GUJARAT TECHNOLOGICAL UNIVERSITY

BRANCH NAME: INSTRUMENTATION & CONTROL ENGINEERING (17)

SUBJECT NAME: DISTRIBUTED CONTROL SYSTEM & SCADA

SUBJECT CODE: 2171709

B.E. 7th SEMESTER

Type of course: Core Engineering

Prerequisite: Sensor/ transducer, field transmitters, converters, final control element, basic instrumentation symbols, process control modes and techniques, PLC architecture

Rationale: DCS system and SCADA systems are used extensively in industries. In such computer based automation system; information, communication, and networking technologies have become integral part. So, it is necessary to know hardware interfacing with software driven automation system. This course gives an idea of general structure of DCS/SCADA system, functional elements, data links, software and algorithms, communication and control aspects of modern plant automation system.

Teaching and Examination Scheme:

TeachingScheme			Credits	Examination Marks						Total Marks
L	T	P	C	TheoryMarks			PracticalMarks			
				ESE (E)	PA(M)		ESE (V)		PA (I)	
					PA	ALA	ESE	OEP		
3	0	2	5	70	20	10	20	10	20	150

Content:

S. N.	Content	Total Hrs	% Weightage
1	**DCS – Introduction & Development History** Early Computer systems: Direct digital control, Centralized computer system, Distributed control Hierarchical Control: Hierarchical computer system for a large manufacturing process, overall task, detail task listing, lower level computer task, higher level computer task	04	10
2	**DCS-Basic packages** Analog control, direct Digital control, Distributed process control, DCS configurations Local Control Units (Relay rack mounted equipment) :Dedicated card controllers, Unit operations controllers, Multiplexers- Design, system configuration, Remote stations, Super-commutation and sub-commutation - Power supplies, - Input/ Output, - Controller file The control console equipment: - Video display, - key board, - peripheral	10	24

	devices, - Displays: Group displays, Overview displays, Detail displays, Graphic displays, Trend displays, Alarm reporting, generation and acceptance Communication between components: Data highway designs, highway compatibility, Network access protocols, Network topologies, Maintenance considerations- Reliability, availability, Single loop integrity, backup systems, Redundant and Fault tolerant systems		
3	**Software configuration** Operating system configuration, - Controller function configuration, - Algorithm libraries, Process control programming: - Types of program, Features of process control programs, The executive program, Programming language for process control Algorithms- The position algorithm, Velocity algorithm, cascade and ratio control, Feed-forward, Other algorithm like Dead band control, emergency response, error squared	06	14
4	**System Integration with PLC and computers** Supervisory computer functions: Supervisory control and optimization, production monitoring and control, on-line information system DCS and supervisory computer displays- Display access method, display features, alarm access architecture, voice input machine interface Man Machine Interface – Sequencing, Supervisory control Computer interface with DCS- Hardware: Gateway, Interface with PLC, Interface with Direct I/O, Network linkages, Links between networks	04	10
5	**Field buses, MAP/TOP, Network protocol** Computer integrated processing, communication hierarchy Industrial communication systems: Management system – MAP/TOP protocol Field buses- fieldbus standardization, Smart transmitters- Rackbus: Bus access method, transmitter, gateways, availability MODBUS - bus access method, application services, transmission modes, function, acceptance PROFIBUS- bus access method, data link services, application services, acceptance FIPBUS - bus access method, other features, acceptance International FIELDBUS standard	10	24
6	**SCADA Overview** Basics of SCADA, SCADA key features, remote Terminal Units (RTU), PLC used as RTU, DCS versus SCADA terminology, SCADA software packages, Application example of SCADA	5	12
7	**Typical DCS and SCADA systems** Honeywell PlantScape system, Foxboro I/A series DCS, Delta system, Citect, Wonderware	3	6

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
7	**14**	**21**	**14**	**14**	**0**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's 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.

Reference Books:

1. Process Control- Instrument Engineers Handbook by Bela G. Liptak, Chilton book co.
2. Overview of Industrial Process Automation by KLS Sharma, Elsevier pub.
3. Practical Distributed Control Systems (DCS) for engineers and technicians by IDC Technologies
4. Distributed Computer Control Systems in Industrial Autoation by D. Popovic and V. Bhatkar, Marcel Dekker

Course Outcome:

After learning the course the students should be able to:

CO1 analyze current philosophy, technology, terminology, and practices used in automation industries.
CO2 evaluate computer based automation system used in industries ranging from discrete, continuous process to hybrid processes.
CO3 select hardware and software for modern automation system required for industrial application.
CO4 demonstrate interfacing of hardware and software of computer based automation system.

List of Experiments:

1. DCS-Flow-sheet symbol (ch. 7.11- B.G. Liptak –II – Process control)
2. Study of various DCS display options
3. DCS cost estimation procedure (ch. 7.8- B.G. Liptak –II – Process control)
4. Study of stand-alone single loop PID controller
5. Interfacing of different devices using RS-232, RS-485 and RS-422 communication
6. Study of important features of SCADA software package
7. Study of different type of animations used in SCADA software
8. Development of GUI using different type of scripting on SCADA software
9. Interfacing of PLC with SCADA software package
10. Communication of SCADA software with Ms-excel/SQL/MS-Access
11. Interfacing of I/O modules with SCADA/ DCS package

12. Study of LAN of computer lab (to understand the network topology, network access protocol, data highway option, Ethernet, etc.)

Design based Problems (DP)/Open Ended Problem:

- ➔ For water heating process (level control by manipulating inlet flow, temperature control by varying current, water meter and energy meters are provided), design a system if all field devices are discrete devices (discrete control), continuous devices (continuous control) and hybrid control (few devices analog and few are discrete devices). The design must include listing of instrumentation devices, allocation table of I/O channels to process parameters, allocation of memory locations for special requirements, control flow chart and any other necessary drawing/ diagram.

- ➔ Sample Case study for SCADA and DCS

Major Equipment:

Computers, I/O modules, PLC, SCADA software, DCS set up, PID Controller, etc.

List of Open Source Software/learning website:

http://coep.vlab.co.in/?sub=33&brch=97

http://www.idc-online.com

http://www.isa.org

http://www.controleng.com/

http://literature.rockwellautomation.com/

http://www.automation.siemens.com/

http://nptel.ac.in/video.php

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.