SEM III

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2024-25

Course Information

Programme	M. Tech. (Control System Engineering)
Class, Semester	Second Year M. Tech., Sem III
Course Code	7CS691
Course Name	Dissertation Phase - I
Desired Requisites:	

Teaching Scheme		**Examination Scheme (Marks)**			
Practical	20 Hrs/ Week	**LA1**	**LA2**	**Lab ESE**	**Total**
Interaction	-	30	30	40	100
		Credits: 12			

Course Objectives

1	The M. Tech. Dissertation is aimed at training the students to analyze independently any problem in the field of Electrical Control Systems Engineering and applications of control theory. The Dissertation may be analytical, computational, experimental or a combination of three. The Dissertation report is expected to show clarity of thoughts and expression, critical appreciation of the existing literature and analytical, experimental, computational aptitude. The student progress of the dissertation work shall be evaluated in stage I and II in semester III and in stage III and IV in semester IV.

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	**Defend** the objectives of the dissertation by grasping and **analyzing** through an extensive literature review in the area of study.	IV V	Analyzing Evaluating
CO2	**Formulate** the methodology and **Execute** the study through conduct of analytical/Experimental work to achieve the objectives.	III VI	Applying Creating
CO3	**Analyze, interpret and critique** the findings of the study.	III IV V	Applying Analyzing Evaluating
CO4	**Defend** the outcomes of the dissertation through self-learning and **justify** the project work as per appropriate standards of documentation and presentation.	V	Evaluating

List of Experiments / Lab Activities/Topics

Course Contents:

The third semester is completely devoted to dissertation work which is defined based on the interest of the students to specialize in a particular area.

Student is expected to carry out independent research work on the chosen topic. In this semester it is expected that the student has carried out substantial research work including exhaustive literature survey, formulation of the research problem, development/fabrication of experimental set-up (if any/required) and testing, and analysis of initial results thus obtained. In fourth semester, the student continues his/her dissertation work. It is expected that the student has completed most of the experimental/computation works and analyzed the results so obtained as proposed in the synopsis. The work should be completed in all respects in this semester. The student is required to submit the dissertation work in the form of report as per the institute rule.

Textbooks

References

1	Proceedings of Reputed National and International journals in Control Systems (Electrical Engineering) [a. IEEE Transactions on – Automatic control systems, Power Electronics, Circuits and systems, Control systems technology, Automatic Control etc. b. IEEE magazines/ newsletters/ proceedings on- Control systems, Industrial electronics magazine, etc. c. IET Proceedings/ journals/ magazines on – Control Theory and Control Systems etc. d. Elsevier journals and magazines on- Electrical and Electronics Engineering, Circuits and systems, Advance process control, Dynamics and control etc. e. Journal of Institution of Engineers India- Electrical Engineering f. The Journal of the Institute of Electrical Engineers of Japan, g. Circuits, Systems & Signal Processing –Springer, h. Energy Efficiency – Springer i. Mathematics of Control, Signals, and Systems – Springer j. Soft Computing– Springer k. An International Journal for Simulation-Based Engineering – Springer l. Journal of Control Theory and Applications –Springer m. Journal of Dynamical and Control Systems – Springer Proceedings of Reputed International Conferences organized by IFAC, IEEE in association with IITs and NITs, Elsevier and Springer conferences and IET conferences.
Useful Links	
1	

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

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 Courses (NPTEL/SWAYAM)

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2024-25

Course Information

Programme	M.Tech Comtrol System Engineering
Class, Semester	S.Y. Mtech, Sem- IV
Course Code	7CS611
Course Name	Solar Energy Engineering and Technology
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 understand fundamentals of solar PV energy.
2	To explain solar collector and grid connections of solar energy.
3	To analyse the performance of solar energy.
4	To understand thermal energy storage.

