SEM V

Professional Core (Theory)

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2023-24

Course Information	
Programme	B.Tech. (Electrical Engineering)
Class, Semester	Third Year B. Tech., Sem V
Course Code	6EL301
Course Name	Power System Analysis and Stability
Desired Requisites:	Electrical transmission and distribution and A.C. Machines

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

Course Objectives	
1	To gain knowledge of load flow analysis and short circuit studies.
2	To provide knowledge about stability problems and dynamic mechanisms in electric power systems.
3	To analyse case studies and real-world examples of power system stability and develop critical thinking skills for problem solving.
4	To help students in preparing for competitive examinations.

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	Summarize the use of various load flow analysis method and assess the power system under symmetrical fault.	II	Understanding
CO2	Analyse symmetrical components of network and power system under unbalanced fault	IV	Analysing
CO3	Evaluate the power system stability for rotor angle, voltage stability and to solve swing equation	V	Evaluating

Module	**Module Contents**	**Hours**
I	**Power Flow Analysis** Bus classification, Bus admittance matrix, General form of power flow equations, Gauss-Seidel and Newton-Raphson methods, Comparison of load flow methods, Reactive power control and Series compensation.	7
II	**Symmetrical Components** Symmetrical components, Dr. Fortescue Theorem, Component synthesis, Component analysis, Sequence impedances and Sequence networks, Sequence impedances of transmission lines, transformers, and synchronous machines, Construction of sequence network of a power system.	6
III	**Fault Analysis: Balanced Fault** Introduction, Classification, Severity and occurrence of fault, Effect of faults, Balanced three phase fault, Transient on transmission line, Short circuit capacity, Symmetric fault analysis using bus impedance matrix.	6
IV	**Fault Analysis: Unbalanced Fault** Introduction, Assumptions, Sequence voltages of generator, General procedure for analysis of various faults, Analysis of unbalanced faults-SLG,LL and DLG, Short circuit studies of a large power system network.	6

V	**Power System Stability- Revisited and extended** Basic concepts and definitions, Classification of stability including inverter based resources(IBR), Power angle curve, An elementary view of transient stability ,swing equation ,M and H constant, Equal Area Criterion and its applications, critical clearing angle, Rotor angle stability, Voltage stability, Factors influencing transient stability.	7
VI	**Case Studies and Real-World Applications for Stability Evaluation** Case studies of power system oscillations and their impact on grid stability, real-world power stability events in power grid with high penetration of inverter based resources (IBR), Role of advanced technologies in enhancing grid stability, Emerging technologies and trends in power system stability, Research challenges and opportunities in this field.	7

Textbooks	
1	I.J. Nagrath and D.P. Kothari, "Power System Analysis", 2nd Edition and TMH Publication 2015.
2	Hadi Saadat, Power System Analysis, TMH, 1st Edition, 2002
3	"Power System Analysis", B.S.R. Murty, B.S. Publications.

References	
1	Glover, Sharma, Overbye Power Systems Analysis and Design, Thompson, 5th Ed., 2012.
2	Stevenson W.D., Elements of Power System Analysis, TMH, 4th Edition, 2014.
3.	Power System Stability and Control" by Prabha Kundur

Useful Links	
1	**NPTEL Courses:** https://nptel.ac.in/
2	**Research Papers IEEE :** https://ieeexplore.ieee.org/
3.	N. Hatziargyriou et al., "Definition and Classification of Power System Stability – Revisited & Extended," in IEEE Transactions on Power Systems, vol. 36, no. 4, pp. 3271-3281, July 2021, doi: 10.1109/TPWRS.2020.3041774.
4	Y. Cheng et al., "Real-World Subsynchronous Oscillation Events in Power Grids With High Penetrations of Inverter-Based Resources," in IEEE Transactions on Power Systems, vol. 38, no. 1, pp. 316-330, Jan. 2023, doi: 10.1109/TPWRS.2022.3161418.

CO-PO Mapping

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

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2023-24

Course Information

Programme	B.Tech. (Electrical Engineering)
Class, Semester	Third Year B. Tech., Sem V
Course Code	6EL302
Course Name	Control System Engineering
Desired Requisites:	Engineering Mathematics III, Signals and Systems, Electrical Circuit Analysis

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 modeling physical systems.
2	To analyze physical systems using various time and frequency domain methods.
3	To enable students for determining the stability of linear systems using different methods.
4	To introduce the use of state space method for system analysis.

