Walchand College of Engineering

(Government Aided Autonomous Institute)

Vishrambag, Sangli-416415

Course Content for

F. Y. M. Tech. (Control and Instrumentation)

Semester-I and II

2024-25

Semester- I
Professional Core Theory Courses

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2024-25

Course Information

Programme	M. Tech. All Branches
Class, Semester	First Year M. Tech., Sem I
Course Code	1IC501
Course Name	Research Methodology
Desired Requisites:	NIL

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives

1	To prepare students for undergoing research, identify and formulate the research problems, state the hypothesis, design a research layout, set a research process and methodology.
2	To enable students to interpret the results, propose theories, suggest possible/alternative solutions, solve, and prove the solution adapted–logically and analytically, conclude the research findings.
3	To impart knowledge to analyze critically the literature and publish research in reputed conferences/ journals.
4	To expose students to research ethics, IPR and Patents

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Demonstrate a research solution in each engineering domain using appropriate Engineering research process and research methodology.	II	Apply
CO2	Device feasible solution to a research problem in the respective engineering domain based on economic, social and legal aspects using appropriate research procedures and practices.	III	Analyze
CO3	Compose research publications and dissertation reports efficiently.	VI	Create
CO4	Draft IPR and patent documents, as well as copyright documentation for research work.	VI	Create

Module	**Module Contents**	**Hours**
I	**Engineering Research Process:** Meaning of research problem, Sources of research problem, Criteria and Characteristics of a good research problem, Errors in selecting a research problem, Definition, scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation.	6
II	**Research Methodology :** Problem statement formulation, resources identification for solution, Experimental and Analytical modeling, Simulations, Numerical and Statistical methods in engineering research. Hypothesis and its testing by different techniques: T-Test, Z-test etc.,	6
III	**Research Methods:** Uni and Multivariate Analysis: ANOVA, Design of Experiments/Taguchi Method, Regression Analysis. Software tools like spreadsheets. Processing and Analysis of Data: Processing Operations, Types of Analysis- Presentation and Interpretation of Data Editing, Classification and Tabulation- Interpretation. Analyse your results and draw conclusions.	7

IV	**Research Practices:** Effective literature studies approaches, critical analysis, Plagiarism, Research ethics, Mendeley - Reference Management Software. Research communication- Effective Technical Writing, Writing a research article for Journal/conference paper, Technical report, Dissertation/ Thesis report writing, Software used for report writing such as word, Latex etc. Presentation techniques for paper/report/seminar. Publishing article in Scopus/SCI/Web of science indexed journal or conference.	7
V	**Intellectual Property Rights (IPR):** Nature of Intellectual Property: Patents, Designs, Trade and Copyright, Ownership of copyright, Term of copyright, Technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property, New developments in IPR, Traditional knowledge, Various Case Studies.	7
VI	**Patents** Patent Rights: Scope of Patent Rights, Various Patent databases, Geographical Indications. Procedure for grants of patents, Patenting under Patent Cooperation Treaty (PCT). Licensing and transfer of technology. Administration of Patent System. Introduction to International Scenario: World Intellectual Property Organization (WIPO), Trade-Related Aspects of Intellectual Property Rights (TRIPs), Patenting under PCT.	6

	Textbooks
1	Kothari C. R, "Research Methodology", 5th Edition, New Age International, 2023
2	Melville Stuart and Goddard Wayne, "Research Methodology: An Introduction for Science & Engineering Students" Juta and Company Ltd, 4th edition 2023.
3	Kumar Ranjit, "Research Methodology: A Step-by-Step Guide for beginners", SAGE Publications, , 4th edition 2023.
	References
1	**References**
2	Merges Robert, Menell Peter, Lemley Mark, "Intellectual Property in New Technological Age", ASPEN Publishers, 2018.
3	Ramappa T., "Intellectual Property Rights Under WTO", S. Chand, 2008
4	Mayall, "Industrial Design", McGraw Hill, Oct 2021.
5	Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2020

	Useful Links
1	**Useful Links**
2	https://onlinecourses.nptel.ac.in/noc21_ge03/preview- Introduction to reseach
3	https://onlinecourses.swayam2.ac.in/ntr21_ed23/preview - Academic Research & Report Writing
4	https://onlinecourses.nptel.ac.in/noc21_ge12/preview - Qualitative Research Methods And Research Writing
5	https://onlinecourses.nptel.ac.in/noc21_hs44/preview - Effective Writing
6	https://www.scopus.com/search/form.uri?display=basic#basic
7	https://webofscienceacademy.clarivate.com/learn
8	https://www.wipo.int/about-wipo/en/
9	https://iprsearch.ipindia.gov.in/publicsearch

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1	2	2	1			
CO2	3	2	2	3	2	2
CO3		3		3	1	
CO4				3	1	
The strength of mapping is to be written as 1: Low, 2: Medium, 3: High Each CO of the course must map to at least one PO.						

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

Syllabus Prepared By	Mrs. A. A. Dhamangaonkar
Syllabus Checked By	

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2024-25

Course Information	
Programme	M. Tech Control and Instrumentation
Class, Semester	First Year M. Tech., Sem. I
Course Code	1CI501
Course Name	Linear Control Systems
Desired Requisites:	Control System Engineering

Teaching Scheme		Examination Scheme (Marks)			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives	
1	To impart knowledge for modelling physical systems.
2	To enable students to analyse physical systems using State Space Approach.
3	To enable students to determine the stability of linear systems using different methods.
4	To introduce the use of optimal control and state feedback design.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	Course Outcome Statement/s	Bloom's Taxonomy Level	Bloom's Taxonomy Description
CO1	**Construct** state models for linear continuous–time systems.	III	Applying
CO2	**Analyze** the stability of control systems using state space approach.	IV	Analyzing
CO3	**Assess** the stability of linear control system using State Transition Matrix	V	Evaluating
CO4	**Design** pole placement and state observer controllers using state feedback design.	VI	Creating

Module	Module Contents	Hours
I	**Introduction to State Space** State Space Representation: Companion Form (Controllable Canonical Form), Extended Controllable Canonical Form, Observable Canonical Form, Diagonal Canonical Form, Jordan Canonical Form, Numerical Examples on State Space Modelling.	6
II	**Modelling of Linear Control Systems** Modelling of Mechanical Systems in State Space, Modelling of DC Servo Motor, Determination of Transfer Function from State Space Model, Numerical Examples on Modelling of Mechanical and Electromechanical Systems.	7
III	**Stability Analysis in State Space** Concept of Eigenvalues and Eigenvectors, Lyapunov Stability Analysis: Sylvester's Criterion, Stability Criterion, Direct Method, Concept of Diagonalization, Solution of State Equation, Steady State Error for State Space System.	6
IV	**State Transition Matrix** State Transition Matrix using Caley Hamilton Theorem, Controllability in State Space, Observability in State Space, Observable Decomposition and Detectability.	7
V	**State Feedback Design** Kalman Decomposition and Minimal Realisation, Canonical Forms and State Feedback Control, Control Design using Pole Placement, State Estimation and Output Feedback, Tracking Problem in State Feedback Design, Design of Observer and Observer based Controller.	6

VI	**Optimal Control** Optimal Control and Linear Quadratic Regulator (LQR), Feedback Invariant and Algebraic Ricatti Equation, Linear Matrix Inequalities, Properties of LMIs and Delay LMIs.	7

Textbooks	
1	K. Ogata, “Modern Control Engineering”, 4th Edition, Prentice Hall, 2002.
2	N. S. Nise, “Control Systems Engineering”, 6/e, Wiley Eastern, 2010.
3	D. Roy Choudhuary, “Modern Control Engineering, PHI, 2005.
4	Ashish Tewari, Modern Control Design: with MATLAB and SIMULINK, Wiley, 2002.
References	
1	M. Gopal, “Control Systems: Principles and Design”,4th Edition, McGraw Hill Education, 2012.
2	B. C. Kuo, “Automatic Control System”, 9th Edition, Prentice Hall, 2010.
3	R. C. Dorf and R. H. Bishop, “Modern Control Systems”, Pearson Education, 2011.
Useful Links	
1	https://nptel.ac.in/courses/108107115
2	https://nptel.ac.in/courses/108106150

CO-PO Mapping

	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1			3			
CO2			3			
CO3				3		
CO4				3		

The strength of mapping is to be written as 1: Low, 2: Medium, 3: High
Each CO of the course must map to at least one PO.

Assessment

The assessment is based on MSE, ISE and ESE.
MSE shall be typically on modules 1 to 3.
ISE shall be taken throughout the semester in the form of teacher’s assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.
ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.
For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

Syllabus Prepared By	Dr. Mrs. A. S. Karvekar
Syllabus Checked By	

Walchand College of Engineering, Sangli

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AY 2024-25

Course Information

Programme	M. Tech. Control and Instrumentation
Class, Semester	First Year M. Tech., Sem. I
Course Code	1CI502
Course Name	PLC and Embedded Control
Desired Requisites:	Electrical Measurement and Instrumentation

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives

1	The course intends to explore the PLC and Embedded Control for industrial automation
2	The course aims at developing programs using ladder logic for industrial automation
3	It intends to analyze the performance of automation systems employing PLC and Embedded Control
4	The course aims to integrate sensors with PLCs for application development

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	**Use** key concepts related to PLC and SCADA systems, including hardware components, communication protocols for industrial automation.	III	Applying
CO2	**Implement** ladder logic programming technique to demonstrate use of PLC timers, counters for industrial automation	III	Applying
CO3	**Construct** PLC programs using ladder logic to control simple industrial processes	III	Applying
CO4	**Evaluate** the performance of PLC network configurations, PLC functions used for different application	V	Evaluating

Module	**Module Contents**	**Hours**
I	**Introduction to PLC:** Introduction, Basics of Industrial Control and Automation, PLC Wiring, Advantages, Disadvantages, Parts of PLC, PLC Input module, PLC Output Module, PLC Architecture, PLC Operation, PLC as a computer, PLC memory and interfacing, Power Supply for PLC	6
II	**Basic PLC programming:** Ladder Logic Symbols, Latching and Unlatching of PLC, Programming on/ off inputs to produce on/off outputs, relation of digital gate logic to contact / coil logic, creating ladder diagrams from process control description.	7
III	**PLC Timer and Counter Functions:** PLC timer functions, Types of PLC timers, Programming of Non-retentive timers for various applications, Programming of ON timers, OFF timers, PLC counter functions, Programming of UP, DOWN counters, Case studies related to Industrial Automations, Counter Application examples	7
IV	**PLC Arithmetic and Comparison Functions:** PLC Arithmetic functions, PLC comparison functions, Conversion functions, Master control relay functions, PLC jump functions, Jump with return and Jump with No return functions, Programs related to Arithmetic, Comparison and Branch functions	7

V	**PLC Functions** Data move system, data handling functions, Digital bit functions and applications, sequencer functions, Analog input and outputs in PLC , Analog PLC operations, Application Examples, PID control using PLC, Updates in Industrial Internet of Things	6
VI	**PLC Networking** Networking of PLCs, Levels of Industrial Control, Types of Networking, Network Communications, Cell control by PLC Networks, Factors to consider in selecting a PLC, PLC troubleshooting and maintenance	6

