GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering

Subject Code: 3161709

SUB NAME : **Safety Instrumented System**

Semester – VI

Type of course:

Prerequisite:

Rationale:

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
2	0	2	3	70	30	30	20	150

Sr No.	Course Content	Hrs	Weightage %
1	Introduction of safety instrumented system Safety Instrumented system, Confusion in the industry, industry guidelines-standards and regulations, standards are changing their direction, things are not as obvious as they may seem	3	10
2	Design Lifecycle Hindsight/Foresights, Findings of the HSE, Design life cycle, SIS design & Engineering ,Installation, commissioning and validation, operation and maintenance, decommissioning	2	7
3	Process control vs. safety control : Control and safety defined, process control-active/dynamic, safety control-passive/dormant, separation of control and safety systems, Common cause and systematic/functional fallers	2	10
4	Protection layers: Prevention layers, mitigation layers, Diversifications	3	10
5	Developing the Safety requirement specifications Introduction, why are 44%n of accidents caused by incorrect specifications?, ANSI/ISA-84.00.01.2004,part 1-3 requirements, documenting the specifications requirements.	3	10
6	Determining SIL Introduction, common issues, evaluating risk, Safety integrity level,SIL determination methods(ALARP and Risk matrix, risk graph, LOPA)	3	10
7	Choosing a technology Phumatic systems, relay systems, solid state systems, microprocessor/PLC(software based)systems, issues related to system size, issue related to system complexity, communication with other systems,certified vs prior use	2	8
8	Initial system evolution Things are not as obvious as they may seem, why systems should be analyzed before they are built, need to get failere rate information, failure	4	15

	modes, metrics, degree of modeling accuracy, modeling methods, the real impact of redundancy, analysis of a relay system, non redundant PLC system, TMR systems, Field devices, fault tolerance requirements, Sample SIS design cookbook, Engineering tools available for analyzing system performance		
9	Issue relating to field devices Introduction, importance of field devices, Sensors, Final elements, Redundancy, Design requirements of field devices, Installation concerns, Wiring of field devices	2	10
10	Engineering a system General management considerations, General hardware consideration, General software consideration	2	10

Course Outcomes: Students will be able to

Sr. No.	CO statement	Marks % weightage
CO-1	Able to explain Safety instrumented system and SIL, choosing technlology	
CO-2	Able to analyze the safety specification for process control and safety control of various processes	
CO-3	Will be able to analyze failure of field devices and apply modifications	

Text Books

1. Safety Instrumented Systems:Design,Analysis and Justification 2nd edition by Paul Gruhn,P.E. and Harry L. Cheddie,P.E. Published by ISA.(ISBN -13 978-1-55617-956-3)
2. Safety Instrumented Systems: A Life Cycle Approach by Paul Gruhn and Simon Lucchini
3. Safety Instrumented System Design: Techniques and Design Verification by William M. Goble

Reference Book

1. Safety Instrumented Systems Verification: Practical Probabilistic Calculations by William M. Goble
2. Safety Integrity Level Selection: Systematic Methods Including Layer of Protection analysis by Eric William Scharpf

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3161710
Semester – VI
Subject Name: Artificial Intelligence and Machine Learning

Type of course: Core Engineering

Prerequisite: Knowledge of engineering mathematics, basics of algorithms, simulation know- howon Matlab/ Scilab or other equivalent software

Rationale: AI ML is very useful in Industry 4.0. Machine Learning enables IT systems to recognize patterns on the basis of existing algorithms and data sets and to develop adequate solution concepts. Therefore, in Machine Learning, artificial knowledge is generated on the basis of experience.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
2	0	2	3	70	30	30	20	150

Content:

S. N.	Content	Total Hrs	% Weigh tage
1	**Artificial Intelligence** - Overview, Supervised and unsupervised learning, Learning task, instances, features, labels, reward/loss, training, testing	02	5
2	**Gradient Descent and Linear Algebra** Model representation, cost function, mathematics of gradient descent, gradient descent intuition, gradient descent for linear regression, matrix, vector, transpose matrix, matrix multiplication, and matrix multiplication properties, inverse of matrix.	04	15
3	**Multiple features gradient descent** Multiple features, gradient descent calculations for multiple features, features and polynomial regression, normal equations, linear regression with multiple variables.	04	15
4	**Classification** Overview of classification: setup, training, test, validation dataset, over fitting. Classification families: linear discriminative, non-linear discriminative, decision trees, probabilistic (conditional and generative), nearest neighbor and Logistic regression.	04	10
5	**Support Vector Machine** Max margin motivation: low density, high stability, Margin geometry to primal SVM formulation for separable training data, Dual formulation and role of alpha in a form of sparse local regression, Inseparable data, slack variables, hinge loss, upper bound on 0/1 training loss Handling non-linear regression by lifting data points to higher dimension	06	20

6	**Dimensionality reduction** Curse of dimensionality, Principal Component Analysis, Latent Semantic Analysis	04	10
7	**Artificial Neural Network** Model representation, working of neurons, back propagation algorithm, adjusting parameters, multiclass classification, bias value, random and Gaussian initialization of parameters, final implementation of ANN	04	10
8	**Unsupervised learning** Mixture model and Expectation maximization, K-Means Clustering, Distance based clustering, Density based clustering techniques	02	5
9	**Ensemble learning** Random forest, Adaboost	02	5
10	**Gradient Descent with large data set** Stochastic gradient descent, mini batch gradient descent, stochastic gradient descent convergence	02	5

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
14	**14**	**14**	**14**	**07**	**07**

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.

Text Books

1. Stuart J. Russell and Peter Norvig, "Artificial Intelligence A Modern Approach," *3rd edition, Prentice Hall*

2. Tom Mitchell, "Machine Learning", *McGraw-Hill,1997*

3. EthemAlpaydin, "Introduction to Machine Learning", *PHI,2005*

4. Bishop, C., "Pattern Recognition and Machine Learning:," *Berlin: Springer-Verlag, 2006*

Reference Books/Courses

1. K.P. Soman, R. Longonathan and V. Vijay, "Machine Learning with SVM andOther Kernel Methods", *PHI-2009*
2.. T. Hastie, R. Tibshirani, and J. Friedman, "The Elements of Statistical Learning" *2009*
3.Pattern recognition and machine learning by Christopher Bishop, Springer Verlag,2006.
4.Understanding Machine Learning. Shai Shalev-Shwartz and Shai Ben David. Cambridge University Press. 2017

Andrew Ng course on Machine Learning, Coursera.

