# Semester- VII

# Professional Core Theory Courses

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

**AY 2024-25**

**Course Information**

| | |
|---|---|
| **Programme** | B. Tech. Electrical Engineering |
| **Class, Semester** | Final Year B. Tech., Sem. VII |
| **Course Code** | 6EL401 |
| **Course Name** | Power System Operation and Control |
| **Desired Requisites:** | Power System Analysis and Stability, Control System Engineering |

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

**Course Objectives**

| | |
|---|---|
| **1** | To provide the knowledge of Power System Operation |
| **2** | To impart knowledge of various controls in power systems. |
| **3** | Introduce the recent trends in power systems |
| **4** | To inform the students about responsibilities of various levels of controls |

**Course Outcomes (CO) with Bloom's Taxonomy Level**

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

| **CO** | **Course Outcome Statement/s** | **Bloom's Taxonomy Level** | **Bloom's Taxonomy Description** |
|---|---|---|---|
| **CO1** | Describe the concepts of operation of power system considering various constraints of power apparatus. | II | Understanding |
| **CO2** | Analyze different power flow control methods. | III | Applying |
| **CO3** | Summarize the load dispatch centre functions | IV | Analyzing |
| **CO4** | Explain the effects of control system. | VI | Creating |

| **Module** | **Module Contents** | **Hours** |
|---|---|---|
| I | **Introduction to Characteristics of Modern Power Systems:** Physical Structure, Operation and Control Functions and Hierarchies, Design and Operating Criteria, comparison between ac and dc transmission. | 4 |
| II | **Equipment and Stability Constraints:** Capabilities and Constraints of Generators/Exciters/Turbines/Network Elements (Lines, Transformers etc.),Constraints of Energy Supply Systems, Load Characteristics, Introduction to Angle/Voltage Instability phenomena, Stability Constraints | 9 |
| III | **Frequency Control:** Advantages of Interconnections, role of system frequency in real power control, philosophy of real and reactive power control, single area load frequency control(AGC) Primary Control of Frequency : Governors, Secondary Control of Frequency : AGC Load Frequency Control (LFC) of single area system-static and dynamic analysis of uncontrolled and controlled cases - LFC of two area system, state variability model - integration of economic dispatch control with LFC. | 8 |

| | | |
|---|---|---|
| IV | **Voltage control:**<br>Definition of reactive power, positive and negative reactive power, reactive power requirements during peak and off peak hours, line voltage regulation and compensation, sources of reactive power. Automatic Voltage Regulators (generators), Shunt Compensation, SVC and excitation control system. | 8 |
| V | **Introduction to Power Flow Control:**<br>HVDC, FACTS, Load Curves, Unit Commitment, Introduction to the use of Optimization Methods. | 6 |
| VI | **Load Dispatch Centre Functions:**<br>Contingency Analysis, Preventive, Emergency and Restorative Control, recent trends in generation transmission and distribution, power former, GITL, deregulated energy system. | 4 |

| **Textbooks** | |
|---|---|
| 1 | Power System Analysis: Operation and Control by S. Sivanagaraju Pearson Education India, 2009 |
| 2 | Power System Operation and Control by Prabha Kundur. |
| **References** | |
| 1 | Power System Operation and Control Robert Herschel Miller, McGraw Hill Professional, 1994 |
| 2 | Power System Operation and Control by DR. K. UMA RAO, Wiley India, 2010 |
| 3 | Power System Operation and Control by N. V. Ramana Pearson Education India, 2010 |
| 4 | Power System Operation and Control Robert Herschel Miller, McGraw Hill Professional, 1994 |
| **Useful Links** | |
| 1 | https://archive.nptel.ac.in/courses/108/104/108104052/ |

**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 | | | | | | | | | | | | 3 |
| **CO3** | | | | 2 | | | | | | | | | | 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)

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|---|---|
| Syllabus Prepared By | Mrs. S. L. Shaikh |
| Syllabus Checked By | Dr V. P. Mohale |

# Walchand College of Engineering, Sangli

*(Government Aided Autonomous Institute)*

**AY 2024-25**

## Course Information

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|---|---|
| **Programme** | B. Tech. Electrical Engineering |
| **Class, Semester** | Final Year B. Tech., Sem. VII |
| **Course Code** | 6EL402 |
| **Course Name** | Power System Harmonics |
| **Desired Requisites:** | Power Electronics, Power System Analysis and Stability |

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

## Course Objectives

| | |
|---|---|
| **1** | Equip students with fundamental knowledge about power quality, including its significance, standards, and the various classes of power quality problems. |
| **2** | Provide a comprehensive understanding of harmonic distortion, its sources, effects, and methods for locating harmonic sources in commercial and industrial settings. |
| **3** | Educate students on both passive and active harmonic mitigation techniques, including the design, operation, and control of filters. |
| **4** | Teach students the definitions and calculations of power in single-phase and three-phase circuits under various conditions, adhering to IEEE standards. |

## 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 basic concepts of Power Quality disturbances, power definitions and other figures of merit under distorted operation. | II | Understanding |
| **CO2** | Apply power definitions and calculations for single-phase and three-phase circuits, under sinusoidal, non-sinusoidal, balanced, and unbalanced conditions, using IEEE 1459 standards. | III | Applying |
| **CO3** | Analyse voltage and current harmonic distortions, understanding their sources, and evaluating their effects on power systems. | IV | Analysing |
| **CO4** | Evaluate the design of passive and active filters for harmonic mitigation, including performing numerical analysis and case studies. | V | Evaluating |

| **Module** | **Module Contents** | **Hours** |
|---|---|---|
| I | **Introduction to Power Quality**<br>What is Power Quality? Power Quality -- Voltage Quality, Why Are We Concerned About Power Quality, Power Quality standards, General Classes of Power Quality Problems, Transients, Long-Duration Voltage Variations, Short-Duration Voltage Variations, Voltage Imbalance, Waveform Distortion<br>Voltage Fluctuation, Power Frequency Variations, Power Quality Terms | 6 |
| II | **Fundamentals of Harmonics**<br>Harmonic Distortion, Voltage versus Current Distortion, Harmonics versus Transients, Harmonic Indexes, Harmonic Sources from Commercial Loads, Harmonic Sources from Industrial Loads, Locating Harmonic Sources, System Response Characteristics, Effects of Harmonic Distortion, Interharmonics, Parallel resonance, case study on parallel resonance. | 7 |