	Textbooks
1	John W. Webb, Ronald A. Reis, Programmable logic controllers, principles & applications, PHI publication, Eastern Economic Edition, 1994.
2	Gary dunning, Introduction to PLC, Thomson learning, Edition III, 2006.
3	Frank D. Petruzella ,Programmable Logic Controllers, 3rd Edition, Tata McGraw Hill, New York, 2010
4	Madhuchhanda Mitra, Samarjit Sengupta, Programmable logic controllers and Industrial Automation: An Introduction, Penram International, Edition II, 2017.
	References
1	John R. Hackworth and Peterson, PLC controllers programming methods and applications, PHI, 2004.
2	Stuart A. Boyer , SCADA: Supervisory Control and Data Acquisition Systems, 4th Edition, ISA Press, 2010.
3	William H. Bolton, Programmable logic controllers, Newnes , Edition VI, 2006.
	Useful Links
1	Industrial Automation and Control, IIT Kharagpur Prof. S. Mukhopadhyay, Prof. S. Sen https://nptel.ac.in/courses/108105063
2	NOC:Industrial Automation and Control, IIT Kharagpur: https://nptel.ac.in/courses/108105088

CO-PO Mapping

	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1			3			
CO2				3		3
CO3				3		
CO4			3			

Assessment

The assessment is based on MSE, ISE and ESE.
MSE shall be typically on modules 1 to 3.
ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.
ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.
For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

Syllabus Prepared By	Dr. S. S. Karvekar
Syllabus Checked By	

Walchand College of Engineering, Sangli

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AY 2023-24

Course Information

Programme	M. Tech. Control and Instrumentation
Class, Semester	First Year M. Tech., Sem. I
Course Code	1CI503
Course Name	Process Instrumentation
Desired Requisites:	Control System Engineering

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives

1	To provide the basics of process control.
2	To provides the methodology of modelling the process and close loop control.
3	To provide the design of various types of controllers for single loop and multi loop control system.
4	To give the overview of advanced controllers used in process control and multivariable predictive control.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Calculate the various models of industrial processes.	III	Appling
CO2	Analyze the problems associated with open loop and close loop process control system.	IV	Analyzing
CO3	Evaluate the performance of processes with various conventional and advanced controllers.	V	Evaluating
CO4	Design various conventional and advanced controllers for the processes.	VI	Creating

Module	**Module Contents**	**Hours**
I	**Introduction to Process Control** Introduction, Design aspects of a process control system, Hardware for a process control system. Mathematical modeling and analysis of processes, development of a mathematical model, Modeling considerations for control purposes, the input-output model, degree of freedom.	7
II	**Modeling of Process** Computer Simulation and linearization of nonlinear systems, Transfer functions and the Input-output models. Dynamic behavior of first-order systems, second-order system and higher order systems.	6
III	**Feedback Control of Process** Elements of feedback control system, types of feedback controllers, sensors, Transmission lines, final control elements. Dynamic behavior of feedback-controlled process, Effect of proportional (p) control, Integral (I) control and derivative (D) control on the response of controlled process, effect of composite control actions.	6
IV	**Multi Loop Control** Feedback control of system with large dead time or inverse response, processes with large Dead time, Dead time compensation, and control of systems with inverse response. Control systems with multiple loops, cascade control, split-range control, feed forward control, Ratio-control, problem in designing feed forward controllers, practical aspects on the design of feed forward controllers, F/F – F/B control.	7

V	**MIMO Process** Multi-input, multi-output processes, degree of freedom and number of controlled and Manipulated variables, interaction and decoupling of control loops, relative gain array and selection of loops, design of non-interacting control loops. Overview of modern control methodologies: PLC, SCADA, DCS, Adaptive control, variable structure control.	6
VI	**Centralized Multivariable Control** Multivariable model predictive control, single-variable dynamic matrix control (DMC) algorithm, multivariable dynamic matrix control, internal model control, smith predictive, model predictive control, process model based control, implementation guidelines. Process control design: sequence of design steps, statistical process control.	7

Textbooks	
1	*"Chemical Process Control - An introduction to Theory and Practice",* by George Stephanopoulos, Prentice-Hall of India, 1st Edition 1984.
References	
1	"Process Control - Design Processes and Control System for Dynamic Performance", by Thomas E. Marlin, 2nd Edition, McGraw Hill publication.
2	"Process Control System – Application, Design and Tuning", by F.G. Shinskey, McGraw-Hill Publication, 3rd Edition, 1988.
3	"Process Control Instrumentation Technology", by Curtis D. Johnson, 7th Edition, Pearson Education, 7th Edition. 2003.
Useful Links	
1	https://nptel.ac.in/courses/103105064
2	https://archive.nptel.ac.in/courses/103/101/103101142/

CO-PO Mapping

	Programme Outcomes (POs)					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1			1			
CO2			1			
CO3				2		
CO4				2		1

The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High
Each CO of the course must map to at least one PO.

Assessment

The assessment is based on MSE, ISE and ESE.
MSE shall be typically on modules 1 to 3.
ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.
ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.
For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

Professional Core Laboratory Courses

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2024-25

Course Information	
Programme	M. Tech Control and Instrumentation
Class, Semester	First Year M. Tech., Sem. I
Course Code	1CI551
Course Name	Linear Control Systems Lab
Desired Requisites:	Control System Engineering

Teaching Scheme		Examination Scheme (Marks)			
Practical	2 Hrs/ Week	**LA1**	**LA2**	**Lab ESE**	**Total**
Interaction	-	30	30	40	100
		Credits: 1			

Course Objectives

1	To provide practical knowledge regarding modelling of different physical systems.
2	To impart skills to evaluate the performance of systems using transient analysis.
3	To provide hands on skills to estimate the stability of linear systems.
4	To provide skills to design state feedback and optimal control for linear systems.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	Course Outcome Statement/s	Bloom's Taxonomy Level	Bloom's Taxonomy Description
CO1	**Construct** and **Analyze** physical systems using simulation tools.	III	Applying
CO2	**Analyze** the stability of systems using state space techniques using simulation tools.	IV	Analyzing
CO3	**Assess** the stability of linear control system based on State Transition Matrix using MATLAB code.	V	Evaluating
CO4	**Design** pole placement and state observer controllers based on state feedback design in MATLAB code.	VI	Creating

List of Experiments / Lab Activities/Topics

List of Lab Activities:

1. Construct transfer function using software tools.
2. Analyze the effect of feedback using software and simulation tools.
3. Conversion of transfer functions to state space and vice versa using software tools
4. Calculate the transfer function of Electrical, Mechanical and Rotational systems using MATLAB
5. Calculate the state transition matrix, state and eigen values for Electrical Systems.
6. Evaluate the transient response of first and second order systems.
7. Compute the Controllability and Observability of physical systems
8. Stability analysis of control system using software tools.
9. Sketch root locus and design compensator using G.U.I. and software tools.
10. Design pole placement controller for physical system.
11. Design LQR using MATLAB.

Textbooks

1	K. Ogata, "Modern Control Engineering", 4th Edition, Prentice Hall, 2002.
2	N. S. Nise, "Control Systems Engineering", 6/e, Wiley Eastern, 2010.
3	D. Roy Choudhuary, "Modern Control Engineering, PHI, 2005.
4	Ashish Tewari, Modern Control Design: with MATLAB and SIMULINK, Wiley, 2002.

References

1	M. Gopal, "Control Systems: Principles and Design",4th Edition, McGraw Hill Education, 2012.
2	B. C. Kuo, "Automatic Control System", 9th Edition, Prentice Hall, 2010.
3	R. C. Dorf and R. H. Bishop, "Modern Control Systems", Pearson Education, 2011.

Useful Links	
1	https://nptel.ac.in/courses/108107115
2	https://nptel.ac.in/courses/108106150

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1			3	2		
CO2			3	2		
CO3			3	2		2
CO4			3	2		2

The strength of mapping is to be written as 1: Low, 2: Medium, 3: High
Each CO of the course must map to at least one PO.

Assessment

There are three components of lab assessment, LA1, LA2 and Lab ESE.
IMP: Lab ESE is a separate head of passing.(min 40 %), LA1+LA2 should be min 40%

Assessment	Based on	Conducted by	Typical Schedule	Marks
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 8 Marks Submission at the end of Week 8	30
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 9 to Week 16 Marks Submission at the end of Week 16	30
Lab ESE	Lab activities, journal/ performance	Lab Course Faculty and External Examiner as applicable	During Week 18 to Week 19 Marks Submission at the end of Week 19	40

Week 1 indicates starting week of a semester. Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming, and other suitable activities, as per the nature and requirement of the lab course. The experimental lab shall have typically 8-10 experiments and related activities if any.

Syllabus Prepared By	Dr. Mrs. A. S. Karvekar
Syllabus Checked By	

Walchand College of Engineering, Sangli

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AY 2024-25

Course Information

Programme	M. Tech. Control and Instrumentation
Class, Semester	First Year M. Tech., Sem. I
Course Code	1CI552
Course Name	PLC and Embedded Control Lab
Desired Requisites:	Electrical Measurement and Instrumentation

Teaching Scheme		**Examination Scheme (Marks)**			
Practical	2 Hrs/ Week	**LA1**	**LA2**	**Lab ESE**	**Total**
Interaction	-	30	30	40	100
		Credits: 1			

Course Objectives

1	The lab course is aimed to develop programming skills using PLC for Industrial Automation
2	The course intends to introduce the use of PLC for solving real world problems.
3	It will enable students to use PLC for control applications in electrical engineering
4	The lab course will enable students to integrate PLC, SCADA and HMI for various projects in industrial automation

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	**Demonstrate** skills to design, write, and troubleshoot PLC programs using various programming languages such as ladder logic	III	Applying
CO2	**Execute** experiments based on PLC and SCADA systems.	III	Applying
CO3	**Construct** control strategies using PLCs to improve reliability and operational efficiency in industries.	IV	Analyzing
CO4	**Design** ladder logic programs for various PLC applications.	VI	Creating

List of Experiments / Lab Activities/Topics

List of Lab Activities:

1. To understand and implement the functionality logic gates using PLC
2. Implement ladder diagram for ON/OFF and latching functions.
3. Design of PLC program for motor reversal control.
4. Illustrate stair case lighting using PLC programming.
5. Implement PLC program for building automation.
6. Design of PLC program for various arithmetical functions.
7. Devise the PLC program for traffic control system.
8. Design of ON/ OFF control mechanism using PLC timer functions.
9. Design of basic applications employing PLC counter functions.
10. Design of basic applications employing PLC analog inputs.
11. Demonstrate analog input operations using PLC

Textbooks

1	John W. Webb, Ronald A. Reis, Programmable logic controllers, principles & applications, PHI publication, Eastern Economic Edition, 1994.
2	Gary dunning, Introduction to PLC, Thomson learning, Edition III, 2006.
3	Frank D. Petruzella ,Programmable Logic Controllers, 3rd Edition, Tata McGraw Hill, New York, 2010
4	Madhuchhanda Mitra, Samarjit Sengupta, Programmable logic controllers and Industrial Automation: An Introduction, Penram International, Edition II, 2017.

References	
1	John R. Hackworth and Peterson, PLC controllers programming methods and applications, PHI, 2004.
2	Stuart A. Boyer , SCADA: Supervisory Control and Data Acquisition Systems, 4th Edition, ISA Press, 2010.
3	William H. Bolton, Programmable logic controllers, Newnes , Edition VI, 2006.
Useful Links	
1	Industrial Automation and Control, IIT Kharagpur Prof. S. Mukhopadhyay, Prof. S. Sen https://nptel.ac.in/courses/108105063
2	NOC:Industrial Automation and Control, IIT Kharagpur: https://nptel.ac.in/courses/108105088

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1			3		3	
CO2				3	3	
CO3					3	3
CO4				3	3	

Assessment

There are three components of lab assessment, LA1, LA2 and Lab ESE.
IMP: Lab ESE is a separate head of passing.(min 40 %), LA1+LA2 should be min 40%

Assessment	Based on	Conducted by	Typical Schedule	Marks
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 8 Marks Submission at the end of Week 8	30
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 9 to Week 16 Marks Submission at the end of Week 16	30
Lab ESE	Lab activities, journal/ performance	Lab Course Faculty and External Examiner as applicable	During Week 18 to Week 19 Marks Submission at the end of Week 19	40

Week 1 indicates starting week of a semester. Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming, and other suitable activities, as per the nature and requirement of the lab course. The experimental lab shall have typically 8-10 experiments and related activities if any.