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	Identify the fundamentals of solar PV energy.	III	Applying
CO2	Select grid connections of solar PV system.	III	Applying
CO3	Analyse the performance of solar energy.	IV	Analysing
CO4	Analyse the thermal energy storage and emerging technologies.	IV	Analysing

Module	Module Contents	Hours
I	**Overview of solar energy:** Energy Scenario, overview of solar energy conversion devices and applications, physics of propagation of solar radiation from the sun to earth, Sun-Earth Geometry, Extra-Terrestrial and Terrestrial Radiation, Solar energy measuring instruments.	6
II	**Fundamentals of solar PV cells:** Estimation of solar radiation under different climatic conditions, Estimation of total radiation, Fundamentals of solar PV cells, principles and performance analysis, modules, arrays, theoretical maximum power generation from PV cells.	7
III	**Components of grid-connected PV system:** PV standalone system components, Standalone PV-system design, Components of grid-connected PV system, solar power plant design and performance analysis.	7
IV	**Solar collectors:** Fundamentals of solar collectors, Snails law, Bougers law, Physical significance of Transmissivity – absorptivity product, Performance anlaysis of Liquid flat plate collectors and testing.	7
V	**Performance analysis** of Solar Air heaters and testing, Solar thermal power generation (Solar concentrators).	6
VI	**Thermal Energy Storage** (sensible, latent and thermochemical) and solar pond Applications: Solar Refrigeration, Passive architecture, solar distillation, and emerging technologies.	6

Textbooks

1	G. N. Tiwari, Solar Energy, Fundamentals, Design, Modeling and Applications, Narosa, 2002.
2	C. S. Solanki, Solar Photovoltaics: Fundamentals, Technologies and Applications, Prentice Hall India, 2nd Edition, 2011.
3	T. C. Kandpal and H.P. Garg, Financial Evaluation of Renewable Energy Technologies, McMillan India Ltd., 2013

References

1	S. P. Sukhatme and J. K. Nayak, Solar Energy: Principles of Thermal Collection and Storage, Tata McGraw Hill, 2006.
2	J. A. Duffie and W. A. Beckman, Solar Engineering of Thermal Processes, John Wiley, 2006.
3	K. Jager, O. Isabella, A. H. M. Smets, R.A.C.M.M. Van Swaaij, and M. Zeman, Solar Energy – fundamentals, technology and systems, Delft University of Technology, 2014
Useful Links	
1	https://onlinecourses.nptel.ac.in/noc24_ge51/preview

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1	3	2				
CO2	3	2				
CO3	3	2				
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	Dr. Swapnil D. Patil
Syllabus Checked By	

Walchand College of Engineering, Sangli

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AY 2024-25

Course Information

Programme	M. Tech. Control System Engineering
Class, Semester	Second Year M. Tech., Sem. III
Course Code	7CS612
Course Name	Sustainable Power Generation Systems
Desired Requisites:	Power 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 familiarize a student with the basics of electrical engineering that are essential for better understanding on how to integrate Renewable energy sources and operate and model the power network.
2	To make students familiar with the basics of most clean and renewable energy technologies
3	To understand the concepts of solar cells, underlying physics, optoelectronic processes and techniques used for photovoltaic characterization.

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 thermal conversion and storage routes for solar energy	III	Applying
CO2	Interpret the photovoltaic devices and their fundamentals	III	Applying
CO3	Analyze the environmental and social impact of various generation technologies	IV	Analyzing
CO4	Analyze recent technological advancements in sustainable power generation and assess their potential to improve efficiency, reduce costs, and enhance sustainability	IV	Analyzing

Module	**Module Contents**	**Hours**
I	Introduction to power generation Global and Indian scenario, an overview of current technologies available for power generation, Concept of the renewable energy- based power plant	4
II	Solar Thermal Power Generation Fundamentals of Solar thermal energy conversion, solar thermal based power plant design and analysis (flat plate and concentrator), ORC, RC, and Stirling engine. Solar Photovoltaic Power Generation Fundamentals of Solar photovoltaic energy conversion, Solar PV power plant design, Performance analysis of standalone and grid connected PV systems.	7
III	Wind Power Generation Introduction to wind turbine, classification and analysis of different components, Theory, design and analysis of wind turbines (horizontal axis and vertical axis) and wind farms. Hydro Power Generation Introduction to hydro power plant, overview of micro, mini and small hydro power plants, hydraulic turbines, Selection and design criteria of pumps and turbines, Brief theory, design and analysis of hydro power plants	7

IV	Biomass Power Generation Fundamentals of bioenergy production technologies through different routes, design and analysis of biochemical and thermochemical reactors for clean power generation and value- added products, IGCC. Hydrogen energy and fuel cells Importance, various routes of hydrogen generation, basic principle and design of different types of fuel cells and their applications, future prospects, IGFC	7
V	Geothermal Energy Fundamentals, classification, theory, design and analysis of geothermal power plant Ocean Thermal Energy Fundamentals, classification, theory, design and analysis of ocean thermal power plant Wave and Tidal Energy Fundamentals, classification, theory, design, and analysis of wave and tidal power plant	7
VI	Energy Storage Different modes of energy storage; design and analysis of different technologies for thermal, mechanical, and electro-chemical energy storage systems Energy Economics Cost analysis, interest, Accounting rate of return, Payback, Discounted cash flow, Net present value, Internal rate of return, Inflation and life cycle analysis of energy systems.	7