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 system transfer function and system characteristics of different Systems.	III	Applying
CO2	Analyze performance of physical systems using mathematical models.	IV	Analysing
CO3	Check the stability of linear systems in time and frequency domain.	V	Evaluating

Module	Module Contents	Hours
I	**Analysis of System in Frequency Domain** History of control systems, Laplace transforms review, transfer function of Electrical systems, Mechanical systems, Rotational Systems, Electrical circuit analogs, Transfer function of DC motor	6
II	**Analysis of System in Time Domain** State space representation, Converting transfer function to state space: Phase Variable Form, State space to transfer function, State Transition Matrix, Solutionof state equation, Controllability, Observability.	7
III	**Transient Response and Reduction of multiple subsystem** Time response, poles, zero and system response, Response of first, second and general second order system, system response with additional poles, additional zeros Block diagram analysis and design of feedback systems, signal flow graph, mason's rule, signal flow graphs of state equation, similarity transformation.	7

IV	**Steady State Error** Steady state error for unity feedback systems, static error constants, and system type. Steady state error specifications, steady state error for system with disturbances, non-unity feedback systems. steady state error for systems in state space, PID Controllers.	4
V	**Stability Analysis: Routh Criterion and Root Locus** Routh criterion for stability and stability in state space, Sketching the root locus, transient response design via gain adjustment, Root locus for positive feedback system, pole sensitivity, lag, lead, lag-lead compensators in root locus domain.	7
VI	**Stability Analysis: Bode Plot and Nyquist Plot , Compensators** Bode plot, Nyquist criterion, Determination of stability, gain margin, phase margin via the Nyquist diagram and bode plots Introduction to Compensators, lag, lead,lag-lead compensator in frequency domain.	8

Textbooks	
1	Norman Nise, "Control System Engineering", John Wiley, Sixth Edition, 2011.
2	I.J. Nagrath and M. Gopal, "Control System Engineering", Anshan Publishers, Fifth edition, 2008.
References	
1	M Gopal, "Control System Principle & Design", T.M.H., Fourth Edition, 2012.
2	K Ogata, "Modern Control Engineering", P.H.I., Fourth Edition, 2002.
3	Dorf and Bishop, "Modern Control System", Adison Wesley Longman, Eight Edition, 1998.
Useful Links	
1	https://nptel.ac.in/courses/108/106/108106098/

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		3												2

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

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AY 2023-24

Course Information	
Programme	B.Tech. (Electrical Engineering)
Class, Semester	Third Year B. Tech., Sem V
Course Code	6EL303
Course Name	Digital Signal Processing
Desired Requisites:	Engineering Mathematics –III, Signals and 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 develop basic knowledge of DSP systems and signal processing.
2	To develop basic knowledge of FFT and filter design.
3	To enable students to learn different modern signal processing tools.

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 signal processing tools and transforms.	III	Applying
CO2	Apply different techniques for Filter design	III	Applying
CO3	Explain modern signal processing tools and algorithms.	II	Understanding

Module	**Module Contents**	**Hours**
I	**Digital Signals and Systems-** Sampling, transfer function and frequency response, Digital system's response to different inputs.	6
II	**Discrete Fourier Transform-** DFT, Relation between DFT & Z- Transform, Circular convolution and DFT, FFT Algorithms –DIT-FFT and DIF-FFT, Overlap save algorithm, overlap add algorithm.	7
III	**IIR Filter Design-** Filter design using impulse invariant technique, bilinear transformation and Analog filter approximation (Butterworth) and Realization.	7
IV	**FIR Filter Design-** FIR Filter Design, Linear phase property, Fourier series method, Windowing method, Filter design using window, frequency sampling methods, quantization and realization.	7
V	**Digital Signal Processors-** Introduction, real time signals processing, modifications in structure and architecture, important blocks, Programming Aspects, Applications.	6

