C. U. SHAH UNIVERSITY
Wadhwan City

FACULTY OF: Technology & Engineering
DEPARTMENT OF: Instrumentation & Control Engineering
SEMESTER: VIII
CODE: 4TE08CSA1
NAME: Control System Architecture

Teaching & Evaluation Scheme

Subject Code	Subject Name	Teaching Hours/Week				Credits	Evaluation Scheme/Semester							
							Theory				Practical			
							Sessional Exam		University Exam		Internal		University	Total Marks
		Th	Tu	Pr	Total		Marks	Hrs	Marks	Hrs	Pr/Viva	TW	Pr	
4TE08CSA1	Control System Architecture	4	0	2	6	5	30	1.5	70	3	--	20	30	**150**

OBJECTIVES:

1. To introduce the students about various control and structure of control system.
2. To make the students familiar with HMI.
3. To make students learn various control Architecture.

PREREQUISITES:

1. Basics Process control and Instrumentation system.

COURSE OUTLINES:

Sr. No.	COURSE CONTENT	HOURS

1.	**Introduction of Automation System Structure** Introduction; Subsystems - Instrumentation Subsystem, Human Interface Subsystem, Control Subsystem; Instrumentation Subsystem - Measurement of Information, Transfer of Control Command; Human Interface Subsystem - Manual Display and Monitoring, Manual Control; Control Subsystem - Information Acquisition, Information Analysis and Decision Making, Control Execution	**1**
2.	**Instrumentation Subsystem** **Structure:** Continuous/Analog Instrumentation Devices: Information Acquisition, Control Execution; Discrete/Digital Instrumentation Devices: Information Acquisition, Control Execution, Fluctuating/Pulse Signals **Special Instrumentation Devices:** Switching Instrumentation Devices, Integrating Instrumentation Devices **Interfacing Standards:** Analog Input and Output Devices, Digital Input and Output Devices, Switching and Integrating Devices **Information Reliability:** Analog Inputs, Digital Inputs **Isolation and Protection**	**1**
3.	**Control Subsystem :**Structure; **Interfacing:** General, Instrumentation Subsystem, Human Interface Subsystem	**1**
4.	**Human Interface Subsystem** **Operator Panel:** Active Display Elements, Active Control Elements, Panel; **Construction:** Basic Approach, Mimic Approach **Interfacing with Control Subsystem; Types of Mimic Panels**	**1**
5.	**Automation Strategies** **Basic Strategies:** Open Loop Control, Closed Loop Control **Discrete Control:** Discrete Control—Open Loop, Discrete Control—Sequential Control with Interlocks **Continuous Control:** Continuous Control—Open Loop, Continuous Control—Closed Loop **Hybrid Control:** Hybrid Control—Two-Step, Hybrid Control—Two-Step with DeadBand **Programmable Control Subsystem** Sequential Control with Interlocks; Continuous Control: Closed Loop Control, Multi- Input/Multi-Output Control; Hybrid Control: Two-Step Control with Dead-Band; Controller with Additional Features: Communicability, Self-Supervision or Watchdog	**4**
6.	**Hardware Structure of Controller** **Major Modules of Controller:** Rack, Bus, Functional Modules, System Cable; **Data Exchange on Bus; Functional Subsystems**: Power Supply Subsystem, Processor Subsystem (Processor Module, Memory Module, Watchdog Module), Input/Output Subsystem (Digital Input Module, Digital Output Module, Analog Input Module, Analog Output Module, Pulse Input Module, Pulse Output Module, Capacity in I/O Modules); **Communication Subsystem:** Communication Module, Communication Cables, Integrated Processor Module; **Controller Capacity Expansion**: Bus Extension (Parallel) Module, Bus Extension (Serial) Module; **Integrated Controller**	**4**
7.	**Software Structure of Controller** **Types of Software Systems:** Non-Real-Time System, Real-Time System **Software Structure of Controller:** Hardware Platform, Real-Time Operating System, Utility Software, Application Software **Scheduling of Tasks:** Sequential Scheduling, Sequential Scheduling with Time-Slice, Real-Time Scheduling (Program Interrupt, Task Execution) **Scheduling of Tasks in Automation Systems:** Process Data Acquisition, Process Data Monitoring, Process Control; **Memory Organization**	**4**

8.	**Programming of Controller** **Higher-level Programming:** Ladder Diagram, Function Block Diagram **Programming Examples:** Sequential Control with Interlocks, Loop Control, Two-Step Control with Dead-Band	**2**

