GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Diploma Engineering

Level: Diploma

Branch: Instrumentation and Control Engineering

Subject Code : DI04017021

Subject Name : Analytical Instrumentation

w. e. f. Academic Year:	2025-26
Semester:	4th
Category of the Course:	PCC

Prerequisite:	Students should have a foundational understanding of mathematics, basic physics, chemistry, and electronics from their instrumentation or engineering coursework.
Rationale:	Analytical Instrumentation takes extensive use in area of medical field, drugs and pathological laboratories, pharmaceutical, dairy, chemical industries, water treatment etc. This course aids students to obtain knowledge and skills to select, understand working, operate and maintain analytical instruments for relevant industry application. This course tries to build these qualities in students.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level
1	Identify analytical instruments for various applications	R,U
2	Operate analytical instruments to investigate the thermal and mechanical behavior of materials.	A
3	Illustrate the use of instruments for assessing the electrical behavior of materials.	A
4	Analyze the radiant characteristics of a material via appropriate instruments.	A
5	Select appropriate analytical instrumentation for the detection and quantification of various air and water pollutants.	A

**Revised Bloom's Taxonomy (RBT)*

Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+(PR/2)	Assessment Pattern and Marks				Total Marks
				Theory		Tutorial / Practical		
L	T	PR	C	ESE(E)	PA(M)	PA(I)	ESE(V)	
3	0	2	4	70	30	20	30	150

Course Content

Unit	Topics and Sub-topics	No. Of Hrs.	% Weightage
Unit – I Introduction to analytical instrumentation	1.1 Analytical Instrumentation: - Definition, Block diagram of analytical instrument and each element explanation 1.2 Compare Classical analytical techniques with instrumental technique 1.3 Classification: -Spectral, Electro-analytical and Separation methods(introduction to each method) 1.4 Elements of optical Radiation sources:-Introduction to sunlight, incandescent, Fluorescent, LASER optical filter, Monochromator-prism, Grating.	9	20%
Unit – II Analytical Instrumentation for Measurement Thermo-Mechanical Properties Measurement	2.1 Viscosity measurement techniques. 2.1.1 Terminologies 2.1.2 Saybolt viscometer 2.1.3 Zahn Cup viscometer 2.1.4 Ford Cup viscometer 2.2 Density measurement techniques. 2.2.1 Pressure head type densitometer 2.2.2 Displacer type densitometer 2.2.3 Float type densitometer 2.2.4 Buoyancy effect type densitometer 2.3 Thermal conductivity analysis. 2.3.1 Principle 2.3.2 Dual hot wire thermal conductivity cell.	9	20%
Unit – III Analytical Instrumentation for Electrical Property Measurement	3.1 Introduction and applications Methods of measurement of conductance : 3.1.1.null method 3.1.2direct reading method 3.1.3Conductivity cell 3.1.4Temperature compensation in conductivity measurement 3.2 pH analyzer 3.2.1Principle of pH measurement. 3.2.2Electrodes for pH measurement. 3.2.3Electronics circuit for pH measurement. 3.3 O2 Analyzer	9	20%

	3.3.1Paramagnetic O2 analyzer 3.3.2dumb-bell type 3.3.3wind type 3.3.2Heat of reaction analyzer 3.3.4Dissolved O2 analyzer. 3.4 Polarography		
Unit – IV Analytical Instrumentation for radiant Properties Measurement	4.1 Electromagnetic radiation 4.1.1 Electromagnetic spectrum 4.1.2 Interaction of radiation with matter 4.2Laws relating to Absorption of radiation. 4.2.1 Lambert's law 4.2.2 Beer's law 4.2.3 Beer- Lambert's law 4.3 Absorption instruments 4.3.1 Colorimeters (photometer) 4.3.2 Spectrophotometer 4.3.3 X-ray technique of analysis by absorption. 4.3.4 X-ray technique of analysis by diffraction. 4.4 Nuclear Magnetic Resonance(NMR) 4.4.1 Principle 4.4.2 Block diagram	9	20%
Unit – V Analytical Instrumentation for Auxiliary & Environmental Monitoring Technology	5.1 Chromatography: - Principle and classification of chromatography 5.1.1 Gas chromatographic system: principle, diagram, basic components of GC, working applications 5.1.2 Liquid chromatographic system: principle, diagram, basic components of LC, working applications 5.2 Refractometer 5.2.1 Theory of operation 5.2.2 Classify Refractometer 5.3 Environmental pollution monitoring instruments 5.3.1 Types and concentration of various Gas pollutant 5.3.2 SO2 measurement using conductivity method 5.3.3 Nitrogen oxide measurement using Chemiluminescence 5.3.4 Ozone measurement using conductivity meter	9	20%
	Total	**45**	**100**