Syllabus Prepared By	Dr. S. S. Karvekar
Syllabus Checked By	

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(Government Aided Autonomous Institute)

AY 2023-24

Course Information	
Programme	M. Tech. Control and Instrumentation
Class, Semester	First Year M. Tech., Sem. I
Course Code	1CI553
Course Name	Process Instrumentation Lab
Desired Requisites:	Control System Engineering

Teaching Scheme		**Examination Scheme (Marks)**			
Practical	2 Hrs/ Week	**LA1**	**LA2**	**Lab ESE**	**Total**
Interaction	-	30	30	40	100
		Credits: 1			

Course Objectives

1	To provide the foundation level knowledge of Process Control.
2	To provide the basics for mathematical model of the process.
3	To provide the knowledge of various types of controller for single loop and multi-loop control system.
4	To provide the knowledge of advanced controllers used in process control.
5	Provide the knowledge of multivariable predictive control.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Apply experimental methods to determine the model of processes in Process Control Systems.	III	Applying
CO2	Apply the tuning techniques for various controllers.	III	Applying
CO3	Demonstrate the use of advanced controllers.	III	Applying
CO4	Evaluate the performance of given Process Control system.	V	Evaluating

List of Experiments / Lab Activities/Topics

List of Lab Activities:

1. Step response of first order system (single capacity system).
2. Step response of multi capacity process (coupled tank system).
3. Closed loop computer controlled pressure control system.
4. Tuning of P PI and PID controllers based on process reaction curve and Ziegler Nichols method.
5. Closed loop computer controlled level control system.
6. Closed loop computer controlled flow control system.
7. Tuning of controllers for level control system.
8. Tuning of controllers for flow control system.
9. Study of cascade controller for a flow control system.
10. Study of PLC and its process controlled applications.

Textbooks

1	George Stephanopoulos, "Chemical Process Control - An introduction to Theory and Practice", Prentice-Hall of India, 1st Edition 1984.

References

1	Thomas E. Marlin, "Process Control - Design Processes and Control System for Dynamic Performance, 2nd Edition", McGraw Hill publication.

2	F.G. Shinskey, “Process Control System – Application, Design and Tuning”, McGraw-Hill Publication, 3rd Edition, 1988.
3	Curtis D. Johnson, “Process Control Instrumentation Technology”, 7th Edition, Pearson Education, 7th Edition. 2003.
Useful Links	
1	

CO-PO Mapping						
	Programme Outcomes (POs)					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2		1			
CO2				1		1
CO3				2		2
CO4			2			
The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High Each CO of the course must map to at least one PO.						

Assessment				
There are three components of lab assessment, LA1, LA2 and Lab ESE. IMP: Lab ESE is a separate head of passing.(min 40 %), LA1+LA2 should be min 40%				
Assessment	**Based on**	**Conducted by**	**Typical Schedule**	**Marks**
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 8 Marks Submission at the end of Week 8	30
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 9 to Week 16 Marks Submission at the end of Week 16	30
Lab ESE	Lab activities, journal/ performance	Lab Course Faculty and External Examiner as applicable	During Week 18 to Week 19 Marks Submission at the end of Week 19	40
Week 1 indicates starting week of a semester. Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming, and other suitable activities, as per the nature and requirement of the lab course. The experimental lab shall have typically 8-10 experiments and related activities if any.				

Professional Elective Theory Courses

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2024-25

Course Information

Programme	M. Tech Control and Instrumentation
Class, Semester	First Year M. Tech., Sem. I
Course Code	1CI511
Course Name	Professional Elective 1: Advanced Digital Signal Processing
Desired Requisites:	Digital Signal Processing

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives

1	To impart skills for analyzing discrete time signals using transforms.
2	To make students familiar with methods of digital filters design.
3	To impart basic knowledge of random signal processing.
4	To introduce the concept of signal modelling.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	**Apply** transforms to discrete time signals for analysis.	III	Applying
CO2	**Analyze** the properties of discrete time systems and random signals processing.	IV	Analyzing
CO3	**Evaluate** digital filters, structures, and discrete time random signals.	V	Evaluating
CO4	**Design** digital filters for desired specifications.	VI	Creating

Module	**Module Contents**	**Hours**
I	**Discrete time signal and system** Classification of signals, operation on sequences, properties of systems, convolution sum, sampling process.	6
II	**Discrete Time Fourier Transform** DFT, FFT, DIT FFT, DIF FFT algorithm, circular convolution.	7
III	**Digital filter structure** review of z - transform, transfer function classification, IIR and FIR filter characteristics, complementary transfer function, inverse system, digital two-pairs, algebraic stability test, block diagram representation, equivalent structures, FIR and IIR digital filter structures, all pass filters, lattice structures, all pass realization of IIR transfer function.	7
IV	**Digital Filter Design** Butterworth and Chebyshev filters, IIR filter design, impulse invariant method, bilinear transformation, FIR filter design.	7
V	**Discrete Time Random Processes** Review of linear algebra, quadratic and Hermitian form, random variables, random processes, filtering random processes, special type of random processes.	6
VI	**Signal Modelling** Least square method, Pade approximation, Prony's method, FIR least square inverse filters.	6

Textbooks

1	Sanjit Mitra , "Digital Signal Processing '', Tata McGraw Hill Publication, 3rd Edition, 2008.
2	Monson Hayes , "Statistical Signal Modelling'', John Wiley 2002.
3	Rao & Gejji, "Digital Signal processing'', Pearson Education, 2nd Edition, 2008.

References	
1	Oppenheim Schafer, Ronald, "Discrete Time Signal Processing", Pearson Education, 2nd Edition, 1999.
2	Ifeachor, Jerris , "Discrete Signal Processing", Pearson Education, 2nd Edition, 2002.
3	Ashok Ambardar , "Digital Signal Processing: A Modern Introduction'', Thomson, 2007.
Useful Links	
1	https://nptel.ac.in/courses/117102060

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1			3			
CO2			3			
CO3				3		
CO4				3		

The strength of mapping is to be written as 1: Low, 2: Medium, 3: High
Each CO of the course must map to at least one PO.

Assessment

The assessment is based on MSE, ISE and ESE.
MSE shall be typically on modules 1 to 3.
ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.
ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.
For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

Syllabus Prepared By	Dr. Mrs. A. S. Karvekar
Syllabus Checked By	

Walchand College of Engineering, Sangli
(Government Aided Autonomous Institute)

AY 2024-25

Course Information

Programme	M. Tech. Control and Instrumentation
Class, Semester	First Year M. Tech., Sem. I
Course Code	1CI512
Course Name	Professional Elective 1: Optimization Techniques
Desired Requisites:	-

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs./week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives

1	To develop basic knowledge of Optimization Techniques.
2	To provide skills for classical optimization techniques for applications in engineering.
3	To impart skills for Single-variable and multivariable optimization algorithms.
4	It will make students to study and implement the applications related Non-traditional Optimization Algorithms

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Apply the concepts of Optimization Techniques	III	Applying
CO2	Apply Optimization Techniques to develop solutions to engineering systems.	III	Applying
CO3	Implement the applications related to Single-variable and multivariable optimization algorithms	III	Applying
CO4	Implement the applications related Non-traditional Optimization Algorithms	III	Applying

Module	**Module Contents**	**Hours**
I	**Introduction to Optimization** Historical Development, Engineering Applications of Optimization, Statement of an Optimization Problem, Classification of Optimization Problems, Optimization Techniques, Solution of Optimization Problems Using MATLAB.	6
II	**Classical Optimization Techniques** Introduction, Single-Variable Optimization, Multivariable Optimization with No Constraints and with Equality Constraints, Direct Substitution , Lagrange Multipliers , Multivariable Optimization with Inequality Constraints, Kuhn–Tucker Conditions, Constraint Qualification , Convex Programming Problem.	6
III	**Linear Programming I: Simplex Method** Introduction, Applications of Linear Programming, Standard Form of a Linear Programming Problem, Simplex Algorithm, Two Phases of the Simplex Method, MATLAB Solution of LP Problems.	6

IV	**Single-variable Optimization Algorithms** Optimality Criteria ,Bracketing Methods , Exhaustive search method , Region-Elimination Methods ,Interval halving method, Golden section search method, Point-Estimation Method, Successive quadratic estimation method ,Gradient-based Methods, Newton-Raphson method, Bisection method. MATLAB Solution of One-Dimensional Minimization Problem.	7
V	**Multivariable Optimization Algorithms** Optimality Criteria, Unidirectional Search, Direct Search Methods Simplex search method, Powell's conjugate direction method , Gradient-based Methods ,Cauchy's (steepest descent) method, Newton's method , MATLAB Solution of Optimization Problems.	7
VI	**Non-traditional Optimization Algorithms** Evolutionary algorithms, Genetic Algorithms ,Working principles ,Differences between GAs and traditional methods, GAs for constrained optimization, Simulated Annealing, particle swarm and artificial bee algorithms, Modern nature inspired algorithms.	7
Textbooks		
1	Singiresu S. Rao , *' Engineering Optimization Theory and Practice',* John Wiley & Sons,4th Edition,2009.	
2	Kalyanmoy Deb, '*Optimization For Engineering Design: Algorithms And Examples'*, Prentice-Hall of India Private Limited, 1995.	
References		
1	Chankong, V., Haimes, Y. Y, '*Multiobjective Decision Making Theory and Methodology.*' New York: North-Holland Pub., 1983.	
2	David E. Goldberg , 'Genetic Algorithms in Search, Optimization, and Machine Learning', Addison Wesley, 1995.	
Useful Links		

CO-PO Mapping

	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1			3			
CO2			3			
CO3				3		
CO4				3		2

The strength of mapping is to be written as 1: Low, 2: Medium, 3: High
Each CO of the course must map to at least one PO.

