Program Name : **Diploma in Digital Electronics Engineering**

Program Code : **DE**

Semester : **Third**

Course Title : **Industrial Instrumentation and Sensors**

Course Code : **22332**

1. RATIONALE

Diploma engineers (also called technologists) have to operate instruments and control different parameters in industry. In order to measure and control the physical parameters in industry, it requires adequate knowledge of operating principles and construction of sensors/transducers and instrumentation system. In practical situation engineers are required to select sensor/ transducer for given application, handle, maintain and calibrate it. This course is designed keeping in view developing these skills.

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 the electronic circuits in instrumentation systems.**

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant 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. Select transducer and sensor for given application.
b. Calibrate given pressure transducer/sensor.
c. Test given flow/level/speed transducer/sensor.
d. Use temperature/humidity transducer for given application.
e. Maintain industrial instrumentation 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
3	-	2	5	3	70	28	30*	00	100	40	25@	10	25	10	50	20

(*): 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.

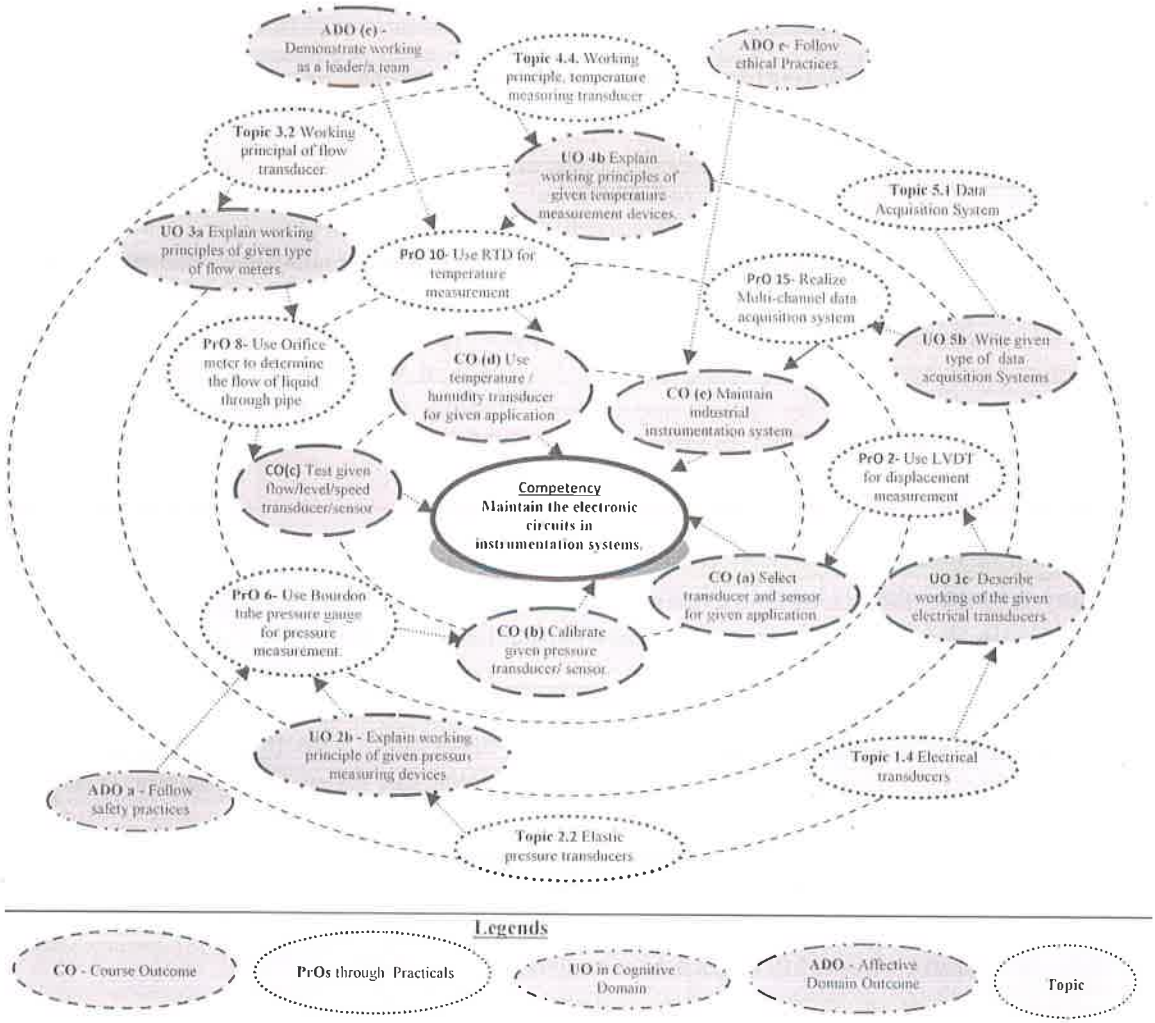

Figure 1 - Course Map

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 Exercises(PrOs)	Unit No.	Approx. Hrs. Required
1	Use proximity sensor to measure speed of motor.	1	02*
2	Use LVDT for displacement measurement.	1	02
3	Determine LDR characteristics	I	02
4	Measure output voltage and force in strain gauge and plot Force/voltage characteristics.	I	02
5	Use strain gauge with cantilever setup for weight measurement.	II	02*
6	Use Bourdon tube pressure gauge for pressure measurement.	II	02
7	Calibrate pressure gauge using Dead weight pressure gauge tester.	II	02
8	Use Orifice meter/rotameter to determine the flow of liquid through pipe.	III	02*

S. No.	Practical Exercises(PrOs)	Unit No.	Approx. Hrs. Required
9	Determine level of liquid in a tank using capacitive type level measurement technique.	III	02
10	Use RTD for temperature measurement.	IV	02*
11	Use thermocouple to temperature measurement.	IV	02
12	Use non contact type photo electric tachometer to measure speed of motor.	IV	02
13	Determine relative humidity by wet and dry bulb hygrometer.	IV	02
14	Realize single- channel data acquisition system.	V	02*
15	Realize Multi-channel data acquisition system.	V	02
16	Convert current to pressure (I to P) and pressure to current (P to I) using electric transmission.	V	02
	Total		**32**