Textbooks	
1	J. Twidell, T. Weir, Renewable Energy Resources, Taylor and Francis, 4th Edition, 2021
2	G. Boyle (Editor), Renewable Energy: Power for a Sustainable Future, Oxford University press, 3rd Edition, 2012.
3	G. N. Tiwari, Solar Energy, Fundamentals, Design, Modelling and Applications, Narosa, 2002.
4	J. A. Duffie and W. A. Beckman, Solar Engineering of Thermal Processes, John Wiley, 4th Edition, 2013.

References	
1	R. Gasch, J. Twele, Wind Power Plants: Fundamentals, Design, Construction and Operation, Springer, 2nd Edition, 2012.
2	P. Breeze, Hydropower, Elsevier, 1st Edition, 2018.
3	S. C. Bhattacharyya, Energy Economics Concepts, Issues, Markets and Governance, springer, 2nd Edition, 2019.
4	S. P. Sukhatme and J.K. Nayak, Solar Energy: Principles of Thermal Collection and Storage, Tata Mc-Graw Hill Education Private Limited, 3rd Edition, 2010.

Useful Links	
1	https://nptel.ac.in/courses/127103236

CO-PO Mapping						
Programme Outcomes (PO)						
	1	2	3	4	5	6
CO1	2		1			
CO2					2	2
CO3				2		
CO4		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. V. S. Sathe
Syllabus Checked By	

Walchand College of Engineering, Sangli

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AY 2024-25

Course Information

Programme	M. Tech. Control System Engineering
Class, Semester	Second Year M. Tech., Sem. III
Course Code	7CS613
Course Name	Fundamentals of Artificial intelligence
Desired Requisites:	Basic programming knowledge (preferably Python) and proficiency in linear algebra, probability, and statistics.

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 Comprehensive Overview of AI
2	Teach Problem-Solving and Search Techniques
3	Introduce Knowledge Representation and Reasoning
4	Cover Machine Learning and NLP 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	Understand the core principles and techniques of artificial intelligence, including its history, applications, and ethical considerations.	II	Understand
CO2	Apply search algorithms and heuristics to formulate and solve AI problems efficiently.	III	Apply
CO3	Represent knowledge using logical formalisms and perform logical reasoning and inference techniques.	IV	Analyze
CO4	Design and implement machine learning models and natural language processing techniques using AI tools and frameworks.	VI	Create

Module	Module Contents	Hours
I	**Introduction to Artificial Intelligence** Overview of AI: History, Evolution, and Scope, Definitions and Key Concepts, Applications of AI in Various Domains, Ethics and Challenges in AI	4
II	**Problem-Solving and Search Algorithms** Problem Formulation: State Space Representation, Uninformed Search, Techniques: BFS, DFS, Informed Search Techniques: Best-First Search, A* Algorithm, Heuristics and Optimization	7
III	**Knowledge Representation and Reasoning** Introduction to Knowledge Representation, Propositional Logic and Inference First-Order Logic: Syntax, Semantics, and Inference, Ontologies and Semantic Web Technologies	7
IV	**Reasoning Under Uncertainty** Basics of Probability Theory, Bayesian Networks: Representation, Inference, and Learning, Markov Decision Processes (MDPs), Hidden Markov Models (HMMs) and their Applications	7

V	**Machine Learning Techniques** Supervised Learning: Regression, Classification, and Neural Networks, Unsupervised Learning: Clustering, Dimensionality Reduction, Reinforcement Learning: Principles and Algorithms, Introduction to Deep Learning: Basics and Architectures	7
VI	**Natural Language Processing and AI Tools** Introduction to Natural Language Processing (NLP), Language Models and Parsing Techniques, Information Retrieval and Extraction, AI Tools and Frameworks: Python, TensorFlow, PyTorch	7

