INDUSTRIAL MEASUREMENTS **Course Code : 313345**

Programme Name/s : **Mechatronics**
Programme Code : **MK**
Semester : **Third**
Course Title : **INDUSTRIAL MEASUREMENTS**
Course Code : **313345**

I. RATIONALE

Industrial measurement systems are crucial in monitoring and control applications. This course helps to measure industrial process parameters in given situation using suitable sensor or/and transducer.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Select suitable measuring instrument for required measurement process by knowing their working principle.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Apply various performance characteristics of measuring instruments.
- CO2 - Select relevant mechanical transducers for measuring required parameters.
- CO3 - Choose suitable transducers for measuring pressure and temperature.
- CO4 - Select relevant transducers for level and flow measurement.
- CO5 - Use suitable signal conditioning and data acquisition system.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme												
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical							
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
313345	INDUSTRIAL MEASUREMENTS	IME	DSC	4	-	2	2	8	4	3	30	70	100	40	25	10	25#	10	25	10	175

Total IKS Hrs for Sem. : 0 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

MSBTE Approval Dt. **Semester - 3, K Scheme**

INDUSTRIAL MEASUREMENTS **Course Code : 313345**

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Describe block diagram of an instrumentation system. TLO 1.2 Describe performance characteristics of measuring instruments. TLO 1.3 Classify types of error in measurement. TLO 1.4 Define the term Sensor and transducer. TLO 1.5 Select relevant sensor and transducer for a given application.	**Unit - I Introduction to measurement system** 1.1 Introduction to measurement system-Definition of measurement, Significance of measurement, block diagram of instrumentation system, Standard and calibration. 1.2 Instrument and its performance characteristics- Static characteristics: - Accuracy, Precision, Range, Span, Error, Linearity, Hysteresis, Reproducibility, Repeatability, Dead zone, Span, Range, Threshold. Dynamic Characteristics: - Speed of response, lag, Fidelity, Dynamic error. 1.3 Types of Error- Gross, Systematic and random errors. 1.4 Primary elements of measurement system – Sensors: Working principle and applications of proximity and optical sensor. Transducer -Need and classification a. Mechanical and Electrical b. Active and Passive c. Primary and secondary d. Analog and Digital. 1.5 Selection Criteria of transducer.	Lecture Using Chalk-Board Video Demonstrations Presentations
2	TLO 2.1 Explain construction and working principle of displacement. TLO 2.2 Describe the working principle of different strain measuring transducer. TLO 2.3 Explain construction and working of force measuring transducer with their applications. TLO 2.4 Explain working of dynamometers and torque measuring devices.	**Unit - II Displacement, strain, force and torque measurement** 2.1 Displacement Measurement- Working principle and construction of resistive transducer-potentiometer, Inductive transducer-LVDT, RVDT. Capacitive transducer. 2.2 Strain Measurement - Strain gauge types, construction and working principle of strain gauge transducer (Bonded and Unbonded). 2.3 Force measurement – Force transducer types, construction and working principle of strain gauge load cell and piezoelectric load cell. 2.4 Torque measurement construction and working principle of inline rotating torque sensor, inline stationary torque sensor, proximity torque sensor and eddy current dynamometer.	Model Demonstration Video Demonstrations Lecture Using Chalk-Board Hands-on

