
	POs and PSOs									
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**	**PSO 1** An ability to apply principles of material selection, product & mould/die design and development in plastics engineering.	**PSO 2** An ability to conduct safe and environment friendly manufacturing and recycling of plastic products	**PSO 3** (If needed)
Competency *Troubleshoot and maintain different plant machineries and various instruments safely. * Able to use all safety precautions in plant.	3	2	2	3	1	1	2	2	1	
Course Outcomes 1 Utilize various measuring and controlling instruments	3	1	1	3	1	1	1	1	1	
2.Understand the fundamentals of servomechanism and PLC systems	3	2	1	2	1	1	1	2	1	
3.Practice various types of plant maintenance such as preventive, schedule and break- down maintenance	3	2	1	3	1	1	2	1	1	
4. Manage the maintenance activities for different equipment.	2	1	2	1	1	1	1	1	1	
5. Develop newer lubricating methods for prevention of wear, corrosion.	1	1	1	1	1	1	3	1	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
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