GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Diploma Engineering

Level: Diploma

Branch: Instrumentation and Control Engineering

Subject Code : DI04017041

Subject Name: Simulation Practice with Micro Project

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

Prerequisite:	Basic Knowledge of circuits and data communication.
Rationale:	In the present industrial scenario, diploma engineering students should be able to understand, simulate, and analyze the prevalent Process Control Systems in the industry. They are required to foresee the effects of changes in the various process parameters on the system behavior before actual implementation of the Plant Control System. Therefore, this course has been designed so that students can familiarize themselves with various simulation software tools to build and simulate the different types of Control Systems for Process Application.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level
1	Recognize appropriate instrumentation simulating and analyzing software.	U
2	Simulate the circuit using simulation software used in Instrumentation.	A
3	Select guided and unguided medium for various types of data transmission.	A
4	Use virtual instrumentation simulation software to test different systems.	A
5	Generate the output plot relevant to input for different process control loops using appropriate simulation software.	A
6	Simulate different control actions using appropriate simulation software.	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)	
0	0	6	3	0	0	20	30	50

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	To Study the function and Importance of simulating software in instrumentation and control engineering.	2
2	Perform Installation of simulation software in a given system and familiarize with features/specifications of simulation software.	2
3	Perform basic commands in the given simulation software.	2
4	Verify Kirchhoff's Voltage Law (KVL) and analyze the input-output for a given circuit using simulation software.	2
5	Verify Kirchhoff's Current Law and analyze the input-output for a given circuit using simulation software.	2
6	Simulate rectifier circuit and analyze its input-output the using simulation software.	2
7	Simulate a circuit to demonstrate the use of semiconductor devices and analyze its input-output plot using simulation software.	2
8	Simulate a circuit to demonstrate the use of optoelectronic devices and analyze its input-output plot using simulation software.	2
9	Simulate an analog AC (Alternative Current) circuit and analyze its input-output plot using simulation software.	2
10	Simulate an analog DC (Direct Current) circuit and analyze its input-output plot using simulation software.	2
11	Simulate a given digital circuit and analyze its input-output plot using simulation software.	2
12	Simulate a circuit to demonstrate the use of relay and analyze its input-output plot using simulation software.	2
13	Simulate and analyze the input-output for basic instruments viz indicators, recorders (Cathode Ray Oscilloscope (CRO), Multimeter, Function generator, Signal generator, Voltage source, Current source) using simulation software.	4
14	Simulate a circuit to perform mathematical operations like addition, subtraction, Integration, and Differentiation using an Operational Amplifier (Op-Amp), then analyzes its input-output plot using simulation software.	4

S.No.	Practical Outcomes (PrOs)	Approx. Hrs. required
15	Simulate an instrumentation amplifier circuit and analyze its input-output plot using simulation software.	2
16	Simulate a circuit to demonstrate the function of the Stepper Motor and analyze its input-output plot using simulation software.	2
17	Simulate level measurement and analyze its input-output plot using simulation software.	2
18	Simulate flow measurement and analyze its input-output plot using simulation software.	2
19	Simulate temperature measurement and analyze its input-output plot using simulation software.	2
20	Simulate pressure measurement and analyze its input-output plot using simulation software.	2
21	Simulate relative humidity measurement and analyze its input-output plot using simulation software.	2
22	Simulate relative distance measurement and analyze its input-output plot using simulation software.	2
23	Simulate light Intensity measurement and analyze its input-output plot using simulation software.	2
24	Simulate soil moisture measurement and analyze its input-output plot using simulation software.	2
25	Simulate the level control system and analyze the input-output plot of the system for step input using simulation software.	2
26	Simulate a simple feedback control loop for a given process parameter and analyze the input-output plot by varying set-point in simulation software.	4
27	Simulate On-Off control action on temperature control system and analyze its input-output plot for step input using simulation software.	2
28	Simulate On-Off control action on level control system and analyze its input-output plot for step input using simulation software.	2
29	Simulate P-control action on a given system for a given step/ramp input and set point, then analyze the input-output plot by varying Kp of P-control action using simulation software.	2
30	Simulate I-control action on a given system for a given step/ramp input and set point, then analyze the input-output plot by varying Ki of I-control action using simulation software.	2

