MEASUREMENTS & AUTOMATION BASICS **Course Code : 313330**

Programme Name/s : **Automation and Robotics**

Programme Code : **AO**

Semester : **Third**

Course Title : **MEASUREMENTS & AUTOMATION BASICS**

Course Code : **313330**

I. RATIONALE

Engineering diploma holders in electronics and allied disciplines are expected to identify and use various measuring instruments in industrial applications. Measurement-based control has always been at the core of industrial automation. This course is designed to give overview of the basics of Industrial measurements and its subsequent requirement in automation

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help students to attain the following industry/employer expected outcome through various teaching learning experiences:
Test various electronic parameters in automation systems.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Interpret the characteristics of measuring instrument.
- CO2 - Use relevant instrument to measure specified parameters.
- CO3 - Maintain signal conditioning and data acquisition systems.
- CO4 - Identify different components of automation system.
- CO5 - Identify different components of robotic 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	
313330	MEASUREMENTS & AUTOMATION BASICS	MAB	DSC	4	-	4	2	10	5	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.

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 the concept of measuring instrument and their types. TLO 1.2 Determine static and dynamic characteristics of measuring instruments. TLO 1.3 Identify standards of measurements. TLO 1.4 Identify errors in industrial measurement.	**Unit - I Fundamentals of Electrical and Electronics Measurements** 1.1 Fundamentals of measuring instrument 1.2 Types of measuring instruments: Analog, digital, electrical and electronics 1.3 Compare analog and digital instruments 1.4 Static and dynamic characteristics of instruments 1.5 Calibration(need and methods:direct,indirect)standards of Instrument 1.6 Errors in measurement, types of errors, sources of errors	Lecture Using Chalk-Board Presentations
2	TLO 2.1 Describe the procedure to measure displacement in automation system. TLO 2.2 Describe the use of rotary encoder to measure angle of given rotating device. TLO 2.3 Describe the procedure to measure frequency, period, voltage using DSO. TLO 2.4 Explain the working of function generator and signal generator with block diagram.	**Unit - II Measuring Devices and Instruments** 2.1 Angular and linear displacement using potentiometer 2.2 Rotary encoder: Working principle, specifications, applications 2.3 Digital multi meter: Working principle, specifications, applications 2.4 DSO: Functional block diagram and uses of Digital Storage Oscilloscope 2.5 Signal generator: Basic working principle 2.6 Function generators: Functional block diagram and applications	Lecture Using Chalk-Board Model Demonstration Presentations Video Demonstrations
3	TLO 3.1 Explain the need of signal conditioning in the measurement. TLO 3.2 Differentiate AC and DC signal conditioning circuits. TLO 3.3 Describe function of	**Unit - III Data Acquisition System** 3.1 Signal conditioning: Need, types of signal conditioning (block diagram of AC and DC signal conditioners) 3.2 Filter, isolator, amplifier and converter as a signal conditioner (only function) 3.3 Data Acquisition Systems (DAS): Need, types	Lecture Using Chalk-Board Presentations

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.
	given block of DAS. TLO 3.4 Differentiate types of DAS system.	(single channel, multi-channel and computer based) 3.4 Comparison of types of DAS 3.5 Data loggers: Concept and applications	
4	TLO 4.1 Identify the need and benefits of industrial automation. TLO 4.2 List applications of automation system. TLO 4.3 Describe function of components of automation system. TLO 4.4 Identify different types of automation system.	**Unit - IV Basics of Automation System** 4.1 Need and benefits of automation system 4.2 Application areas: Process industries, building, robotics, railways, infrastructure development, aerospace, automobiles electrical distribution, medical, telecommunication etc. 4.3 Automation hierarchy:Basic components and function of each component 4.4 Types of automation system: Fixed, programmable, flexible machine automation, process automation,factory automation 4.5 Different systems used in industrial automation: PLC, HMI, SCADA, DCS, drives	Lecture Using Chalk-Board Video Demonstrations Presentations
5	TLO 5.1 Describe the function of the given element of the robotic systems with the help of sketch. TLO 5.2 Explain with sketches the given degree of freedom for a robot. TLO 5.3 Compare given types of robot on the basis of degree of freedom, construction, end effector used and applications.	**Unit - V Basics of Robotics in Automation System** 5.1 Robotics: Block diagram and function of each component (sensors, drive system, control system, end effectors) 5.2 Construction and degrees of freedom of cylindrical robot 5.3 Construction and degrees of freedom of spherical and cartesian robots	Lecture Using Chalk-Board Presentations Video Demonstrations