| | | |
|---|---|---|
| III | **Harmonic Mitigation Techniques- Passive Filters**<br>Shunt passive filters, types, Design considerations of single tuned filters, Detuned filters, Design considerations of Detuned filters, High pass filters, Design considerations of HP filters, Case studies and numerical examples | 6 |
| IV | **Harmonic Mitigation Techniques-Shunt Active Power Filters**<br>Introduction, State of the Art on Shunt Active Power Filters, Classification of Shunt Active Power Filters, Principle of Operation and Control of Shunt Active Power Filters, Analysis and Design of Shunt Active Power Filters, Numerical Examples | 7 |
| V | **Power Definitions in Single Phase Circuits**<br>Definitions of various powers, power factor and other figures of merit under sinusoidal and non-sinusoidal conditions applicable to single phase circuits. | 6 |
| VI | **Power Definitions in Three Phase Circuits**<br>Definitions of various powers, power factor and other figures of merit under balanced, unbalanced and non-sinusoidal conditions. IEEE 1459 power definitions applicable to three phase circuits | 7 |
| | | |
| **Textbooks** | | |
| 1 | Roger C. Dugan, Mark F. McGranton and H. Wayne Beety, "*Electrical Power Systems Quality*" McGraw Hill. | |
| 2 | Dr. Mahesh Kumar, IIT Chennai, *Power Quality in Distribution Systems*. | |
| **References** | | |
| 1 | George J. Wakileh, "*Power System Harmonics* - Fundamentals, Analysis & Filter Design" Springer. | |
| 2 | Bhim Singh, Ambrish Chandra, Kamal Al-Haddad, *Power Quality Problems and Mitigation Techniques*, Wiley, 2015. | |
| | | |
| **Useful Links** | | |
| 1 | https://nptel.ac.in/courses/108/107/108107114/ | |

**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** | 2 | | | | | | | | | | | | 2 | |
| **CO3** | | 2 | | | | | | | | | | | 2 | |
| **CO4** | | | 2 | | | | | | | | | | 2 | |

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

**Assessment**

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

| | |
|---|---|
| Syllabus Prepared By | Seema P Diwan |
| Syllabus Checked By | Swapnil Patil |

# Walchand College of Engineering, Sangli

*(Government Aided Autonomous Institute)*

**AY 2024-25**

| **Course Information** | |
|---|---|
| **Programme** | B. Tech. Electrical Engineering |
| **Class, Semester** | Final Year B. Tech., Sem. VII |
| **Course Code** | 6EL403 |
| **Course Name** | Electrical Machine Design |
| **Desired Requisites:** | DC Machine and Transformers, AC Machines |

| **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 intends to provide basic knowledge of design process of Electrical Machines. |
| **2** | It is aimed to impart skills to perform and apply basics of Electrical Engineering for design of Electrical machines. |
| **3** | To develop knowledge on cooling and ventilation schemes of static and rotating machines. |
| **4** | To solve design problems related to static and rotating machines. |

**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 design procedure for electrical machine. | II | Understanding |
| **CO2** | Solve different problems related to design of electrical machines. | III | Applying |
| **CO3** | Analyze the performance of machine based on design details. | IV | Analyzing |
| **CO4** | Design transformer, induction motor and synchronous machine. | VI | Creating |

| **Module** | **Module Contents** | **Hours** |
|---|---|---|
| I | **Constructional Details And Design of Transformers**<br>Output equation, EMF per turn. Ratio of iron loss to copper loss, Relation between core area and weights of iron and copper, optimum designs, Core design. Design of windings. | 6 |
| II | **Performance Evaluation of Transformer**<br>Calculation of no-load current. Equivalent circuit and performance characteristics. Temperature rise. Design of tank and radiators. | 6 |
| III | **Constructional Details And Design of Three Phase Induction Motors**<br>Output equation. Specific electric and magnetic loadings. Efficiency and power factor, main dimensions. Type of winding and connection .Turns per phase, shape of stator slots. Number of stator slots, design of stators. | 7 |
| IV | **Operating Characteristics of Three Phase Induction Motors**<br>No load current Magnetizing current, loss component short circuit current. Use of circle diagram to obtain performance figures. Calculation of static torque, maximum torque, maximum output, maximum power factor. Dispersion coefficient. | 7 |

| | | |
|---|---|---|
| V | **Design of Synchronous Machines**<br>Construction of water wheel and turbo alternators. Different parts and materials used for Synchronous machine, choice of electric and magnetic loadings, Output equation. Determination of diameter and length, effect of short circuit ratio on machine performance. | 7 |
| VI | **Computer Aided Design of Electrical Machines**<br>Benefits of computer in machine design, methods of approach, optimization and computer aided design of induction motor and three phase transformer, Testing as per IS. | 6 |

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| | |
| **Textbooks** | |
| 1 | "A Course in Electrical Machine Design" - by A. K. Sawhney, Dhanpat Rai and Sons, Delhi, 6th Edition, 2006. |
| 2 | "Design of Electrical Machines", by V.N. Mittle and A. Mittle, Standard Publications & Distributors, Delhi, 2002. |
| **References** | |
| 1 | "Principles of Electrical Machine Design", by R. K. Agarwal, S. K. Kataria and Sons, Delhi, 2002. |
| 2 | "Principles of Electrical Machine Design with Computer Programmes" S.K. Sen, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, 1987. |
| | |
| **Useful Links** | |
| 1 | Design of Electric Motors (NPTEL): https://nptel.ac.in/courses/108108191 |
| 2 | Computer-Aided Design of Electrical Machines (NPTEL): https://nptel.ac.in/courses/108102372 |

**CO-PO Mapping**

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

| | |
|---|---|
| Syllabus Prepared By | Mr. S. S. Medhekar |
| Syllabus Checked By | Dr. R. P. Hasabe |

# Walchand College of Engineering, Sangli

*(Government Aided Autonomous Institute)*

**AY 2023-24**

## Course Information

| | |
|---|---|
| **Programme** | B. Tech. Electrical Engineering |
| **Class, Semester** | Final Year B. Tech. Sem. VII |
| **Course Code** | 6EL404 |
| **Course Name** | Research Methodology and IPR |
| **Desired Requisites:** | NIL |

| **Teaching Scheme** | | **Examination Scheme (Marks)** | | | |
|---|---|---|---|---|---|
| **Lecture** | 2 Hrs/week | **MSE** | **ISE** | **ESE** | **Total** |
| **Tutorial** | - | 30 | 20 | 50 | 100 |
| | | **Credits: 2** | | | |

## Course Objectives

| | |
|---|---|
| **1** | To prepare students for undergoing research, identify and formulate the research problems, state the hypothesis, design a research layout, set a research process and methodology. |
| **2** | To be aware about current trends in IPR and Govt. steps in fostering IPR. |
| **3** | To enable student interpret the results, propose theories, suggest possible/alternative solutions, solve, and prove the solution adapted–logically and analytically, conclude the research findings. |
| **4** | To impart knowledge to analyse critically the literature and publish research in conferences, journals and to expose students to research ethics, IPR and Patents |