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3161710

Course Outcomes: Students will be able to

Sr. No.	CO statement	Marks % weightage
CO-1	Understand Artificial Intelligence and its approaches	
CO-2	Solving problems using Artificial Intelligence	
CO-3	Understand Supervised, unsupervised and semi supervised machine learning algorithm	
CO-4	Apply Gradient descent and linear algebra for problem solving	
CO-5	Apply support vector machine in development of algorithm	

List of Practical:

*(Followingpracticals are recommended but they are not limited for modifications and or alterations by the faculty member/s teaching the particular subject. The use of MATLAB or SCILAB or equivalent software is suggested.***)**

1. Implementation of gradient descent with single variable
2. Implementation of gradient descent with multiple variables.
3. Implementation of linear and polynomial regression.
4. Implementation of logistic regression or binary classification.
5. Implementation of SVM with simple features.
6. Implementation of ANN using back propagation.
7. Learning basic library of python for machine learning to be used in Raspberry PI
8. Loading of SVM in raspberry PI
9. Decision making on the basis of input data on raspberry PI.
10. Implementing K-Means clustering algorithm.
11. Implementation of Principal component analysis.

Design based Problems (DP)/Open Ended Problem:

Major Equipment/Software: Raspberry pie, Python, MATLAB **,** LabVIEW

List of Open Source Software/learning website:

http://vlab.co.in/
www.isa.org
http://nptel.ac.in/video.php
http://www.idc-online.com/

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3161713
INSTRUMENTATION PROJECT MANAGEMENT
6th SEMESTER

Type of course: Core Engineering

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

Rationale: For Instrumentation and Control engineer it is very important to know the kind of standard documents available in manufacturing processes along with necessary design, test and calibration procedure. This subject will help student to understand the project procedures and various stages of project like planning, estimation, designing, installation, testing, calibration and commissioning of instruments and systems. Last topic of the syllabus will introduce student with quality manufacturing process.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
2	2	0	4	70	30	0	0	100

Content:

S. N.	Content	Total Hrs	% Weigh tage
1	**Introduction to project management** Definition of project purpose - Scope, time, quality and organization structure. Basic and detailed engineering: Degree of automation, Project S curves, manpower considerations, inter-department and inter-organization interactions, Multi agency interaction. Types of projects and types of contracts e.g. EPC, BOOT etc.	03	11
2	**Project management functions** Controlling, directing, project authority, responsibility, accountability, interpersonal influences and standard communication formats, project reviews. project planning and scheduling, life project engineering and management cycle phases, the statement of work (SOW), projects specifications, bar charts, milestones, schedules, work breakdown structures, cost breakdown structures and planning cycle.	03	11
3	**Project cost and estimation** Types and estimates, pricing process, salary and other overheads, man-hours, materials and support costs. program evaluation and review techniques (PERT) and critical path method (CPM), estimating activity time and total program time, total PERT/CPM planning crash times, software's used in project management.	03	11
4	**Instrument Project Control**	04	14

	Project engineering documents and drawing: Process flow sheets, Mechanical flow sheets, Instrument index sheets, loop wiring diagram, panel drawings and specifications, plot plans, installation details, special drawings, purchase requisition, other documents. **Information required:** Process information, Instrument specifications and standards, piping specifications, Electrical specifications, bid documents, Project procedure, project schedule, Equipment Information, Vendor drawing **Work coordination**: Project manager, process engineer, equipment engineer, Piping design supervisor, Structural, architectural and civil, Electrical, purchasing and expediting and others **Planning hints and Project check list**		
5	**Engineering Design criteria** **Pneumatic versus electronics system, Control centers, Future and spare capacity** **Specifications for various measurement and control groups:** Flow, Pressure, Level, Temperature, Control valves, Control panels, Analytical instruments **Transmission systems:** Pneumatic & Electronic – Materials, Distribution, Terminations and Identification **Process connections –** Take-offs and Piping, Location of taps, Sealing instruments from process, Manifolds and gage valves **Miscellaneous Design Criteria:** Mounting instruments, Selections of units, charts, ranges; Instrument identification, Winterizing, Material of construction, Package equipment systems **Electrical safety:** NEC code, Purging and pressurization, Enclosures, Intrinsic safety	08	28
6	**Construction and Start up** **Organizing:** Documents, schedule, cost control **Ordering and Receiving equipment and Material:** Purchase orders, Material status, storage **Installing instrument systems:** Procedures, Coordination, Good installation practices Calibration **Testing:** Process connections, Pneumatic lines, Electrical **Loop checking:** Flow transmitter , Temperature transmitter, Control valve, Miscellaneous checks **Startup:** Placing instruments in service, Tuning loop controls, evaluating process upsets and disturbances, Repairing or replacing defective equipment, special equipment, Additional control	04	14
7	**Introduction to International quality systems - ISO 9000** Quality management practices worldwide, certifying agencies. Quality, customers and ISO 9000 ISO 9000- A management overview ISO 9000- Quality system Inspection, Test standards and Calibration	03	11

Suggested Specification table with Marks (Theory):

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3161713

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
14	**14**	**14**	**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.

Text Books

1. Applied Instrumentation in Process Industries by W.G. Andrew and H.B. Williams, *Gulf Professional Publishing, 3rd ed. 2008*, ISBN-13: 978-0872010475.

2. Project management: A systems approach to planning scheduling and controlling by Harlod Kerzner and Van Nostrand, *John Wiley & Sons, 11th ed., 2013*, ISBN: 978-1-118-02227-6.

3. Successful Instrumentation & Control Systems Design, by Michael D. Whitt, 2nd Edition, 2012, *ISA*, ISBN: 978-1-93600-745-5.

4. ISO- 9000 Concepts, Methods & Implementation by Tapan B. Bagchi, *Wheeler pub., 1995.* ISBN-81-85814-24-4

5. ISO- 9000 Guidelines for the chemical & process industries : By ASQC (American Society of Quality Control) , ISBN-13: 978-0873893527, www.asq.org

Reference Books:

Instrument Engineers Handbook: Process Control by Bela G Liptak, CRC Press, 3rd ed., 1995, ISBN-13: 978-0801982422.

Course Outcome: Students will be able to

Sr. No.	CO statement	Marks % weightage
CO-1	Understand the importance of project management from industrial perspective	
CO-2	Estimate cost for implementing various industrial projects	
CO-3	Apply various engineering design criteria for optimized project management	
CO-4	Evaluate and select various sensors and control valve for successful realization of specific project	
CO-5	Follow standard practices as well as procedures for construction and startup of project	

List of Tutorial activties:

1) Study of standards and symbols (ANSI / ISA Std.)
2) Study of specification sheets.
3) Development of Process & Instrument diagram of typical process.