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 12 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.	Identify the requirements of practical set up	20
b.	Arrange and operate the set up	30
c.	Observe and understand the performance	20
d.	Answer to sample questions	15
e.	Submit report in time	15
	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 instrumentation systems.
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 and
- 'Characterising Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipments with broad specification mentioned here will usher in uniformity in conduct of experiments, as well as aid to procure equipment by authorities concerned.

S. No.	Equipment Name with Broad Specifications	PrO. S. No.
1	Educational trainer kit for measurement of speed of motor using proximity sensor.	1
2	Educational trainer kit for measurement of linear displacement using LVDT.	2
3	Educational trainer kit for measurement of weight using strain gauge with cantilever setup.	5
4	Educational trainer kit for measurement of pressure using bourdon pressure gauge.	6
5	Educational trainer kit for calibration of pressure gauge using dead Weight tester.	7
6	Educational trainer kit for measurement of liquid flow using rotameter.	8
7	Educational trainer kit to calculate flow of liquid through pipe using Orifice meter.	8
8	Educational trainer kit to determine level of liquid in a tank using capacitive type level measurement	9
9	Educational trainer kit to measure the temperature using RTD.	10
10	Educational trainer kit to measure temperature using thermocouple.	11
11	Educational trainer kit to measure speed of motor using non contact type photo electric tachometer.	12
12	Educational trainer kit to determine relative humidity by wet and dry bulb hygrometer.	13
13	Educational trainer kit to determine LDR characteristics	3
14	Educational trainer kit to measure output voltage and force in strain gauge and plot Force/voltage characteristics.	4
15	Electric transmission setup.	16
16	Single channel data acquisition system educational setup.	14
17	Multi-channel data acquisition system educational setup.	15
18	CRO -30 MHz, dual channel, Y-deflection: 5mV/div,~20V/div, sweep rate 0.1µsec/div, ~0.2sec/div. Input- 230V AC mains, sensitivity 1mV/div.	All
19	Digital Multimeter :- 3 ½ digit, Voltage range-(0-750 V AC, 0-1000V DC), Transistor and diode test, continuity test, Resistance range- (0-200MΩ), Current Range-(0-2000mA) .	All
20	Single phase AC motor, ½ HP	12
21	Hand held Pressure gauge.	2,3
22	Function generator –(0-30MHz in the decade ranges), Output amplitude-(1mV to 10 V p-p). Attenuation: 20db,40db, 60db.	All
23	Voltmeter (0-20V)	All
24	Ammeter (0-100 mA)	All
25	Photo electric type tachometer- Non contact type, handheld	1,12