SUGGESTED PRACTICAL EXERCISES

The following practical outcomes (PrOs) that are the sub-components of the Cos. *Some of the **PrOs** marked**'*'** are compulsory, as they are crucial for that particular CO. These PrOs need to be attained at least at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain'.*

S.No.	Practical Outcomes (PrOs)	Approx. Hrs. required
1	Identify the elements of analytical instruments in Laboratory	2Hrs
2	Measure viscosity of a given solution using a viscometer.	2Hrs
3	Measure density of a given solution using float type densitometer.	4Hrs
4	Measure conductivity of given solution using digital conductivity meter.	2Hrs
5	Plot effect of temperature on conductivity of given aqueous solution	2Hrs
6	Measure pH of given solution using double electrode method.	4Hrs
7	Measure pH of given solution using combination electrode method.	4Hrs
8	Plot the effect of temperature on pH of given aqueous solution	4Hrs
9	To study wind type O2 analyzer.	4Hrs
10	Measure O2 concentration in given gas mixture.	2Hrs
11	Prepare electrode and measure dissolved O2 concentration in given sample.	2Hrs
12	Water analysis using water analyzer	2Hrs
13	Verify Beer-Lambert's law using Trainer kit.	2Hrs
14	Analyze given sample using colorimeter.	2Hrs
15	Test and calibrate spectrophotometer.	2Hrs
16	Measure % transmission, absorption and concentration of given sample using spectrophotometer.	2Hrs

S.No.	Practical Outcomes (PrOs)	Approx. Hrs. required
17	Analyze given gas mixture using gas chromatograph.	2Hrs
18	Measure refractive index using refactometer.	2Hrs
		48

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..*

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

MAJOR EQUIPMENT / INSTRUMENTS AND SOFTWARE REQUIRED

These major equipment / instruments and Software required to develop PrOs are given below with broad specifications to facilitate procurement of them by the administrators / management of the institutes.This will ensure conduction of practical in all institutions across the state in proper way so that the desired skills are developed in students.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	pH meter	6,7,8
2	Conductivity meter	4,5

3	Spectrophotometer	15,16

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 fulfil the development of this competency.

a) Work as a leader/a team member for assigned student activity.
b) Follow safety practices and procedure in Lab.
c) Realize the importance of engineering for societal development.
d) Develop gradually the engineering mindset in day-to-day observation

SUGGESTEDSTUDENTACTIVITIES

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 a chart of components currently used for analytical instruments
b) Prepare a chart that displays the different types of analyzers
c) Participate in a seminar/workshop for learning new trends and technology in analytical instrumentation
d) Prepare a poster for safety guidelines

SUGGESTEDSPECIALINSTRUCTIONALSTRATEGIES (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/ subtopics.
b) Guide student(s) in undertaking micro-projects.
c) Visit to Industries/ Process and CSMRI type laboratories/ industries
d) Video films/animation films on working of different types of analytical instruments.

SUGGESTEDLEARNINGRESOURCES

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
1	Handbook of Analytical Instruments	R.S. Khandpur	Tata McGraw Hill, New Delhi
2	Analytical Instrumentation	Bela G. Lipkat	Chilton book company
3	Principle of industrial instrumentation	D. Patranabis	Tata McGraw Hill, New Delhi
4	Process instrumentation and control	A.P. Kulkarni	NiraliPrakashan,pune
5	Instrumental methods of analysis	H.H. Willard	CBS Publishers & Distributors
6	Introduction to instrumental analysis	Braun Robert D	McGraw Hill Education, New Delhi
7	Principle of Instrumental Analysis	Skoog	holler, Nieman, Saunders college publishing,1998.

SUGGESTED LEARNING WEBSITES

1. https://www.slideshare.net
2. https://nptel.ac.in
3. https://instrumentationtools.com
4. www.youtube.com

5 https://vlab.amrita.edu

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