VI	**Multirate Signal Processing-** Up-sampling and down-sampling time and frequency effects, aliasing and imaging effects, Applications.	6
Textbooks		
1	John G, Proakis' Digital Signal Processing Principles, Algorithms and Applications', Pearson Education, 2008.	
2	Sanjeet Mitra, 'Digital Signal Processing', The MIT Press, 2007.	
3	Venkatramani, Bhaskar, 'Digital Signal Processors', TMH Pub., 2006.	
References		
1	Oppenheim and R. W. Schafer, 'Discrete Time Signal Processing' PHI Pub., 2005	
Useful Links		
1	https://nptel.ac.in/	

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

Professional Core
(Lab)

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2023-24

Course Information

Programme	B.Tech. (Electrical Engineering)
Class, Semester	Third Year B. Tech., Sem V
Course Code	6EL351
Course Name	Power System Analysis and Stability Lab
Desired Requisites:	Electrical Transmission and Distribution, AC Machines

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 cover steady state analysis and fault studies for a power system.
2	To provides hand on skills to simulation of stability studies.
3	To lay the foundation for conducting higher level study in power system

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	Simulate various methods of power system analysis.	II	Understanding
CO2	Carry out simulation for symmetrical components of network and analyse the power system under various fault.	III	Applying
CO3	Evaluate the equal Area criterion and swing curve for stability.	V	Evaluating

List of Experiments / Lab Activities

List of Experiments:

1. Development of the MATLAB program of bus admittance matrix Ybus.
2. Outline of SIM Power Systems toolbox in MATLAB
3. Analyze Load flow using MiPower/MATLAB/ETAP.
4. Simulation of Short circuit analysis using MiPower/MATLAB/ETAP .
5. Simulation of Transient analysis using MiPower/MATLAB/ETAP.
6. Demonstration of unbalanced Fault Using transmission line simulator (TLS)
7. Analyse Symmetrical components of 3phase unbalanced system using MATLAB.
8. Development of the program for Equal Area Criteria analysis using MATLAB.
9. Examination of Swing Curve using power world/ MiPower/MATLAB/ETAP simulation
10. Development of the MATLAB programm to calculate series compensation
11. Outline of MiPower/MATLAB/ETAP for power system analysis and stability.

12. Small Signal Stability Analysis: Measurement and analysis of system eigenvalues and damping ratios

13 .Determination of critical clearing time for a transient stability event

14. Develop programme for Eigen value analysis of power system stability

15. Analysis of the dynamic response of the power system to disturbances

16. Analysis of power system oscillations in real world application

17. Simulation Case Studies and Real-World Applications for Stability Evaluation

18. Impact of Surge Impedance loading on high voltage transmission lines

Note: Any eight to nine experiments will be conducted during practical

Text Books	
1	I.J. Nagrath and D.P. Kothari, “Power System Analysis”, 2nd Edition and TMH Publication 2015.
References	
1	Glover, Sharma, Overbye Power Systems Analysis and Design, Thompson, 5th Ed., 2012.
2	Hadi Saadat, Power System Analysis, TMH, 1st Edition, 2002.
3	Stevenson W.D., Elements of Power System Analysis, TMH, 4th Edition, 1994.
4	Power System Stability and Control" by Prabha Kundur
Useful Links	
1	**NPTEL Courses:** https://nptel.ac.in/
2	**Research Papers IEEE :** https://ieeexplore.ieee.org/
3	N. Hatziargyriou et al., "Definition and Classification of Power System Stability – Revisited & Extended," in IEEE Transactions on Power Systems, vol. 36, no. 4, pp. 3271-3281, July 2021, doi: 10.1109/TPWRS.2020.3041774.
4	Y. Cheng et al., "Real-World Subsynchronous Oscillation Events in Power Grids With High Penetrations of Inverter-Based Resources," in IEEE Transactions on Power Systems, vol. 38, no. 1, pp. 316-330, Jan. 2023, doi: 10.1109/TPWRS.2022.3161418.