4) Development of Loop Wiring diagram.
5) Cable scheduling.
6) GA and mimic diagram of a control panel.
7) Development of Bar charts for certain project.
8) Prepare the cost estimation sheet for the project under consideration
9) Hands on experience for engineering management software such as MS Project, Primavera, etc.
10) Designing of control valve for liquid/gas/vapor applications as per standard
11) Design of orifice plates for liquid/gas/vapor as per ISO 5167
12) Operating range calculation for transmitters considering different applications.

Major Equipment:

Field instruments (includes sensor/ transducers, transmitters, single loop controllers, Converters, control valve, etc.) for flow, level, pressure, temperature parameters.

Test and calibration instruments at least for temperature and pressure parameters.

List of Open Source Software/learning website:

http://vlab.co.in/
www.isa.org
http://nptel.ac.in/video.php
http://www.idc-online.com/

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering

Subject Code: 3161714

Programmable Logic Controller and Supervisory Control and Data Acquisition System

6th SEMESTER

Type of course: Professional Core Course

Prerequisite: Digital Logic Design, Concept of Micro Processor and Micro Controller, Relay Logic, Control System, Knowledge of programming and flow charts

Rationale: Students of Instrumentation & Control engineering should have detailed skill of controlling any system. Programmable Logic Controller (PLC) is a very important device to control any system and is widely used in industries now a day. Therefore the person who wants to work in control and automation industries must have enhance knowledge of PLC. This course gives a detailed knowledge and practice of PLC programming

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
4	0	2	5	70	30	30	20	150

Content:

S. N.	Content	Total Hrs	% Weightage
1	PLC BASICS Programmable Logic Controllers (PLCs): Introduction; definition & history of the PLC; Principles of Operation; Various Parts of a PLC: CPU & programmer/ monitors; PLC input & output modules; Solid state memory; the processor; I/O modules; power supplies. PLC advantage & disadvantage; PLC versus Computers, PLC Application. Programming equipment; proper construction of PLC ladder diagrams; process scanning consideration; PLC operational faults.	2	4
2	PLC Hardware Components The I/O section, Discrete I/O Modules, Analog I/O Modules, Special I/O Modules, I/O specifications, The CPU, Memory design, Memory Types, Programming Devices, Selection of wire types and size.	2	4
3	Fundamentals of Logic The Binary Concept, AND, OR and NOT functions, Boolean Algebra, Developing circuits from Boolean Expression expressions, Producing the Boolean equation from given circuit, Hardwired logic versus programmed logic, Programming word level logic instructions. Converting Relay schematics and Boolean equation into PLC Ladder Programs, Writing a ladder logic program directly from a narrative description.	2	4
4	Various INPUT /OUTPUT Devices and its interfacing with PLC. Different types of Input devices : Switches: Pushbutton Switches, Toggle Switches, Proximity switches, Photo	4	8

	switches, Temperature Switch, Pressure Switch, and Level Switch,Flow Switches, manually operated switches,Motor starters, Transducers and sensors, Transmitters etc. Their working, specification and interfacing with PLC. Different types of Output devices : Electromagnetic Control Relays, Latching relays, Contactors, Motors, Pumps, Solenoid Valves etc. Their working, specification and interfacing with PLC.		
5	Basics of PLC Programming Processor Memory Organization, Program Scan, PLC Programming languages, Relay type instructions, Instruction addressing, Branch Instructions, Internal Relay Instructions, Programming Examine if Closed and examine If Open instructions, Entering the ladder diagram, Modes of operation. Creating Ladder Diagrams from Process Control Descriptions. Ladder diagram & sequence listing; large process ladder diagram construction, flow charting as programming method, Industrial Examples	6	12
6	PLC INSTRUCTIONS Bit Logic Instructions: NO, NC, Set, Reset, rising edge Pulse, Falling Edge Pulse, RS, SR, NOP, OUTPUT etc. Clock: READ RTC, SET_RTC. Different Logical operation Instructions: INVERT BIT, BYTE, WORD DOUBLE WORD. OR: BIT, BYTE, WORD DOUBLE WORD. AND: BIT, BYTE, WORD DOUBLE WORD. X-OR: BIT, BYTE, WORD DOUBLE WORD.	3	6
7	Different Integer Math Instructions: Addition, Subtraction, Multiplication, Division, Increment, Decrement- Integer, Byte, Double Word. Different Floating-Point Math Instructions: Addition, Subtraction, Multiplication, Division, Square Root, Sin, Cosine, Tan, LN, Exponential, PID.	4	8
8	Programming Timers Mechanical Timing relay, Timer instructions, ON delay timer instruction, Off-Delay timer instruction, Retentive Timer, Cascading Timers, examples of timer function industrial application; industrial process timing application.	2	4
9	Programming Counters Counter Instructions, Up-counter, down counter, Up- Down counter, Cascading counters, Incremental encoder counter applications, Combining counter and timer functions, High Speed counter instruction, HSC, PLS, examples of counter function industrial application.	2	4
10	Different Conversion Instructions : Byte – Integer, Integer To Byte, Integer To Double Integer, Double Integer To Integer, Real To Integer, Real To Integer, Integer To String, String To Integer, Integer To ASCII , ASCII To Integer, Real To ASCII , ASCII To Real, ASCII To Hexadecimal, Hexa- Decimal To ASCII , Decode,, encode, segment. Truncate.	2	4
11	Different Comparison Instructions Data manipulation, data transfer operations, Data compare instructions, Data manipulation Programs, Numerical Data I/O interfaces, Set-point control.	2	4
12	Program Control Instructions The PLC SKIP and MASTER CONTROL RELAY Functions. Introduction; the SKIP function & application; the MASTER CNTROL RELAY function & application. Introduction: Jump with non-return; jump with return.	3	6
13	DATA HANDLING FUNCTIONS PLC Data Move Systems. Introduction; PLC MOVE function & application; moving large blocks of PLC data; PLC table & registers moves; other PLC MOVE functions. Other PLC Data Handling Functions.	2	4

	Different Move Instructions: BIT, BYTE, WORD DOUBLE WORD, REAL, SWAP Byte, Move Byte Immediate Read, Move Byte Immediate Write. Different Shift/Rotate Instructions		
14	Sequencer and shift register instructions PLC Sequencer Functions. Introduction; electromechanical sequencing; the basic PLC sequencerfunction; a basic PLC sequencer application with timing; other PLCsequencer function; cascading sequencer. Controlling a Robot with a PLC. Introduction; basic two axis ROBOT with PLC sequencer control; industrial three axis ROBOT with PLC control.	3	6
15	Different Interrupt Instructions- ENI, DSI, RETI, ATCH, DTCH, CLR_EVNT.	1	2
16	PLC Networking Introduction, Levels of Industrial Control, Types of Networking, Network Communications.	2	4
17	Analog PLC Operation Introduction, Types of PLC Analog Modules and Systems, PLC Analog Signal Processing, PLC Analog Application Examples, PID Modules, PID Tuning, Typical PID Functions.	2	4
18	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 Maintenance, Troubleshooting, Connecting PC with PLC.	2	4
19	Alternative Programming Languages Structured Text, Function block diagram, Instruction list, sequential function chart – Introduction and of few instructions with LD.	3	6
20	Various Brands of PLCs and their revolution. Overview, Siemens PLC, Allen Bradley PLC, Schneider electric PLC, Omron PLC, Mitsubishi PLC. Their comparison of various instructions.	1	2

