GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM
COURSE TITLE: DCS AND SCADA
(COURSE CODE: 3361703)

Diploma Programme in which this course is offered	Semester in which offered
Instrumentation and Control Engineering	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

The theory should be taught and practical should be carried out in such a manner that students are able to acquire required learning out comes in cognitive, psychomotor and affective domain to demonstrate following course outcomes:

i. Identify and interpret PI diagram on HMI.
ii. Identify different elements of SCADA.
iii. Interpret the functionality of various elements of SCADA.
iv. Control process parameters of given process using DCS and SCADA

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	
3	0	2	5	70	30	20	30	150

Legends: L-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** - Practical; **C** – Credit, **ESE** - End Semester Examination; **PA** - Progressive Assessment.

5. COURSE DETAILS

Unit	Major Learning Outcomes (In Cognitive Domain)	Topics and Sub-topics
Unit – I **DCS Structure** .	1a. Sketch and explain hierarchical architecture of DCS	1.1 DCS architecture
	1b. Explain database organization in DCS with sketch.	1.2 Database organization in DCS
	1c. Identify, explain and select system elements of DCS	1.3 System elements of DCS 1.3.1 Field station 1.3.2 Intermediate station 1.3.3.Central computer station
	1d. Define reliability parameters of DCS and determine Interrelationship between them. 1e. Apply major voting technique to determine reliability of DCS	1.4 Reliability parameters of DCS
	1f. Classify different types of alarms and briefly describe each of them	1.5 Classification of alarms in DCS
Unit– II **HMI IN AUTOMATION**	2a. Sketch and explain in brief basic structure of Automation system.	2.1 Automation system structure
	2b. Determine transfer of control commands for Instrumentation subsystem. 2c. Classify various types of devices connected to Instrumentation subsystem.	2.2 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. 2g. Explain interfacing of control subsystem with human interface subsystem with the help of suitable example.	2.3 Control subsystem

Unit	Major Learning Outcomes (In Cognitive Domain)	Topics and Sub-topics
	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.	2.4 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 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,PLC and Smart Instrumentation
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.	4.1 Definition and Introduction of real time control 4.2 Real time control for Continuous process
	4c. Describe master-slave communication access method in brief. 4d. Determine scan interval for SCADA.	4.3 Communication Access and Master-Slave concept 4.4 Determination of Scan Interval
	4e. Describe SCADA software components in brief. 4f. Implement FBD technique on suitable examples. 4g. Compare centralized and distributed processing. 4h. Explain HDLC protocol used in SCADA.	4.5 SCADA software components 4.6 Concept of FBD technique 4.7 Comparison of centralized and distributed processing 4.8 HDLC Protocol

Unit	Major Learning Outcomes (In Cognitive Domain)	Topics and Sub-topics
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. 5e. Describe ANSI/IEEEC37.1 protocol in brief.	5.1 Remote Terminal Unit (RTU) 5.1.1 Structure of RTU 5.1.1.1.CPU 5.1.1.2.Analog I/O 5.1.1.3.Pulse I/P 5.1.1.4. Digital I/Os 5.1.1.5.Communication Interface 5.1.1.6.Power supply 5.1.1.7.RTU Rack and Enclosure 5.1.2. Test and maintenance of RTU 5.1.3. Requirements for RTU system 5.1.4. ANSI/IEEE C37.1 Protocol
	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.	5.2 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

6. SUGGESTED SPECIFICATION TABLE WITH HOURS and MARKS (THEORY)

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	DCS Structure	06	07	04	03	14
II	HMI for Automation	10	04	05	05	14
III	Introduction to SCADA	04	02	03	02	07
IV	Real time system and SCADA software	10	03	07	04	14
V	SCADA Hardware	12	07	07	07	21
	Total	**42**	**23**	**26**	**21**	**70**

Legends: R = Remember; **U** = Understand; **A** = Apply and above levels (Bloom's revised taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

7. SUGGESTED LIST OF PRACTICALS/EXERCISES

The practical should be properly designed and implemented with an attempt to develop different types of skills **(outcomes in psychomotor and affective domain)** so that students are

able to acquire the competencies/programme outcomes. Following is the list of practical exercises for guidance.

***Note**: Here only outcomes in psychomotor domain are listed as practical. However, if these practical are completed appropriately, they would also lead to development of certain outcomes in affective domain which would in turn lead to development of **Course Outcomes** related to affective domain. Thus over all development of **Programme Outcomes (**as given in a common list at the beginning of curriculum document for this programme) would be assured. Faculty should refer to that common list and should ensure that students also acquire outcomes in affective domain which are required for overall achievement of Programme Outcomes/Course Outcomes.*

