GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
Semester-VI

Course Title: DCS and SCADA
(Course Code: 4361701)

Diploma programmer in which this course is offered	Semester in which offered
Instrumentation and control	sixth

1. RATIONALE

In present global scenario of manufacturing, industries are moving towards more and more automation. Small scale and medium scale industries require PLC and SCADA technology, but large scale and very large scale industries require DCS. So, it is very necessary for instrumentation engineers to have knowledge of both DCS and SCADA. So this course attempts to provide basic configurationally knowledge of these technologies to develop operational competency. Hence this course is very important for instrumentation engineers who want to specialize in industrial automation.

2. COMPETENCY

The course content should be taught and implemented with the aim to develop required skills in the students so that they are able to acquire following competency:
Configure and maintain DCS and SCADA system related to instrumentation and control for industrial automation.

3. COURSE OUTCOMES (COs)

1. Describe the structure of DCS.
2. Operate Human Interface system.
3. Simulate Industrial processes with the help of SCADA Software.
4. Identify the Structure of MTU and RTU

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
3	0	4	5	30	70	25	25	150

5. SUGGESTED PRACTICAL EXERCISES:

Sr. No.	Practicals/Exercises (Outcomes in Psychomotor Domain)	Unit No.	Approx.Hours Required
1	To measure Temperature using thermocouple	I	2
2	To measure Liquid Level by Capacitive Level Transducer	I	2
3	Understand Hardware structure of DCS	I	4
4	Identify and select system elements of DCS	I	2
5	Determine the reliability of given DCS system.	I	2
6	Interface control subsystem with Instrumentation subsystem.	II	2
7	Interface control subsystem with human interface subsystem.	II	2
8	Identify elements of SCADA.	III	2
9	Use various functions of SCADA simulation editor to develop various application	IV	4
10	To simulate Discrete control (Switch and Lamp) using available SCADA software.	IV	2
11	To simulate tank filling and emptying process using SCADA	IV	4
12	To simulate Tank Level control using SCADA	IV	4
13	To simulate temperature control process by heater using SCADA	IV	4
14	Develop SCADA mimic diagram for tank temperature control	IV	4
15	Develop SCADA mimic diagram for bottle filling plant.	IV	4
16	To simulate mixing process in the tank using available SCADA system	IV	4
17	Develop SCADA mimic diagram to create an alarm.	IV	2
18	To study about HDLC protocol	IV	2
19	To study about ANSI IEEE C37.1 Protocol	IV	2
20	Develop application for real time trend Configuration in SCADA software.	IV	4

Practical Outcomes(PrOs):

21	Develop scada application to learn Recipe management feature	IV	4
22	Identify and list various components of RTU	V	2
23	To understand configuration of MTU	V	2

Upon the completion of DCS & SCADA practical course, the student will be able to:

1. Measure particular process parameter such as tank level or temperature of the liquid inside the closed tank.
2. Understand various system elements of DCS
3. Interface various subsystems of Automation system i.e. DCS.
4. To construct mimic diagram of basic processes such as automatic tank filling and emptying, Tank level and temperature control, bottle filling etc.
5. To develop and run the SCADA program by writing proper script and executing the program such that mimic diagram represents the actual process going on in the field.
6. To understand configuration of RTU and MTU.

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

Sr.No.	Equipment Name with Broad Specifications	PrO. No.
1	DCS trainer KIT: DCS shall be based on "open" system architecture. That is the system shall maximize the use of general purpose computing hardware and software products and have inherent capability to integrate and exchange information with other brand software packages, system devices and platforms via industry standard communications, platforms and protocols. The DCS conceptual system architecture shall include operator workstations, engineering workstations, controllers, I/O networks, bulk storage devices, e.g. hard drives, and backup storage devices Communication Network	2, 3

Sr.No.	Equipment Name with Broad Specifications	PrO. No.
	High speed redundant networks shall be provided for connectivity of all the components of the DCS to perform real time and historical information transfer between various components. Digital input module(at least 16 digital inputs), Digital output module(at least 16 digital outputs), Analog Input module(at least 4 analog inputs), Analog output module(at least 2 analog outputs)	
2	SCADA software: Mimic diagram based software. Mimic diagram of any process can be created easily by using inbuilt symbol directory. Any process can be simulated by writing appropriate script. Also ther must be facility to interface any branded PLC with SCADA software so that PLC controlled process can be visualized on mimic diagram and manual control should also be possible.	4,5
3	level switch, temperature switch, flow switch	1
4	3” conveyor system operated 12V DC motor with digital shaft encoder	4,5
5	Proximity switch (Inductive, Optical, motion, light etc.)	4,5
6	12 V DC motor with digital shaft encoder	2,3,4,5
7	Flow, temperature, level control setup for DCS based automation using Flow, temperature, level switches	1,2,3,4,5