Textbooks	
1	"Artificial Intelligence: A Modern Approach" by Stuart Russell and Peter Norvig
2	"Pattern Recognition and Machine Learning" by Christopher M. Bishop
3	"Machine Learning" by Tom M. Mitchell
4	"Deep Learning" by Ian Goodfellow, Yoshua Bengio, and Aaron Courville

References	
1	"Speech and Language Processing" by Daniel Jurafsky and James H. Martin
2	"Reinforcement Learning: An Introduction" by Richard S. Sutton and Andrew G. Barto

Useful Links	
1	https://onlinecourses.nptel.ac.in/noc24_ge47/preview

CO-PO Mapping

	Programme Outcomes (PO)					
	1	2	3	4	5	6
CO1	1	1	3	1	1	1
CO2	3	1	1	3	1	1
CO3	3	1	1	3	1	1
CO4	3	1	1	3	1	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	Mr. A. N. Inamdar
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	Second Year M. Tech., Sem. I
Course Code	7CS614
Course Name	Non-Linear Dynamical Systems and Control (NPTEL Course)
Desired Requisites:	Control System Engineering, Non-Linear Digital 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 introduce stability and control of nonlinear systems described by ordinary differential equations.
2	To enable students to analyse the non-linear systems asymptotically using Lyapunov function.
3	To provide applications of the Lyapunov function approach to control of linear and nonlinear systems.
4	To introduce the use of robust control, adaptive control, and feedback linearization.

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	**Illustrate** features of nonlinear systems.	III	Applying
CO2	**Investigate** behaviour of nonlinear systems through various mathematical tools.	IV	Analyzing
CO3	**Assess** the dynamics of nonlinear systems using advanced control theories.	V	Evaluating
CO4	**Design** adaptive and optimal control for non-linear systems	VI	Creating

Module	Module Contents	Hours
I	**Introduction and preliminaries** Examples and definitions of nonlinear models, state and equilibrium, existence and uniqueness through examples, Existence and uniqueness of solutions, dependence on initial conditions.	6
II	**Stability Theory** Lagrange, Lyapunov, and asymptotic stability, Lyapunov method and theorems, Invariant set theorems and Chetaev's theorem for instability.	7
III	**Nonlinear Systems** Linear Systems and Linearization, Construction of Lyapunov functions.	6
IV	**Robust stability and Lure problem** Structured and sector uncertainties, Passivity and dissipativity - General theory, Applications to mechanical and electrical systems.	7
V	**Stable adaptive control** Estimation, indirect, and direct adaptive control, Lyapunov function theory for control problems - General form, specialization to linear systems, linearization, and cascade systems.	6
VI	**Optimal control** Optimal control and inverse optimality, Integrator backstepping, Model predictive control.	7

Textbooks

1	Haddad, Wassim M. and Vijay Sekhar Chellaboina, "*Nonlinear Dynamical Systems and Control: A Lyapunov-Based Approach.*" (2008).
2	H. K. Khalil, "*Nonlinear systems*", Prentice Hall,3rd Edition 2002.

3	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://onlinecourses.nptel.ac.in/noc24ee128/preview

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 System Engineering
Class, Semester	Second Year M. Tech., Sem. III
Course Code	7CS615
Course Name	Introduction to Machine Learning
Desired Requisites:	Basic programming knowledge (preferably Python) and understanding of linear algebra, calculus, probability, and statistics.

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 comprehensive introduction to machine learning concepts, algorithms, and techniques.
2	Develop practical skills in implementing and evaluating machine learning models using appropriate tools and frameworks.
3	Analyze and interpret the performance of machine learning algorithms to solve real-world 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	Understand fundamental machine learning concepts and algorithms.	II	Understand
CO2	Apply machine learning algorithms to real-world problems using programming tools.	III	Apply
CO3	Analyze the performance and effectiveness of different machine learning models.	IV	Analyze
CO4	Design and implement end-to-end machine learning solutions for complex tasks.	VI	Create