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 Use multimeter to determine accuracy, resolution, precision for specified measured quantity.	1	*Measurement of accuracy, resolution and precision of given measuring device	2	CO1
LLO 2.1 Calibrate given measuring instrument using direct method. LLO 2.2 Calibrate given measuring instrument using indirect method.	2	*Caliberation of given measuring instruments by direct and indirect method	2	CO1
LLO 3.1 Identify use of analog multimeter.	3	Measurement of AC voltage, current and resistance using analog multimeter	2	CO1
LLO 4.1 Identify use of digital multimeter.	4	*Measurement of DC voltage, current and resistance using digital multimeter	2	CO2
LLO 5.1 Identify controls of function generator.	5	*Identification of front panel controls of function genrator	2	CO2
LLO 6.1 Use function generator to generate different types of waveforms (sine, square, triangular). LLO 6.2 Measure the frequency and amplitude of the waveform using DSO.	6	*Analysis of different waveforms using function generator and DSO	2	CO2
LLO 7.1 Use DSO to measure amplitude and frequency of the given input signal.	7	*Measurement of amplitude and frequency of input signal using DSO	2	CO2

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Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 8.1 Use potentiometer for linear displacement measurement.	8	*Measurement of linear displacement using potentiometer	2	CO2
LLO 9.1 Use potentiometer for angular displacement measurement.	9	*Measurement of angular displacement using potentiometer	2	CO2
LLO 10.1 Use of rotary encoder for angular displacement measurement.	10	Measurement of angular displacement using rotary encoder	2	CO2
LLO 11.1 Verify concept of data acquisition system.	11	Verification of working of data acquisition system available in laboratory	2	CO3
LLO 12.1 Verify filter as signal conditioner.	12	*Verification of filter as signal conditioning circuits	2	CO3
LLO 13.1 Verify isolator as signal conditioner.	13	Verification of isolator as signal conditioning circuits	2	CO3
LLO 14.1 Verify converter as signal conditioner.	14	Verification of function of converter (ADC/ DAC) as signal conditioning circuits	2	CO3
LLO 15.1 Verify current to voltage conversion operation.	15	Verification of current to voltage convertor as signal cinditioner(4-20mA signal into 0-5 volt)	2	CO3
LLO 16.1 Verify voltage to current conversion operation.	16	Verification of use of voltage to current converter as signal conditioner	2	CO3
LLO 17.1 Identify components of automation system available in laboratory. LLO 17.2 Identify facilities of automation system available in laboratory.	17	*Identification of components and facilities of automation trainer kit available in laboratory	2	CO4
LLO 18.1 Identify various PLC brands used in Industries.	18	*Identification of major industrial PLC available in market which are used for industrial process	2	CO4
LLO 19.1 Inspection of Controls of PLC front panel.	19	*Identification of various parts of front panel of any 3 general purpose PLC	2	CO4
LLO 20.1 Identify various input devices used in Industries. LLO 20.2 Identify various output devices used in Industries.	20	*Identification of various input and output devices used in PLC system available in laboratory	2	CO4
LLO 21.1 Identify software and hardware of automation system using virtual lab.	21	Identification of hardware and software of PLC automation system with virtual lab	2	CO4
LLO 22.1 Identify components of automation hierarchy.	22	*Identification of flow of automation hierarchy of automation system	2	CO4
LLO 23.1 Inspect use of Human Machine Interface (HMI) in automation system.	23	Verification of use of HMI in automation system	2	CO4
LLO 24.1 Identify components of robotics.	24	*Identification of function of major components of roboticavailable in laboratory	4	CO5
LLO 25.1 Verify Degree of freedom of robotic system.	25	* Verification of number of Degree of freedom for robotic available in laboratory	2	CO5
LLO 26.1 Measure various parameters(Amplitude, time, frequency).	26	Measurement of amplitude,frequency and time of a signal using simulation software	2	CO2
LLO 27.1 Measure voltage resistance and current of a circuit.	27	Measurement of voltage, resistance and current of a circuit using simulation software	2	CO2

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 28.1 Measure linear displacement using potentiometer using simulation software.	28	Measurement of linear displacement using potentiometer using simulation software	2	CO2
LLO 29.1 Verify of function of data acquisition system using simulation software.	29	Verification of function of data acquisition system using simulation software	2	CO2

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

- Design practical model for measurement of linear or angular displacement using potentiometer and calculate its sensitivity.
- Build and test I to V converter circuit.
- Design and simulate any one signal conditioning circuit using open source simulating software.