INDUSTRIAL MEASUREMENTS **Course Code : 313345**

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
3	TLO 3.1 Define absolute and atmospheric pressure. TLO 3.2 Classify different types of pressure measuring devices. TLO 3.3 Explain construction and working principle of different pressure measuring transducers. TLO 3.4 Classify different types of temperature measuring devices. TLO 3.5 Explain construction and working principle of different temperature measuring transducers. TLO 3.6 Differentiate between optical and radiation pyrometers. TLO 3.7 State applications of pressure and temperature measuring transducers.	**Unit - III Pressure and temperature measurement** 3.1 Pressure: Definition, units, Types - absolute, Gauge, atmospheric and Vacuum pressure. 3.2 Classifications of pressure measuring devices. 3.3 Elastic pressure transducers- Bourdon tube, Bellow, Diaphragm, Capsule. 3.4 Electrical pressure transducer- -Bourdon tube with LVDT -Piezoelectric Pressure Transducer -Photoelectric pressure transducer. 3.5 Vacuum pressure Measurement -Mc Leod gauge, Pirani gauge. 3.6 Temperature: units , temperature scales. 3.7 Classifications of temperature measuring transducers. 3.8 Electrical methods -Thermistor - RTD - Thermocouple. 3.9 Pyrometer: Optical and Radiation pyrometers.	Model Demonstration Video Demonstrations Lecture Using Chalk-Board Hands-on
4	TLO 4.1 Define types of flow. TLO 4.2 List various types of flow measuring devices. TLO 4.3 Explain construction and working principle of different flow measuring transducers. TLO 4.4 Classify different types of level measuring devices. TLO 4.5 Explain construction and working principle of different level measuring transducers. TLO 4.6 Compare direct and indirect methods of level measurement.	**Unit - IV Flow and Level measurement** 4.1 Flow: Definition, units, Types - laminar, turbulent Reynolds number. 4.2 Classifications of flow measuring transducers a. Variable head flowmeter - Venturi meter - Orifice plate meters b. Variable area flowmeter - Rotameter c. Electrical flow meter - Turbine flow meter -Electromagnetic flow meter - Ultrasonic flow meter (Time difference and Doppler type) -Hot wire anemometer d. Vortex flowmeter- Swirl meter. 4.3 Level, its units, classification of level measuring methods. 4.4 Direct methods -Sight glass - Float type with linear and rotary potentiometer. 4.5 Indirect measurement methods - Capacitive type - Ultrasonic type -Nuclear radiation type - optical level detectors.	Lecture Using Chalk-Board Model Demonstration Video Demonstrations Hands-on

INDUSTRIAL MEASUREMENTS **Course Code : 313345**

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
5	TLO 5.1 Classify speed measuring devices. TLO 5.2 Explain working principle of speed measuring transducers with application. TLO 5.3 Explain construction and working principle sound measuring transducer. TLO 5.4 Explain working principle of humidity measuring transducer with application.	**Unit - V Speed, sound and humidity measurement** 5.1 Speed measurement- Classification of speed transducers Mechanical Tachometer-Revolution Counter. Electrical tachometer-Eddy current tachometer, Tachogenerators (AC and DC). Magnetic Pick-up, Stroboscope. 5.2 Sound measurement- Sound Characteristics, Microphone and its types. 5.3 Construction, working and applications of- -Carbon microphone -Dynamic microphone. 5.4 Humidity measurement Hair hygrometer, Resistive hygrometer and capacitive hygrometer.	Lecture Using Chalk-Board Video Demonstrations Model Demonstration Hands-on
6	TLO 6.1 State the need of signal conditioning system. TLO 6.2 Describe block diagram of signal conditioning circuit. TLO 6.3 Describe block diagram of data acquisition system. TLO 6.4 State the need of non-Linear signal conditioning system.	**Unit - VI Signal conditioning system** 6.1 Basic signal conditioning-Definition. Need and function. 6.2 Linear signal conditioning-Adder, Subtractor, Instrumentation amplifier. 6.3 Non-Linear signal conditioning- Amplitude modulation-Demodulation, Filtering. 6.4 Data acquisition system-Introduction, Block diagram of DAS.	Video Demonstrations Lecture Using Chalk-Board Site/Industry Visit Hands-on

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Identify types of error in measurement. LLO 1.2 Apply procedure to find error in measurement.	1	Error measurement in a given instrument.	2	CO1
LLO 2.1 Prepare experimental set-up for displacement measurement. LLO 2.2 Use LVDT to measure displacement. LLO 2.3 Draw LVDT input-output characteristics.	2	*Linear displacement measurement using LVDT.	2	CO1 CO2
LLO 3.1 Prepare experimental set-up for weight measurement. LLO 3.2 Use strain gauge load cell to measure weight. LLO 3.3 Draw strain gauge load cell input-output characteristics.	3	*Weight measurement using strain gauge load cell.	2	CO1 CO2