## Course Outcomes (CO) with Bloom's Taxonomy Level

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

| **CO** | **Course Outcome Statement/s** | **Bloom's Taxonomy Level** | **Bloom's Taxonomy Description** |
|---|---|---|---|
| **CO1** | Demonstrate a research solution in respective engineering domain using appropriate Engineering research process and research methodology. | III | Apply |
| **CO2** | Interpret patent and copyright in innovative research work. | III | Apply |
| **CO3** | Device feasible solution to a research problem in respective engineering domain based on economic, social and legal aspects using appropriate research procedures and practices. | IV | Analyse |
| **CO4** | Write research publication, Dissertation, IPR and patent document. | VI | Create |

| **Module** | **Module Contents** | **Hours** |
|---|---|---|
| I | **Engineering Research Process**<br>Research problem- meaning, sources, criteria and characteristics<br>Definition, scope and objectives of research problem, Errors in selecting a research problem, Approaches of investigation of solutions for research problem, data collection, analysis, interpretation. | 4 |
| II | **Research Methodology**<br>Problem statement formulation, resources identification for solution, Experimental and Analytical modelling, Simulations, Numerical and Statistical methods in engineering research. Hypothesis and its testing by different techniques: Z-test etc., | 4 |
| III | **Research Methods**<br>Uni and Multivariate Analysis: ANOVA, Design of Experiments/Taguchi Method, Regression Analysis. Software tools like spread sheets.<br>Processing and Analysis of Data: Processing Operations, Types of Analysis Presentation and Interpretation of Data Editing, Classification and Tabulation Interpretation. Analyse your results and draw conclusions. | 5 |

| | | |
|---|---|---|
| IV | **Research Practices**<br>Effective literature studies approaches, critical analysis, Plagiarism, Research ethics, Medley - Reference Management Software.<br>Research communication- Effective Technical Writing, Writing a research article for Journal/conference paper, Technical report, Dissertation/ Thesis report writing, Software used for report writing ,Presentation techniques for paper/report/seminar, Publishing article. | 5 |
| V | **Intellectual Property Rights (IPR)**<br>Nature of Intellectual Property: Patents, Designs, Trade and Copyright, Ownership of copyright, Term of copyright, Technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. New developments in IPR, Traditional knowledge, Various Case Studies. | 4 |
| VI | **Patents**<br>Patent Rights: Scope of Patent Rights. Various Patent databases. Geographical Indications. Procedure for grants of patents, Patenting under PCT. Licensing and transfer of technology. Administration of Patent System. Introduction to International Scenario: WIPO, TRIPs, Patenting under PCT. | 4 |

| **Textbooks** | |
|---|---|
| 1 | Kothari C. R, "Research Methodology", 2nd Edition, New Age International, 2004 |
| 2 | Melville Stuart and Goddard Wayne, "Research Methodology: An Introduction for Science & Engineering Students" Juta and Company Ltd, 2000. |
| 3 | Kumar Ranjit, "Research Methodology: A Step-by-Step Guide for beginners", SAGE Publications, 4th Ed.-2014. |

| **References** | |
|---|---|
| 1 | Merges Robert, Menell Peter, Lemley Mark, "Intellectual Property in New Technological Age", ASPEN Publishers, 2016. |
| 2 | Ramappa T., "Intellectual Property Rights Under WTO", S. Chand, 2008 |
| 3 | Mayall, "Industrial Design", McGraw Hill, 1992. |
| 4 | Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007 |
| 5 | Deepak Chopra and Neena Sondhi, Research Methodology : Concepts and cases, Vikas Publishing House, New Delhi |

| **Useful Links** | |
|---|---|
| 1 | NPTEL :: General - NOC:Introduction to Research |
| 2 | Introduction to Research - Course (nptel.ac.in) |
| 3 | Qualitative Research Methods And Research Writing - Course (nptel.ac.in) |
| 4 | https://onlinecourses.swayam2.ac.in/ntr21_ed23/preview - Academic Research & Report Writing |
| 5 | https://www.scopus.com/search/form.uri?display=basic#basic |
| 6 | https://onlinecourses.nptel.ac.in/noc21_ge12/preview - Qualitative Research Methods And Research Writing |
| 7 | https://onlinecourses.nptel.ac.in/noc21_hs44/preview - Effective Writing |
| 8 | https://webofscienceacademy.clarivate.com/learn |
| 9 | https://onlinecourses.swayam2.ac.in/ntr21_ed23/preview - Academic Research & Report Writing |
| 10 | https://nptel.ac.in/courses/121/106/121106007/ |
| 11 | https://nptel.ac.in/courses/121/106/121106007/ |

| **CO-PO Mapping** | | |
|---|---|---|
| | **Programme Outcomes (PO)** | **PSO** |

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | | | | | | | | | | | |
| **CO2** | | | | | | 3 | | 3 | | | | | | |
| **CO3** | | | | | 2 | | | 3 | | | | | | |
| **CO4** | | | | | | | | | | | 2 | | | |
| The strength of mapping is to be written as 1: Low, 2: Medium, 3: High<br>Each CO of the course must map to at least one PO. | | | | | | | | | | | | | | |

| **Assessment** |
|---|
| The assessment is based on MSE, ISE and ESE.<br>MSE shall be typically on modules 1 to 3.<br>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.<br>ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.<br>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) |

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

# Professional Core Laboratory Courses

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

**AY 2024-25**

**Course Information**

| | |
|---|---|
| **Programme** | B. Tech. Electrical Engineering |
| **Class, Semester** | Final Year B. Tech., Sem VII |
| **Course Code** | 6EL451 |
| **Course Name** | Power System Operation and Control Lab |
| **Desired Requisites:** | Power System Analysis and Stability Lab |

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

**Course Objectives**

| | |
|---|---|
| **1** | To provide the knowledge of Power System Operation. |
| **2** | To impart knowledge of various controls in power systems. |
| **3** | To develop simulation skills for power system operation and control |
| **4** | To explain the functions of various dispatch centre in control hierarchy. |

**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** | Assemble experimental set-up for collection and analysis of data for power system operation. | III | Applying |
| **CO2** | Conduct simulation studies for evaluating different power flow control methods. | IV | Analysing |
| **CO3** | Tell the load dispatch centre functions as group task. | IV | Analysing |
| **CO4** | Discuss strategies of power system operation and control for given load conditions. | IV | Analysing |

**List of Experiments / Lab Activities/Topics**

**List of Lab Activities:**

1. Modeling of single area and multi-line load frequency control in Simulink
2. Modeling AVR in Simulink
3. Study of effect of faults (LG, LL and DLG) on a single machine connected to infinite Bus
4. Solution of swing equation by any one method
5. To compute voltage, current, power factor, regulation, and efficiency at the receiving end of a three phase transmission line when the voltage and power
6. To evaluate performance of long transmission line without compensation
7. To evaluate performance of long transmission line with shunt compensation
8. To control load frequency of a two area power system without & with pi controller
9. To simulate transient stability analysis of power system.