Assessment

The assessment is based on MSE, ISE and ESE.
MSE shall be typically on modules 1 to 3.
ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.
ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.
For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

Syllabus Prepared By	Mr. A.B. Patil
Syllabus Checked By	

Walchand College of Engineering, Sangli *(Government Aided Autonomous Institute)*	
AY 2024-25	
Course Information	
Programme	M. Tech. Control and Instrumentation
Class, Semester	First Year M. Tech., Sem. I
Course Code	1CI513
Course Name	Professional Elective 1: Modern Control Systems
Desired Requisites:	Linear Control Systems

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives	
1	To provide the basics of modeling of the physical system, analysis.
2	To provides the methodology of designing the controller with realization.
3	To give an overview of advanced controllers like LQR.
4	Incorporate practical implementation considerations into controller design methodologies, including issues such as hardware limitations, sensor noise, and actuator constraints.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Demonstrate the ability to apply controller design techniques.	III	Applying
CO2	Analyze various controller structures.	IV	Analyzing
CO3	Evaluate controller performance using various control algorithms.	V	Evaluating
CO4	Design a controller to meet given performance specification.	VI	Creating

Module	**Module Contents**	**Hours**
I	**Controller Structures** Feed forward controllers, one degree of freedom, Two degree of freedom, Lag-Lead controller, PID Controller, Well behaved signal, Solving Aryabhatta's Identity.	7
II	**Controller Realization** Direct structure, Canonical and non-canonical structure, Cascade and parallel realization, PID controller Implementation, Microcontroller implementation of 1st, 2nd and higher order modules, Choice of Sampling interval.	7
III	**PID Controller** Introduction, sampling, discretization techniques, PID controller, methods of tuning, 2-DOF controller with integral action, bumpless PID controller, PID with filtering, 2-DOF PID, systems with delay.	6
IV	**Pole Placement Controllers** Dead-Beat and Dahlin Control, Pole Placement Controller with performance specifications, Implementation of Unstable Controllers, Internal Model Principle for Robustness, Redefining Good & Bad Polynomials, Comparing 1-DOF & 2-DOF Controllers, Anti Windup Controller, PID Tuning Through Pole Placement Control.	7
V	**Pole Placement Controller with IMC** Smith Predictor, Internal Model Control (IMC), IMC Design for Stable Plants, IMC in Conventional Form for Stable Plants, PID Tuning Through IMC, and IMC design fo unstable plant, LQR through pole placement.	6

VI	**State Space Technique to Control Design** Pole placement, Ackerman formula, controllability, estimators, prediction estimators, observability, current estimators, regulator design, combined control law and estimator, LQR, kalman filter design.	6

	Textbooks
1	*"Digital Control*", by Kannan M. Moudgalya, John Wiley and Sons Ltd., 2007.
2	*"Microcontroller Based Applied Digital Control",* by Dogan Ibrahim, John Wiley and sons Ltd., Edition 2006.
	References
1	*"Digital Control Engineering Analysis and Design*", by M. Sami Fadali and Antoni Visioli Else vier publication 2^{nd} Edition 2013.
2	*"Discrete Time Control System"* By Katsuhiko Ogata, Pearson Education 2^{nd} Edition 2005.
	Useful Links
1	http://moudgalya.org/

CO-PO Mapping

	Programme Outcomes (POs)					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1				3	2	
CO2				3		
CO3			2			
CO4				3		

The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High
Each CO of the course must map to at least one PO.

Assessment

The assessment is based on MSE, ISE and ESE.
MSE shall be typically on modules 1 to 3.
ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.
ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.
For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

Syllabus Prepared By	
Syllabus Checked By	

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2024-25

Course Information	
Programme	M. Tech. Control and Instrumentation
Class, Semester	First Year M. Tech., Sem. I
Course Code	1CI514
Course Name	Professional Elective 2: Advanced Transducers and Measurement Technique
Desired Requisites:	Basic Electronics, Instrumentation, Linear Control Systems, Digital Signal Processing

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives	
1	To understand about measurement systems and their classification
2	To understand about errors in measurement systems and calibration of measurement systems
3	To enable the students to select and design suitable instruments to meet the requirements of industrial applications and various transducers used for the measurement of various physical quantities
4	To understand about Various types of Sensors & Transducers and their working principle.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Apply the concepts and principles of different types of transducers in practical applications.	III	Applying
CO2	Apply the principles and operation of various pressure and temperature measurement devices in real word scenarios.	III	Applying
CO3	Apply the basic principles of different flow and level measurement techniques	III	Applying
CO4	Analyze and optimize signal conditioning circuits for different types of transducers	IV	Analyzing

Module	**Module Contents**	**Hours**
I	**Introduction to Transducer Fundamentals** Transducer fundamentals, Classification of transducers, General transducer characteristics, Resistance- Capacitance, Inductance- reluctance- Piezoelectric Magneto strictive- Hall effect- Photo electric type of transducers and their applications. Smart Transducers- Transducers for Bio-Medical applications-tactile sensors-MEMS and their applications.	7
II	**Measurement of Force, Acceleration, Strain, and Torque** Measurement of Force, Acceleration, Strain and Torque. Design of Electrical, Optical, & MEMS Accelerometers. Design of Gyroscopes.	7
III	**Measurement of Physical Quantities** Pressure measurement: Elastic Types-Resistive- Capacitive and Inductive pressure pickups. Piezoelectric- Piezoresistive types. Vacuum measurement: McLeod Gauges-Ionization gauges- Alphatron gauge. High Pressure measurement. Force balance and Motion balance type transmitters – P/I and I/P converters. IC pressure sensors and calibration of pressure measuring devices.	6

IV	**Pressure and Temperature Measurement Techniques** Temperature measurement: Filled-in thermal systems- Bimetallic thermometers - RTD, Thermistor, Thermocouple - Radiation and Optical pyrometers - Digital IC thermometers - Accuracy, errors, and compensation.	7
V	**Flow Measurement Methods** Flow measurement: Head flow meters- types, Area flow meters– Rotameter bypass rotameter-Turbine meter. Electromagnetic flowmeter – Principle – DC AC and pulsed type. Ultrasonic flow meters – Principles – transit time – Doppler shift – beam deflection– Cross correlation flowmeters. Vortex flowmeters - Coriolis flowmeters- Solid flow measurement- conveyor belt type. Installation and Calibration procedures of various flowmeters	6
VI	**Level Measurement and Other Techniques** Level Measurement: Conductive and Capacitive methods –Ultrasonic, Microwave and RADAR level sensors - Solid level measurement by Paddlers method. Capacitance method for powder level measurement. Density, Viscosity and PH measurement.	6

Textbooks	
1	Patranabis.D., "Principles of Industrial Instrumentation," McGraw-Hill PublishingCompany, 1984.
2	D. V.S.Murthy, Transducers in instrumentation, Prentice Hall, 1995.
3	Ernest. O. E. Doebelin, "Measurement Systems", McGraw-Hill publishing company, 1990.

References	
1	Bela G. Liptak, Process measurement and Analysis-Instrument Engineers' Handbook- Vol. I Third edition- Butterworth Heinemann publishing company
2	James.W.Dally, "Instrumentation for Engineering Measurement", John Wiley &Sons, Inc., 1993.

Useful Links	
1	https://www.coursera.org/learn/sensors-circuit-interface

CO-PO Mapping

	Programme Outcomes (POs)					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1			3			
CO2	2		2			
CO3	2		3	3		
	3			3		

The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High
Each CO of the course must map to at least one PO.

Assessment

The assessment is based on MSE, ISE and ESE.
MSE shall be typically on modules 1 to 3.
ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.
ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.
For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

Walchand College of Engineering, Sangli *(Government Aided Autonomous Institute)*	
AY 2024-25	
Course Information	
Programme	M. Tech. Control and Instrumentation
Class, Semester	First Year M. Tech., Sem. I
Course Code	1CI515
Course Name	Professional Elective 2: Smart Sensors and Actuators
Desired Requisites:	Basic Electronics, Digital Signal Processing, Instrumentation, and Measurement

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs./week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives	
1	To develop basic knowledge of Sensor Systems In Engineering
2	To provide skills for Integrated Smart Sensors :
3	To impart skills for Implementation of Micro machined Actuators
4	It will make students to study Communication And Standards For Smart Sensors

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Apply the basic Sensor Systems In Engineering	III	Applying
CO2	Apply Integrated Smart Sensors	III	Applying
CO3	Implement Micro machined Actuators	III	Applying
CO4	Implement the Communication And Standards For Smart Sensors	III	Applying

Module	**Module Contents**	**Hours**
I	**Sensor Systems In Engineering** Role of sensors and sensor systems – Innovative sensor Technologies, Application scenarios - Instrumentation Process – Instrumentation Steps, Application examples. Smart sensor, basics - General sensing system, Classical sensor Model – Smart sensor model – Monolithic integrated smart sensor - Hybrid integrated smart sensor.	7
II	**Signal Conditioning For Smart Sensors** Instrumentation Amplifier , Step mode operational amplifier ,Rail to rail Op-Amp , Switched Capacitor Amplifier , 4 to 20 mA Signal transmitter , Inherent power supply rejection, Separate Versus Integrated Signal Conditioning ,Digital Conversion.	7
III	**Integrated Smart Sensors** Monolithic sensor interface, MCU's for sensor interface, DSP for sensor interface, Techniques and system considerations: Linearization, PWM Control, Auto-zero and Auto range, Diagnostics. Software tools and support, Sensor integration, Alternative views of smart sensing.	6

IV	**Micro machined Actuators** Micro valves , Micro motors, Micro Pumps , Micro dynamometer , Micro steam engines , Actuators in other semiconductor materials , Various Micro machined structures: Cooling channels , Micro optical actuator , Micro grippers.	7
V	**Communication And Standards For Smart Sensors** Automotive Protocols, CAN protocol , Industrial networks. Industrial usage of CAN, Protocols in Silicon: MI-Bus. IEEE 1451 family of standards, Extending the system to network.	7
VI	**Introduction To Internet Of Things** Overview of Internet of Things , The Edge, Cloud and the Application, Development, Anatomy of the Thing , Industrial Internet of Things (IIoT - Industry 5.0) , Real Time Diagnostics ,Design and Development for IoT.	5
	Textbooks	
1	Randy Frank, "*Understanding Smart Sensors*", 3rd Edition, Artech House, 2013.	
2	Ananthasuresh G K, Vinoy K J, Gopalakrishnan S, Bhat K N, Aatre V K , "*Micro and Smart Systems"*, Wiley Publishers,2011.	
	References	
1	Subhas Chandra Mukhopadhyay , "Smart Sensors, measurement and Instrumentation", Springer Heidelberg, New York, 2013.	
2	Gerord C M Meijer , "Smart Sensor Systems", John Wiley and Sons, 2008..	
	Useful Links	

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1			3			
CO2			3			
CO3				3		
CO4				3		2

The strength of mapping is to be written as 1: Low, 2: Medium, 3: High
Each CO of the course must map to at least one PO.

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher’s assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

Syllabus Prepared By	Mr. A.B. Patil
Syllabus Checked By	

Walchand College of Engineering, Sangli *(Government Aided Autonomous Institute)*	
AY 2024-25	
Course Information	
Programme	M. Tech. Control and Instrumentation
Class, Semester	First Year M. Tech., Sem. I
Course Code	1CI516
Course Name	Professional Elective 2: Biomedical Instrumentation
Desired Requisites:	Basic Electronics, Digital Signal Processing, Instrumentation, and Measurement

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives	
1	To explain the basics body cell structure and different types of transducers
2	To explain the different types of patient monitoring system
3	Understand the design concept of different medical instruments
4	To demonstrate different medical instruments

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Apply knowledge of the CNS-PNS and Cardiopulmonary systems in clinical practice.	III	Applying
CO2	Apply the understanding of block diagrams to explain the operation of patient monitoring systems, X-ray machines, CT scans, and ultrasonography machines.	III	Applying
CO3	Select proper sensors for sensing biomedical signals to be applied to biomedical instrumentation setup	III	Applying
CO4	Design ECG, EEG and EMG amplifier	VI	Creating

Module	**Module Contents**	**Hours**
I	**Fundamentals of Medical Instrumentation** Physiological Systems of the body, Sources of Biomedical signals, Basic Medical Instrumentation system, Micro-Electro-Mechanical System (Mems), Wireless Connectivity in Medical Instruments, General Constraints in design of Medical Instrumentation Systems	7
II	**The Origin of Bio potentials, Bio potential Electrodes & Biosensors** Electrical activity of Excitable Cells, Functional Organization of the Peripheral Nervous System, Electrocardiogram (ECG), Electromyogram (EMG), Electroencephalogram (EEG), Electroretinogram (ERG) and their recording system, Biomedical signal Analysis and Processing Techniques.	7
III	**Patient Monitoring Systems** System Concepts, Cardiac Monitor, Bedside patient Monitoring Systems, Central Monitors, Measurement of Heart rate, Measurement of Temperature, Measurement of respiration Rate, Biomedical Telemetry Systems	6
IV	**Modern Imaging Systems** X-ray machines And Digital Radiography, X-ray Computed Tomography, Nuclear Medical Imaging Systems, Magnetic Resonance Imaging Systems, Ultrasonic Imaging Systems and Thermal Imaging Systems.	7

V	**Assisting and Therapeutic Equipment's** Cardiac Pacemakers, Defibrillators, Diathermy, Haemodialysis Machines, Ventilators	6
VI	**Laser Application in Biomedical Field** The Laser, Types of Lasers, Laser Application, Laser Safety	6
	Textbooks	
1	"Medical Instrumentation", John. G. Webster , John Wiley	
2	"Principles of Applied Biomedical Instrumentation", Goddes& Baker, John Wiley	
3	"Biomedical Instrumentation & Measurement", Carr & Brown, Pearson	
	References	
1	Hand book of Medical instruments by R.S. Khandpur –TMH, New Delhi, 1987.	
2	Medical Electronics and Instrumentation by Sanjay Guha – University Publication, 200.	
3	Introduction to Biomedical electronics by Edwand J. Bukstein –sane and Co. Inc, 1973	
	Useful Links	
1	https://www.coursera.org/specializations/biomedical-engineering	
2	https://nptel.ac.in/courses/102106457	

CO-PO Mapping						
	Programme Outcomes (POs)					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3					
CO2				3		
CO3	3					
CO4						3
The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High Each CO of the course must map to at least one PO.						