CO-PO Mapping

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

Walchand College of Engineering, Sangli

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AY 2023-24

Course Information

Programme	B.Tech. (Electrical Engineering)
Class, Semester	Third Year B. Tech., Sem V
Course Code	6EL352
Course Name	Control System Engineering Lab
Desired Requisites:	Engineering Mathematics III, Signals and Systems, Electrical Circuit Analysis

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 estimate the stability of 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	Solve and analyze physical systems using simulation tools.	III	Applying
CO2	Assess the stability of systems using frequency domain techniques.	IV	Analyzing
CO3	Study transient analysis of physical systems.	IV	Analyzing

List of Experiments / Lab Activities

List of Experiments:

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. Sketch Nyquist, Bode Diagram and design compensator using G.U.I. and software tools.
11. Design a PID controller for speed control of electric machine.

Text Books

1	Norman Nise, "Control System Engineering", John Wiley, Sixth Edition, 2011.
2	I.J. Nagrath and M. Gopal, "Control System Engineering", Anshan Publishers, Fifth edition, 2008.

References

1	M Gopal, "Control System Principle & Design", T.M.H., Fourth Edition, 2012.

2	K Ogata, “Modern Control Engineering”, P.H.I., Fourth Edition, 2002.
3	Dorf and Bishop, “Modern Control System”, Adison Wesley Longman, Eight Edition, 1998.

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										2
CO3				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.

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.

Walchand College of Engineering, Sangli

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AY 2023-24

Course Information

Programme	B.Tech. (Electrical Engineering)
Class, Semester	Third Year B. Tech., Sem V
Course Code	6EL353
Course Name	Digital Signal Processing Lab
Desired Requisites:	Engineering Mathematics –III, Signals and 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 develop basic knowledge of DSP systems and signal processing.
2	To develop basic knowledge of FFT and filter design.
3	To enable students to learn different modern signal processing tools.

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 signal processing tools and transforms.	III	Applying
CO2	Apply different techniques for Filter design	III	Applying
CO3	Explain modern signal processing tools and algorithms.	II	Understanding

List of Experiments / Lab Activities/Topics

List of Lab Activities: Minimum 10-12 experiments using Matlab and DSP kit with reference to following list-

1. Generation and convolution of DT signals.
2. Digital frequency and aliasing effect in sampling.
3. Frequency response and magnitude, phase plot of system.
4. Response of system to standard test signals.
5. DFT and IDFT computation and magnitude, phase plot.
6. Circular convolution and comparison with linear convolution.
7. IIR filter design.
8. FIR filters design.
9. IIR and FIR filter design using toolbox.
10. Multirate signal processing-up and down sampling and Frequency domain effects.
11. Multirate signal processing- anti- imaging and antialiasing filter.
12. DSP processor- Linear and circular convolution.
13. DSP processor- Difference equation and impulse response.
14. DSP processor- Implementation of filter.

Textbooks

1	John G, Proakis' Digital Signal Processing Principles, Algorithms and Applications', Pearson Education, 2008.
2	Sanjeet Mitra, 'Digital Signal Processing', The MIT Press, 2007.

3	Venkatramani, Bhaskar, 'Digital Signal Processors', TMH Pub., 2006.
References	
1	Oppenheim and R. W. Schafer, 'Discrete Time Signal Processing', PHI Pub., 2005
Useful Links	
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CO-PO Mapping														
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CO1	3													2
CO2			3											2
CO3					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				
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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.				

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AY 2023-24

Course Information

Programme	B.Tech. (Electrical Engineering)
Class, Semester	Third Year B. Tech., Sem I
Course Code	6EL354
Course Name	Presentation and Report Writing
Desired Requisites:	MS-Office

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

Course Objectives

1	To convey ethical guidelines during technical content preparation and showcasing
2	To make aware of soft tools for information handling
3	To provide various relevant benchmark case studies
4	To share rubric assessing reading, writing and presentation skills

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	Follow ethical guidelines during technical writing and presentations	II	Understanding
CO2	Choose and practice tools for sharing and linking the information	III	Applying
CO3	Compare and identify suitable platforms towards practicing write-up and demonstrations	IV	Analysing
CO4	Discuss within groups to assess his/her own improvement in overall technical expressions	V	Evaluating
CO5	Create contented reports and meaningful presentations authoring the work	VI	Creating

List of Experiments / Lab Activities/Topics

List of Sessions:

PART - A Technical Report Writing

1. **Session 1**: Writing technical reports using proper Tense and grammar.
2. **Session 2:** Study of various types of technical Reports
    a. Project report
    b. Conference paper
    c. Journal Paper
    d. Intellectual Property Rights (IPR)
    e. Selection of paper type for possible publication.
3. **Session 3**: Study of technical report Structure - I
    a. Preamble
    b. Abstract
    c. Literature review/survey
    d. Problem statement
    e. Objectives
4. **Session 4**: Study of technical report Structure – II
    a. Methodologies
    b. Results
    c. Discussions
    d. Conclusion
    e. Acknowledgements
5. **Session 5**: Use of Bibliographies/references and proper citations in reports.
6. **Session 6**: Use of Citations, referring style and method of using citations.
7. **Session 7**: Study of Plagiarism
    a. Checking plagiarism
    b. Minimizing plagiarism

PART - B Presentation

1. PPT's and Animations
2. Presentation structure, Number of slides and Time management
3. Presentation styles
4. Figures and Tables for data representations

Part - C Tools and Practices

1. MS Office, Open Office, Latex, MS Visio, Inkspace etc.
2. End Note; Mendeley, Grammarly, Ginger, 1 Checker, Turnitin etc.

Textbooks	
1	Kothari C. R, *"Research Methodology"*, 2nd Edition, New Age International, 1990
2	Chopra Deepak and Sondhi Neena, *"Research Methodology: Concepts and cases"*,2nd Edition, Vikas Publishing House, New Delhi,2015

References	
1	Melville Stuart and Goddard Wayne, *"Research Methodology: An Introduction For Science & Engineering Students"*, 1st Edition, Kenwyn Juta & Co. Ltd., 1996
2	G. Ramamurthy, *"Research Methodology"*, 2nd Edition, Dream Tech Press, New Delhi, 2015

Useful Links	
1	Academic Research & Report Writing https://onlinecourses.swayam2.ac.in/ntr21_ed23/preview
2	Academic Writing https://onlinecourses.swayam2.ac.in/cec21_ge18/preview

3	Qualitative Research Methods and Research Writing https://onlinecourses.nptel.ac.in/noc21_ge12/preview
4	Effective Writing https://onlinecourses.nptel.ac.in/noc21_hs44/preview

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

Professional Elective 1

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2022-23

Course Information

Programme	B.Tech. (Electrical Engineering)
Class, Semester	Third Year B. Tech., Sem V
Course Code	6EL311
Course Name	Professional Elective I: Electromagnetic Field
Desired Requisites:	Electrical Circuits, DC Machines and Transformers

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

Course Objectives

1	This course develops foundational concepts in electrostatic and electromagnetic fields.
2	It familiarizes the students with electrical field and scalar potential, magnetic field and vector potential, Maxwell's equations, Biot-Savart Law, electrostatic boundary conditions, time varying potential.
3	This course will help students in preparing for competitive examinations.

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	**Catch** the concepts of electrostatic and electromagnetic fields.	II	Understanding
CO2	**Apply** various laws in electromagnetics to identify the nature and strength of electric and magnetic fields.	III	Applying
CO3	**Test** the boundary value conditions in electromagnetic fields.	IV	Analyzing

Module	**Module Contents**	**Hours**
I	**Vector Analysis** Vector Algebra, Rectangular Coordinate System, Vector Component, Vector Field, Dot Product, Cross Product, Circular and Cylindrical Coordinate System, Vector Calculus, Del Operator, Gradient of Scalar, Divergence of Vector and Divergence Theorem, Curl of a Vector and Stroke's Theorem, Classification of Vector Fields.	6
II	**Electrostatic Fields** Coulombs Law and Field Intensity, Electric Fields due to Continuous Charge Distributions, Electric Flux Density, Gauss's Law- Maxwell's Equation, Electric Potential, Relationship between E and V-Maxwell's Equation, Electric Dipole and Flux Lines, Energy Density in Electrostatic Fields.	**7**
III	**Electric Fields in Material Space** Properties of Materials, Convection and Conduction Current, Conductors, Polarization in Dielectrics, Dielectric Constant and Strength, Linear , Isotropic and Homogenous Dielectrics, Continuity Equation and Relaxation Time, Boundary Conditions.	**6**