S. No.	Unit No.	Practicals/Exercises (Outcomes in Psychomotor Domain)	Approx. Hours Required
1	I	Identify and select system elements of DCS.	2
2	I	Tune the DCS controller by applying suitable PID control algorithm.	2
3	I	Determine the reliability of given DCS system.	2
4	I	Control level and flow of given continuous process using DCS.	4
5	II	Measure temperature and level for the given process using Instrumentation subsystem.	2
6	II	Interface control subsystem with Instrumentation subsystem.	2
7	III	Interface control subsystem with human interface subsystem.	2
8	III	Mount digital panel meter on operator panel.	2
9	III	Mount different types of switches, buzzers and indication lamp on operator panel.	2
10	III	Make necessary connections to interface various devices mounted on control panel. Test the panel by providing appropriate inputs and checking the corresponding outputs.	2
11	IV	Develop SCADA mimic diagram for tank level control	2
12	IV	Develop SCADA mimic diagram for tank pressure control	2
13	IV	Develop SCADA mimic diagram for tank temperature control	2
14	IV	Develop SCADA mimic diagram for flow control in the given process	2
15	IV	Simulate level control system using available SCADA system	2
16	IV	Simulate Pressure control system using available SCADA system	2
17	IV	Simulate Temperature control system using available SCADA system	2
18	IV	Simulate flow control system using available SCADA system	2
19	IV	Control the tank level using available PLC/DCS and SCADA	4

S. No.	Unit No.	Practicals/Exercises (Outcomes in Psychomotor Domain)	Approx. Hours Required
		system. Use On/Off control action	
20	IV	Control continuous level in the tank using PID control action, available PLC/DCS and SCADA system. Show effect of controller tuning on its control performance.	4
21	IV	Control temperature and pressure of the process tank using available PLC/DCS and SCADA system	4
22	IV	Simulate mixing process in the tank using available SCADA system	2
23	IV	Control mixing process in the tank using available PLC and SCADA system	4
24	IV	Simulate bottle filling system using available SCADA system	2
Total Hours			**58**
Note: Perform any of the practical exercises from above list for total of minimum 28 hours depending upon the availability of resources so that skills matching with the most of the outcomes of every unit are included.			

8. SUGGESTED LIST OF STUDENT ACTIVITIES

Following is the list of proposed student activities such as:

i. Prepare journals based on practical performed in laboratory.
ii. Solve different type of numerical problems from different books as possible
iii. List controlling parameters for different process and find how they affect the performance of plant.
iv. Find troubleshooting techniques and steps to troubleshoot DC drives.
Simulate various components of SCADA
v. Analyze the specifications for various types of DCS.
vi. Find practical applications of DCS and SCADA in various industries.
vii. Make list of various industries based on implemented automation system and also specify the sub process if more than one system is implemented.
viii. Check the performance of at least two different types of system using simulation technique.

9. 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.

10. SUGGESTED LEARNING RESOURCES

A) List of Books

S. No.	Title of Book	Author	Publication
1.	Distributed Computer Control for Industrial	Dobrivoje Popovic and Vijay Bhatkar.	Marcel Dekker Inc.,1990

S. No.	Title of Book	Author	Publication
	Automation		
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

B) List of Major Equipment/ Instrument with Broad Specifications

i. Electrical tool kit
ii. Multi-meter
iii. Distributed Control System with at least 2 analog I/O module, 2 digital I/O module, 1 Engineering Configuration unit, 5 operating work stations, LAN with redundant LAN hub/switch and 16 node facility
iv. 24 analog input module (8 analog input module 3NO.)
v. 24 analog output module (8 analog input module 3NO.)
vi. 24 digital input module (8 digital input module 3 NO.)
vii. 24 digital output module (8 digital input module 3 NO.)
viii. level switch
ix. temperature switch
x. flow switch
xi. 3" conveyor system operated 12V DC motor with digital shaft encoder
xii. Proximity switch (Inductive, Optical, motion, light etc.)
xiii. 12 V DC motor with digital shaft encoder
xiv. PLC based Automatic bottle filling plant interfacing with DCS software.
xv. Flow, temperature, level control setup for DCS based automation using Flow, temperature, level switches.

C) List of Software/Learning Websites

i. http://aboutinstrumentation.blogspot.co.uk/2010/12/dcs.html
ii. http://www.instrumentationengineers.org/2012/02/plc-dcs-scada-hmi-for-beginners.html
iii. http://www.eng-tips.com/viewthread.cfm?qid=161284

iv. http://what-instrumentation.blogspot.co.uk/p/difference-between-scada-dcs-and-plc.html

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Prof. J.T.Patankar**, HOD IC, Government Polytechnic, Ahmedabad
- **Prof. A.K.Bilkhia**, Sr. Lecturer in IC, Government Polytechnic, Gandhinagar
- **Prof. N.B.Mehta** Lecturer in IC, Government Polytechnic, Ahmedabad
- **Prof. S.K.Raval**, Lecturer in IC, Government Polytechnic, Ahmedabad

Coordinator and Faculty Members from NITTTR Bhopal

- **Dr. (Mrs.) C.S. Rajeshwari**, Professor and Head , Dept. of Electrical & Electronics Engineering,
- **Dr. Joshua Earnest**, Professor, Dept. of Electrical & Electronics Engineering,