**Textbooks**

| | |
|---|---|
| 1 | Power System Analysis: Operation and Control by S. Sivanagaraju Pearson Education India, 2009 |

**References**

| | |
|---|---|
| 1 | Power System Operation and Control Robert Herschel Miller, McGraw Hill Professional, 1994 |
| 2 | Power System Operation and Control by DR. K. UMA RAO, Wiley India, 2010 |

| | |
|---|---|
| 3 | Power System Operation and Control by N. V. Ramana Pearson Education India, 2010 |
| **Useful Links** | |
| 1 | https://www.mahatransco.in/information/details/load_despatch |
| 2. | https://www.powergrid.in/ |

| **CO-PO Mapping** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Programme Outcomes (PO)** | | | | | | | | | | | | **PSO** | |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 |
| **CO1** | | | 3 | | | | | | | | | | | |
| **CO2** | | | 3 | | | | | | | | | | | |
| **CO3** | | | | | 3 | | | | | | | | | |
| **CO4** | | | | | 3 | | | | | | | | | |
| The strength of mapping is to be written as 1,2,3; where, 1: Low, 2: Medium, 3: High<br>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<br>Marks Submission at the end of Week 8 | 30 |
| LA2 | Lab activities, attendance, journal | Lab Course Faculty | During Week 9 to Week 16<br>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<br>Marks Submission at the end of Week 19 | 40 |

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

| | |
|---|---|
| Syllabus Prepared By | Mrs. S.L Shaikh |
| Syllabus Checked By | Dr V. P. Mohale |

# Walchand College of Engineering, Sangli

*(Government Aided Autonomous Institute)*

**AY 2024-25**

**Course Information**

| | |
|---|---|
| **Programme** | B. Tech. Electrical Engineering |
| **Class, Semester** | Final Year B. Tech., Sem VII |
| **Course Code** | 6EL452 |
| **Course Name** | Power System Harmonics Lab |
| **Desired Requisites:** | Power Electronics, Power System Analysis and Stability |

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

**Course Objectives**

| | |
|---|---|
| **1** | Equip students with the skills to comprehensively model and simulate various power quality disturbances, including transients, harmonics, and voltage variations. |
| **2** | Provide a deep understanding of power component definitions in both single-phase and three-phase circuits, especially with nonlinear loads. |
| **3** | Educate students on the design and analysis of harmonic mitigation techniques, including single tuned filters, composite passive harmonic filters, and active power filters. |
| **4** | Develop students' ability to apply theoretical concepts in practical scenarios, including calculating K factor and derating factors, solving for resonance frequencies, and developing MATLAB programs for filter design. |

**Course Outcomes (CO) with Bloom's Taxonomy Level**

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

| **CO** | **Course Outcome Statement/s** | **Bloom's Taxonomy Level** | **Bloom's Taxonomy Description** |
|---|---|---|---|
| **CO1** | Identify power quality problems and its solutions. | II | Understanding |
| **CO2** | Calculate power complement definitions in single phase and three phase circuits. | III | Applying |
| **CO3** | Investigate the performance of single phase and three phase circuits with non-linear loads. | IV | Analysing |
| **CO4** | Design suitable harmonic filtering systems for particular applications. | VI | Creating |

**List of Experiments / Lab Activities/Topics**

**List of Lab Activities:**

1. A Comprehensive Modeling and Simulation of Power Quality Disturbances. (Transients and Harmonics)
2. A Comprehensive Modeling and Simulation of Power Quality Disturbances. (Short duration voltage variations)
3. Analysis of Power components definitions in single phase circuits with nonlinear loads.
4. Calculate K factor of load and transformer derating factor.
5. Calculate the parallel resonance frequency and solve for the magnified currents and voltages in the circuit.
6. Design and analysis of 5th Harmonic Single Tuned Filter for Harmonic Mitigation.
7. Design and analysis of Detuned Filter for Harmonic Mitigation.
8. Design and analysis of Composite Passive Harmonic Filter for Harmonic Mitigation.
9. Simulation of Shunt active power filter using p-q theory.
10. Simulation of Shunt active power filter using d-q theory.
11. Develop MATLAB program(*.m) for design of single tuned and high pass filters
12. Analysis of Power Component definitions in three phase circuits with a balanced Sinusoidal supply and Nonlinear load.

| **Textbooks** | |
|---|---|
| 1 | Roger C. Dugan, Mark F. McGranton and H. Wayne Beety, "*Electrical Power Systems Quality*" McGraw Hill. |
| 2 | Dr. Mahesh Kumar, IIT Chennai, *Power Quality in Distribution Systems*. |

| **References** | |
|---|---|
| 1 | George J. Wakileh, "*Power System Harmonics* - Fundamentals, Analysis & Filter Design" Springer. |
| 2 | Bhim Singh, Ambrish Chandra, Kamal Al-Haddad, *Power Quality Problems and Mitigation Techniques*, Wiley, 2015. |

| **Useful Links** | |
|---|---|
| 1 | https://nptel.ac.in/courses/108/107/108107114/ |

**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** | 2 | | | | | | | | | | | | 2 | |
| **CO3** | | 2 | | | | | | | | | | | 2 | |
| **CO4** | | | 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<br>Marks Submission at the end of Week 8 | 30 |
| LA2 | Lab activities, attendance, journal | Lab Course Faculty | During Week 9 to Week 16<br>Marks Submission at the end of Week 16 | 30 |

| | | | | |
|---|---|---|---|---|
| Lab ESE | Lab activities, journal/ performance | Lab Course Faculty and External Examiner as applicable | During Week 18 to Week 19 Marks Submission at the end of Week 19 | 40 |
| Week 1 indicates starting week of a semester. Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming, and other suitable activities, as per the nature and requirement of the lab course. The experimental lab shall have typically 8-10 experiments and related activities if any. | | | | |

| | |
|---|---|
| Syllabus Prepared By | Seema P Diwan |
| Syllabus Checked By | Swapnil Patil |

# Walchand College of Engineering, Sangli

*(Government Aided Autonomous Institute)*

**AY 2024-25**

## Course Information

| | |
|---|---|
| **Programme** | B. Tech. Electrical Engineering |
| **Class, Semester** | Final Year B. Tech., Sem. VII |
| **Course Code** | 6EL453 |
| **Course Name** | Electrical Machine Design Lab |
| **Desired Requisites:** | AC Machines, Advanced Simulation Lab |