S.No.	Practical Outcomes (PrOs)	Approx. Hrs. required
31	Simulate P+I-control action on a given system for a given step/ramp input and set point, then analyze the input-output plot by varying Kp and Ki of P+I-control action using simulation software.	2
32	Simulate P+D-control action on a given system for a given step/ramp input and set point, then analyze the input-output plot by varying Kp and Kd of P+D-control action using simulation software.	2
33	Simulate P+I+D-control action on a given system for a given step/ramp input and set point, then analyze the input-output plot by varying Kp, Ki, and Kd of P+I+D-control action using simulation software.	4
34	Simulate tuning of P+I+D-control action on a given system for a given step/ramp input and set point, then analyze the input-output plot using simulation software.	4
35	Simulate a simple feed-forward loop for a given process parameter and analyze the input-output plot by varying set point in simulation software.	2
36	Simulate FOPDT (First Order Plus Dead Time) model and analyze the input-output plot for step input in simulation software.	2

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.

i. Computer with basic configuration with windows or Unix OS.
ii. Simulation Software/ Tools like. MATLAB, LABVIEW, VLAB, ORCAD, myopenlab, PARTSIM, easyeda, tinkercad, PSPICE, PROTEUS, QUCSSTUDIO, Octave, and Scilab.

S. No.	Equipment Name	Pro No.
1	Computer (Latest version)	01 to 36

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

SUGGESTED STUDENT ACTIVITIES

Following is the list of proposed student activities such as:

i. Students may be asked to collect photographs using the internet which is relevant to field application of various topics and have to prepare learning materials using it.
ii. Teachers guided self-learning activities through internet/ lab based mini projects, industrial visit etc.
iii. Student activities like: course/ topic-based seminars, Internet based assignments.
iv. Students should deliver a seminar in groups on Simulation software.
v. Visit library and collect information from various magazines on recent developments in simulation software used in Instrumentation & control engineering and its applications and then make report of that.
vi. Students can join various channels / pages of simulation software used in Instrumentation & control engineering on social media and conduct group discussion on learned topics.

SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

Following Sample strategies teacher can use to accelerate the attainment of the various outcomes in this course:

a) Use Free Simulators Software for teaching / learning activities.
b) Show Video/ Animation Films relevant to Process Automation and Control System.
c) Internet-based home assignments.
d) Mini project.

SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her at 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 he/she 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 a dated work diary consisting of individual contributions 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 a 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. Study of First and Second Order Control System using various simulation software.
b. Develop a simple simulated instrumentation and process control system for different control actions strategies.
c. Develop a simple simulation to check input and output for different types of sensors using various simulation software.
d. Develop a simple simulation to check input and output for different types of analog and digital circuits using various simulation software.
e. Prepare Presentation on given topics.

SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Books	Author	Publication
1	Process Control: Modeling, Design, and Simulation, Prentice Hall PTR, 2002.	B. WayneBequette	Publisher : Prentice Hall India Learning Private Limited, ISBN-10 8120322657, ISBN-13 8120322653-978 :
2	Circuit Analysis with Multisim	David Baez-Lopez and Felix Guerrero-Castro	Publisher : Morgan & Claypool, ISBN : 10- 1608457567, ISBN : 13-160845756-978 .
3	A Guide to MATLAB: For Beginners and Experienced Users	Ronald L. Lipsman, Jonathan Rosenberg	Publisher :Cambridge University Press.
4	Getting Started with Matlab 7: A Quick Introduction For Scientists And Engineers	Rudra Pratap	Publisher : Oxford University press.
5	LabVIEW 7 Express Student Edition	Robert Bishop	Publisher : PHI Learning, New Delhi
6	LabVIEW™ Basics II Course Manual PDF	Worldwide TechnIcal Support and Product Information ni.com	Publisher : National Instruments Corporate.
7	Instrumentation Control, Data Acquisition and Processing with MATLAB	Fornetti Francesco	Publisher : Explore RF Ltd, ISBN-10 : 0957663501, ISBN-13 : 978-0957663503.
8	LabVIEW based Advanced Instrumentation Systems	S. Sumathi	Publisher : Springer, ISBN-10 : 3540485007, ISBN-13 : 978-3540485001.