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 Transducers and Sensors	1a. Describe function of the given blocks of instrumentation system. 1b. Describe selection of relevant transducer for the given application. 1c. Explain with sketches the working of the given electrical transducers. 1d. Explain with sketches the working principle of the given sensor. 1e. Describe selection of relevant sensor for the given application.	1.1 **Instrumentation Systems:** Block diagram of instrumentation system, function of each block. 1.2 **Transducers:** Need of transducer, classification of transducer: Active and passive, analog and digital, primary and secondary. 1.3 **Need of Signal Conditioning.** 1.4 **Electrical Transducers:** a. **Resistive Transducer**- Linear and angular potentiometer, Strain gauge, types of strain gauge, Wheatstone's bridge. b. **Capacitive Transducer:** - Variable area, variable plate distance and variable dielectric constant. c. **Inductive Transducer**- Linear variable differential transformer, Rotary variable differential transformer. d. **Piezoelectric Transducer:**- Piezo electric effect, piezo electric materials, Selection criterion for transducers. 1.5 **Sensors**: pneumatic sensor ,light Sensors, proximity sensors, tactile sensor, smart sensor.
Unit– II Pressure measurement	2a. Differentiate the features of the given type of pressures. 2b. Explain with sketches the working principle of the given pressure measuring device. 2c. Describe with sketches the construction of the given type of pressure measuring device. 2d. Explain with sketches the procedure for calibration of the given pressure transducer.	2.1 **Pressure:** Definition, types of pressure- Atmospheric, absolute, gauge, vacuum 2.2 **Pressure Transducers:** a. **Non elastic pressure transducers**: U-tube, inclined tube, well type manometer (Working principle, construction) b. **Elastic pressure transducers:** Bourdon tube, bellows, diaphragm, capsule (Working principle, construction,). c. **Electronic pressure transducers:** Bourdon tube with LVDT, diaphragm with strain gauge. 2.3 **Calibration:** Calibration of pressure gauge using dead weight tester
Unit– III Flow, Level and Speed measurement	3a. Explain with sketches the working principle of the given type flow meter. 3b. Describe with sketches the construction of the	3.1 **Flow**: definition, Types of flow- Laminar, turbulent, Reynolds number, Classification of flow measuring transducers: Working principle. construction, advantages, disadvantages and applications of Venturimeter, orifice plate meter, Rotameter.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	given type of flow meter. 3c. Explain with sketches the working principles of the given type of level measuring device. 3d. Explain with sketches the working principle of the given speed measurement technique.	time difference ultrasonic flow meter and Doppler type ultrasonic flow meter, Coriolis mass flow meter 3.2 **Level**: definition, need of level measurement, Classification of level measurement, working principle, construction, of float type, capacitive type, ultrasonic types, radiation types and RADAR type. 3.3 **Speed and Distance**: speed measurement methods (contact type and non contact type), distance (Ultrasonic, proximity) measurement, working principle, construction of photoelectric pick-up, Magnetic pick-up.
Unit –IV Temperature and Humidity Measurement	4a. Explain with sketches the working principle of the given type of temperature measurement device. 4b. Describe with sketches the construction of given temperature measuring device. 4c. Explain with sketches the working principle of the given type of humidity measurement device. 4d. Select the relevant transducer for the given temperature/humidity measurement application with justifiction.	4.1 **Temperature:** Definition and unit of measurements ,different temperature scale and their conversion, Law of thermodynamics, 4.2 **Temperature Measuring Transducer**: filled system types, bimetallic thermometer types, and electric / electronics types, optical types, working principle, construction and application of RTD, thermistors, thermocouple, and pyrometer 4.3 **Humidity:** Definition, types- absolute and relative; Humidity Measurement Devices: Psycho meter- dry & wet bulb thermometer, Hygrometer- hair type, capacitive type, resistive type.
Unit – V Data Acquisition systems.	5a. Explain functions of the given component of data acquisition system. 5b. Explain with sketches the working of the given the data acquisition system. 5c. Explain with sketches the given method of data transmission. 5d. Explain with sketches the working of the given data telemetry system. 5e. Explain with sketches	5.1 **Data Acquisition System**: Introduction, objective and configuration of data acquisition system, analog and automated data acquisition system, single channel data acquisition system, multi channel data acquisition system, application of data acquisition system. 5.2 **Data Transmission**: Mechanical Transmission, Hydraulic transmission, pneumatic transmission, magnetic transmission, electric type transmission. 5.3 **Data Telemetry**: definition, general telemetering system, types of telemetry voltage telemetry, current telemetry, RF telemetry, position telemetry.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	the working of the given display device and recorder.	5.4 **Display Devices and Recorders**: Indication instruments: analog and Digital; Display units LED, LCD,EPID and LVD, Recorders: Strip chart, X-Y, Oscillographic and printers