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

## Course Objectives

| | |
|---|---|
| **1** | This course intends to provide basic knowledge of draw and design process of simple Electrical machines. |
| **2** | It is aimed to impart skills to perform and apply basics of Electrical Engineering for draw and design of Electrical machines. |
| **3** | To solve design problems related to static and rotating machines. |
| **4** | To understand different computer aided techniques in design of static and rotating machines. |

## 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 design procedure for electrical machine. | II | Understanding |
| **CO2** | Solve different design problems using computer aided techniques | III | Applying |
| **CO3** | Analyze the performance of machine based on design details. | IV | Analyzing |
| **CO4** | Design transformer, induction motor and synchronous machine. | VI | Creating |

## List of Experiments / Lab Activities/Topics

**List of Lab Activities:**

1. Design the transformer with given suitable data.
2. Calculate the radiators for transformer.
3. Design the Induction Motor stator with provided input data.
4. Design the Induction Motor rotor with applications.
5. Design the Synchronous Machine parts.
6. Drawing sheets on Transformer parts, Transformer Design.
7. Drawing sheets on Induction motor parts, Induction Motor design.
8. Design the machines with computer aided Methods.
9. Assignments using software or problem solving, seminars, and any other work based on syllabus.
10. Use Software for design of Electrical Machine parts.

## Textbooks

| | |
|---|---|
| 1 | "A Course in Electrical Machine Design" - by A. K. Sawhney, Dhanpat Rai and Sons, Delhi, 6th Edition, 2006. |
| 2 | "Design of Electrical Machines", by V.N. Mittle and A. Mittle, Standard Publications & Distributors, Delhi, 2002. |

## References

| | |
|---|---|
| 1 | “Principles of Electrical Machine Design” , by R.K. Agarwal, S.K. Kataria and Sons, Delhi, 2002 |
| 2 | “Principles of Electrical Machine Design with Computer Programmes” S. K. Sen, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, 1987. |
| | |
| **Useful Links** | |
| 1 | Design Of Electric Motors (NPTEL): https://nptel.ac.in/courses/108108191 |
| 2 | Computer-Aided Design of Electrical Machines (NPTEL): https://nptel.ac.in/courses/108102372 |

**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 | | | | | | | | | | | | |
| **CO4** | | | 2 | | | | | | | | | | | 3 |

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

**Assessment**

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

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

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

| | |
|---|---|
| Syllabus Prepared By | Mr. S. S. Medhekar |
| Syllabus Checked By | Dr. R. P. Hasabe |

# Walchand College of Engineering, Sangli

*(Government Aided Autonomous Institute)*

**AY 2024-25**

| **Course Information** | |
|---|---|
| **Programme** | B. Tech. Electrical Engineering |
| **Class, Semester** | Final Year B. Tech., Sem. VII |
| **Course Code** | 6EL491 |
| **Course Name** | Project-I |
| **Desired Requisites:** | -- |

| **Teaching Scheme** | | **Examination Scheme (Marks)** | | | |
|---|---|---|---|---|---|
| **Practical** | 6 Hrs/ Week | **LA1** | **LA2** | **Lab ESE** | **Total** |
| **Interaction** | - | 30 | 30 | 40 | 100 |
| | | **Credits: 3** | | | |

| **Course Objectives** | |
|---|---|
| **1** | This course is intended to review and demonstrate their understanding of the selected specific topic. |
| **2** | It is aimed to enable students to interpret, analyze and infer research papers and understand how they are written critically and efficiently |
| **3** | It provides the ability to review the research papers and present the understanding of a new field. |
| **4** | It is expected to identify new directions in Electrical Engineering and illustrate its importance. |

**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 conceptual idea behind the project | II | Understanding |
| **CO2** | Interpret and communicate different contributions in Electrical Engineering and identify promising directions in the same. | III | Applying |
| **CO3** | Analyze the research papers/ magazine articles and their impact on global, economic, environmental and societal issues. | IV | Analyzing |
| **CO4** | Evaluate and present the research papers/ magazine articles and outline the important points in the papers/ articles. | V | Evaluating |

**List of Experiments / Lab Activities/Topics**

**List of Lab Activities:**

Seminar shall be delivered on one of the advanced topics chosen for project in consultation with the guide after compiling the information from the latest literature and also internet. The concepts must be clearly understood and presented by the student. Student should work on his project. He/She should complete the literature survey and develop the design of the project. All modern methods of presentation should be used by the student. A hard copy of the report on selected project topic (25 to 30 pages A4 size, 12 fonts, Times New Roman, single spacing both side printed as per the format specified by the department) should be submitted to the department. A PDF copy of the report in soft form must be submitted to the guide along with other details if any.

| **Textbooks** | |
|---|---|
| 1 | As per topic Selected and Journal papers, Conference papers, Handbooks |

| **References** | |
|---|---|
| 1 | As per topic Selected and Journal papers, Conference papers, Handbooks |

| **Useful Links** | |
|---|---|
| 1 | ---- |

| CO-PO Mapping | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Programme Outcomes (PO) | | | | | | | | | | | | PSO | |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 |
| **CO1** | | | | | | | 2 | | | 3 | | | | |
| **CO2** | | | | | | | | 3 | | | | | | |
| **CO3** | | | | | | | | | 3 | | | | | |
| **CO4** | | | | | 2 | | 3 | | | | | | | |
| The strength of mapping is to be written as 1,2,3; where, 1: Low, 2: Medium, 3: High<br>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.<br>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<br>Marks Submission at the end of Week 8 | 30 |
| LA2 | Lab activities, attendance, journal | Lab Course Faculty | During Week 9 to Week 16<br>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<br>Marks Submission at the end of Week 19 | 40 |
| Week 1 indicates starting week of a semester. Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming, and other suitable activities, as per the nature and requirement of the lab course. The experimental lab shall have typically 8-10 experiments and related activities if any. | | | | |

| | |
|---|---|
| Syllabus Prepared By | Mr. N.V. Patel |
| Syllabus Checked By | Mrs. A.A. Dhamangaonkar |