9	Virtual Instrumentation using LABVIEW	Sanjay Gupta	Publisher : McGraw Hill Education, ISBN-10 : 0070700281, ISBN-13 : 978-0070700284.
10	Instrumentation Design Studies	Ernest Doebelin	Publisher : CRC Press, ISBN-10 : 1439819483, ISBN-13 : 978-1439819487.
11	System Simulation Techniques with MATLAB and Simulink	D Xue (Dingyü Xue)	Publisher : John Wiley & Sons Inc, ISBN-10 : 1118647920, ISBN-13 : 978-1118647929.
12	MATLAB Control Systems Engineering	Cesar Lopez	ASIN : 1484202902 Publisher : Apress, ISBN-10 : 9781484202906, ISBN-13 : 978-1484202906.
13	Getting Started with Simulink	Luca Zamboni	Publisher : Packt Publishing , ISBN-10 : 178217138X, ISBN-13 : 978-1782171386.
14	Introduction to Multisim Schematic Capture and SPICE Simulation	Janell Rodriguez and Erik Luther	Publisher : CNX
15	Complete PCB Design Using OrCAD Capture and PCB Editor	Kraig Mitzner	Publisher : Newnes (Butterworth-Heinemann Ltd), ISBN-10 : 0750689714, ISBN-13 : 978-0750689717.
16	VIRTUAL INSTRUMENTATION USING LabVIEW	Jovitha Jerome	Publisher:PHI Learning Private Limited, ISBN-978-81-203-4030-5.

17	Arduino-based embedded systems : interfacing, simulation, and LabVIEWGUI	Rajesh Singh, Anita Gehlot, Bhupendra Singh and Sushabhan Choudhury	Publisher: Taylor & Francis, CRC Press, Identifiers: LCCN 2017029926 ISBN 9781138060784 (hardback : alk. paper) ISBN 9781315162881 (ebook)

SUGGESTED LEARNING WEBSITES

i. www.nptel.com
ii. https://www.vlab.co.in/
iii. https://www.scilab.org/
iv. https://dwsim.org/
v. https://matlab.mathworks.com/
vi. https://www.multisim.com/
vii. https://octave.org/
viii. https://www.orcad.com/
ix. http://www.scicos.org/
x. http://qucsstudio.de/
xi. https://www.analog.com/en/design-center/design-tools-and-calculators/ltspice-simulator.html
xii. https://www.tango-controls.org/
xiii. https://www.ni.com/en-in/shop/labview/select-edition/labview-community-edition.html
xiv. https://www.myopenlab.org/inicio/descargar-myopenlab/
xv. https://www.coursera.org/
xvi. http://www.edx.org/
xvii. https://www.simscale.com/
xviii. https://openmodelica.org/
xix. https://www.vlab.co.in/broad-area-electronics-and-communications
xx. https://www.vlab.co.in/broad-area-electrical-engineering
xxi. https://wokwi.com/projects/new/arduino-uno
xxii. https://www.tinkercad.com/things/dEOWWJatCtv-arduino-simulator
xxiii. https://www.circuitlab.com/accounts/login/?next=/workbench/
xxiv. https://easyeda.com/editor
xxv. https://www.partsim.com/
xxvi. https://www.simulator.io/
xxvii. https://www.falstad.com/circuit/

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