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. Programmable logic controller by Frank D. Petrusella, Tata McGraw-Hill publication
2. Introduction to programmable logic controller by Gary dunning, Thomson Asia Pte Ltd. Publication, Singapore
3. Programmable Logic Controllers: Principles and Applications by John W. Webb and Ronald A. Reis, Prentice – Hall India publication, 5th edition
4. Programmable Logic Controllers by W. Bolton, Elsevier Newnes publication, 4th edition
5. Programmable Controllers An engineer's guide by E.A.Parr, Elsevier Newnes publication 3rd edition

6. S7-200, PLC Manual of Siemens for Instructions
7. S7-300, PLC Manual of Siemens for Instructions
8. Programmable Controller by T. A. Huges, ISA publication, 2nd edition
9. Programmable Logic Controllers: Programming methods and applications by
10. John R. Hackworth and Frederick D. Hackworth Jr., Pearson publication

Course Outcome:

Students will be able to

Sr. No.	CO statement	Marks % weightage
CO-1	Describe and understand the hardware structure of PLC and interfacing of input-output modules, power supply and computer with PLC	
CO-2	Apply knowledge of digital logic and microcontroller concepts for understanding and use of functional blocks in ladder programming, process scanning and status table updation	
CO-3	Interface different on-off switches, push buttons, keypad, analog sensors etc. with input modules and relay, solenoid valve, LED, servo valve, solid state devices etc. to output modules of PLC	
CO-4	Write, simulate, debug and analyze the ladder programs and SCADA tagging to develop program related to control, arithmetic, relay, data handling, sequencer, timer, counter, interrupt and PID blocks.	
CO-5	Work as an individual and as a team member to design, formulate, implement and troubleshoot industrial automation application using PLC	

List of Experiments:

1. Introduction to ladder programming& to implement basic logic gates.
2. Develop, Simulate and Test Ladder diagram for
   a.a. A Door Bell Operationb. A Combination Lock.
3. Develop, Simulate and Test Ladder diagram for Bottle Filling system.
4. Develop, Simulate and Test Ladder diagram for Traffic Light Control System.
5. Develop, Simulate and Test Ladder diagram for Car Parking system.
6. Develop Simulate and Test Ladder diagram for an alarm annunciator system.
7. Develop Simulate and Test Ladder diagram for Batch Mixer and Drink Dispenser system.
8. Develop, Simulate andTest Ladder diagram for three phase motor and stepper motor control in forward and reverse direction.
9. Develop and test PLC program for two axis Robotic arm for pick and place application
10. Develop, Simulate and Test Ladder diagram for Packing line system and Elevator system
11. Develop and test PLC program for PID Controller for Temperature control Application.
12. Develop and test PLC program in FBD, SFC, IL, ST, and Ladder Logic Language for Motor starter application.
13. Detail study of PLC Hardware and its interfacing.
14. 17. Study of important features of SCADA software package
15. 18.. Study of different type of animations used in SCADA software

16. 19. Development of GUI using different type of scripting on SCADA software
17. . Interfacing of PLC with SCADA software package
18. Interfacing of I/O modules with SCADA/ DCS package

Major Equipment:

Computers, simulation software, PLCs, Input/ Output devices.

List of Open Source Software/learning website:

https://plc-coep.vlabs.ac.in/

http://www.plcdev.com/book/export/html/9

http://www.plcmanual.com/

http://literature.rockwellautomation.com/

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

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

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3161715

INDUSTRIAL DATA COMMUNICATION AND DISTRIBUTED CONTROL SYSTEM

6th Semester

Type of course: Professional Elective Course

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

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			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	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	16
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	12
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	**Typical DCS used in Industry.** Honeywell PlantScape system, Foxboro I/A series DCS, Delta system, Citect, Wonderware	04	14

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 Outcomes: Students will be able to

Sr. No.	CO statement	Marks % weightage
CO-1	Analyze current philosophy, technology, terminology, and practices used in automation industries..	
CO-2	Evaluate computer based automation system used in industries ranging from discrete, continuous process to hybrid processes.	
CO-3	Identify hardware and software for modern automation system required for industrial application.	
CO-4	Apply relevant concept to configure hardware with software for automation application	
CO-5	Understand various communication protocols	

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.)

Major Equipment:

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

List of Open Source Software/learning website:

http://ial-coep.vlabs.ac.in/

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

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3161716
INDUSTRY 4.0
6th SEMESTER

Type of course: Core Engineering

Prerequisite: Sensor/ transducer, field transmitters, converters, final control element, Computer based control system architecture, Basics of Internet of Things (IoT)

Rationale: The world is at the onset of the Fourth Industrial Revolution and this revolution is very much driven by the smarts in automating decision making and processes. Advancements in IT has resulted in immense improvements in computational power across nearly all electronic devices and enhanced capabilities in connecting the dots in an increasingly networked society. Industry 4.0 concerns the transformation of industrial processes through the integration of modern technologies such as sensors, communication, and computational processing. Technologies such as Cyber Physical Systems (CPS), Internet of Things (IoT), Cloud Computing, Machine Learning, and Data Analytics are considered to be the different drivers necessary for the transformation. This course provides learners an introduction to Industry 4.0 (or the Industrial Internet), its applications in the business world. Learners will gain deep insights into how smartness is being harnessed from data and appreciate what needs to be done in order to overcome some of the challenges

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

S. N.	Content	Total Hrs	% Weigh tage
1	Module 1: Introduction to Industry 4.0 1.1 The Various Industrial Revolutions 1.2 Digitalisation and the Networked Economy 1.3 Drivers, Enablers, Compelling Forces and Challenges for Industry 4.0 1.4 The Journey so far: Developments in USA, Europe, China and other countries 1.5 Comparison of Industry 4.0 Factory and Today's Factory 1.6 Trends of Industrial Big Data and Predictive Analytics for Smart Business Transformation	08	21
2	Module 2: Road to Industry 4.0 2.1 Internet of Things (IoT) & Industrial Internet of Things (IIoT) & Internet of Services 2.2 Smart Manufacturing 2.3 Smart Devices and Products 2.4 Smart Logistics 2.5 Smart Cities 2.6 Predictive Analytics	06	16