# Professional Elective Theory Courses

# Walchand College of Engineering, Sangli

*(Government Aided Autonomous Institute)*

**AY 2024-25**

## Course Information

| | |
|---|---|
| **Programme** | B. Tech. Electrical Engineering |
| **Class, Semester** | Final Year B. Tech., Sem VII |
| **Course Code** | 6EL411 |
| **Course Name** | Professional Elective- 3: HVDC |
| **Desired Requisites:** | Power Electronics**,** Electrical Transmission and Distribution |

| **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 intends the students to analyze concept of HVDC transmission system. |
| **2** | It provides the knowledge of appropriate control and protection systems in HVDC transmission systems. |
| **3** | It gives the overview of recent trends in HVDC transmission systems. |
| **4** | This course intends the students to understand the concept of multi terminal HVDC transmission 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** | Describe the operation of HVDC systems. | II | Understanding |
| **CO2** | Explain different configurations of HVDC system | II | Understanding |
| **CO3** | Determine various control and protection schemes for HVDC transmission system. | III | Applying |
| **CO4** | Categorize multi terminal HVDC transmission system. | IV | Analysing |

| **Module** | **Module Contents** | **Hours** |
|---|---|---|

| | | |
|---|---|---|
| I | **Introduction to HVDC Transmission Technology**<br>Comparison of EHVAC and HVDC Transmission, types of HVDC transmission systems, components of HVDC transmission system. | 6 |
| II | **Analysis of HVDC converter**<br>Different modes of valve operation, o/p voltage waveforms and D C voltage in rectification, and inverter operation, valve voltages, equivalent electrical circuit, converter charts. | 7 |
| III | **HVDCTS control features**<br>Control modes, control schemes and their comparisons, energization and de-energization of bridges, starting and stopping of D C link. | 7 |
| IV | **Faults and over-voltages**<br>Converter mal-operations, commutation failure, over-voltages in HVDCTS, protection of converters, D C reactor and damper circuits. | 6 |
| V | **Harmonics and their suppression in HVDCTS**<br>Harmonic analysis, filter design, minimum cost tuned A C filters, reactive power requirements. | 7 |
| VI | **Multi terminal HVDCTS**<br>Series and parallel MTDCTS, their control, introduction to HVDC light, recent trends in HVDCTS. | 6 |

| **Text Books** | |
|---|---|
| 1 | K.R. Padiyar, "*H.V.D.C. Power Transmission*", Wiley Eastern, New Delhi. |
| 2 | E.W. Kimbark, "*Direct Current Transmission*", Win publisher. |

| **References** | |
|---|---|
| 1 | J. Arrillaga, "*H.V.D.C. Transmission*", Peter limited |
| 2 | S.Rao, "*E.H.V.A.C. & H.V.D.C. Transmission*", Khanna Publishers. |

| **Useful Links** | |
|---|---|
| 1 | https://nptel.ac.in/courses/108104013 |

**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 |
| **CO4** | | 2 | | | | | | | | | | | | 2 |

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

**Assessment**

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

| | |
|---|---|
| Syllabus Prepared By | Mr. M.S. Mahagaonkar |
| Syllabus Checked By | Mrs. S.L. Shaikh |

# Walchand College of Engineering, Sangli

*(Government Aided Autonomous Institute)*

**AY 2024-25**

| **Course Information** | |
|---|---|
| **Programme** | B. Tech. Electrical Engineering |
| **Class, Semester** | Final Year B. Tech., Sem. VII |
| **Course Code** | 6EL412 |
| **Course Name** | Professional Elective- 3: Industrial Automation with PLC |
| **Desired Requisites:** | Electrical Measurement and Instrumentation |

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

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

**Course Outcomes (CO) with Bloom's Taxonomy Level**

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

| **CO** | **Course Outcome Statement/s** | **Bloom's Taxonomy Level** | **Bloom's Taxonomy Description** |
|---|---|---|---|
| **CO1** | Interpret features of PLC and Embedded Control Systems used for Industrial Automation. | III | Applying |
| **CO2** | Use ladder logic programming technique for various PLC applications | III | Applying |
| **CO3** | Construct PLC-based control systems for various industrial applications | III | Applying |
| **CO4** | Evaluate the performance of PLC network configurations, PLC functions used for different application | V | Evaluating |

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

| | | |
|---|---|---|
| V | **Advanced PLC Functions**<br>Data move system, data handling functions, Digital bit functions and applications, sequencer functions, Analog input and outputs in PLC , Analog PLC operations, PID control using PLC | 7 |
| VI | **PLC Networking**<br>Networking of PLCs, Levels of Industrial Control, Types of Networking, Network Communications, Cell control by PLC Networks, Factors to consider in selecting a PLC | 6 |

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

**CO-PO Mapping**

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

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

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

**AY 2024-25**

**Course Information**

| | |
|---|---|
| **Programme** | B. Tech. Electrical Engineering |
| **Class, Semester** | Final Year B. Tech., Sem. VII |
| **Course Code** | 6EL413 |
| **Course Name** | Professional Elective- 3: Advanced Power Electronics |
| **Desired Requisites:** | Power Electronics |

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

**Course Objectives**

| | |
|---|---|
| **1** | To provide advanced knowledge of different power electronic converters such as PWM voltage source converters, multi-level inverters, resonant converters, solar inverters and matrix converters. |
| **2** | To impart skills of analysis for different types of advanced converters and shunt active power filters. |
| **3** | To make the students acquainted with control strategies of different types of advanced converters and shunt active power filters. |
| **4** | To make the students aware of the recent advances in power electronics and their use in industrial applications. |

**Course Outcomes (CO) with Bloom's Taxonomy Level**

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

| **CO** | **Course Outcome Statement/s** | **Bloom's Taxonomy Level** | **Bloom's Taxonomy Description** |
|---|---|---|---|
| **CO1** | Distinguish configuration and working of different advanced power electronic converters. | II | Understanding |
| **CO2** | Identify the appropriate power electronic converter for the given application. | III | Applying |
| **CO3** | Analyse different advanced power electronic converters and systems. | IV | Analyzing |
| **CO4** | Evaluate performance of different power electronic system using power electronic devices and converters. | V | Evaluating |

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

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

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| | |
| **Textbooks** | |
| 1 | M. H. Rashid, "Power Electronics: circuits devices and applications" , Pearson Education, Third edition. |
| **References** | |
| 1 | B. K. Bose, "Modern Power Electronics & AC drives" , PHIPL, New Delhi. |
| 2 | M. B. Patil, V. Ramayanan and V. T. Ranganathan, "Simulation of Power Electronics circuits" , Narosa publication. |
| 3 | IEEE Transaction papers. |
| | |
| **Useful Links** | |
| 1 | https://onlinecourses.nptel.ac.in/noc23_ee127/preview |

**CO-PO Mapping**

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

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

**Assessment**

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

| | |
|---|---|
| Syllabus Prepared By | Dr. D. S. More |
| Syllabus Checked By | Dr. Mrs. A. S. Karvekar |

# Professional Elective Laboratory Courses

# Walchand College of Engineering, Sangli

*(Government Aided Autonomous Institute)*

**AY 2024-25**

**Course Information**

| | |
|---|---|
| **Programme** | B. Tech. Electrical Engineering |
| **Class, Semester** | Final Year B. Tech., Sem VII |
| **Course Code** | 6EL454 |
| **Course Name** | Professional Elective -3: HVDC Lab |
| **Desired Requisites:** | Power Electronics, Simulation Lab |