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

Semester- II
Professional Core Theory Courses

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2024-25

Course Information	
Programme	M. Tech. Control and Instrumentation
Class, Semester	First Year M. Tech., Sem. II
Course Code	1CI521
Course Name	Instrumentation System Design
Desired Requisites:	Process Instrumentation

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives	
1	To make students understand the overall view of instrumentation system and various processing blocks associated with instrumentation system.
2	Student should able to understand the use of various types of sensor.
3	Student should able to understand the signal processing required for instruments.
4	Student should able to design the instrumentation system to measure the process parameters.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Applying design specifications to meet accuracy and sampling speed requirements in systems.	III	Applying
CO2	Applying principles of operation for sensors like thermocouples, strain gauges (including Wheatstone bridge circuits), and chemical electrodes.	III	Applying
CO3	Evaluate of Instrumentation system for typical process industry.	V	Evaluating
CO4	Explain the principles of analog and digital signal and data processing, including amplifiers, filters and A-D conversion techniques.	VI	Creating

Module	**Module Contents**	**Hours**
I	**Introduction to Instrumentation system:** Introduction to instrumentation system design (ISD). Scope of ISD in process industry. General transducer design, selection of transducer general procedure for testing of transducer.	6
II	**Design of transducers:** Design of RTD, T/C, thermistor based temperature instrumentation, Design of LVDT strain gauges and piezo electric crystal based displacement instrumentation. Design of sensing elements such as resistive sensing elements, (Potentiometers), capacitive sensing elements (Variable separation, area and dielectric), Induction sensing element (eg. Variable reluctance), electromagnetic sensing element (e.g. velocity sensors), level instrumentation design.	7
III	**Design of signal conditioning elements:** Deflection bridges, amplifiers and AC carrier systems current transmitters, Oscillations and Resonation, analog to digital conversion, sampling, Quantization, encoding, signal processing calculations, steady state compensation, dynamic digital compensation and filtering.	6

IV	**Intrinsically safe measurement systems:** i) Pneumatic measurement system: Fapper Nozzle, relay, torque balance transmitters, transmission and data presentation. ii) Intrinsically safe Electronic systems: Zener barrier, Energy storage calculations.	6
V	**Instrumentation and Control system component Design:** Classification of instruments, indications, recorders, monitors, analysers, data loggers and controller selection of instruments, general design considerations. Control valve and their selections, pumps motors and transmission systems, design of control panels.	7
VI	**Process Industry Instrumentation:** Comparison of Pneumatic, hydraulic and Electrical electronic instrumentation systems and their selection for present process industry requirement. Project documentation, Specification sheet, Index sheet, flow diagrams, schedule used in typical process industry, testing, erection and commission of typical process industry.	7

	Textbooks
1	B. G. Liptak, Instrument Engineers Handbook, Vol. I and II, Third Edition, Chilton and Book Company, 1990.
2	D. M. Considine, Process/Industrial Instruments and Control Handbook, Fourth Edition, McGraw-Hill Inc., 1993
3	C. D. Johnson, Process Control Instrumentation Technology, Fourth Edition, PHI, 1996.
4	Andrew and Williams, Applied Instrumentation in Process Industries, Vol. I, II, III, IV Gulf Publishing Company, 1979.
	References
1	John P. Bentley, Principles of Measurement Systems, Addison-Wesley Publication, 1999.
2	T. R. Padmanabhan, Industrial Instrumentation: Principles and Design, Springer-Verlag Publication, 1999.
3	B. C. Nakra and K. K. Choudhari, Instrumentation: Measurement and Analysis, Tata McGraw Hill Pub, 1985.
	Useful Links
1	--

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1	2			2		
CO2	1		3			1
CO3	1			3		2
CO4	1			2		2

The strength of mapping is to be written as 1: Low, 2: Medium, 3: High
Each CO of the course must map to at least one PO.

Assessment

The assessment is based on MSE, ISE and ESE.
MSE shall be typically on modules 1 to 3.
ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.
ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.
For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

Syllabus Prepared By	Dr. D. S. More
Syllabus Checked By	

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2024-25

Course Information	
Programme	M. Tech. Control and Instrumentation
Class, Semester	First Year M. Tech., Sem. II
Course Code	1CI522
Course Name	Non-Linear System Analysis
Desired Requisites:	Linear Control Systems

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives	
1	To make students understand difference between Linear and Non-Linear Systems.
2	To make students familiar with features of Non-Linear Systems.
3	To develop skills in students for analyzing the behavior of Non-Linear Systems.
4	To develop skills in students for evaluating Non-Linear Systems.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Examine features of Non-Linear Systems.	III	Applying
CO2	Analyze the stability of Non-Linear Systems.	IV	Analyzing
CO3	Explain the behavior of Non-Linear Systems through various mathematical tools.	IV	Analyzing
CO4	Assess interconnection between Linear System and nonlinearities	V	Evaluating

Module	**Module Contents**	**Hours**
I	Nonlinear dynamical systems:- Introduction, Some features of nonlinear dynamical systems, First order systems, Second order system, Equilibrium points, Classification of equilibrium points.	6
II	Differential equation solution:- Lipschitz functions, Locally/Globally Lipschitz, Eexistence/Uniqueness of solutions, Cauchy sequence, Banach spaces, Bellman Gronwall inequality, Stability of equilibrium point, Stability in sense of Lyapunov, Asymptotic stability, Lyapunov's theorem on stability, Global asymptotic stability, Linear systems.	8
III	Advanced Stability theory:- Extension of Lyapunov's theorem in different context, Converse Lyapunov theorem, Instability theorem, Equilibrium sets, LaSalle's Invariance principle, Barbashin and Krasovskii's theorems.	5
IV	Periodic Orbits:- Bendixson criterion and Poincare-Bendixson criterion, Lotka predator prey model, Van-der-Pol oscillator, Linearization.	6
V	Interconnection between linear system and nonlinearities:- Signals, operators, Norm of signals, Finite gain L2 stable, Passive filters, Dissipation equality, Positive real lemma, Kalman Yakubovich-Popov theorem, Memoryless nonlinearities, Loop transformation, Circle criterion, Limit cycle, Popov criterion.	8

VI	Describing function:- Describing function method, jump hysteresis, sufficient condition for existence and nonexistence of periodic orbits, Describing function for nonlinearities, Ideal relay with hysteresis and dead zone.	6

Textbooks	
1	H.K.Khalil. Nonlinear systems Prentice Hall, 3rd Edition 2002.
2	Jean-Jacques E.Slotine & Weiping Li. Applied Nonlinear Control by Prentice Hall, 1991.
References	
1	Shankar Sastry, Nonlinear Systems: Analysis, Stability and Control, Springer, New-York, 1999.
2	M. Vidyasagar, Nonlinear Systems Analysis, Prentice-Hall, 1993.
Useful Links	
1	https://archive.nptel.ac.in/courses/108/101/108101002/

CO-PO Mapping

	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1	2					
CO2	1		2			
CO3	1			2		
CO4						

The strength of mapping is to be written as 1: Low, 2: Medium, 3: High
Each CO of the course must map to at least one PO.

Assessment

The assessment is based on MSE, ISE and ESE.
MSE shall be typically on modules 1 to 3.
ISE shall be taken throughout the semester in the form of teacher’s assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.
ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.
For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

Syllabus Prepared By	Mr. N. V. Patel
Syllabus Checked By	

Walchand College of Engineering, Sangli
(Government Aided Autonomous Institute)

AY 2024-25

Course Information

Programme	M. Tech. Control and Instrumentation
Class, Semester	First Year M. Tech. Control and Instrumentation, Sem. II
Course Code	1CI523
Course Name	Adaptive Control
Desired Requisites:	Linear Control

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs./week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives

1	To develop basic knowledge of Adaptive Control
2	To provide skills for Parameter Estimation and Observer design.
3	To impart skills for Self-Tuning Regulators and Adaptive Pole Placement Control
4	It will make students to study the Adaptive Control Of Deterministic Systems

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Apply the concepts of Adaptive Control	III	Applying
CO2	Apply Parameter Estimation and Observer design.	III	Applying
CO3	Implement the Self-Tuning Regulators and Adaptive Pole Placement Control	III	Applying
CO4	Implement the Adaptive Control Of Deterministic Systems	III	Applying

Module	**Module Contents**	**Hours**
I	**Adaptive Control** Introduction, Control System Design Steps, Robust Control gain Scheduling, Direct and Indirect Adaptive Control ,Model Reference Adaptive Control, Conventional techniques of identification , systems with dead time , ARMA process , Least squares techniques , Recursive Least Squares algorithms.	7
II	**On-Line Parameter Estimation** Introduction, Adaptive Laws with Normalization, Gradient Method , Least-Squares, Effect of Initial Conditions, Parameter Identifier, Adaptive Observers, The Luenberger Observer , Adaptive Luenberger Observer, Hybrid Adaptive Luenberger Observer	7
III	**Self-Tuning Regulators** Introduction, Pole placement design, indirect Self-Tuning Regulators, continuous time and direct Self-Tuning Regulators, disturbances with known characteristics, Adaptive Pole Placement Control.	7
IV	**Stochastic and Predictive Self-Tuning Regulators** Introduction, minimum variance, moving average controllers, linear quadratic STR, Adaptive predictive controller. Model Reference Adaptive Control	7

V	**Adaptive Control Of Deterministic Systems** Introduction, The MIT rule, Determination of adaptation gain, Minimum prediction error adaptive controls, Adaptive control of time varying systems, MRAC using Lyapunov method, BIBO Stability, Model free adaptive control, Applications of adaptive control.	7
VI	**Modern Adaptive Control Methods** Introduction, modern methods, neural network and fuzzy systems based adaptive control schemes.	4
Textbooks		
1	Karl J Astrom, Bjorn Wittenmark , "*Adaptive Control*", Pearson Education Inc, 2003.	
2	Arun K. Tangirala , "*Principles of System Identification: Theory and Practice*", CRC Press, 2014.	
References		
1	Anthony Zaknich,” *Principles of adaptive filters and self-learning systems”,* Springer London, Year: 2005	
2	Simon Haykin, ‘*Adaptive Filter Theory’*, Prentice Hall, 2010	
Useful Links		

CO-PO Mapping						
Programme Outcomes (PO)						
	1	2	3	4	5	6
CO1	2					
CO2	1	1				1
CO3	1			2		2
CO4	1			2		
The strength of mapping is to be written as 1: Low, 2: Medium, 3: High Each CO of the course must map to at least one PO.						