IV	**Electrostatic Boundary-Value Problems** Introduction, Poisson's and Laplace's Equations, Uniqueness Theorem, General Procedures for Solving Poisson's and Laplace's Equations, Resistance and Capacitance, Method of Images.	**7**
V	**Magneto Static Fields and Magnetic Forces** Biot- Savart's Law, Ampere's Circuital Law-Maxwell's Equation, Application of Ampere's Law, Magnetic Flux Density-Maxwell's Equation, Maxwell's Equation for Static Fields, Magnetic Scalar and Vector Potentials. Introduction, Forces due to Magnetic Torque and Moment, Magnetic Dipole.	**7**
VI	**Maxwell's Equations** Introduction, Faraday's Law, Transformer and Motional ElectromotiveForces, Displacement Current, Maxwell's equations in Final Forms, Time-Varying Potentials, Time Harmonic Fields.	**6**

Textbooks	
1	W.H. Hayt, J A Buck, M J Akhtar "Engineering Electromagnetic", McGraw Hill, 8th Edition 2014.
2	M. Sadiku, "Elements of Electromagnetics", Oxford University Press, 4th Edition 2007.

References	
1	Joseph A. Edminster, "Electromagnetics", Tata Mc Graw Hill, 2nd Edition. 2010
2	John D. Kraus, "Electromagnetics", Tata Mc Graw Hill, 4th Edition 2006
3	Jorden and Balmen, "Electromagnetic Wave and Radiation System" Pearson Publication 2nd Edition 2015.

Useful Links	
1	https://nptel.ac.in/courses/108/106/108106073/

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	

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)

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2023-24

Course Information

Programme	B.Tech. (Electrical Engineering)
Class, Semester	Third Year B. Tech., Sem V
Course Code	6EL312
Course Name	Professional Elective I : Linear Algebra
Desired Requisites:	Engineering Mathematics I

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

Course Objectives

1	To become computational proficiency involving procedures in Linear Algebra.
2	To understand the axiomatic structure of a modern mathematical subject and learn to construct simple proofs.
3	To solve problems that apply Linear Algebra to Economics and Engineering.

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 mathematical methods involving arithmetic, algebra, geometry, and graphs to solve problems.	III	Applying
CO2	Analyze the solution set of a system of linear equations	IV	Analysing
CO3	Evaluate Engineering problems using the concept of Linear Algebra.	V	Evaluating

Module	**Module Contents**	**Hours**
I	**Solving Linear Equations** Vectors, The Idea of Elimination, Elimination Using Matrices, Rules for MatrixOperations, Inverse Matrices, Elimination = Factorization: A = LU, Transposes and Permutations	4
II	**Vector Spaces and Subspaces** Spaces of Vectors, The Nullspace of A: Solving Ax = 0 and Rx = 0, The Complete Solution to Ax = b, Independence, Basis and Dimension, Dimensions of the Four Subspaces, Orthogonality, Orthogonality of the Four Subspaces. Projections, Least Squares Approximations, Orthonormal Bases and Gram-Schmidt ,The Properties of Determinants, Permutations and Cofactors, Cramer's Rule, Inverses, and Volumes, Review of Eigenvalues and Eigenvectors , Review of Diagonalizing a Matrix , Systems of Differential Equations , Review of Symmetric Matrices, Positive Definite Matrices, ,	7
III	**The Singular Value Decomposition** Image Processing by Linear Algebra, Bases and Matrices in the SVD, Principal Component Analysis (PCA by the SVD), The Geometry of the SVD, Linear Transformations, The Idea of a Linear Transformation , The Matrix of a Linear Transformation, The Search for a Good Basis .	7

IV	**Complex Vectors and Matrices** Complex Numbers, Hermitian and Unitary Matrices , The Fast Fourier Transform,. Matrices in Engineering, Markov Matrices, Population, Linear Programming, Fourier Series: Linear Algebra for Functions, Computer Graphics, Linear Algebra for Cryptography**.**	8
V	**Numerical Linear Algebra** Gaussian Elimination in Practice , Norms and Condition Numbers, IterativeMethods and Preconditioners	7
VI	**Linear Algebra in Probability & Statistics** Mean, Variance, and Probability, Covariance Matrices and Joint Probabilities, Multivariate Gaussian and Weighted Least Squares	6