Module	**Module Contents**	**Hours**
I	**Introduction to Machine Learning** Overview of Machine Learning: Definition, history, and application Types of Learning: Supervised, unsupervised, semi-supervised, and reinforcement learning Basic Concepts: Features, labels, training and test sets, overfitting, and underfitting Introduction to Machine Learning Tools: Overview of popular tools and frameworks (e.g., Scikit-Learn, TensorFlow, PyTorch)	4
II	**Supervised Learning** Linear Regression: Simple linear regression, multiple linear regression, and regularization techniques (Lasso, Ridge) Logistic Regression: Binary classification, multinomial logistic regression, and evaluation metrics (confusion matrix, ROC curve) Classification Algorithms: Decision trees, k-Nearest Neighbors (k-NN), Support Vector Machines (SVM) Model Evaluation: Cross-validation, bias-variance tradeoff, performance metrics (accuracy, precision, recall, F1-score)	7
III	**Unsupervised Learning** Clustering Techniques: k-Means clustering, hierarchical clustering, DBSCAN Dimensionality Reduction: Principal Component Analysis (PCA), t-Distributed Stochastic Neighbor Embedding (t-SNE) Anomaly Detection: Techniques for detecting outliers and anomalies in data Feature Extraction: Methods for extracting useful features from data.	7

IV	**Model Evaluation and Selection** Model Evaluation Techniques: Cross-validation methods (k-Fold, Leave-One-Out), hyperparameter tuning Evaluation Metrics: Precision, recall, F1-score, ROC-AUC Bias-Variance Tradeoff: Understanding overfitting and underfitting, regularization techniques Model Selection: Comparing different models, selecting the best model for a given problem	7
V	**Advanced Topics** Ensemble Methods: Bagging, Boosting, Random Forests, Gradient Boosting Machines (GBMs) Neural Networks: Basics of neural networks, activation functions, backpropagation, and deep learning introduction Introduction to Deep Learning: Convolutional Neural Networks (CNNs), Recurrent Neural Networks (RNNs), and applications	7
VI	**Practical Applications and Case Studies** Case Studies: Real-world applications of machine learning in various domains (e.g., healthcare, finance, marketing) Project Work: Implementing a machine learning project from scratch, including data collection, preprocessing, model building, and evaluation Industry Trends: Overview of emerging trends and technologies in machine learning.	7

Textbooks	
1	"Pattern Recognition and Machine Learning" by Christopher M. Bishop
2	"Machine Learning: A Probabilistic Perspective" by Kevin P. Murphy
3	"Deep Learning" by Ian Goodfellow, Yoshua Bengio, and Aaron Courville
4	"Introduction to Machine Learning" by Ethem Alpaydin

References	
1	"Machine Learning" by Tom M. Mitchell
2	"Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow" by Aurélien Géron
3	"The Elements of Statistical Learning" by Trevor Hastie, Robert Tibshirani, and Jerome Friedman
4	"Bayesian Reasoning and Machine Learning" by David Barber

Useful Links	
1	https://onlinecourses.nptel.ac.in/noc24_cs101/preview

CO-PO Mapping

Programme Outcomes (PO)						
CO1	1	1	3	1	1	1
CO2	3	1	1	3	1	1
CO3	3	1	1	3	1	1
CO4	3	1	1	3	1	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	Mr. A. N. Inamdar
Syllabus Checked By	

Walchand College of Engineering, Sangli *(Government Aided Autonomous Institute)*					
AY 2023-24					
Course Information					
Programme	M.Tech. (Control System Engineering)				
Class, Semester	Second Year M. Tech., Sem III				
Course Code	7CS616				
Course Name	Optimization theory and Algorithms				
Desired Requisites:	Linear algebra				
Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
Practical	-				
Interaction	-	**Credits: 3**			

Course Objectives	
1	To provide the basics of unconstrained and constrained optimization.
2	To provides the methodology of contemporary algorithms in optimization.
3	To provides the methodology of conjugate gradient method.
4	To give the overview of linear and nonlinear least squares constrained optimization.

Course Outcomes (CO) with Bloom's Taxonomy Level		
At the end of the course, the students will be able to,		
CO1	**Analyze** the unconstrained and constrained optimization.	Analyze
CO2	**Analyze** the contemporary algorithms in optimization techniques.	Analyze
CO3	**Evaluate** the performance of processes with conjugate gradient method	Evaluate
CO4	**Evaluate** linear and nonlinear least squares constrained optimization.	Evaluate

