SARVAJANIK UNIVERSITY
Sarvajanik College of Engineering and Technology

Bachelor of Technology (B. Tech.)

Instrumentation and Control

B. Tech.Year- III Semester – VI

Subject Name: Distributed Control System **Subject Code: BTIC13602**

Type of course: Professional Core Course

Prerequisite (if any): Sensor/ transducer, field transmitters, converters, final control element, basic instrumentation symbols, process control modes and techniques

List of Courses where this course will be prerequisite : Not applicable

Rationale:
DCS 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 and communication protocol system, functional elements, data links, software and algorithms, communication and control aspects of modern plant automation system.

Teaching and Examination Scheme:

TEACHING SCHEME				Theory Marks			Practical Marks		Total
L	T	P	C	TEE	CA1	CA2	TEP	CA3	
3	0	2	4	60	25	15	30	20	150

CA1: Continuous Assessment (assignments/projects/open book tests/closed book tests CA2: Sincerity in attending classes/class tests/ timely submissions of assignments/self-learning attitude/solving advanced problems TEE: Term End Examination TEP: Term End Practical Exam (Performance and viva on practical skills learned in course) CA3: Regular submission of Lab work/Quality of work submitted/Active participation in lab sessions/viva on practical skills learned in course

BSC: basic science course /ESC: Engineering Science Course /HSM: Humanities and management /PCC: Professional Core course /PEC: professional Elective course /OEC: Open Elective course/ MD: mandatory non-credit course

Content:

S. N.	Content	Total Hrs	Module 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	**5**	**11 %**
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, PC- based controller, Programmable automation controller **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 devices, **Displays:** Group displays, Overview displays, Detail displays, Graphic displays, Trend displays, Alarm reporting, generation and acceptance, **Advance human interface** - Intelligent operator panels, operator station, enhanced operator station, mimic panel, logging station **Communication between components:** Data highway designs, highway compatibility, Network access protocols, Network topologies, Maintenance considerations- **Availability and reliability of Control system -** Definition of Reliability, MTBF, MTTR, MDT, , single loop integrity, backup	**15**	**33 %**

	systems, redundant and fault tolerant systems, Models of redundancy, ESD design basis and architecture, voting scheme		
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	**6**	**13 %**
4	**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**	**22%**
5	**Safety Instrumented System (SIS)** Definition, SIS life cycle, examples, Risk class, good engineering practices for SIS, standards, SIL levels	**3**	**7%**
6	**HART protocol** Introduction, Working, communication, advantages, calibration, wireless HART	**3**	**7%**

7	**Typical DCS systems** Honeywell PlantScape system, Foxboro I/A series DCS, Delta system	**3**	**7%**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20 %	**30 %**	**20 %**	**10 %**	**10 %**	**10 %**

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:

Sr no	Title of book /article	Author(s)	Publisher and details like ISBN	Year of publication	Publication Edition
1	Process Control-Instrument Engineers Handbook	Bela G. Liptak,	Butterworth-Heinemann ISBN- 9780801972904	2013	3rd ed. .
2	Overview of Industrial Process Automation	K.L.S. Sharma	Elsevier pub. ISBN-9780128053546	2016	2nd ed.
3	Practical Distributed Control Systems (DCS) for engineers and technicians	IDC Technologies	IDC Technologies ISBN- 781921716270	2004	6th ed.

4	Distributed Computer Control Systems in Industrial Automation	D. Popovic and V. Bhatkar,	Marcel Dekker ISBN-9780824781187	1993	1st ed.
5	Safety Instrumented Systems:Design,Analysis and Justification	Paul Gruhn, and Harry L. Cheddie	ISA ISBN:9781556179563	2005	2nd ed.

Course Outcomes:

After learning the course the students should be able to:

Sr. No.	CO statement	Marks % weightage
CO-1	analyze current philosophy, technology, terminology, and practices used in automation industries.	25 %
CO-2	evaluate computer based automation system used in industries ranging from discrete, continuous process to hybrid processes.	25 %
CO-3	select hardware and software for modern automation system required for industrial application.	20 %
CO-4	demonstrate interfacing of hardware and software of computer based automation system.	20 %
CO-5	evaluate the need of safety and emergency shut down system	10 %

Mapping with POs:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO-1	1	2	1	1	2	2	2	1	1	1	3	3	2	2	3
CO-2	1	2	1	2	2	1	2		1	1		3	2	2	1
CO-3	1	2	2	2	3				1	1	3		3	1	2
CO-4	1	2	1	1	3				1	1	3		2	3	2
CO-5	1	2	3	1	2	3	2	2	1	1			2	2	2

List of Open 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

List of Open Source Software:

https://www.tango-controls.org/
http://openapc.net
https://rapidscada.org/
https://instrumentationtools.com/open-source-plc-and-scada-software/

FOR LAB SESSIONS:

List of Experiments:

1. DCS - Flow- sheet symbol
2. Study of various DCS display options
3. DCS cost estimation procedure
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 DCS/ SCADA software package
7. Study of different type of animations used in DCS/ SCADA software
8. Development of GUI using different type of scripting on DCS/ SCADA software
9. Interfacing of PLC with DCS/ SCADA software package
10. Communication of DCS/SCADA software with Ms-excel/SQL/MS-Access
11. Interfacing of I/O modules with DCS/ SCADA package
12. Study of LAN of computer lab (to understand the network topology, network access protocol, data highway option, Ethernet, etc.)
13. 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 Needed:

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