3	Module 3: Related Disciplines, System, Technologies for enabling Industry 4.0 3.1 Cyberphysical Systems 3.2 Robotic Automation and Collaborative Robots 3.3 Support System for Industry 4.0 3.4 Mobile Computing 3.5 Related Disciplines 3.6 Cyber Security	08	21
4	Module 4: Role of data, information, knowledge and collaboration in future organizations 4.1 Resource-based view of a firm 4.2 Data as a new resource for organizations 4.3 Harnessing and sharing knowledge in organizations 4.4 Cloud Computing Basics 4.5 Cloud Computing and Industry 4.0	08	21
5	Module 5: Other Applications and Case Studies 5.1 IIoT case studies 5.2 Case studies from students	04	10
6	Module 6: Business issues in Industry 4.0 6.1 Opportunities and Challenges 6.2 Future of Works and Skills for Workers in the Industry 4.0 Era 6.3 Strategies for competing in an Industry 4.0 world	04	11

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
07	**14**	**14**	**14**	**14**	**07**

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.

Text Books

1. Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things", *Apress, 2016*

2. Lan Gibson, David W. Rosen and Brent Stucker, "Additive Manufacturing Technologies Rapid Prototyping to Direct Digital Manufacturing", *Springer, 2010.*

3. Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat, "Industrial Internet of Things: Cyber manufacturing Systems" *(Springer)*

4. A. McEwen and H. Cassimally, Designing the Internet of Things, 1st edition, *Wiley, 2013, ISBN-10: 111843062X*

5. A. Bagha and V. Madisetti, Cloud Computing: A Hands-on Approach, *1st edition, Universities press, 2015, ISBN-10: 8173719233.*

6. B. Evans, Beginning Arduino Programming – Writing Code for the Most Popular Microcontroller Board in the World, *1st edition, Apress, 2011, ISBN13: 9781430237778.*

7. S. Chin and J. Weaver, Raspberry Pi with Java: Programming the Internet of Things (IoT), *1st edition, McGraw Hill Publisher, 2015, ISBN-10: 0071842012.*

Reference Books:

1. Andreas Gebhardt, "Understanding Additive Manufacturing: Rapid Prototyping, Rapid Tooling, Rapid Manufacturing", Hanser Publisher, 2011.
2. J. Chanchaichujit, A.Tan, Meng, F., Eaimkhong, S. "Healthcare 4.0 Next Generation Processes with the Latest Technologies", Palgrave Pivot, 2019.
3. F. Lamb, Industrial Automation: Hands on, 1st edition, McGraw-Hill Education, 2013, ISBN-10:0071816453
4. M. Kuniavsky, Smart Things: Ubiquitous Computing User Experience Design, 1st edition, Morgan Kaufmann, 2010, ISBN-10: 0123748992
5. Industrial Internet Vocabulary - IIC
6. The Industrial Internet of Things Volume G1: Reference Architecture – IIC
7. Industrial Internet of Things Volume G4: Security Framework –IIC

Course Outcomes: Students will be able to

Sr. No.	CO statement	Marks % weightage
CO-1	Understand the drivers and enablers of Industry 4.0	
CO-2	Appreciate the smartness in Smart Factories, Smart cities, smart products and smart services	
CO-3	Outline the various systems used in a manufacturing plant and their role in an Industry 4.0 world	
CO-4	Understand the opportunities, challenges brought about by Industry 4.0 and how organisations and individuals should prepare to reap the benefits	
CO-5	Publish and distribute Android Application	

List of Practical:

Introduction to Microcontrollers and Sensors.

Prototyping Embedded devices using Arduino/ Raspberry Pi/ BeagleBone Black/ etc. notable platforms

I/O control interface programming.

Communication protocol implementation and testing using Microcontroller.

Configuring Wired/Wireless network interface to Microcontroller and programming

Configuring cloud database management and accessing

Sensors, Gateway and Cloud interface

Data analysis from cloud and reporting

Prototyping online Components – Getting Started with an API, Writing a New API, Real Time Reactions, Other Protocols.

Major Equipment:

List of Open Source Software/learning website:

http://vlab.co.in/
www.isa.org
http://nptel.ac.in/video.php
http://www.idc-online.com/
https://www.i-scoop.eu/industry-4-0/
https://new.siemens.com/in/en/company/topic-areas/digital-enterprise.html

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject code: 3160002
Contributor Personality Development Program

SEMESTER VI

Type of course: Work-Personality Development

For Year: Pre-final year for all Diploma, Degree & Masters programmes over 2 semesters. For e.g. for Bachelors of Pharmacy and Engineering, the course will be conducted in Semesters V & VI.

Rationale: The Contributor Program aims to accomplish the following outcomes in the lives of students–

- Improve the employability of students by giving them the right work ethic and thinking that employers are looking for.
- Build their confidence with which they can go into any job and contribute meaningfully.
- Improve their ability to engage better in the workplace and to be able to handle the challenges that come up there.
- Build their career-worthiness and help them develop into future-ready contributors with ability to navigate a career in a volatile, changing world.
- Widen their choices of career and success, so that they are able to open up more opportunities for themselves and take up unconventional career pathways.
- Enable them to recognize how they, as technical professionals, can participate and make a positive contribution to their communities and to their state.

Towards this goal, the Contributor Program has been designed to awaken and strengthen students from within, in terms of building positive self-esteem, increasing their confidence level and I-can attitude, improving their aspirations, giving them new methods of thinking, building their cognitive capacities, exposing them to the skills and practices associated with being contributors in the workplace (not mere employees).

The Program content is also designed to expose students to real-world workplace scenarios and sensitize them to some of the challenges faced in society around them, especially in the local communities around them and in their own state of Gujarat.

The Contributor Program syllabus has been evolved and fine-tuned over several years, (a) to address the changing need and contemporary challenges being faced by industry and what employers of today are looking for in the people they hire and (b) by working extensively with universities and students building an appreciation of their challenges and concerns. At the core, the program is guided by the higher ideas and principles of practical Vedanta in work.