Activity

- Prepare activity report on calibration, its need and procedure for a measuring instrument.
- Market survey of electronic measuring instruments used in laboratory.
- Prepare market survey report of major PLCs used in industry with their specifications.
- Prepare detailed informative chart of static and dynamic characteristics of measuring instrument.

Assignment

- Identify all controls of a DSO available in laboratory and give its specifications as per data sheet.
- Prepare report on a Robotic system with the observations of industrial visit to any industry based on robotic system.
- Identification various automation systems available in day to day life and draw schematic of any system.

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.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- 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

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Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Digital multimeter 0-10A, 0-600V, 0-10 Mega ohm	1,2,4,8,9,15,16
2	Analog multimeter 0-10 A, 0-600 V, 0-10 Mega ohm	1,3
3	Portable data acquisition system: 8 bit ADC/channel 4 analog voltage inputs powered by USB.	11
4	Input and Output devices for PLC: like Lamp, DC Motor, Proximity sensors, Thermocouple/RTD, Red, green, yellow LEDs, Stepper Motor, limit switches, push button	17,18,19,20,21,22,23
5	IEC 1131-3 compatible PLC with programming Software and interfacing hardware, user manual, (complete PLC trainer system) with HMI	17,18,19,20,22,23,21
6	Robotic system: 6 DoF, 8Kg Payload, arm range:930 mm,max speed 10.5 mm/ sec.with compatible software	24,25
7	Computer system installed with required simulation software.	26,27,28,29
8	Any open source or online simulation software.	26,27,28,29
9	Function generator: Frequency ranges 0.1Hz to 11Mz,Pulse and ramp, aspect ratio 95:5	5,6,7
10	Digital storage oscilloscope :BW 60 MHz Dual channel	6,7

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	Fundamentals of Electrical and Electronics Measurements	CO1	8	2	2	4	8
2	II	Measuring Devices and Instruments	CO2	13	4	6	6	16
3	III	Data Acquisition System	CO3	14	4	4	8	16
4	IV	Basics of Automation System	CO4	13	4	6	8	18
5	V	Basics of Robotics in Automation System	CO5	12	2	4	6	12
Grand Total				**60**	**16**	**22**	**32**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Two offline unit tests are of 30 marks and average of two unit test marks will be consider for out of 30 marks.

For formative assessment of laboratory learning 25 marks.
Each practical will be assessed considering 60% weightage to process, 40% weightage to product.

Summative Assessment (Assessment of Learning)

- End semester assessment is of 70 marks.

End semester summative assessment is of 25 marks for laboratory learning.

XI. SUGGESTED COS - POS MATRIX FORM

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

	Knowledge				Sustainability and Environment					
CO1	3	2	2	2	2	1	1			
CO2	3	2	2	2	2	1	1			
CO3	3	3	3	2	1	1	1			
CO4	3	1	2	1	2	1	1			
CO5	3	1	2	1	2	1	1			

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	Jadhav, V. R.	Programmable Logic Controller	Khanna publishers, New Delhi, 2017, ISBN: 978-8174092281
2	Madhuchhand A Mitra, Samarjit Sen Gupta	Programmable logic controllers and industrial automation an introduction	Penram international publication, New Delhi, 2015, ISBN: 978-8187972174
3	Kalsi H.S.	Electronics Instrumentation	McGraw Hill, New Delhi, 2010, ISBN:978-0070702066
4	Sawhney A.K.	Electrical and Electronic Measurements and Instrumentation	Dhanpat Rai and Sons, New Delhi, 2005, ISBN: 978-8177000160
5	David A.Bell	Electronic Instrumentation and Measurments	Oxford University,Press New Delhi India 3rd Edition, 2013, ISBN-13 978-0195696141
6	W.Boltan	Mechatronics	Pearson Education, ISBN 978-8131732533

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://youtu.be/tN7iAzVEqa0?feature=shared	NPTEL lecture on measurement
2	https://youtu.be/fg9No42IjnM?feature=shared	How potentiometer works(linear and rotary type potentiometer)
3	https://youtu.be/tw-79FiRYKA?feature=shared	What is industrial automation
4	https://youtu.be/uOtdWHMKhnw?feature=shared	Programmable logic controller basics explained - automation engineering
5	https://youtu.be/E2WNPXJf-Kw?feature=shared	PLC Introduction,PLC basics, Components of PLC,modular PLC, Modules (input Output)
6	https://youtu.be/kujHQgK352o?feature=shared	What is HMI
7	https://youtu.be/uxKyLTMv9js?feature=shared	How to do measurements using digital storage oscilloscope (DSO)

Note :

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