INDUSTRIAL MEASUREMENTS **Course Code : 313345**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 4.1 Measure pressure using bourdon tube pressure gauge.. LLO 4.2 Draw input-output characteristics of bourdon tube pressure gauge.	4	*Pressure measurement using bourdon tube.	2	CO1 CO3
LLO 5.1 Measure temperature using RTD. LLO 5.2 Draw RTD input-output characteristics.	5	Temperature measurement using RTD.	2	CO1 CO3
LLO 6.1 Identify steps to calibrate RTD. LLO 6.2 Use NIST data values as standard and calibrate RTD.	6	*Calibration of RTD temperature measuring instruments (Prefer NIST data table as standard).	2	CO1 CO3
LLO 7.1 Use thermocouple to measure temperature. LLO 7.2 Draw thermocouple input-output characteristics.	7	*Temperature measurement using thermocouple.	2	CO1 CO3
LLO 8.1 Identify steps to calibrate thermocouple. LLO 8.2 Use NIST data values as standard and calibrate thermocouple.	8	Calibration of thermocouple temperature measuring instruments (Prefer NIST data table as standard).	2	CO1 CO3
LLO 9.1 Identify type of orifice meter LLO 9.2 Measure flow rate using orifice meter.	9	Flow rate measurement using orifice meter.	2	CO4
LLO 10.1 Identify type of variable area flowmeter. LLO 10.2 Measure flow rate using rotameter.	10	*Flow rate measurement using rotameter.	2	CO4
LLO 11.1 Identify type of level indicator. LLO 11.2 Measure level using float type level indicator.	11	Level measurement using float type level indicator.	2	CO4
LLO 12.1 Identify type of level transducer. LLO 12.2 Measure level using capacitive transducer.	12	Level measurement using capacitive transducer.	2	CO4
LLO 13.1 Identify type of speed measuring transducer. LLO 13.2 Measure speed using stroboscope.	13	*Speed measurement using stroboscope.	2	CO2
LLO 14.1 Identify type of sound measuring instrument. LLO 14.2 Measure level using sound meter.	14	Sound intensity measurement using sound meter.	2	CO2
LLO 15.1 Identify type of hygrometer. LLO 15.2 Measure humidity using hair hygrometer.	15	Humidity measurement using hair hygrometer.	2	CO2
LLO 16.1 Select the components to design of signal conditioning circuit. LLO 16.2 Use breadboard to implement signal conditioning circuit for RTD /thermistor/thermocouple. LLO 16.3 Measure output using designed signal conditioning circuit.	16	*Design and implement signal conditioning circuit for RTD /thermistor/thermocouple.	2	CO1 CO3 CO5

MSBTE Approval Dt. **Semester - 3, K Scheme**

INDUSTRIAL MEASUREMENTS **Course Code : 313345**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Micro project

- Develop a quarter/ half / full bridge configuration of RTD for temperature measurement.
- Implement op-amp based linearizer for NTC thermistor.
- Develop set-up for force measurement using load cell.
- Build distance measurement set-up using IR sensor.

Assignment

- Evaluate drift in thermocouple.
- Thickness measurement using differential roller LVDT.
- Prepare a specification of sensors and transducers identified during visit to process industry.
- Discover real time applications of dynamometers used in industries.