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher’s assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

Syllabus Prepared By	Mr. A.B. Patil
Syllabus Checked By	

Professional Core Laboratory Courses

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2024-25

Course Information

Programme	M. Tech. Control and Instrumentation
Class, Semester	First Year M. Tech., Sem. II
Course Code	1CI571
Course Name	Non-Linear System Analysis Lab
Desired Requisites:	Linear Control Systems

Teaching Scheme		**Examination Scheme (Marks)**			
Practical	2 Hrs/ Week	**LA1**	**LA2**	**Lab ESE**	**Total**
Interaction	-	30	30	40	100
		Credits: 1			

Course Objectives

1	To make students simulate Non-Linear Systems for analyzing its properties.
2	To develop skills in programming for determining stability of Non-Linear Systems.
3	To make students understand behaviour of the Non-Linear Systems by plotting phase plane diagram using simulation tools.
4	To make students understand the behavior of Periodic orbit through programming and simulation.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Demonstrate the properties of Non-Linear Systems using simulation.	III	Applying
CO2	Examine the behaviour of Non-Linear Systems by plotting phase plane diagram using simulation tools.	III	Applying
CO3	Analyze the stability of Non-Linear Systems using programming and simulation tools.	IV	Analyzing
CO4	Assess the behavior of periodic orbit using programming and simulation tools.	V	Evaluating

List of Experiments / Lab Activities/Topics

List of Lab Activities:

1. To simulate the effects of various non-linearities on linear system using MATLAB.
2. To simulate linear and non-linear differential equations using MATLAB.
3. To calculate equilibrium states of Non-Linear Systems using MATLAB.
4. To calculate linear model of Non-Linear Systems using MATLAB.
5. Constructing phase portrait of Linear System using MATLAB.
6. Constructing phase portrait of Non-Linear Systems using MATLAB.
7. Study of limit cycle using MATLAB Simulink.
8. Simulation of predicting limit cycle using describing function analysis.
9. Study of Cart mounted Inverted Pendulum system.
10. Stability analysis using MATLAB.
11. Coding for constructing phase portrait of Non-Linear Systems.

Textbooks

1	Jean-Jacques E.Slotine & Weiping Li. Applied Nonlinear Control by Prentice Hall, 1991.

References

1	H.K.Khalil Nonlinear systems 3rd Edition Prentice Hall, 2002.
2	Vukic, kuljaca, Donlagic, Nonlinear control systems by Marcel Dekker publisher, 2003

Useful Links

1	https://archive.nptel.ac.in/courses/108/101/108101002/

CO-PO Mapping

	Programme Outcomes (PO)												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3													
CO2	3	2												
CO3	2		2											
CO4				3										

The strength of mapping is to be written as 1,2,3; where, 1: Low, 2: Medium, 3: High
Each CO of the course must map to at least one PO, and preferably to only one PO.

Assessment

There are three components of lab assessment, LA1, LA2 and Lab ESE.
IMP: Lab ESE is a separate head of passing.(min 40 %), LA1+LA2 should be min 40%

Assessment	Based on	Conducted by	Typical Schedule	Marks
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 8 Marks Submission at the end of Week 8	30
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 9 to Week 16 Marks Submission at the end of Week 16	30
Lab ESE	Lab activities, journal/ performance	Lab Course Faculty and External Examiner as applicable	During Week 18 to Week 19 Marks Submission at the end of Week 19	40

Week 1 indicates starting week of a semester. Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming, and other suitable activities, as per the nature and requirement of the lab course. The experimental lab shall have typically 8-10 experiments and related activities if any.

Syllabus Prepared By	Mr. N.V. Patel
Syllabus Checked By	

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2024-25

Course Information	
Programme	First Year M. Tech. Control and Instrumentation
Class, Semester	First Year M. Tech. Control and Instrumentation, Sem. II
Course Code	1CI572
Course Name	Adaptive Control Lab
Desired Requisites:	Adaptive Control

Teaching Scheme		**Examination Scheme (Marks)**			
Practical	2 Hrs/ Week	**LA1**	**LA2**	**Lab ESE**	**Total**
Interaction	-	30	30	40	100
		Credits: 1			

Course Objectives	
1	To develop basic knowledge of Adaptive Control
2	To provide skills for Parameter Estimation and Observer design.
3	To impart skills for Self-Tuning Regulators and Adaptive Pole Placement Control
4	It will make students to study the Adaptive Control Of Deterministic Systems

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Apply the salient features of Adaptive Control	III	Applying
CO2	Apply Parameter Estimation and Observer design.	III	Applying
CO3	Implement Adaptive algorithm for Control.	III	Applying
CO4	Implement the Adaptive Control using modern algorithms.	III	Applying

List of Experiments / Lab Activities/Topics

List of Lab Activities:

Lab experiments based on simulation study as per following contents (minimum 8)-

1. Control system design using Matlab and Simulink model for closed loop performance.
2. Study of System identification using Matlab and Simulink.
3. Parameter identification using System identification toolbox.
4. Robust performance of system study.
5. Estimation and optimal performance algorithm study using Matlab and Simulink.
6. Steepest descent and LMS based adaptive algorithm Matlab and Simulink.
7. Study of Neuro-adaptive algorithm for control system design.
8. Case study for adaptive algorithm applications.

Textbooks

1	Karl J Astrom, Bjorn Wittenmark , "Adaptive Control", Pearson Education Inc, 2003.
2	Arun K. Tangirala , "Principles of System Identification: Theory and Practice", CRC Press, 2014.

References

1	Anthony Zaknich," Principles of adaptive filters and self-learning systems", Springer London, Year: 2005
2	Simon Haykin, 'Adaptive Filter Theory', Prentice Hall, 2010

Useful Links

CO-PO Mapping														
	Programme Outcomes (PO)												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1			3											
CO2					3									
CO3					3									
CO4			3											2
The strength of mapping is to be written as 1,2,3; where, 1: Low, 2: Medium, 3: High Each CO of the course must map to at least one PO, and preferably to only one PO.														

Assessment				
There are three components of lab assessment, LA1, LA2 and Lab ESE. IMP: Lab ESE is a separate head of passing.(min 40 %), LA1+LA2 should be min 40%				
Assessment	**Based on**	**Conducted by**	**Typical Schedule**	**Marks**
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 8 Marks Submission at the end of Week 8	30
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 9 to Week 16 Marks Submission at the end of Week 16	30
Lab ESE	Lab activities, journal/ performance	Lab Course Faculty and External Examiner as applicable	During Week 18 to Week 19 Marks Submission at the end of Week 19	40
Week 1 indicates starting week of a semester. Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming, and other suitable activities, as per the nature and requirement of the lab course. The experimental lab shall have typically 8-10 experiments and related activities if any.				

Syllabus Prepared By	Mr. A.B. Patil
Syllabus Checked By	

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2023-24

Course Information	
Programme	M. Tech. Control and Instrumentation
Class, Semester	First Year M. Tech., Sem. II
Course Code	1CI545
Course Name	Seminar
Desired Requisites:	Control System Engineering

Teaching Scheme		Examination Scheme (Marks)			
Practical	2 Hrs/ Week	**LA1**	**LA2**	**Lab ESE**	**Total**
Interaction	--	30	30	40	100
		Credits: 1			

Course Objectives	
1	To understand industrial problems.
2	To suggest engineering solutions to the defined problem.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	Course Outcome Statement/s	Bloom's Taxonomy Level	Bloom's Taxonomy Description
CO1	Chose, Formulate a clear problem.	III	Applying
CO2	Select and apply appropriate engineering methods and toolsfor solving the problem.	VI	Creating
CO3	Develop the project and its results following an establishedproject methodology.	V	Evaluating
CO4	Present the project results.	IV	Analyzing

List of Experiments / Lab Activities/Topics

List of Lab Activities:

The Industry project will involve the selection of appropriate real time industry problem by understanding the working of particular industry application. Formulate the problem, select design and methodology to find the solution. Construct an electrical system by using appropriate hardware software tools. Each student should conceive, design and develop the idea leading to a project/product. The student should submit a soft bound report at the end of the semester. The final product as a result of Industry project should be demonstrated in phases at the time of examination.

This will help student to understand structured management in industry, sustainable development, with consideration to both scientific and ethical aspects and its presentation with technical report.

Textbooks	
1	To be used based on selected project

References	
1	Industry 4.0 : fourth Industrial Revolution guide to Industry 4.0

Useful Links	
1	

CO-PO Mapping						
	Programme Outcomes (POs)					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2				
CO2				2		2
CO3			2			
CO4				3		
The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High Each CO of the course must map to at least one PO.						

Assessment				
There are three components of lab assessment, LA1, LA2 and Lab ESE. IMP: Lab ESE is a separate head of passing.(min 40 %), LA1+LA2 should be min 40%				
Assessment	**Based on**	**Conducted by**	**Typical Schedule**	**Marks**
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 8 Marks Submission at the end of Week 8	30
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 9 to Week 16 Marks Submission at the end of Week 16	30
Lab ESE	Lab activities, journal/ performance	Lab Course Faculty and External Examiner as applicable	During Week 18 to Week 19 Marks Submission at the end of Week 19	40
Week 1 indicates starting week of a semester. Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming, and other suitable activities, as per the nature and requirement of the lab course. The experimental lab shall have typically 8-10 experiments and related activities if any.				

Professional Elective Theory Courses

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2023-24

Course Information	
Programme	M. Tech. Control and Instrumentation
Class, Semester	First Year M. Tech., Sem. I
Course Code	1CI531
Course Name	Professional Elective 3: Modern Power Electronics
Desired Requisites:	Power Electronics

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives	
1	It is aimed to impart skills of analysis for different types of advanced converters and shunt active power filters.
2	Make the students acquainted with control strategies of different types of advanced converters and shunt active power filters.
3	To make the students aware of research avenues in the field of power electronics.
4	To make the students aware of the recent advances in power electronics and their use in industrial applications

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Interpret configuration and working of various Power Electronic converters.	III	Applying
CO2	Analyse different advanced power electronic converters and systems.	IV	Analyzing
CO3	Evaluate various power electronic systems using power electronic converters.	V	Evaluating
CO4	Design active power filters using advanced power electronic systems for power quality improvement.	VI	Creating

Module	**Module Contents**	**Hours**
I	**PWM rectifiers** Advantages & disadvantages of three phase thyristor converter, Single phase and three phase VSI PWM converters working, types, Control of PWM rectifiers, analysis and application. Three phase CSI PWM converter, control and applications.	6
II	**Multilevel inverters** Three phase two level Voltage source inverter, various PWM methods, Multilevel Voltage source inverter, Types: Diode clamp multilevel inverter, flying capacitor multilevel inverter, cascaded multilevel inverter, applications of multilevel inverters, comparison of multilevel inverter. Control method: Multiple carrier PWM for MLI	7

III	**Resonant pulse inverters** Series resonant inverter with unidirectional and bi-directional switches, parallel resonant inverters, voltage control of resonant inverters, zero current and zero voltage switching resonant converters, two-quadrant ZVS resonant converters, resonant DC link inverters and control technique.	6
IV	**Photovoltaic Inverters** Photovoltaic Inverters structures derived from H bridge topology such as H5 inverter, Heric inverter, REFU inverter, full bridge inverter with DC bypass, inverter structures derived from NPC topology such as neutral point clamped half bridge inverter, co-energy NPC inverter, three phase PV inverter.	7
V	**Matrix Converters and Z source inverters** Topology, working and control methods of Matrix converters, Various circuit topologies and control of Z source inverter, Application of Z source in induction motor control.	7
VI	**Active power filters** Power Quality Issues due to power Electronics, Introduction to active power filter, types of active power filters overall control of shunt active power filter, control of shunt active filter based on SRF theory. Control of shunt active filter based on instantaneous power theory. Harmonic compensation & reactive power compensation.	6

Textbooks

1	M. H. Rashid, "Power Electronics: circuits devices and applications", Pearson Education, Third edition.

References

1	B. K. Bose, "*Modern Power Electronics and AC drives*", PHIPL, New Delhi.
2	M. B. Patil, V. Ramayanan and V. T. Ranganathan, "*Simulation of Power Electronics circuits*", Narosa publication.
3	Remus Teodorescu, Marco Liserre and Pedro Rodrigues, "*Grid- Converters for Photovoltaic and Wind Power Converters*", A john Wiley and sons Ltd., first edition 2011.
4	IEEE Transaction papers.