Module	**Module Contents**	**Hours**
I	**Linear Algebra and Calculus** Introduction and background, Review of Linear Algebra, Subspaces, Eigen and SVD analysis, Matrix factorizations, Analysis, Sequences, Convex sets , Convex functions.	6
II	**Unconstrained optimization** Introduction, Unconstrained optimization, Taylor's theorem, 1st and 2nd order conditions on a stationary point, Properties of descent directions, Line search theory and analysis Wolfe conditions, backtracking algorithm, convergence and rate.	7
III	**Conjugate gradient method** Introduction to conjugate directions method, geometric interpretations, Formulating the conjugate gradient method, expanding subspace theorem, preconditioned conjugate gradient method	7
IV	**Nonlinear optimization methods** Introduction to Nonlinear optimization, Nonlinear conjugate gradient method, Convergence and rate for Newton methods, Hessian modification, Linear and nonlinear least squares problems Formulations and techniques for solving least square problems	6
V	**Constrained optimization** Introduction, First order formulation for constrained optimization, equality and inequality constraints, constraint qualification, Constrained optimization - KKT conditions , First order necessary conditions (KKT) and a proof sketch of KKT	6

VI	**Projected gradient descent** Introduction, Constrained optimization - Projected gradient descent, sub gradients and projection operators, examples of projected gradient descent, Duality in optimization, Geometric interpretations of duality, and sample problem solving using the Lagrangian dual function formulation.	7

Text Books	
1	*"Numerical Optimization"* by Jorge Nocedal and Stephen J. Wright,Springer, 2006
2	*"An Introduction to Optimization"by* E.K.P. Chong, S.H. Zak, Wiley, New York, 1996.
References	
3	"Numerical Optimization with Applications", by Jay deva , Suresh Chandra ,Aparna Mehra, Narosa Publications, 2009.
Useful Links	
1	https://nptel.ac.in/courses/noc24-ee122

CO-PO Mapping						
	Programme Outcomes (POs)					
	1	2	3	4	5	6
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)

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 Systems)
Class, Semester	Second Year M. Tech., Sem. I
Course Code	7CS617
Course Name	NPTEL Course : Design of Photovoltaic Systems
Desired Requisites:	Basic knowledge of electrical engineering principles and familiarity with renewable energy.

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

Course Objectives

1	Understand the fundamental principles and operation of photovoltaic cells and systems.
2	Learn to design and size PV systems for various applications, ensuring optimal performance and reliability.
3	Master the implementation and optimization of Maximum Power Point Tracking (MPPT) techniques.
4	Gain knowledge of advanced applications and economic considerations in PV system integration, including PV-grid interfaces and life cycle costing.

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	Implement and optimize various MPPT algorithms to maximize the power output of PV systems	III	Apply
CO2	Analyze and evaluate the performance of photovoltaic cells and their interconnections.	IV	Analyze
CO3	Integrate PV systems with other applications such as battery storage, water pumping, and grid interfaces, while considering economic and lifecycle cost factors	V	Evaluate
CO4	Design and size efficient PV systems tailored to specific energy needs.	VI	Create

Module	**Module Contents**	**Hours**
I	**Fundamentals of Photovoltaic Cells and Systems** Introduction to Photovoltaic Technology, Basics of solar energy conversion, Materials and types of PV cells (e.g., silicon-based, thin-film technologies),PV cell operation: How PV cells convert sunlight into electricity, Efficiency and performance metrics	7

II	**Interconnection and Energy Generation** Series and Parallel Interconnection, Electrical characteristics of PV cells, Series interconnection: Voltage addition, Parallel interconnection: Current addition, Impact on system performance, Energy from the Sun, Solar radiation basics: Nature and composition, Earth-Sun geometry: Solar angles and their effect on energy received, Measuring solar radiation: Tools and methods	7
III	**Incident Energy and System Sizing** Incident Energy Estimation, Solar irradiance and insolation definitions and measurement Angle of incidence and its effect on energy received by PV panels Calculating incident energy using geographical and climatic data Tools and software for solar energy estimation Sizing PV Systems Load analysis: Determining energy needs System sizing calculations: Calculating the number of PV modules required Inverter and battery sizing: Matching components to system requirements Safety factors and design margins	6
IV	**Maximum Power Point Tracking (MPPT)** Principle of MPPT, How MPPT maximizes power output from PV systems, Various MPPT techniques (e.g., perturb and observe, incremental conductance) MPPT controllers: Types and characteristics	7
V	**Advanced MPPT Algorithms and Applications** MPPT Algorithms, Detailed study of popular MPPT algorithms, Algorithm comparison: Advantages and disadvantages, Practical implementation of MPPT algorithms in real systems, Performance metrics for evaluating MPPT effectiveness-Battery Interfaces, Battery technologies used in PV systems (e.g., lead-acid, lithium-ion),Battery charging and discharging dynamics PV to battery interface design considerations	6
VI	**Advanced Applications and Economic Considerations** PV and Water Pumping, Design and application of PV systems for water pumping, Performance and reliability considerations, PV-Grid Interface-grid interface fundamentals: Part I, Advanced concepts of PV-grid integration: Part II- Life cycle costing of PV systems, Economic analysis and financial considerations for PV system deployment	6