7. 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 fulfill the development of this course competency.

a. Work as a leader/a team member (while doing a micro-project).
b. Follow safety practices while using D.C. and AC supply and electrical equipment.
c. Work as a group member (while performing experiments and taking readings)
d. Practice environmentally friendly methods and processes. (Environment related)

The ADOs are best developed through the laboratory/field-based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

a. 'Valuing Level' in 1st year.
b. 'Organization Level' in 2nd year.
c. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

9. SUGGESTED SPECIFICATION TABLE FOR QUESTIONPAPER DESIGN:

Unit	Major Learning Outcomes (In Cognitive Domain)	Topics and Sub-topics
Unit – I DCS Structure	1a. Sketch and explain hierarchical architecture of DCS 1b. Explain database organization in DCS with sketch. 1c.Explain functions of system elements of DCS 1d. Define reliability parameters of DCS and determine interrelationship between them. 1e. Apply major voting technique to determine reliability of DCS 1f. Classify different types of alarms and briefly describe each of them 1g. Describe section criteria for DCS system.	1.1 DCS architecture 1.2 Database organization in DCS 1.3 System elements of DCS 1.4 Reliability parameters of DCS 1.5 Classification of alarms in DCS 1.6 section criteria for DCS system
Unit– II HMI in Automation	2a. Sketch and explain in brief basic structure of Automation system. 2b. Determine information acquisition and transfer of control commands for Instrumentation subsystem. 2c. Classify various types of devices connected to Instrumentation subsystem. 2d. Identify functional steps performed by control subsystem. 2e. Describe interface mechanism to interface control subsystem with other subsystems. 2f. Explain interfacing of control subsystem with Instrumentation subsystem with the help of suitable example.	2.1Automation system structure 2.2 Instrumentation subsystem 2.2.1 input Instrumentation subsystem 2.2.2 output Instrumentation subsystem 2.3 Control subsystem 2.4 Human Interface subsystem 2.4.1 Operator Panel 2.4.2. Construction of the panel 2.4.3. Interfacing with control subsystem 2.4.4 Types of mimic panels 2.5 Advance Human Interface System 2.5.1.Intelligent Operator Panel 2.5.2. Operator Station

	2g. Explain interfacing of control subsystem with human interface subsystem with the help of suitable example. 2h. Explain Human Interface subsystem in brief with sketch. 2i. Identify and select active display elements and active control elements of operator panel. 2j. Compare basic approach and mimic approach for the construction of HMI panel. 2k. Sketch interfacing of mimic panel with control subsystem. 2l. State and compare types of mimic panels. 2m. Explain Intelligent operator panel of HMI. 2n. Explain operator station of advanced human interface with suitable example.	2.5.3. Data logging Station
Unit– III Introduction to SCADA	3a. Define SCADA. 3b. Enumerate application areas of SCADA. 3c. Sketch architecture of SCADA and Describe Major Elements of SCADA. 3d. Compare given automation systems.	3.1 Definition of SCADA 3.2 Application area of SCADA 3.3 Major elements of SCADA 3.4 Advantages and disadvantages of SCADA 3.5 Comparison of SCADA,DCS AND PLC
Unit– IV Real Time Systems and SCADA Software	4a. Describe the terms that deal with time response. 4b. Describe real time control for continuous process with suitable example and bar-graph. 4c. Describe master-slave communication access method in brief. 4d. Determine scan interval for SCADA 4e. Enlist SCADA software components.	4.1 Definition and Introduction of real time control 4.2 Real time control for Continuous process 4.3 Communication Access and Master-Slave concept 4.4 Determination of Scan Interval 4.5 SCADA software components 4.6 Concept of FBD technique 4.7 Comparison of centralized and distributed processing 4.8 HDLC Protocol 4.9 ANSI/IEEE C37.1 Protocol