***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	Transducers and Sensors	10	02	06	06	14
II	Pressure measurement	08	04	04	06	14
III	Flow, Level and Speed measurement	10	02	04	06	12
IV	Temperature and Humidity measurement	08	02	06	06	14
V	Data Acquisition systems	12	04	06	06	16
Total		**48**	**14**	**26**	**30**	**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. Visit to local industry where data acquisition system is used and collect the data.
b. Market survey: Collect from local market the technical specifications and prices of three to four sensors/transducers and prepare comparative analysis.
c. Form a group of three to four students and discuss curriculum contents.
d. Prepare list of local instrumentation industries employing digital controls.
e. Prepare a sheet to display construction of selected transducer.
f. Prepare journals consist of free hand sketches of transducer and equipment's in each practical , detail specification and precautions to be observed while using transducer and equipment
g. Explore datasheet /technical specification of transducer.
h. Explore circuits of temperature/pressure control.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

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. Demonstrate students thoroughly before they start doing the practice.
g. Encourage students to refer different websites to have deeper understanding of the subject.
h. Encourage students to visit local industries.
i. Observe continuously and monitor the performance of students in Lab.
j. Encourage students to analyze local market related to digital electronics.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student assigned to him/her in the ***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. Similar micro-projects could be added by the concerned faculty:

a. Water level measurement.
b. Turn on or off the electric equipment using some transducer.
c. Object detector measurement using some transducer.
d. Open or close the door using some device.
e. Temperature measurement using some transducer.
f. Pressure measurement using some transducer.
g. Smoke detector measurement using some transducer.
h. Light detection using measurement using some transducer
i. Object counter using measurement using some transducer.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Electrical and Electronics Measurements	Sawhney A.H.	Dhanpat rai and sons, New Delhi, 2012, ISBN: 978-8177001006

S. No.	Title of Book	Author	Publication
2	Industrial Instrumentation and Control	Singh S.K.	McGraw Hill , New Delhi, 2009,ISBN: 978-0070678200
3	Principal of Industrial Instrumentation	Patranabis D.	McGraw Hill , New Delhi, 2010,ISBN: 9780070699717
4	Instrumentation System and Devices	Sharma Rangan mani	McGraw Hill , New Delhi , 2011,ISBN: 9780074633502
5	Process Measurement Instrument Engineering Handbook	Bela Liptak; Kriszta Venczel	Chilton Book Co., New Delhi, 1982, ISBN: 978-0801969713
6	Electronic Measurement and Instrumentation	Rajput R.K. Er	S. CHAND , New Delhi , 2008,ISBN: 9788121929172

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. www.proprofs.com/webschool
b. www.en.wikipedia.org/wiki/Sensor
c. www.en.wikipedia.org/wiki/Tranducer
d. www.freestudy.co.uk/instrumentation/tutorial2.pdf
e. www.osvn.com
f. www.controlnet.com
g. www.youtube.com/(here type name of transducer /sensor/instrument)
h. www.freeideolecturers.com/course/2374/indusrial -instrumentation
i. www.ocw.mit.edu
j. www.mooc-list.com