Useful Links

1	https://onlinecourses.nptel.ac.in/noc20_ee28/

CO-PO Mapping

	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1	1		1			
CO2	1	2		1		2
CO3	1	2	2	2		2
CO4				2		1

The strength of mapping is to be written as 1: Low, 2: Medium, 3: High
Each CO of the course must map to at least one PO.

Assessment

The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

Syllabus Prepared By	Dr. D. S. More
Syllabus Checked By	

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2024-25

Course Information

Programme	M. Tech. Control and Instrumentation
Class, Semester	First Year M. Tech., Sem. II
Course Code	1CI532
Course Name	Professional Elective 3: Electric Vehicle Technology
Desired Requisites:	Linear Control Systems, Power Electronics

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives

1	To develop basic knowledge related to architecture of Electric Vehicles.
2	To provide knowledge related to design aspects and dynamics of Electric Vehicles.
3	The course aims at enabling students to understand the motor specifications and charging standards for Electric vehicles.
4	To course aims at enabling students to interpret the design aspects of power converters, electric motors used in Electric vehicles

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Examine the architecture and features of Electric Vehicles	III	Applying
CO2	Illustrate various topologies of Electric vehicles for different design considerations	III	Applying
CO3	Compute the vehicle dynamics for Electric vehicle systems	III	Applying
CO4	Evaluate the performance of control techniques for drive systems used in electric vehicle applications	V	Evaluating

Module	**Module Contents**	**Hours**
I	**Introduction to Electric Vehicles** Background of Electric Vehicles, Electric Vehicle System, Components of Electric Vehicles, Advantages of Electric Vehicles, Efficiency, Pollution Comparison with conventional vehicles, Fundamentals of Electric Vehicles	6
II	**Types of Electric Vehicles and Architecture of EVs** Concept of Electric, Hybrid and Plug-in Electric Vehicles, Typical configuration of Hybrid Electric Vehicle, Topologies of HEVs: Series, Parallel and Series-Parallel Configuration, Topologies of Plug-in Hybrid Electric Vehicles, Fuel Cell Electric Vehicles, Solar Powered Electric Vehicles	7
III	**Design Considerations for Electric Vehicles** Introduction to EV design fundamentals, Aerodynamic Consideration, Rolling resistance, Transmission efficiency, Consideration of vehicle mass, Basics of Electric vehicle chassis and body design, general issues in Electric vehicle design	7
IV	**Vehicle Dynamics** Roadway fundamentals, Vehicle Kinetics, Dynamics of Vehicle Motion, Propulsion power: Force velocity characteristics, Vehicle gradability, Velocity and Acceleration: Velocity Profile, Distance traversed, tractive power, Energy Required, Propulsion System Design for EV systems	7

V	**Electric Vehicle Drives and Control Techniques** Characteristics of ac electrical machines used in hybrid and pure electric vehicles, Induction motors and their optimization for EV applications, Permanent motor drives and their optimization for EV applications, Voltage control of DC- AC Converters using PWM for EV systems	6
VI	**Electric Vehicle Chargers and Charging Standards** EV charging: requirements and Classification, Charging standards for Electric vehicles, Introduction to AC and DC chargers for EV systems, Working of Electric Vehicle Supply Equipment (EVSE), Fast Chargers for EV systems	6

Textbooks	
1	Iqbal Husain ,‘ Electric and Hybrid Vehicles: Design Fundamentals ’, CRC Press, 2003.
2	James Larminie, John Lowry, “ Electric Vehicle Technology Explained”, Wiley , 2nd edition, 2012
References	
1	Sheldon Williamson, ‘ Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles ’, Springer-Verlag, 2012
2	M. Ehsani, Y. Gao, S. Gay and A. Emadi , Modern Electric, Hybrid Electric, and Fuel Cell Vehicles, CRC Press, 2005.
3	William H. Bolton, Programmable logic controllers, Newnes , Edition VI, 2006.
Useful Links	
1	https://nptel.ac.in/courses/108/103/108103009/
2	https://nptel.ac.in/courses/108/102/108102121/
3	https://nptel.ac.in/courses/108/106/108106170/

CO-PO Mapping

	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1			3			
CO2				3		3
CO3				3		
CO4			3			

Assessment

The assessment is based on MSE, ISE and ESE.
MSE shall be typically on modules 1 to 3.
ISE shall be taken throughout the semester in the form of teacher’s assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.
ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.
For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

Syllabus Prepared By	Dr. S. S. Karvekar
Syllabus Checked By	

Walchand College of Engineering, Sangli *(Government Aided Autonomous Institute)*	
AY 2023-24	
Course Information	
Programme	M. Tech. Control and Instrumentation
Class, Semester	First Year M. Tech., Sem. II
Course Code	1CI533
Course Name	Professional Elective 3: Optimal Control
Desired Requisites:	Control System Engineering

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives	
1	To provide the basic concepts of optimal control.
2	To provide the methodology of designing LQR and LQT optimal control.
3	To give the overview of optimization in constrained and non-constrained controls.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Apply various concepts of optimal control.	III	Applying
CO2	Analyze the systems using LQR and LQT optimal control.	IV	Analyzing
CO3	Design of optimal control in constrained and non-constrained systems.	VI	Creating
CO4	Implement optimal control algorithms in simulation and real-world applications	VI	Creating

Module	**Module Contents**	**Hours**
I	**Introduction to Optimal Control** Classical and Modern Control, Optimization, Optimal Control, Plant, Performance Index, Constraints, Calculus of Variations.	7
II	**Calculus of Variations and Optimal Control** Optimum of a Function and a Functional , Basic Variational Problem, Fixed-End Time and Fixed-End State System , Euler-Lagrange Equation ,Different Cases for Euler-Lagrange Equation ,The Second Variation, Extrema of Functions with Conditions ,Direct Method ,Lagrange Multiplier Method ,Extrema of Functionals with Conditions , Terminal Cost Problem.	6
III	**Linear Quadratic Optimal Control Systems** Finite-Time Linear Quadratic Regulator, Riccati Coefficient, Finite-Time Linear Quadratic Regulator: Time-Varying Case, Infinite-Time LQR System.	6
IV	**Linear Quadratic Tracking System** Linear Quadratic Tracking System: Finite-Time Case, LQT System: Infinite-Time Case, Fixed-End-Point Regulator System And Frequency-Domain Interpretation.	7
V	**Constrained Optimal Control Systems** Time-Optimal Control of LTI System, Solution of the TOC System, TOC of a Double Integral System, Fuel-Optimal Control Systems, Energy-Optimal Control Systems. Optimal Control Systems with State Constraints.	6

VI	**Pontryagin Minimum Principle** Constrained System, Pontryagin Minimum Principle, The Hamilton-Jacobi-Bellman Equation, LQR System Using H-J-B Equation.	7

Textbooks	
1	“Optimal Control Systems”, by D.S.Naidu, CRC Press, 2002.
References	
1	*“Optimal Control”,* by Frank L Lewis, John Wiley, New York, 1986.
2	*“Optimal Control Theory*”, by Kirk D.E, Dover Publications, 2004.
Useful Links	
1	https://onlinecourses.nptel.ac.in/noc21_ee48/preview

CO-PO Mapping						
	Programme Outcomes (POs)					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2		3			
CO2	2	2				
CO3	2		2			1
CO4	2		2	2		2
The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High Each CO of the course must map to at least one PO.						

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher’s assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

Walchand College of Engineering, Sangli *(Government Aided Autonomous Institute)*	
AY 2024-25	
Course Information	
Programme	M. Tech. Control and Instrumentation
Class, Semester	First Year M. Tech., Sem. II
Course Code	1CI534
Course Name	Professional Elective 4: Power Plant Instrumentation
Desired Requisites:	-

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs./week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives	
1	To develop basic knowledge of power plant and power generation.
2	To provide skills for measurements in power plants:
3	To make students to study analyzers in power plants.
4	It will make students to study control loops in power plant instrumentation

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Apply the salient features of power plant and power generation.	III	Applying
CO2	Apply measurements in power plants	III	Applying
CO3	Implement the analyzers in power plants.	III	Applying
CO4	Implement the control loops in power plant instrumentation	III	Applying

Module	**Module Contents**	**Hours**
I	**Power Generation** Methods of power generation: Hydro, Thermal, Nuclear, Solar and Wind power, Ocean Energy System, Geothermal Energy, and Energy from Bio mass. Building Blocks of Thermal power plant - Combined Cycle System – Combined Heat and Power System: Sub Critical and Supercritical boilers – Operating Pressure and Temperature ranges – Overview of Instrumentation System in Thermal power plant.	7
II	**Measurements In Power Plants** Measurement of feed water flow, Fuel flow, Airflow and Steam flow with correction factor - Steam pressure and temperature measurement- Turbine speed and vibration measurement.	7
III	**Analyzers In Power Plants** Analysis of impurities in feed water and steam: Dissolved oxygen analyzer, Chromatography pH meter, Fuel analyser, Flue gas oxygen analyser, Pollution monitoring instruments, SOX and NOX measurements.	6

IV	**Control Loops In Boiler** Combustion control , Air/fuel ratio control , Furnace draft control ,Main steam and reheat steam temperature control , Super heater control, Distributed control system in power plants , Interlocks in boiler operation	7
V	**Nuclear Power Plant Instrumentation** Different types of Nuclear power plant, Nuclear reactor control loops, Reactor dynamics, Control and Safety instrumentation, Reliability aspects	7
VI	**Computer Based Process Control** Data loggers - Data Acquisition Systems (DAS) ,Supervisory Control and Data Acquisition Systems (SCADA),Hardware and software, Remote terminal units, Master station, communication architectures.	5

	Textbooks
1	David Lindsley, "*Power Plant Control and Instrumentation*", Institution of Electrical Engineers, London, 2000.
2	Sam G Dukelow, "*The Control of Boilers*", 2nd Edition, Instrument Society of America, 1991.
	References
1	Elonka S M, Kohal A L , "*Standard Boiler Operations*", McGraw Hill, New Delhi, 1994.
2	Bela G Liptak , "*Process Measurement and Analysis*", Vol. 1, CRC press, 2003.
	Useful Links

CO-PO Mapping

	Programme Outcomes (POs)					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3					
CO2		3				
CO3			2			
CO4				2		

The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High
Each CO of the course must map to at least one PO.