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
2	0	0	2	70	30	30	20	150

COURSE CONTENT :

Sr. No.	Content	Total Hrs
1	**Finding Solutions** The market environment in which organizations are operating, is becoming increasingly dynamic and uncertain. So, employers are increasingly seeking out people who can innovate and figure out solutions in the face of any challenge (unlike in the past when it was the	1.5 hrs Classroom engagement (including self-discovery/ solutioning sessions)

	people who were most efficient and productive, who were valued by organizations). At the heart of innovation lies this way of thinking of "finding solutions" rather than "seeing problems or roadblocks". Students learn how to build this way of thinking, in this topic.	
2	**Creating Value** Companies are also looking for employees who do not just work hard, or work efficiently or productively - but those who will make a valuable difference to the fortunes of the company. This difference may come from innovation, but it may also come from focusing on the right things and identifying what really matters – both to the company and to the customers. In this topic, students learn how to build this capability.	Same as above
3	**Engaging deeply** The environment we live in is becoming increasingly complex because more and more things are getting interconnected, new fields are emerging, technologies are rapidly changing, capabilities and knowledge one is trained in will become fast obsolete. In such a scenario, the student's ability to quickly understand and master what is going on, dive deep, get involved in any area, rapidly learn new capabilities that a job demands, is important. Engaging deeply is a core way of thinking that can help them in this. In this topic, students learn how to engage deeply.	Same as above
4	**Enlightened self-interest & collaboration at work** The changing nature of work in organizations and in the global environment is increasingly demanding that people work more collaboratively towards shared goals and more sustainable goals. A key to working successfully when multiple stakeholders are involved is "thinking in enlightened self-interest". In this topic, students learn how to develop this way of thinking (going beyond "narrow self-interest").	Same as above
5	**Human-centered thinking & Empathy** In this topic, students explore a human-centric approach to work – where the ability to recognize and respond to other people (whether they are users or customers or team members) as a human being with human needs and difficulties, is essential. This is at the heart of user-centric design of products and solutions, at the heart of genuine customer-centricity in services, and of any successful interaction with other people.	Same as above
6	**Trust Conduct** The biggest currency in a sustainable career is "trust" i.e. being trusted by team members, bosses, and customers. When we are trusted, people listen to us, they are willing to give us the chance to grow, give us the space to make mistakes, and work seamlessly with each other without always having to "prove ourselves". In this topic, students learn how to demonstrate conduct that builds the trust of people.	Same as above
Showcase Lab Sessions		3 hrs
Project work		Beyond classroom

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Bachelor of Engineering
Subject code: 3160002

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
-	**15**	**15**	**-**	**20**	**20**

Reference resources:

A. Basic reference for both students and teachers

1. Contributor Personality Program textbook cum workbook developed by Illumine
2. Web-based ActivGuide™ for self-exploration of rich media resources to vividly understand many of the ideas, watch role models, learn from industry people, get reference readings – that help them enrich the understanding they gained in the class published by Illumine Foundation

B. Advanced reference for teachers

1. On Contributors, Srinivas V.; Illumine Ideas, 2011
2. Enlightened Citizenship and Democracy; Swami Ranganathananda, Bharatiya Vidya Bhavan, 1989
3. Eternal Values for a Changing Society – Vol I-IV, Swami Ranganathananda; Bharatiya Vidya Bhavan
4. Karma Yoga, Swami Vivekananda; Advaita Ashrama
5. Vivekananda: His Call to the Nation, Swami Vivekananda; Advaita Ashrama
6. Six Pillars of Self Esteem, Nathaniel Branden; Bantam, 1995
7. Mindset: The New Psychology of Success, Carol S. Dweck; Random House Publishing Group, 2007
8. Lasting Contribution: How to Think, Plan, and Act to Accomplish Meaningful Work, Tad Waddington; Agate Publishing, 2007
9. Why not?: how to use everyday ingenuity to solve problems big and small, Barry Nalebuff, Ian Ayres; Harvard Business School Press, 2003
10. The value mindset: returning to the first principles of capitalist enterprise (Ch 8 & 9); Erik Stern, Mike Hutchinson; John Wiley and Sons, 2004
11. The Power of Full Engagement: Managing Energy, Not Time, is the Key to High Performance and Personal Renewal, Jim Loehr, Tony Schwartz; Simon and Schuster, 2003
12. Creating Shared Value, Michael E. Porter and Mark R. Kramer; Harvard Business Review; Jan/Feb2011, Vol. 89 Issue 1/2
13. The Speed of Trust: The One Thing That Changes Everything, Stephen M. R. Covey, Rebecca R. Merrill, Stephen R. Covey; Free Press, 2008
14. The Courage to Meet the Demands of Reality, Henry Cloud; HarperCollins, 2009
15. Responsibility at work: how leading professionals act (or don't act) responsibly, Howard Gardner; John Wiley & Sons, 2007

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Bachelor of Engineering
Subject code: 3160002

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
Outcome of theory sessions		
CO-1	Students will be able to recognize & appreciate the thinking required to find solutions in the face of any challenge.	10-12%
CO-2	Students will be able to recognize & appreciate different types of value that can be created and the different ways to create value for others.	10-12%
CO-3	Students will be able to recognize & appreciate how to engage deeply, and its need, value, payoffs and consequences in different contexts.	10-12%
CO-4	Students will be able to differentiate between 'enlightened self-interest' and 'narrow self-interest' & appreciate the payoffs/ consequences of both when working with multiple stakeholders.	10-12%
CO-5	Students will be able to recognize & appreciate the human side of situations or interactions or projects that will help them develop a more human-centric approach/ response to work.	10-12%
CO-6	Students will be able to recognize & appreciate conduct which builds trust of people in contrast to conduct which breaks trust of people - in teams / organization & the value of trust conduct in various situations.	10-12%
Outcome of practical sessions		
CO-7	Students complete their 'Contributor Showcase Profile' on the Showcase Platform. This includes (a) completing Illumine's Contributor Mindset Assessment (b) building evidence to demonstrate their functional orientations as contributors.	15%
CO-8	Students learn to apply contributor thinking to think-through and address real-world challenges.	15%

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject code: 3160003
INTEGRATED PERSONALITY DEVELOPMENT COURSE

SEMESTER VI

TYPE OF COURSE –

- Value-based holistic personality development course for university students.

RATIONALE -

- This course aims to help a person understand and know his / her purpose in life, get a positive thought pattern, gain confidence, improve behaviour, learn better communication and develop a healthy physique with morality and ethics in its core.
- Todays youth lack the guidance to face insecurity about their health and career, premature relationships and family breakdown, addictions and substance abuse, negative impact of internet and social media etc. This course includes such topics that will cover all aspects and provide solution to the current challenges through creative and interactive activities.
- This course will allow students to enjoy, understand and practice invaluable lessons preparing them for a successful future.

