# Walchand College of Engineering, Sangli

*(Government Aided Autonomous Institute)*


## Proposed Draft Credit System for

## T.Y. B. Tech. (Electrical Engineering)

## Sem-V and VI

**Academic Year 2022-23**

# Credit System for T.Y. B. Tech. (Electrical Engineering) Sem-V AY 2022-23

| Sr.No. | Category | Course Code | Course Name | L | T | P | I | Hrs | Cr | T1/LA1 | T2/LA2 | ESE | PoE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Professional Core (Theory)** | | | | | | | | | | | | | |
| 1 | PC | 5EL301 | Power System Analysis and Stability | 3 | 0 | 0 | 0 | 3 | 3 | 20 | 20 | 60 | |
| 2 | PC | 5EL302 | Control System Engineering | 2 | 0 | 0 | 0 | 2 | 2 | 20 | 20 | 60 | |
| **Professional Core (Lab)** | | | | | | | | | | | | | |
| 3 | PC | 5EL351 | Power System Analysis and Stability Lab | 0 | 0 | 2 | 0 | 2 | 1 | 30 | 30 | 40 | Y |
| 4 | PC | 5EL352 | Control System Engineering Lab | 0 | 0 | 2 | 0 | 2 | 1 | 30 | 30 | 40 | Y |
| 5 | PR | 5EL345 | Mini-Project-1 | 0 | 0 | 2 | 0 | 2 | 1 | 30 | 30 | 40 | |
| 6 | PR | 5EL346 | Mini-Project-2 | 0 | 0 | 2 | 0 | 2 | 1 | 30 | 30 | 40 | |
| 7 | HS | 5HS301 | Humanities-1: German Language | 0 | 0 | 0 | 3 | 3 | 3 | 30 | 30 | 40 | |
| **Professional Elective (Theory)** | | | | | | | | | | | | | |
| 8 | PE | Refer list | Elective-1 | 2 | 0 | 0 | 0 | 2 | 2 | 20 | 20 | 60 | |
| 9 | PE | Refer list | Elective-2 | 2 | 0 | 0 | 0 | 2 | 2 | 20 | 20 | 60 | |
| **Professional Elective (Lab)** | | | | | | | | | | | | | |
| 10 | PE | Refer list | Elective-2 Lab | 0 | 0 | 2 | 0 | 2 | 1 | 30 | 30 | 40 | Y |
| **Open Elective** | | | | | | | | | | | | | |
| 11 | OE | Refer list | Open Elective-1 | 2 | 0 | 0 | 0 | 2 | 2 | 20 | 20 | 60 | |
| 12 | OE | Refer list | Open Elective-2 | 3 | 0 | 0 | 0 | 3 | 3 | 20 | 20 | 60 | |
| **Value Added Professional Courses #** | | | | | | | | | | | | | |
| -- | | | | | | | | | | | | | |
| **Value Added Life-Skill Courses #** | | | | | | | | | | | | | |
| -- | | | | | | | | | | | | | |
| | | | **Total** | **14** | **0** | **10** | **3** | **27** | **22** | | | | |

# Elective Course List for T.Y. B. Tech. (Electrical Engineering) Sem-V AY 2022-23

| Sr.No. | Track | Course Code | Course Name |
|---|---|---|---|
| **Elective-1** | | | |
| 1 | Power System | 5EL311 | Illumination Engineering |
| 2 | Control System | 5EL312 | Digital Signal Processing |
| 3 | Power Electronics and Drives | 5EL313 | Electromagnetic Field |
| **Elective-2** | | | |
| 1 | Power System | 5EL314 | Electrical Machine Design |
| 2 | Control System | 5EL315 | Linear Algebra |
| 3 | Power Electronics and Drives | 5EL316 | Energy Storage Systems for EV |
| **Elective-2 Lab** | | | |
| 1 | Power System | 5EL353 | Electrical Machine Design Lab |
| 2 | Control System | 5EL354 | Linear Algebra Lab |
| 3 | Power Electronics and Drives | 5EL355 | Energy Storage Systems for EV Lab |

# Open Elective Course List for T.Y. B. Tech. (Electrical Engineering) Sem-V AY 2022-23

| Sr.No. | Offering Dept | Sem | Course Code | Course Name |
|---|---|---|---|---|
| **Open Elective 1** | | | | |
| 1 | Civil | 5 | 5OE301 | Basic Civil Engineering |
| 2 | Mech | 5 | 5OE330 | Energy Engineering |
| 3 | Eln | 5 | | Signals and Systems |
| 4 | CSE | 5 | 5OE372 | Data Science using Python |
| 5 | IT | 5 | 5OE385 | Joy of Python Programming |
| **Open Elective 2** | | | | |
| 1 | Civil | 5 | 5OE315 | Application of Remote Sensing |
| 2 | Mech | 5 | 5OE329 | Non-conventional Machining Processes |
| 3 | Eln | 5 | | Introduction to Electronics system |
| 4 | CSE | 5 | 5OE371 | Software Engineering and Database Essentials |
| 5 | IT | 5 | 5OE386 | Cloud Computing System |

**Notes:**

For Theory courses: There shall be MSE, ISE and ESE. The ESE is a separate head of passing.