	4f. Implement FBD technique with suitable examples. 4g. Compare centralized and distributed processing. 4h. Explain HDLC protocol used in SCADA 4i. Describe ANSI/IEEEC37.1 protocol in brief. 4j explain interfacing of SCADA system with PLC	4.10 Interfacing of SCADA system with PLC
Unit– V SCADA Hardware	5a. Explain Hardware structure of RTU. 5b. Test the given RTU. 5c. Explain Maintenance procedure of RTU. 5d. List the typical requirements for the RTU system. 5f. Explain hardware structure of MTU. 5g. Describe functions of MTU in brief. 5h. Configure MTU with suitable example. 5i. Explain redundancy concept in MTU system	5.1 Remote Terminal Unit (RTU) 5.1.1 Structure of RTU • CPU • Analog I/O • Pulse I/P • Digital I/Os Communication Interface • Power supply • RTU Rack and Enclosure 5.1.2. Test and maintenance of RTU 5.1.3. Requirements for RTU system 5.2 Master Terminal Unit 5.2.1. Hardware structure 5.2.2. Functions of MTU 5.2.3. Configuration of MTU 5.2.4. Redundant MTU system

Unit No.	**Unit Title**	**Teaching Hours**	**Distribution of Theory Marks**			
			R Level	**U Level**	**A Level**	**Total Marks**
I	DCS Structure	8	07	04	03	14
II	HMI in Automation	10	04	05	05	14
III	Introduction to SCADA	4	02	03	02	07
IV	Real time system and SCADA software	10	03	07	07	17
V	SCADA Hardware	10	07	07	04	18
Total		**42**	**23**	**26**	**21**	**70**

10. SUGGESTED STUDENT ACTIVITIES

Following is the list of proposed student activities such as:

- Do the internet survey and make a list of leading manufacturers of DCS,SCADA,HMI and other industrial automation tool with their brand name.
- Prepare journals based on practical performed in laboratory.
- Prepare poster of SCADA based automation system
- Present seminar on various topics from course content
- Simulate various components of SCADA
- Analyze the specifications for various types of DCS.
- Find practical applications of DCS and SCADA in various industries.
- Guide the students for steps to be followed to configure available scada software

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

i. Show video/animation film on related topic
ii. Arrange a visit to nearby big industry.
iii. Use flash/animations to explain the working of different control devices.
iv. Give mini projects to students.
v. Arrange expert lecture by engineers working in industry on DCS and SCADA technology.

12. SUGGESTED PROJECT LIST

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-projects are group-based (group of 3 to 5). However, **in the fifth and sixth semesters**, 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 duration of the micro project should be about **12-14 *(fourteen to sixteen) student engagement hours*** during the course. The students 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. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

- Prepare a PLC and SCADA based system for prototype bottle filling station
- Prepare a PLC and SCADA based system to open or close the prototype railway gate automatically.
- Prepare a PLC and SCADA based system to control drip irrigation.

- Prepare PLC and SCADA based prototype home automation.
- Prepare PLC and SCADA based prototype traffic light controller.
- Prepare PLC and SCADA based prototype water distribution system.

13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
1.	Distributed Computer Control for Industrial Automation	Dobrivoje Popovic and Vijay Bhatkar.	Marcel Dekker Inc.,1990
2	Overview of Industrial Process Automation	KLS Sharma	Elsevier Publication
3	Instrumentation Engineer's Handbook Power Electronics	Liptak B.G.	Chilton Book Co., Philadelphia
4	Practical SCADA for Industry	David Bailey, Edwin Wright	Newnes, (an imprint of Elsevier), 2003
5	SCADA-Supervisory Control and Data Acquisition System	Stuart A. Boyer	ISA publication (3rd Edition)
6	Practical Distributed Control System for Engineers and Technicians	----	IDC Technologies
7	Computer based Industrial Control	Krishnakant.	PHI, New Delhi,5th Edition or latest

14. SOFTWARE/LEARNING WEBSITES

1.https://youtu.be/c7UV4xMNOgg
2. https://youtu.be/ITiazU2RADs
3. https://youtu.be/B3YVpgs9RY4

15. PO-COMPETENCY-CO MAPPING:

Semester VI	DCS and SCADA **(Course Code : 4361701)**						
	POs						
Competency & Course Outcomes	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
	Basic & Discipline specific knowledge	Problem Analysis	Design/ development of solution	Engineering Tools, Experimentation & Testing	Engineering practices for society, sustainability & environment	Project Management	Life-long learning
Competency	Configure and maintain DCS and SCADA system related to instrumentation and control for industrial automation						
CO1	3	-	-	-	1	-	-
CO2	1	-	-	2	-	-	1
CO3	1	3	2	-	-	2	2
CO4	3	-	-	-	1	-	-

*Legend: '**3**' for high, '**2**' for medium, '**1**' for low and '**-**' for no correlation of each CO with PO.*

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Member – Board of Studies (GTU), Electrical and Allied branches

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