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

**Course Objectives**

| | |
|---|---|
| **1** | To Understand the advantages of dc transmission over ac transmission. |
| **2** | To provide the knowledge of appropriate control and protection systems in HVDC transmission systems |
| **3** | To perform MATLAB Simulation of AC/DC side voltage and current waveforms of six pulse converter |
| **4** | To perform MATLAB Simulation of AC/DC side voltage and current waveforms of twelve pulse converter |

**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 suitable control strategies used for LCC and VSC based HVDC transmission system. | III | Applying |
| **CO2** | Apply reactive power control in HVDC transmission system | III | Applying |
| **CO3** | Analyse the Line Commutated Converters and Voltage Source Converters in HVDC Transmission System. | IV | Analysing |
| **CO4** | Analyse various passive filters used in LCC based HVDC transmission system | IV | Analysing |

**List of Experiments / Lab Activities/Topics**

**List of Lab Activities:**

1. Study of various HVDC transmission system components and its applications.
2. MATLAB Simulation of AC/DC side voltage and current waveforms of six pulse converter system under variable RL Load using simulation.
3. MATLAB Simulation of AC/DC side voltage and current waveforms of twelve pulse converter system under variable R-L Load using simulation.
4. Study of reactive power control in HVDC transmission system.
5. Study of various types of Multi terminal HVDC transmission system.
6. MATLAB Simulation of HVDC power and voltage stability.
7. MATLAB Simulation of DC link control in VSC based HVDC transmission system.
8. Study of various passive filters used in LCC based HVDC transmission system.
9. Operation of VSC for power factor correction at AC side of HVDC system using sinusoidal pulse width modulation.

| Textbooks | |
|---|---|
| 1 | K.R. Padiyar, “H.V.D.C. Power Transmission”, Wiley Eastern, New Delhi. |
| 2 | E.W. Kimbark, “Direct Current Transmission”, Win publisher. |
| | |
| **References** | |
| 1 | J. Arrillaga, “H.V.D.C. Transmission”, Peter limited |
| 2 | S.Rao, “E.H.V.A.C. & H.V.D.C. Transmission”, Khanna Publishers. |
| | |
| **Useful Links** | |
| 1 | https://nptel.ac.in/courses/108104013 |

| CO-PO Mapping | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Programme Outcomes (PO) | | | | | | | | | | | | PSO | |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 |
| **CO1** | | 3 | | | | | | | | | | | | |
| **CO2** | | | | 3 | | | | | | | | | | |
| **CO3** | | | | 3 | | | | | | | | | | |
| **CO4** | | | | | 3 | | | | | | | | | |
| The strength of mapping is to be written as 1,2,3; where, 1: Low, 2: Medium, 3: High<br>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.<br>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<br>Marks Submission at the end of Week 8 | 30 |
| LA2 | Lab activities, attendance, journal | Lab Course Faculty | During Week 9 to Week 16<br>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<br>Marks Submission at the end of Week 19 | 40 |
| Week 1 indicates starting week of a semester. Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming, and other suitable activities, as per the nature and requirement of the lab course. The experimental lab shall have typically 8-10 experiments and related activities if any. | | | | |

| | |
|---|---|
| Syllabus Prepared By | Mr. M. S. Mahagaonkar |
| Syllabus Checked By | Mrs. S. L. Shaikh |

# Walchand College of Engineering, Sangli

*(Government Aided Autonomous Institute)*

**AY 2024-25**

## Course Information

| | |
|---|---|
| **Programme** | B. Tech. Electrical Engineering |
| **Class, Semester** | Final Year B. Tech., Sem. VII |
| **Course Code** | 4EL455 |
| **Course Name** | Professional Elective- 3 Lab: Industrial Automation with PLC Lab |
| **Desired Requisites:** | Electrical Measurement and Instrumentation |

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

## Course Objectives

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

## Course Outcomes (CO) with Bloom's Taxonomy Level

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

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

## List of Experiments / Lab Activities/Topics

**List of Lab Activities:**

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

## Textbooks


| | |
|---|---|
| 1 | John W. Webb, Ronald A. Reis, Programmable logic controllers, principles & applications, PHI publication, Eastern Economic Edition, 1994. |
| 2 | Gary dunning, Introduction to PLC, Thomson learning, Edition III, 2006. |
| 3 | Frank D. Petruzella ,Programmable Logic Controllers, 3rd Edition, Tata McGraw Hill, New York, 2010 |

| | |
|---|---|
| 4 | Madhuchhanda Mitra, Samarjit Sengupta, Programmable logic controllers and Industrial Automation: An Introduction, Penram International, Edition II, 2017. |
| | |
| **References** | |
| 1 | John R. Hackworth and Peterson, PLC controllers programming methods and applications, PHI, 2004. |
| 2 | Stuart A. Boyer , SCADA: Supervisory Control and Data Acquisition Systems, 4th Edition, ISA Press, 2010. |
| 3 | William H. Bolton, Programmable logic controllers, Newnes , Edition VI, 2006. |
| | |
| **Useful Links** | |
| 1 | Industrial Automation and Control, IIT Kharagpur<br>Prof. S. Mukhopadhyay, Prof. S. Sen https://nptel.ac.in/courses/108105063 |
| 2 | NOC:Industrial Automation and Control, IIT Kharagpur: https://nptel.ac.in/courses/108105088 |

**CO-PO Mapping**

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

The strength of mapping is to be written as 1,2,3; where, 1: Low, 2: Medium, 3: High
Each CO of the course must map to at least one PO, 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<br>Marks Submission at the end of Week 8 | 30 |
| LA2 | Lab activities, attendance, journal | Lab Course Faculty | During Week 9 to Week 16<br>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<br>Marks Submission at the end of Week 19 | 40 |

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

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

# Walchand College of Engineering, Sangli

*(Government Aided Autonomous Institute)*

**AY 2024-25**

## Course Information

| | |
|---|---|
| **Programme** | B. Tech. Electrical Engineering |
| **Class, Semester** | Final Year B. Tech., Sem. VII |
| **Course Code** | 6EL456 |
| **Course Name** | Professional Elective- 3 Lab: Advanced Power Electronics Lab |
| **Desired Requisites:** | Power Electronics Lab |

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

## Course Objectives

| | |
|---|---|
| **1** | To provide the advance knowledge in the field of power electronics. |
| **2** | To understand the working of different power electronic converter through simulation and experimentation. |
| **3** | To develop the skills of simulation, analysis and design of power electronics system. |
| **4** | To make the students conversant with the recent advances in power electronics and their use in industrial applications. |