For Lab courses: There shall be continuous assessment (LA1, LA2, ESE). The ESE is a separate head of passing. The Y in the PoE indicates external component for ESE.

For further details, refer to Academic and Examination rules and regulations.

**For further details, refer to Academic and Examination rules and regulations.**

## Credit System for T.Y. B. Tech. (Electrical Engineering) Sem-VI AY 2022-23

| Sr.No. | Category | Course Code | Course Name | L | T | P | I | Hrs | Cr | T1/LA1 | T2/LA2 | ESE | PoE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Professional Core (Theory)** | | | | | | | | | | | | | |
| 1 | PC | 5EL321 | Power System Protection | 3 | 0 | 0 | 0 | 3 | 3 | 20 | 20 | 60 | |
| 2 | PC | 5EL322 | Industrial Drives and Control | 2 | 0 | 0 | 0 | 2 | 2 | 20 | 20 | 60 | |
| 3 | PC | 5EL323 | Microcontroller and Applications | 2 | 0 | 0 | 0 | 2 | 2 | 20 | 20 | 60 | |
| **Professional Core (Lab)** | | | | | | | | | | | | | |
| 4 | PC | 5EL371 | Power System Protection Lab | 0 | 0 | 2 | 0 | 2 | 1 | 30 | 30 | 40 | Y |
| 5 | PR | 5EL347 | Mini-Project-3 | 0 | 0 | 2 | 0 | 2 | 1 | 30 | 30 | 40 | |
| 6 | PR | 5EL348 | Mini-Project-4 Industrial Drives and Control Lab | 0 | 0 | 2 | 0 | 2 | 1 | 30 | 30 | 40 | |
| 7 | PC | 5EL372 | Microcontroller and Applications Lab | 0 | 0 | 2 | 0 | 2 | 1 | 30 | 30 | 40 | Y |
| 8 | HS | 5HS302 | Humanities-2: Human Relations at Work | 0 | 0 | 0 | 3 | 3 | 3 | 30 | 30 | 40 | |
| **Professional Elective (Theory)** | | | | | | | | | | | | | |
| 9 | PE | Refer list | Elective-3 | 2 | 0 | 0 | 0 | 2 | 2 | 20 | 20 | 60 | |
| **Open Elective** | | | | | | | | | | | | | |
| 10 | OE | Refer list | Open Elective-3 | 2 | 0 | 0 | 0 | 2 | 2 | 20 | 20 | 60 | |
| 11 | OE | Refer list | Open Elective-4 | 3 | 0 | 0 | 0 | 3 | 3 | 20 | 20 | 60 | |
| **Value Added Professional Courses #** | | | | | | | | | | | | | |
| -- | | | | | | | | | | | | | |
| **Value Added Life-Skill Courses #** | | | | | | | | | | | | | |
| -- | | | | | | | | | | | | | |
| | | | **Total** | **14** | **0** | **8** | **3** | **25** | **21** | | | | |

# Elective Course List for T.Y. B. Tech. (Electrical Engineering) Sem-VI AY 2022-23

| Sr.No. | Track | Course Code | Course Name |
|---|---|---|---|
| **Elective-3** | | | |
| 1 | Power System | 5EL331 | Artificial Neural Network |
| 2 | Control System | 5EL332 | Non Linear and Digital Control System |
| 3 | Power Electronics and Drives | 5EL333 | Introduction to Electric Vehicle |

## Open Elective Course List for T.Y. B. Tech. (Electrical Engineering) Sem-VI AY 2022-23

| Sr.No. | Offering Dept | Sem | Course Code | Course Name |
|---|---|---|---|---|
| **Open Elective 3** | | | | |
| 1 | Mech | 6 | 5OE336 | 3D Printing |
| 2 | Eln | 6 | 5OE364 | Cyber Physical System |
| 3 | CSE | 6 | 5OE378 | Fundamentals of Internet of Things |
| 4 | IT | 6 | 5OE392 | Web Development & Applications |
| **Open Elective 4** | | | | |
| 1 | Mech | 6 | 5OE337 | Basics of Automobile Engineering |
| 2 | Eln | 6 | 5OE365 | Biomedical Engineering |
| 3 | CSE | 6 | 5OE379 | Artificial Intelligence and Machine Learning |
| 4 | IT | 6 | 5OE393 | Fundamentals Of Machine Learning |