Textbooks	
1	Gilbert Strang, "Linear Algebra and its Applications", Fourth Edition, Cengage Learning, 2005, ISBN: 9788131501726
2	David C Lay, "Linear Algebra and its Applications", third Edition, Pearson Education,2002, ISBN: 8177583336
References	
1	Kenneth M Hoffman, "Linear Algebra", Pearson Education, second Edition, 2015, ISBN: 9332550077
2	Kuldeep Singh, "Linear Algebra", Oxford University Press, 2013, ISBN: 9780199654444
Useful Links	
1	https://nptel.ac.in/courses/108/104/108104174/
2	https://ocw.mit.edu/courses/mathematics/18-06-linear-algebra-spring-2010/video-lectures/

CO-PO Mapping

	Programme Outcomes (PO)												**PSO**	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3													
CO2		2												
CO3			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 2022-23

Course Information

Programme	B.Tech. (Electrical Engineering)
Class, Semester	Third Year B. Tech., Sem V
Course Code	6EL313
Course Name	Professional Elective I: Energy Storage Systems for EV
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	This course aims to provide the foundation level knowledge of different energy storage systems.
2	The course will enable student to use various energy systems and study various components of battery management system.
3	The course will help the students to examine the power converters for electric vehicles.
4	The course will also help the students to analyse the performance of fuel cells and supercapacitors.

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 operation of various energy storage systems used for Electrical Vehicle applications	II	Understanding
CO2	**Analyse** the components and working of battery management system, fuel cells and supercapacitors to meet the performance criteria	III	Applying
CO3	**Investigate** the performance of different power electronic converters used in electric vehicles	IV	Analysing

Module	**Module Contents**	**Hours**
I	**Introduction to Energy Storage Systems** Introduction and need for storage for EV, Basics of vehicle mechanisms, history of electric vehicles (EV) and hybrid electric vehicles (HEV), need for and Importance of EV and HEV, classification of EV and HEV, Power/Energy supply requirements, traditional energy storage systems, global market and scenario, battery, fuel cell, supercapacitors, compressed air, hydrogen storage, fly-wheels, Comparison of different Energy Storage Systems.	6

II	**Batteries** Introduction to Batteries, Batteries Types and Battery Packs, Recent EVs and Battery Chemistries, Basic Battery Operation, Basic Electrochemistry, Lead-Acid Battery, Nickel-Metal Hydride, Lithium-Ion, Lithium-Ion Chemistries Units of Battery Energy Storage, Battery Parameters and Comparisons, Cell Voltage, Specific Energy, Cycle Life, Specific Power, Self-Discharge, Life time and Sizing Considerations, Examples of Battery Sizing, BEV Battery Sizing, PHEV Battery Sizing, Aging. Battery Models, applications of batteries, future developments.	8
III	**Converters for Batteries** Introduction, Power Conversion–Common and Basic Principles, The Basic Topologies, The Buck or Step-Down Converter, Analysis of Voltage Gain of Buck Converter in CCM, Analysis of Buck Converter in CCM, BCM, DCM, Examples, The Boost or Step-up Converter, Analysis of Voltage Gain of Boost Converter in CCM, Analysis of Boost Converter in CCM, BCM, DCM, Examples, Power Semiconductors, Power Semiconductor Power Loss, Conduction Losses of IGBT and Diode, Examples , Passive Components for Power Converters, Example: Inductor Sizing, Capacitor Sizing, Interleaving, Example: Two-Phase Interleaved Boost Converter.	7
IV	**Battery Management System** Objectives and functions of the BMS, SOC and DOD, charge controller, sensors in BMS, protection of batteries, CCCV, charging topologies, cell equalization, pulse power capability, dynamic power limits.	6
V	**Fuel Cells and its Classification** Basic structure and functions of fuel cell, its characteristics and working, fuel cell power conversion, classification of fuel cells, PEM and alkaline fuel cells, molten carbonate fuel cells, phosphoric acid, solid oxide fuel cells.	6
VI	**Supercapacitors and Hydrogen Storage Systems** Supercapacitor: characteristics, components, schematic, classification, advantages, disadvantages, Hydrogen storage systems: Basics, working and applications.	6
Textbooks		
1	“Electric Powertrain”, John G Hayes and G. Abas Gudarazi, First edition, A John Wiley & Sons Ltd. Publication, 2018	
2	“Electrical Vehicle Technology Explained”, James Larminie and John Lowry, Second edition, A John Wiley & Sons Ltd. Publication, 2012	
References		
1	“Renewable and efficient electric power systems “, Masters, Gilbert M., John Wiley & Sons, 2013.	
2	“Lithium-ion batteries: fundamentals and performance “, Wakihara, Masataka, and Osamu Yamamoto, eds. John Wiley & Sons, 2008.	
Useful Links		
1	https://nptel.ac.in/courses/113105102	