Textbooks	
1	Chenming, H. and White, R.M., *Solar Cells from B to Advanced Systems*, McGraw Hill Book Co, 1983
2	Ruschenbach, HS, *Solar Cell Array Design Hand* Varmostrand, Reinhold, NY, 1980
3	Proceedings of IEEE Photovoltaics Specialists Conferences, Solar Energy Journal.
References	
1	G.S.Sawhney, "*Non-Conventional Resources of Energy*", PHI Publication 2012. Gary-L. Johnson Wind Energy Systems Tata Mc-Graw-Hill Book Company.
2	S. P. Sukhatme, J. K. Nayak, "*Solar Energy- Principles of Thermal Collection and Storage",* (3rd edition), Tata McGraw-Hill Publication.
Useful Links	
1	https://onlinecourses.nptel.ac.in/noc24_ee109/preview

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

SEM IV

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2024-25

Course Information

Programme	M. Tech. (Control System Engineering)
Class, Semester	Second Year M. Tech., Sem IV
Course Code	7CS692
Course Name	Dissertation Phase II
Desired Requisites:	Dissertation Phase I

Teaching Scheme		**Examination Scheme (Marks)**			
Practical	20 Hrs/ Week	**LA1**	**LA2**	**Lab ESE**	**Total**
Interaction	-	30	30	40	100
		Credits: 17			

Course Objectives

1	The M. Tech. Dissertation is aimed at training the students to analyze independently any problem in the field of Electrical Control Systems Engineering and applications of control theory. The Dissertation may be analytical, computational, experimental or a combination of three. The Dissertation report is expected to show clarity of thoughts and expression, critical appreciation of the existing literature and analytical, experimental, computational aptitude. The student progress of the dissertation work shall be evaluated in stage I and II in semester I and II respectively.

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	**Defend** the objectives of the dissertation by grasping and analysing throughan extensive literature review in the area of study.	IV V	Analyzing Evaluating
CO2	**Formulate** the methodology and **Execute** the study through conduct ofAnalytical/Experimental work to achieve the objectives.	III VI	Applying Creating
CO3	**Analyse, interpret** and **critique** the findings of the study.	III IV V	Applying Analyzing Evaluating
CO4	**Defend** the outcomes of the dissertation through self-learning and justify the project work as per appropriate standards of documentation and presentation.	V	Evaluating

List of Experiments / Lab Activities/Topics

Course Contents:

The fourth semester is completely devoted to dissertation work which is defined based on the interest of the students to specialize in a particular area.

Student is expected to carry out independent research work on the chosen topic. In this semester it is expected that the student has carried out substantial research work including exhaustive literature survey, formulation of the research problem, development/fabrication of experimental set-up (if any/required) and testing, and analysis of initial results thus obtained. In fourth semester, the student continues his/her dissertation work. It is expected that the student has completed most of the experimental/computation works and analyzed the results so obtained as proposed in the synopsis. The work should be completed in all respects in this semester. The student is required to submit the dissertation work in the form of report as per the institute rule.

Textbooks

References

1	Proceedings of Reputed National and International journals in Control Systems (Electrical Engineering) [a. IEEE Transactions on – Automatic control systems, Power Electronics, Circuits and systems, Control systems technology, Automatic Control etc. b. IEEE magazines/ newsletters/ proceedings on- Control systems, Industrial electronics magazine, etc. c. IET Proceedings/ journals/ magazines on – Control Theory and Control Systems etc. d. Elsevier journals and magazines on- Electrical and Electronics Engineering, Circuits and systems, Advance process control, Dynamics and control etc. e. Journal of Institution of Engineers India- Electrical Engineering f. The Journal of the Institute of Electrical Engineers of Japan, g. Circuits, Systems & Signal Processing –Springer, h. Energy Efficiency – Springer i. Mathematics of Control, Signals, and Systems – Springer j. Soft Computing– Springer k. An International Journal for Simulation-Based Engineering – Springer l. Journal of Control Theory and Applications –Springer m. Journal of Dynamical and Control Systems – Springer Proceedings of Reputed International Conferences organized by IFAC, IEEE in association with IITs and NITs, Elsevier and Springer conferences and IET conferences.
Useful Links	
1	