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Capacitive transducer for level measurement: Capacitive probe, Range 0-100mm, Digital Display.	12
2	Stroboscope: range up to 5000 rpm with digital display.	13
3	Sound level meter: Measuring range 30-130 dB, portable and easy to use.	14
4	Thermistor: Range 0- 120 deg. C.	16
5	LVDT displacement measuring kit:measurement range 0-50mm. Micrometer screw gauge assembly for displacement.	2
6	Strain gauge trainer-Strain/force measurement -Sensor-4 arm bridge with strain gauge mounted cantilever 2kg, with digital display.	3
7	Load cell: force measurement range 5-50N, Strain gauge capacity 2kg.	3
8	Bourdon tube pressure gauge: C type.	4

INDUSTRIAL MEASUREMENTS **Course Code : 313345**

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
9	RTD(Pt-100) 0- 150 deg. C.	5,6,16
10	Dual-Well Dry-Well temperature calibrator 0 to 350 deg. C.	5,6,7,8,16
11	Glass thermometer: Range 0- 100 deg. C.	6,8
12	Thermocouple: Range 0- 1500 deg. C.	7,8,16
13	Flow measurement set-up (Venturi meter, orifice and rotameter).	9,10

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Introduction to measurement system	CO1	8	2	2	4	8
2	II	Displacement, strain, force and torque measurement	CO2	10	2	4	6	12
3	III	Pressure and temperature measurement	CO3	12	2	6	8	16
4	IV	Flow and Level measurement	CO4	10	2	4	6	12
5	V	Speed, sound and humidity measurement	CO2	12	2	4	6	12
6	VI	Signal conditioning system	CO5	8	2	2	6	10
Grand Total				**60**	**12**	**22**	**36**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- For laboratory learning 25 marks.
- Two unit tests of 30 marks and average of two unit tests.
- Each practical will be assessed considering appropriate % weightage to process and product and other instructions of assessment.

Summative Assessment (Assessment of Learning)

- End semester assessment of 70 marks through offline mode of examination.
- End semester assessment of 25 marks for laboratory learning.
- End semester assessment of 70 marks through offline mode of examination
- End semester assessment of 70 marks through offline mode of examination.

XI. SUGGESTED COS - POS MATRIX FORM

INDUSTRIAL MEASUREMENTS **Course Code : 313345**

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	3	2	-	2	2	-	2			
CO2	3	2	1	2	2	1	2			
CO3	3	2	1	2	2	1	2			
CO4	3	2	1	2	2	1	2			
CO5	3	2	1	2	2	1	2			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Kumar, D.S	Mechanical Measurements and Control	Metropolitan Book Co. Pvt. Ltd. 2015,ISBN: 9781200041246.
2	Singh, S.K.	Industrial Instrumentation and Control.	Mc Graw Hill Publishing House, 2013,ISBN:978-0-07-026222-5.
3	Nakra, BC Choudhary, KK	Instrument measurement and analysis.	Mc Graw Hill Publishing House, 2016, ISBN:978-9385880629,ISBN:9385880624.
4	Rajput, R.K.	Mechanical Measurement and Instrumentation.	S.K.Kataria and Sons, 2017, ISBN:81-88458-83-X.
5	Sawhney, A.K. , Sawhney,Puneet	Mechanical Measurements and Instrumentation and Control.	Dhanpat Rai Publication, 2013, ISBN:9786000598884.
6	Venketashan, S.P.	Mechanical Measurement.	Ane Books India,2022, ISBN:978-3-030-73619-4.

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://archive.nptel.ac.in/courses/112/107/112107242/	Mechanical measurement system.
2	https://archive.nptel.ac.in/courses/108/105/108105064/	Industrial Instrumentation.
3	https://www.youtube.com/watch?v=T2C-19ZZhbg&t=7s	Strain gauge.
4	https://www.youtube.com/watch?v=AwZnWtkzuRQ	Dynamometer.
5	https://www.youtube.com/watch?v=qSRhstdL9WA	Pressure Measuring devices.
6	https://www.youtube.com/watch?v=2ABljUmax0w&t=1s	Temperature measuring devices.
7	https://www.youtube.com/watch?v=D_vbjofZl5E&t=1s	Flow measuring devices.
8	https://www.youtube.com/watch?v=hL2ofn12x_M	Introduction of signal conditioning circuit and operational amplifier.

INDUSTRIAL MEASUREMENTS **Course Code : 313345**

Sr.No	Link / Portal	Description

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

MSBTE Approval Dt. **Semester - 3, K Scheme**