9.	**Advanced Human Interface** **Intelligent Operator Panels; Operator stations:** Display Screen Layout, Interaction with the Process (Direct Interaction, Navigated Interaction, Other Features); **Comparison with Operator Panel:** Advantages and Disadvantages of Operator Stations; **Enhanced Operator Stations:** Multiple Monitors, Large Screen Displays, Displays with Embedded Video, Combined Mimic Panel and Operator Station; **Variants of Operator Stations; Logging stations:** Data Logging; Control Desks.	**3**
10.	**Types of Automation Systems** **Localized Process:** Centralized Control System, Decentralized/Distributed Control System; **Distributed Process:** Remote Control System, Network Control System, Front-End Processor (Controller-Based FEP, Computer-Based FEP); **Supervisory Control and Data Acquisition:** Background, Case Study, Similarities with DCS and NCS (SCADA in DCS, SCADA in NCS)	**3**
11.	**Common Configurations:** Introduction; **Distributed Control System:** Operator Stations, Supervisory Stations, Application Stations; **Network Control System**	**3**
12.	**SCADA systems hardware, software and protocols** Introduction, Comparison of the terms SCADA, DCS, PLC and smart instrument, Considerations and benefits of SCADA system, Remote terminal units ,Digital output module, PLCs used as RTUs, The components of a SCADA system, The DCS and SCADA software package, New technologies in SCADA systems, OPC	**4**
13.	**Basic DCS controller configuration** Historical, Control modes, Tracking and initialization in control slots used for cascade control, Control functions, Control algorithms Sequential programs for batch processing, Defining equipment procedures, Phase logic programming, Phase logic interface, Logic block functions in advanced controller, DCS controller configuration	**4**
14.	**Alarm system management** An alarm system, Functions of the plant or process operator, Functions of an alarm system, An effective alarm system, Design overview, Human and ergonomic factors, Structure of a good alarm system, Safety integrity level (SIL), Definition of strategy, Strategy for alarm system design, Strategy for alarm system maintenance and management at the site/plant, Generation of minimum design documentation for each alarm ,Measurement of the alarms, Field measurements for deriving alarms, Hardware for alarm processing Alarm displays, Testing of alarms, Generation of various types of alarms, Selection of alarm settings, Setting alarm priority, Design of field sensors for generating alarms, Logical processing of alarms, Design of alarm list displays, Measurement of performance, Usefulness of alarms, Measurement of number of alarms and average rate of alarms, Measuring operator response, Management of improvement program, Alarm review, Elimination of spurious alarms, Intermittent and fleeting alarms, Processing alarms, Control of modifications, Hazard and operability studies (HAZOP)	**4**
15.	**Distributed control system reporting** Introduction, Operation of advanced DCS using multi-screen displays, cross screen invocation and linking, Alarm reporting, generation and acceptance, Alarm reporting, Generation of alarms, Different types of logs and reports configurable on a DCS	**2**

16.	**Distributed control system (DCS) configuration** Introduction, An engineering station, System/project tree structure DCS system database, Configuration of control functions, Configuration of operator/monitoring functions, Configuration of system hardware structure, Configuration of system software, Documentation, Commissioning	**2**
17.	**Special-Purpose Controllers** Introduction; **Controller for Localized Processes:** Programmable Logic Controller, Loop Controller, Programmable Controller; **Controller for Distributed Processes:** Remote Terminal Unit; **Other Players:** PC-Based Controller, Programmable Automation Controller	**2**
18.	**System Availability** Introduction; **Standby Schemes:** No Standby, Cold Standby, Hot Standby **Distributed Control System:** Availability Analysis in DCS (Level 1: Instrumentation Subsystems, Level 2: Controllers, Level 3: Local Communication Subsystem, Level 4: Operator Station); **Availability Enhancement in DCS:** Processor in Controller, Ethernet I/F in Controller, LAN; **Network Control System:** Availability Analysis in NCS (Level 1: Instrumentation Subsystem, Level 2: RTUs, Level 3: Remote Communication Subsystem, Level 4: FEP Subsystem, Level 5: Local Communication Subsystem, Level 6: Operator Station); **Availability Enhancement in NCS:** Serial I/F and Processor in RTU, WAN, Serial I/F, Processor, and Ethernet I/F in FEP, LAN; **I/O Redundancy**	**2**
19.	**Advanced Input/Output System** **Centralized I/O:** Intelligent CIO, Advantages and Disadvantages; **Remote I/O:** Advantages and Disadvantages; **Fieldbus I/O:** Advantages and Disadvantages, Fieldbus I/F Module, Intelligent Serial I/F, Protocol Standards	**2**
20.	**Automation System Functionalities and Application Areas** **Major Functionalities:** Data Acquisition, Data Supervision or Monitoring, Process Survey, Process Control, Process Studies, Human Interaction, Data Logging and History Generation, Data Exchange **Data Availability; Current Trends in Automation Systems; Modern Control Center; Application Areas of Automation Systems:** Discrete Process Automation, Continuous Process Automation, Batch Process Automation	**2**
21.	**Distributed control system applications, implementation, and future trends:** **Applications:** Use of DCS in pulp and paper environment, Use of DCS in petroleum refining environment, Use of DCS in oil and gas processing environment **Implementation:** System strategy, Automation plan, Project implementation Installation and commissioning, Change management **Future Trends:** Introduction, Creation of E-commerce solution	**3**

Learning Outcomes:

After studying this subject, the students would be able to design the architecture of various control systems used in various industrial applications.

Books Recommended:

1. Overview of Industrial Process Automation by KLS Sharma; Elsevier Publication

2. Practical Distributed Control Systems (DCS) for Engineers and Technicians by IDC Technologies
3. Instrument Engineers' Handbook by B. G. Liptak