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
2	0	0	2	70	30	30	20	150

COURSE CONTENT :

Lecture No.	Content	Hours
1	**Facing Failures** - Insignificance of Failures	2
2	**Facing Failures** - Power of Faith	2
3	**Facing Failures** - Practicing Faith	2
4	**From House to Home** - Bonding the Family	2
5	**Learning from Legends** - Leading without Leading (Pramukh Swami Maharaj)	2
6	**Review Lecture** – Words of Wisdom	2
7	**My India My Pride** - Glorius Past - Part 1	2
8	**My India My Pride** - Glorius Past - Part 2	2

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9	**My India My Pride** - Present Scenario	2
10	**Remaking Yourself** - Begin with the End in Mind	2
11	**My India My Pride** - An Ideal Citizen - 1 (Accountability - Responsibility - Honesty - Integrity)	2
12	**My India My Pride** - An Ideal Citizen - 2 (Loyalty - Sincerity - Punctuality)	2
13	**My India My Pride** - An Ideal Cititzen - 3 (Ethical & Moral Values/Practices)	2
14	**Financial Wisdom** - Financial Planning Process	2
15	**Review Lecture** - Student Voice-2	2

BASIC STUDY MATERIAL / MAIN COURSE WORK-BOOK -

1. IPDC Workbook-I
2. IPDC Workbook-II

IPDC REFERENCES –

- *These are the reference material for each lectures of IPDC.*

Module No.	Module/ Course Topics	Lectures	References
1	Facing Failures	Factors Affecting Failures Failures are not Always Bad Insignificance of Failures Power of Faith Practicing Faith	1. Thomas Edison's factory burns down, New York Times Archives, Page 1, 10/12/1914 2. Lincoln Financial Foundation, Abraham Lincoln's "Failures": Critiques, Forgotten Books, 2017 3. J.K. Rowling Harvard Commencement Speech | Harvard University Commencement, 2008 4. Born Again on the Mountain: A Story of Losing Everything and Finding It Back, Arunima Sinha, Penguin, 2014 5. Failing Forward: Turning Mistakes Into Stepping Stones for Success, John C. Maxwell, Thomas Nelson, 2007 6. Steve Jobs: The Exclusive Biography Paperback, Walter Isaacson, Abacus, 2015

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2	Learning from Legends	Tendulkar & Tata Leading Without Leading	1. Chase Your Dreams: My Autobiography, Sachin Tendulkar, Hachette India, 2017 2. Playing It My Way: My Autobiography, Sachin Tendulkar, Hodder & Stoughton, 2014 3. The Wit and Wisdom of Ratan Tata, Ratan Tata, Hay House, 2018 4. The Tata Group: From Torchbearers to Trailblazers, Shashank Shah, Penguin Portfolio, 2018 5. The Leader Who Had No Title, Robin Sharma, Jaico Publishing House, 2010 6. In the Joy of Others: A Life Sketch of Pramukh Swami Maharaj, Mohanlal Patel and BAPS Sadhus, Swaminarayan Aksharpith, 2013
3	Mass Management	Project Management	1. Project Management Absolute Beginner's Guide, Gregory Horine, Que Publishing, 2017 2. The Fast Forward MBA in Project Management, Eric Verzuh, Wiley, 2011 3. Guide to Project Management: Getting it right and achieving lasting benefit, Paul Roberts, Wiley, 2013
4	My India My Pride	Glorious Past - Part 1 Glorious Past - Part 2 Present Scenario An Ideal Citizen - 1 An Ideal Citizen - 2 An Ideal Citizen - 3	1. Hidden Horizons, Dr. David Frawley and Dr. Navaratna S. Rajaram, 2006 2. Rishis, Mystics and Heroes of India, Sadhu Mukundcharandas, Swaminarayan Aksharpith, 2011 3. Physics in Ancient India, Narayan Dongre, Shankar Nene, National Book Trust, 2016 4. The Rise of Civilization in India and Pakistan, Raymond Allchin, Bridget Allchin, Cambridge University Press, 1982 5. The Āryabhaṭīya of Āryabhaṭa: An Ancient Indian Work on Mathematics and Astronomy (1930), Walter Eugene Clark, University of Chicago Press, reprint, Kessinger Publishing, 2006
5	Remaking Yourself	Restructuring Yourself Power of Habit Being Addiction-Free Begin with the End in Mind Handling the Devil – Social Media	1. Power of Habit, Charles Duhigg, Random House Trade Paperbacks, 2014 2. Change Your Habit, Change Your Life, Tom Corley, North Loop Books, 2016 3. The Seven Habits of Highly Effective People, Stephen Covey, Simon & Schuster, 2013 4. Seven Habits of Highly Effective Teens, Sean Covey, Simon & Schuster, 2012 5. Atomic Habits, James Clear, Random House, 2018 6. How a handful of tech companies control billions of minds every day, Tristan Harris, TED Talk, 2017

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6	Financial Wisdom	Basics of Financial Planning Financial Planning Process	1. Rich Dad Poor Dad, Robert Kiyosaki, Plata Publishing, 2017 2. The Warren Buffett Way, Robert Hagstrom, Wiley, 2013 3. The Intelligent Investor, Benjamin Graham, Harper Business, 2006 4. Yogic Wealth: The Wealth That Gives Bliss, Gaurav Mashruwala, TV18 Broadcast Ltd, 2016
7	From House to Home	Affectionate Relationships Forgive & Forget Listening & Understanding Bonding the Family	1. "What Makes a Good Life? Lessons from the Longest Study on Happiness", R. Waldinger, Ted Talks, 2015 2. Long Walk To Freedom, Nelson Mandela, Back Bay Books, 1995 3. Outliers, Malcolm Gladwell, Back Bay Books, 2011
8	Soft Skills	Teamwork & Harmony Networking - Decision Making - Leadership	1. The 17 Indisputable Laws of Teamwork, John Maxwell, HarperCollins, 2013 2. Team of Teams: New Rules of Engagement for a Complex World, Stanley McChrystal, Portfolio, 2015 3. Predictably Irrational, Revised and Expanded Edition: The Hidden Forces That Shape Our Decisions, Harper Perennial, Dan Ariely, 2010
9	Review	Student Voice – 1 Student Voice – 2 Words of Wim	

COURSE OUTCOMES –

- To provide students with a holistic education – focused on increasing their intelligence quotient, physical quotient, emotional quotient and spiritual quotient.
- To provide students with hard and soft skills, making them more marketable when entering the workforce.
- To educate students on their social responsibilities as citizens of India and have a greater sense of social responsibility.
- To provide students with a value-based education which will enable them to be successful in their family, professional, and social relationships by improving their moral and ethical values.
- To teach self-analysis and self-improvement exercises to enhance the potential of the participants.
- To have a broader sense of self-confidence and a defined identity.