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

Open Elective - 1

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2022-23

Course Information

Programme	B.Tech. (Electrical Engineering)
Class, Semester	Third Year B. Tech., Sem V
Course Code	6OE343
Course Name	Open Elective I : Electrical Machine Technology
Desired Requisites:	Basic Electrical 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 make students understand operation and performance of ac and dc machines.
2	To make students learn characteristics of ac and dc machines.
3	To develop skills to choose ratings of ac and dc machines for various 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	Explain the construction and working principle of A.C. and D.C. Machines.	II	Understanding
CO2	Examine the various characteristics of A.C. and D.C. machines.	III	Applying
CO3	Analyze the performance of A.C. and D.C. machines for various applications.	IV	Analysing

Module	**Module Contents**	**Hours**
I	**DC Motors** Review of Construction, Working and Types, Back emf, Speed equation, Armature Reaction, Torque equation, Speed torque characteristics, Applications, Power losses in d.c. motors. Need of starter speed control of D.C. shunt and series motor, Thyristor based speed control for D.C. motor. Reversal of rotation, Electric braking of shunt and series motor.	7
II	**Single Phase Transformer** Construction and type, EMF equation phasor diagram, equivalent circuit, efficiency, losses, regulation, Experimental determination of equivalent circuit parameters and calculation of efficiency and regulation, Introductionto three Phase Transformer, Connection of three Phase Transformer, Applications of Transformers	6
III	**Three Phase Induction Motor** Construction, Types, Working, Speed equation, Torque equation, Starting torque, Concept of full load torque, torque speed characteristics, Power stages in motor, Induction Generator.	7
IV	**Three Phase Induction Motor Control** Need of starter, Speed control methods- Pole changing, Voltage control, VFD (V/f) control, Block schematic of electronic VFD control, Rotor resistance speed control, Reversal of rotation.	6

V	**Synchronous Machines** Alternator, Construction of Alternator, Synchronous Motor, Equivalent Circuit, Motor on load, Pull-Out Torque, Motor Phasor Diagram, MechanicalPower Developed by Motor, Power Factor of Synchronous Motor, Application of Synchronous Motor, Comparison of Synchronous Motor with Induction Motor.	6
VI	**Special-Purpose Electric Machines** Stepper motor-Variable-Reluctance Motor, Permanent Magnet Motor, Hybrid Stepper Motor, Servomechanism, D.C. Servomotors, A.C. Servomotors, Switched Reluctance Motor, Permanent Magnet D.C. Motor, Brushless D.C. Motor. Selection and Sizing of Motors based on applications.	7

Textbooks	
1	S. J. Chapman, "Electric Machinery Fundamentals", Tata Mc Graw Hill publication, 4th Edition, 2011, ISBN: 9780071070522
2	M. G. Say. "Performance Design of AC Machines", CBS Publishers, 3rd Edition, 2017, ISBN: 9788123910277
References	
1	SK Bhattacharya, "Electrical Machines", Tata Mc Graw Hill, 3rd Edition, 2010, ISBN: 9789332902855
2	J. B. Gupta, "Electrical Machines", SK Kataria and Sons, 2013, ISBN: 9789350140550
Useful Links	
1	https://nptel.ac.in/courses/108/102/108102146/
2	https://nptel.ac.in/courses/108/105/108105155/
3	https://nptel.ac.in/courses/108/105/108105131/

CO-PO Mapping

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