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

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 Courses

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2024-25

Course Information

Programme	M. Tech. (Control System Engineering)
Class, Semester	Second Year M. Tech., Sem IV
Course Code	7CS645
Course Name	Internship
Desired Requisites:	Courses taught in semester I and II

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	-	**LA1**	**LA2**	**ESE**	**Total**
Tutorial	-	-	-	100	100
Practical	4 Hrs./Week	**Credits: 2**			

Course Objectives

1	To expose the students to real life engineering problems encountered in industry/society.
2	To provide an opportunity to work in collaborative and multidisciplinary environment.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO	Description	Blooms Taxonomy	
		Descriptor	Level
CO1	***Perceive*** knowledge of group dynamics and contribute to multidisciplinary work.	Understand	II
CO2	***Demonstrate*** knowledge to solve societal problems and ***apply*** it for efficient management of projects independently and in teams.	Apply	III
CO3	***Communicate*** with industry/society regarding engineering activities effectively and ***comprehend*** and write effective reports.	Understand	II
CO4	***Demonstrate*** ethical behaviour with professional code of conduct and contribute to sustainable development of society.	Apply	III

Contents

The objective of this training is to expose the students to industry environment and practices. Students are sent to leading Engineering organizations/Research laboratories/Design and Consultancy organizations to undergo a rigorous training for a minimum period of **one month** during summer term/vacation.

CO-PO Mapping

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

Assessment

- The assessment is based on ESE. The panel of minimum two members from the department shall assess the student for the internship.
- The students are expected to present the work done in an internship tenure.
- The students shall also submit a detailed report based on activities done in an internship and learnings through the same.
- The students shall also submit the duly signed internship certificate from the organization/s where internship was done, clearly indicating the period of internship in the certificate.

Syllabus Prepared By	Mr. A. N. Inamdar
Syllabus Checked By	

Walchand College of Engineering, Sangli

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Course Information

Programme	M. Tech. (Control System Engineering)
Class, Semester	Second Year M. Tech., Sem IV
Course Code	7CS646
Course Name	Techno-Socio Activity
Desired Requisites:	-

Teaching Scheme		Examination Scheme (Marks)			
Lecture	-	**LA1**	**LA2**	**ESE**	**Total**
Tutorial	-	-	-	100	100
Practical	2 Hrs./Week				
Interaction	-	**Credits: 1**			

Course Objectives

1	Develop skills like teamwork, and communication through technical contribution on socio-economic issues
2	Enhance understanding of the socio-economic impact of engineering projects and technology on society.
3	Apply engineering knowledge and problem-solving skills to address real-world challenges

Course Outcomes (CO)

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

CO	Description	Blooms Taxonomy	
		Descriptor	Level
CO1	***Explain*** professional culture/ethics and build proficiency in professional communication, working in teams, decision making and leadership.	Understand Apply	II III
CO2	***Apply*** the technical knowledge through participation in techno-socio assignments.	Apply	III
CO3	***Demonstrate*** ethical quality and social responsibilities through the technical knowledge gained.	Evaluate	V

List of Activities

List of Activities:

1. Involvement in techno-socio activity
   a) Presentation on involvement in techno-socio activity individually/through student clubs during F.Y. & S.Y. M. Tech.
   b) Submission of summary report on these activities.
2. Techno-socio activity (Team Activity)
   a) Organization of a technical activity/event for the benefit of society in a batch.
   b) Submission of report on the organized activity.
3. Submission of certificates/documents required for student port-folio (Participation in Curricular and Extra-Curricular Activities within and outside the campus).

References

1	National Institute for Engineering Ethics (NIEE)
2	Professional ethics, National Society of Professional Engineers (NSPE).

Useful Links

1	https://www.asce.org/pdf/ethics_manual.pdf
2	https://www.aicte-india.org/atal

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

Assessment
The assessment is based on ESE. The panel of minimum two members from the department shall assess the student for the techno-socio activity. The students are expected to present the work done in an four semesters. The students shall also submit a detailed report based on activities done and learnings through the same. The students shall also submit the duly signed certificate from the organization/s, local bodies where activities were carried out.

Syllabus Prepared By	Mr. A. N. Inamdar
Syllabus Checked By	