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3161707
CONTROL SYSTEM DESIGN
6th SEMESTER

Type of course: Professional Elective Course

Prerequisite: Knowledge of engineering mathematics, basics of control theory, simulation know-howon Matlab/ Scilab or other equivalent software

Rationale: The course is useful for the students to get idea of ideal practices in the field of control systemsdesign. This makes students capable for further studies and/ or conducting research work in the field. Students get in touch with recent trends in the field of modern control engineering. Importance of designing the control systems is emphasized.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	**Design of Feedback Control Systems :** Introduction; Approaches to System Design; Cascade Compensation Networks; Phase-Lead Design Using the Bode Diagram; Phase-Lead Design Using the Root Locus; Phase-Lag Design Using the Root Locus; Phase-Lag Design Using the Bode Diagram; lead-lag Design using root locus and bode diagram Design Examples.	**12**	33
2	**Design of State Variable Feedback Systems** Introduction, State space representation of physical systems, State space models of some common systems like R-L-C networks, DC motor, inverted pendulum etc., Controllable Canonical Form, Observable Canonical Form, Diagonal Canonical Form, State transition matrix, Solution of state equations, Controllability and Observability, Full-State Feedback Control Design; Observer Design; Integrated Full-State Feedback and Observer.	**12**	33
3	**Introduction to Optimal Control** introduction to optimal control, Riccatti Equation, Linear Quadratic Regulator, Design Examples.	**6**	16

w.e.f. AY 2018-19

4	**Introduction to Robust Control** Robust control system and system sensitivities to parameter perturbations, analysis of robustness, systems with uncertain parameters, considerations in design of robust PID controller.	**6**	18

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
14	**14**	**14**	**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. Modern Control Engineering by K. Ogata, PHI.
2. Discrete Time Control Systems by K. Ogata, PHI.
3. Automatic Control Systems by B C Kuo, PHI.
4. Control Systems, Principles and Design by M. Gopal, MC Graw Hill, 2012.
5. Modern control systems / Richard C. **Dorf**, Robert H. **Bishop, Pearson.**

Course Outcome:

After learning the course the students should be able to:

CO1 Apply time domain techniques to analyses and design closed-loop control system.
CO2 Apply frequency domain techniques to analyses and design closed-loop control system.
CO3 Apply state variable approach to design control systems
CO4 Understand optimal control and design closed loop optimal control system
CO5 Understand robustness of control system and design robust controller for a system with parameter uncertainties

List of Experiments:

*(Followingpracticals are recommended but they are not limited for modifications and or alterations by the faculty member/s teaching the particular subject. The use of MATLAB or SCILAB or equivalent software is suggested.***)**

1 Analysis of root locus using MATLAB.
2 Design lead compensator using time response analysis using MATLAB and design lead network.
3 Design lag compensator using time response analysis using Matlab and design lag network.

4 Find stability of any state space model using eigen value analysis and plot it state response.
5 Check controllability and observability of the given state space models.
6 Design state feedback controller using pole placement method based on MATLAB.
7 Analysis of bode plot using MATLAB.
8 Analysis and design of frequency response of lead compensating network.
9 Analysis and design frequency response of lag compensating network.
10 Design optimal controller using Riccatti equation
11 Design robust PID control system and check its response using Matlab.
12 Studying any prototype closed loop system.

All practical can be designed in MATLAB or SCILAB ,/Proteus /Keil.

Major Equipment:

Educational prototype models, Computers, simulation software, microcontrollers etc.

List of Open Source Software/learning website:

http://nptel.ac.in/courses/108103007/16

https://en.wikipedia.org/wiki/State-space_representation

http://ctms.engin.umich.edu/CTMS/index.php?example=Introduction&section=ControlStateSpace

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3161708
SUBJECT NAME: Motion Control

Type of course: Core Engineering

Prerequisite: DC machine and AC machine, Power Electronics, Control Theory and Motion Sensors Basics.

Rationale: Industrial Applications involves Motion Control as the major field to operate various drives involved. These Drives are selected based on power, torque, speed, size, load, control strategies, cost and many other factors. It is necessary for an engineer to select proper Machine for drive application based on these aspects. This Course deals with various machines, their models to understand its operation and finally its closed loop drive operation, to enable student to identify proper drive for motion control application.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Sr. No.	Course Content	Hrs	Weightage %
1	**Introduction** Components of a Motion Control System, Human–Machine Interface, Motion Controller ,Drives, Actuators, Transmission Mechanisms, Feedback	4	10
2	**DC Machines – Modeling & Motor Parameters** Induced Emf-equivalent circuit & Electromagnetic Torque-Electro-mechanical Modeling- State-Space Modeling- Block Diagram & Transfer Function-Field Excitation- Measurement of Motor Constants.	4	10
3	**Control of DC Drives:** Controlled rectifier based drives, Phase-Controlled Converters, Design of Controllers, Four-Quadrant DC Motor Drive, Closed Loop speed control of Drives. Chopper Control of DC Drives: Principle of operation of the Chopper-Four-Quadrant Chopper Circuit-Chopper for Inversion-Model of Chopper-Input to the Chopper-Other Chopper Circuits-Closed Loop Operation.	10	24
4	**AC Machines – Modeling & Motor Parameters** Construction and Principle of Operation, Induction Motor Equivalent Circuit, Measurement of Motor Parameters, Modeling of Induction Machines, Control Principle of Induction Motor.	4	10
5	**Control of AC Drives:** Control of Induction Motor by AC Voltage Controllers, AC Voltage Controller Circuits, Frequency Controlled Induction Motor Drives, Voltage Source Inverters based control, Constant Volts/Hz Control, Current Source Inverter based control, Current Controlled PWM Inverters, Induction motor Speed control by the use of adjustable frequency PWM inverters—properties of PWM waveforms, single pulse modulation, Multi-pulse modulation, sinusoidal modulation.	10	24
6	**Permanent Magnet Synchronous and Brushless DC Motor Drives:** Synchronous Motors with PM, Control Strategies, Speed Controller Design, PM Brushless DC Motor, Sensorless Control of PMBDCM.	4	10
7	**Stepper Motor Drive:** Stepper motors - Variable reluctance, Permanent	6	12

	Magnet, Torque versus stepping rate characteristic, Drive circuit for stepper motors.		

Course Outcomes: Students will be able to

Sr. No.	CO statement	Marks % weightage
CO-1	Construct Model of AC/DC Machine with all electrical and mechanical parameters consideration.	
CO-2	Design AC and DC Drive with Control parameters.	
CO-3	Design Special Motor Drives using BLDC and Stepper Motor	

Reference Books:

1. Electric Motor Drives–Modeling, Analysis and Control, -R. Krishnan, Pearson Education, 2003
2. Fundamentals of Electrical Drives- Gobal K.Dubey, Alpha Science Int. Ltd., Pangbourne
3. Power Electronics & Motor Control - Shepherd Hullay & Liag, Cambridge Univ. Press
4. Power Semiconductor controlled Drives, -Gopal K Dubey Prentice Hall pub.
5. Industrial Motion Control, Motor Selection, Drives, Controller Tuning, Applications– Hakan Gürocak, Washington State University Vancouver, USA, Wiley Publications.