Assessment

The assessment is based on MSE, ISE and ESE.
MSE shall be typically on modules 1 to 3.
ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.
ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.
For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

Syllabus Prepared By	Mr. A.B. Patil
Syllabus Checked By	

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2024-25

Course Information	
Programme	M. Tech. Control and Instrumentation
Class, Semester	First Year M. Tech., Sem. II
Course Code	1CI535
Course Name	Professional Elective 4: Artificial Intelligence and Machine Learning
Desired Requisites:	Strong mathematical background, knowledge of data structures and algorithms, and familiarity with probability, statistics, and linear algebra.

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives	
1	Understand Artificial Intelligence and its approaches.
2	Solving some problems using supervised, unsupervised, and semi supervised machine learning algorithm.
3	Study of probabilistic analysis, parametric and non-parametric algorithms.
4	Estimation of Maximum Likelihood, losses, and risks for classifications problems.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Apply AI principles, approaches, and methodologies, including supervised, unsupervised, and semi-supervised learning algorithms, to solve real-world problems.	III	Applying
CO2	Apply supervised, unsupervised, and semi-supervised machine learning algorithms to solve diverse problem sets effectively.	III	Applying
CO3	Analyze and compare probabilistic analysis techniques, parametric, and non-parametric algorithms in the context of machine learning.	IV	Analyzing
CO4	Evaluate the estimation of Maximum Likelihood, losses, and risks for classification problems, and propose appropriate strategies to mitigate them.	V	Evaluating

Module	**Module Contents**	**Hours**
I	**Introduction to Artificial Intelligence** Artificial Intelligence – Introduction, Intelligent Agents, Problem-solving, Solving Problems by Searching, Informed Search and Exploration, Constraint Satisfaction Problems, Adversarial Search.	7
II	**Knowledge Representation and Reasoning** Knowledge and reasoning, Logical Agents, First-Order Logic, Inference in First-Order Logic, Knowledge Representation.	7
III	**Planning and Decision Making** Planning, Planning and Acting in the Real World, Uncertain knowledge and reasoning, Uncertainty, Probabilistic Reasoning, Probabilistic Reasoning over Time, Making Simple Decisions, Making Complex Decisions.	6
IV	**Introduction to Machine Learning** Introduction to Machine Learning, Applications of ML, Design Perspective and Issues in ML, Supervised Learning, Unsupervised Learning, Semi-supervised Learning with applications and issues.	7

V	**Data Pre-processing and Representation** Input: Concepts, instances, and attributes, Output: Knowledge Representation Decision tables, Decision trees, Decision rules, Rules involving relations. Instance-based representation, Data Pre-processing: Data cleaning, integration, transformation, reduction, discretization, and concept hierarchy generation.	6
VI	**Classification and Evaluation** Introduction to Classification, Classification, Diagnostic, Accuracy and Error Measures, Decision Tree, Probabilistic Classifier, Clustering: Unsupervised Learning Technique, Similarity and Distance Measures, k-means and k-medoids Algorithm, Optimization Objective, Random Initialization, Choosing Value of k, EM Algorithm	

Textbooks	
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
References	
1	K.P. Soman, R. Longonathan and V. Vijay, ―Machine Learning with SVM and Other Kernel Methods‖, PHI
2	Christopher M. Bishop, ―Pattern Recognition and Machine Learning‖, Springer 2006.
3	Tom M. Mitchell , ―Machine Learning‖, McGraw-Hill, 1997
4	The Elements of Statistical Learning - by T. Hastie, R. Tibshirani, and J. Friedman, 2009
Useful Links	
1	https://www.coursera.org/learn/machine-learning
2	https://www.coursera.org/learn/ai-for-everyone

CO-PO Mapping

	Programme Outcomes (POs)					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1		1				
CO2	2		2	2		
CO3	2		3	2		
CO4				3		

The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High
Each CO of the course must map to at least one PO.

Assessment

The assessment is based on MSE, ISE and ESE.
MSE shall be typically on modules 1 to 3.
ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.
ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.
For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2024-25

Course Information	
Programme	M. Tech. Control and Instrumentation
Class, Semester	First Year M. Tech., Sem. II
Course Code	1CI536
Course Name	Professional Elective 4: Measurement Data Analytics
Desired Requisites:	Measurement principles in engineering

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives	
1	Provide a solid foundation in measurement and statistical concepts.
2	Equip students with techniques to evaluate and analyze measurement data.
3	Teach error propagation methods and uncertainty analysis in measurements.
4	Introduce parameter estimation and data visualization techniques.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Apply key measurement and statistical terms in the analysis and interpretation of data.	III	Applying
CO2	Evaluate validity, compare data sets, and conduct variance analysis.	V	Evaluating
CO3	Propagate errors, perform error analysis, and calculate uncertainties.	IV	Analyzing
CO4	Conduct regressions, interpret results, and utilize data visualization techniques.	VI	Creating

Module	**Module Contents**	**Hours**
I	**INTRODUCTION** Terms pertaining to quantity - Measurement and statistics - Instruments and standards Distribution function	7
II	**EVALUATION OF MEASUREMENT DATA** Evaluation of validity of extreme values of measurement results - Evaluation of the means obtained from two sets of measurement results - Comparison of variances of two sets of measurement results - Measurements concerning travelling standards - F-test for internal and external consistency - Standard error of the overall mean - Analysis of variance - Tests for uniformity of variances	7
III	**ERROR PROPAGATION** Propagating the error in a single-variable function - Propagating the error through a multi- variable function - Experimental strategy based on error analysis - Combined experiments - The weighted mean	6
IV	**UNCERTAINTY IN CALIBRATION OF ELECTRICAL INSTRUMENTS** Uncertainty in calibration of RF power sensor – Uncertainty in calibration of a Digital Instrument - Uncertainty calculation for correlated input quantities - Vector Measurands. Least- squares fitting with uncertainties in both variables - More complex error surfaces - Monte Carlo methods – Bootstrap methods	7
V	**ESTIMATION OF PARAMETERS** Simple Linear Regression - Multiple Linear Regression - Interpretation of regression coefficients - Visualizations - Visual Data Analysis techniques - Interaction techniques - Systems and applications	6

VI	**PRACTICAL APPLICATION** Integration of measurement data analytics concepts in real-world scenarios. Case study analysis.	6

Textbooks	
1	Semyon G. Rabinovich , "Measurement Errors and Uncertainities – Theory and Practice", 3rd Edition, Springer Publication, 2005.
2	S.V. Gupta , "Measurement Uncertainties: Physical Parameters and Calibration of Instruments", Springer Publication, 2012.
3	Ifan Hughes, Thomas Hase , "Measurements and Their Uncertainties: A Practical Guide to Modern Error Analysis", Oxford University Press, 2010.
References	
1	Michael, Grabe , "Measurement Uncertainties in Science and Technology", 2nd Edition, Springer Publication, 2014.
2	Patrick F. Dunn , "Measurement and Data Analysis for Engineering and Science", 2nd Edition, CRC Press, 2010.
3	Hugh W. Coleman, W. Glenn Steele , "Experimentation, Validation, and Uncertainty Analysis for Engineers", 4th Edition,
Useful Links	
1	

CO-PO Mapping

	Programme Outcomes (POs)					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2		3			
CO2		2	3	2		
CO3				2		
CO4		3		2		3

The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High
Each CO of the course must map to at least one PO.

Assessment

The assessment is based on MSE, ISE and ESE.
MSE shall be typically on modules 1 to 3.
ISE shall be taken throughout the semester in the form of teacher’s assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.
ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.
For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

Open Elective

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2023-24

Course Information

Programme	M. Tech. Control and Instrumentation
Class, Semester	First Year M. Tech., Sem. II
Course Code	7OE506
Course Name	Open Elective: Electrical Drives and Applications
Desired Requisites:	

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	--	30	20	50	100
		Credits: 3			

Course Objectives

1	To make students understand concept of fundamental knowledge in dynamics and control of Electric Drives.
2	To strengthen control principles of various DC and AC motors using solid state converters.
3	To cover principles of selection of Electric Motors and highlights the applications of Electrical Drives.
4	Update the modern control trends in the field of electrical drives.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Apply fundamental concepts in Electric drives.	III	Applying
CO2	Apply the control techniques for Electric drives for speed control.	III	Applying
CO3	Analyze the performance of various control techniques used in speed control of electric drives.	IV	Analyzing
CO4	Recommend the drives system for a particular application.	V	Evaluating

Module	**Module Contents**	**Hours**
I	**Fundamentals of Electric Drives** Types & parts of the Electrical drives, Selection criteria of drives, motor rating, selection based on duty cycle, selection of converter rating, fundamental torque equation, speed torques characteristics DC motor & Induction motor, multi quadrant operation of the drive, classification of mechanical load torques, steady state stability of the drive, constant torque and constant HP operation of the drive, closed loop speed control.	7
II	**Power Converters for Electrical Drives** Single phase and three phase rectifiers, Single phase and three phase thyristorised converters, Control and performance of thyristorised converters, Single phase and three phase voltage source inverters and their control.	7
III	**DC Motor Drives** Methods of speed control, starting and braking operation, single phase and three phases full controlled and half controlled converter fed DC drives, Multi quadrant operation of separately excited DC shunt motor, dual converter fed DC drives, circulating and non – circulating mode of operation, converter fed DC series motor drive, chopper control of DC shunt and series motor drives, four quadrant operation of chopper fed DC shunt motor drive.	7

IV	**Induction Motor Drives** Torque equation, Speed control methods for three phase cage induction motor, braking methods, stator voltage control induction motor drive, VSI fed induction motor drive, constant torque (constant E/F and constant V/F), constant HP operation, closed loop speed control block diagram, Various methods of speed control for slip ring induction motors.	6
V	**Synchronous Motor Drives and Brushless DC Motor Drives** VSI fed synchronous motor drives, true synchronous and self-control mode, open loop and closed loop speed control of Permanent magnet synchronous machine, brushless DC motor drives.	6
VI	**Special Drives** Construction and operating principle of switched reluctance motors, Current / Voltage control, torque equation, converter circuits, operating modes and applications of switched reluctance motors. Solar panel VI characteristics, solar powered pump, maximum power point tracking and battery-operated vehicles.	6

Textbooks	
1	G. K. Dubey, *"Fundamentals of Electrical Drives*", Narosa publication, 2nd edition, 2002.
References	
1	*"Fundamentals of Electrical Drives",* NPTEL video lecture series by Prof. Shyama Prasad Das, Department of Electrical Engineering, IIT Kanpur.
2	"*Power Electronics – Converter Application",* By N. Mohan T.M. Undel and W. P. Robbins, John Wiely and sons.
3	"*Electrical Drives – Concept and application*", Vedam Subramanyam.
Useful Links	
1	https://nptel.ac.in/courses/108/104/108104140/

CO-PO Mapping						
Programme Outcomes (PO)						
	1	2	3	4	5	6
CO1			3			
CO2				3		
CO3	3					
CO4				3		

The strength of mapping is to be written as 1: Low, 2: Medium, 3: High
Each CO of the course must map to at least one PO.

Assessment

The assessment is based on MSE, ISE and ESE.
MSE shall be typically on modules 1 to 3.
ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.
ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.
For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

Syllabus Prepared By	Dr. D. S. More
Syllabus Checked By	