## Course Outcomes (CO) with Bloom's Taxonomy Level

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

| **CO** | **Course Outcome Statement/s** | **Bloom's Taxonomy Level** | **Bloom's Taxonomy Description** |
|---|---|---|---|
| **CO1** | Articulate working of different advanced power electronic converters. | II | Understanding |
| **CO2** | Analyze different advanced power electronic converters and systems. | IV | Analyzing |
| **CO3** | Evaluate the performance of different advanced power electronic converters using hardware and simulation software. | V | Evaluating |
| **CO4** | Design control circuits for advanced power electronic circuits. | VI | Creating |

## List of Experiments / Lab Activities/Topics

**List of Lab Activities:**

1. Development of Simulink model and analysis of performance of Single Phase Full and Half controlled converter.
2. Development of Simulink model and analysis of performance of Three Phase Full and Half controlled converter
3. Development of Simulink model and analysis of performance of Cascade type Multilevel Inverter.
4. Development of Simulink model and analysis of performance of Diode clamped Multilevel Inverter.
5. Experimental study of cascade type Multilevel inverter
6. Development and performance analysis of Active power Filter
7. Development of Simulink model and analysis of performance of Z source inverter
8. Study and performance analysis of Matrix converter.

## Textbooks

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

| References | |
|---|---|
| 1 | B. K. Bose, Modern Power Electronics & AC drives, PHIPL, New Delhi |
| 2 | M. B. Patil, V. Ramayanan and V. T. Ranganathan, Simulation of Power Electronics circuits, Narosa publication. |
| | |
| **Useful Links** | |
| 1 | --- |

| 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** | | | | | 1 | | | | | | | | | 1 |
| **CO4** | | | 2 | | 2 | | | | | | | | | 1 |
| The strength of mapping is to be written as 1,2,3; where, 1: Low, 2: Medium, 3: High<br>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.<br>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<br>Marks Submission at the end of Week 8 | 30 |
| LA2 | Lab activities, attendance, journal | Lab Course Faculty | During Week 9 to Week 16<br>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<br>Marks Submission at the end of Week 19 | 40 |
| Week 1 indicates starting week of a semester. Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming, and other suitable activities, as per the nature and requirement of the lab course. The experimental lab shall have typically 8-10 experiments and related activities if any. | | | | |

| | |
|---|---|
| Syllabus Prepared By | Dr. D. S. More |
| Syllabus Checked By | Dr. Mrs. A. S. Karvekar |

# Open Elective- 5

# Walchand College of Engineering, Sangli

*(Government Aided Autonomous Institute)*

**AY 2024-25**

| **Course Information** | |
|---|---|
| **Programme** | B. Tech. Electrical Engineering |
| **Class, Semester** | Final Year B. Tech., Sem. VII |
| **Course Code** | 6OE443 |
| **Course Name** | Open Elective-5: Renewable Energy |
| **Desired Requisites:** | Basic Mechanical Engineering, 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** | Explain the types of renewable energy resources with sustainability. |
| **2** | Explain the working of solar, wind, biomass, and geothermal energy systems. |
| **3** | Apply various renewable energy sources like biogas, geothermal, and MHD |
| **4** | Explain the need and operation of various energy storage technologies. |

**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** | Describe the various renewable energy resources with Sustainability. | II | Understanding |
| **CO2** | Describe the working of solar, wind, biomass, and geothermal energy systems. | II | Understanding |
| **CO3** | Discuss the need and working of various energy storage, fuel cell, and battery management system technologies. | II | Understanding |
| **CO4** | Demonstrate the Grid-connected PV and wind energy system. | III | Applying |

| **Module** | **Module Contents** | **Hours** |
|---|---|---|
| I | **Introduction to Renewable Energy Sources**<br>Energy sources: classification of energy sources, introduction to renewable energy, renewable energy trends, key factors affecting renewable energy supply, global and Indian scenario of renewable energy sources, policies of the government, sustainable development, challenges, advantages and disadvantages of renewable energy sources, and their uses.<br>**Case Study:** PM Kusum Yojana and PM Suryoday Yojana 2024. | 7 |
| II | **Solar Energy**<br>solar earth geometry, solar radiations, and measurement, fundamentals of semi-conductors, absorption of light, solar thermal power generation, heat transfer, solar thermal conversion: basics, solar concentrator, and tracking system, flat plate and concentrating collectors, single axis and two axes axis tracking collectors, selective coatings. | 7 |

| | | |
|---|---|---|
| III | **Grid Connected PV System**<br>PV power generation, basic principle of power generation in PV cell, solar cell, and its parameters, module and array, the efficiency of PV cell, characteristics curves of PV cell, effects of different electrical parameters on I-V & P-V curves, configuration of PV power generation system - off-grid system & grid-connected PV system, design methodology, stand-alone PV system, grid-connected PV systems. | 6 |
| IV | **Wind Energy**<br>Power available in wind, wind turbine power & torque characteristics, types of rotors, characteristics of wind rotor, components of wind turbine, local effects, wind shear, turbulence & acceleration effects, measurement of wind, wind speed statistics, wind power calculations and Betz limit, capacity factor, speed ratio characteristics, grid-connected wind energy system | 7 |
| V | **Biomass Energy and other renewable energy systems**<br>Overview of biomass as energy source, physicochemical and thermal characteristics of biomass as fuel, hydrogen generation methods, storage technologies, compression and chemical compounds, applications in energy storage and transportation, addressing safety, environmental impacts, and future trends in research and policy. geothermal energy different components, advantages, limitations. | 6 |
| VI | **Energy Storage and Fuel cell technologies**<br>Introduction, need for storage for renewable energy sources, basic thermodynamic and electrochemical principles, classification, traditional energy storage system- battery, fuel cell, principle of operation, types, applications for power generation, battery management system. | 6 |

| | |
|---|---|
| | |
| **Textbooks** | |
| 1 | Boyle, Godfrey, "*Renewable Energy*", (2nd edition), Oxford University Press, 2004. |
| 2 | Masters, Gilbert M., "*Renewable and efficient electric power systems*", John Wiley & Sons, 2013. |
| 3 | Solanki, Chetan Singh. , "*Solar Photovoltaics: fundamentals, technologies and applications*", PHI Learning Pvt. Ltd., 2015. |
| | |
| **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://nptel.ac.in/noc/courses/noc21/SEM1/noc21-ch11/ |
| 2 | https://www.coursera.org/learn/exploring-renewable-energy |

**CO-PO Mapping**

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

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.<br>MSE shall be typically on modules 1 to 3.<br>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.<br>ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.<br>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 | Dr. S. D. Patil |