**Notes:**
For Theory courses: There shall be MSE, ISE and ESE. The ESE is a separate head of passing.
For Lab courses: There shall be continuous assessment (LA1, LA2, ESE). The ESE is a separate head of passing. The Y in the PoE indicates external component for ESE.
**For further details, refer to Academic and Examination rules and regulations.**

# ODD Semester
# Professional Core
# (Theory)
# Courses

# 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 VI |
| **Course Code** | 5EL301 |
| **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 |
| **Practical** | - | | | | |
| **Interaction** | - | **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 develop analytical skills in the students for investigating issues related to power systems. |
| **4** | To help students in preparing for competitive examinations. |

| **Course Outcomes (CO) with Bloom's Taxonomy Level** | | |
|---|---|---|
| **CO1** | Summarize the use of various load flow analysis method and assess the power system under symmetrical fault. | Understand |
| **CO2** | Analyze symmetrical components of network and power system under unbalanced fault. | Analyze |
| **CO3** | Evaluate the rotor angle, voltage stability and solve swing equation by various methods. | Evaluate |
| | | |

| **Module** | **Module Contents** | **Hours** |
|---|---|---|
| I | **Power Flow Analysis**<br>Bus classification, bus admittance matrix, general form of power flow equations, GS, NR and FD load flow methods and Comparison of PFA Methods. | 7 |
| II | **Symmetrical Components**<br>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**<br>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**<br>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**<br>Basic concepts and definitions, Classification of stability ,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 | **Numerical Integration Methods And Application To Stability Evaluation**<br>Numerical integration methods – Euler‟s method, Modified Euler‟s method - ,Runge - Kutta methods and Solution of swing equation by point by point method. | 5 |

| | |
|---|---|
| | |
| **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, 2014. |
| | |
| **Useful Links** | |
| 1 | http://nptel.ac.in/ |

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

# Walchand College of Engineering, Sangli

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**AY 2022-23**

| **Course Information** | |
|---|---|
| **Programme** | B.Tech. (Electrical Engineering) |
| **Class, Semester** | Third Year B. Tech., Sem V |
| **Course Code** | 5EL302 |
| **Course Name** | Control System Engineering |
| **Desired Requisites:** | Engineering Mathematics III, Signals and Systems, Electrical Circuit Analysis |

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

| **Course Objectives** | |
|---|---|
| **1** | To impart knowledge for modelling 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,

| | | |
|---|---|---|
| **CO1** | Calculate system transfer function and system characteristics of different Systems. | Apply |
| **CO2** | Analyze performance of physical systems using mathematical models. | Analyze |
| **CO3** | Check the stability of linear systems in time and frequency domain. | Evaluate |

| **Module** | **Module Contents** | **Hours** |
|---|---|---|
| I | **Analysis of System in Frequency Domain**<br>History of control systems, Laplace transforms review, transfer function of Electrical systems, Mechanical systems, Rotational Systems, Electrical circuit analogs, Transfer function of DC motor | 4 |
| II | **Analysis of System in Time Domain**<br>State space representation, Converting transfer function to state space: Phase Variable Form, State space to transfer function, State Transition Matrix, Solution of state equation, Controllability, Observability. | 4 |
| III | **Transient Response and Reduction of multiple subsystem**<br>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. | 5 |
| IV | **Steady State Error**<br>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**<br>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. | 4 |
| VI | **Stability Analysis: Bode Plot and Nyquist Plot , Compensators**<br>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. | 5 |

| **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** | |
|---|---|
| 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.<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) |

# Professional Core (Lab) Courses

# Walchand College of Engineering, Sangli

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**AY 2022-23**

| **Course Information** | |
|---|---|
| **Programme** | B.Tech. (Electrical Engineering) |
| **Class, Semester** | Third Year B. Tech., Sem V |
| **Course Code** | 5EL351 |
| **Course Name** | Power System Analysis and Stability Lab |
| **Desired Requisites:** | Power System Engineering, AC Machine |

| **Teaching Scheme** | | **Examination Scheme (Marks)** | | | |
|---|---|---|---|---|---|
| **Lecture** | - | **LA1** | **LA2** | **Lab ESE** | **Total** |
| **Tutorial** | - | 30 | 30 | 40 | 100 |
| **Practical** | 2 | | | | |
| **Interaction** | - | **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**

| | | |
|---|---|---|
| **CO1** | Simulate the various load flow analysis methods. | Understand |
| **CO2** | Carry out simulation for symmetrical components of network and analyze the power system under unbalanced fault. | Apply |
| **CO3** | Evaluate the equal Area criterion and swing curve. | Evaluate |

**List of Experiments / Lab Activities**

**List of Experiments: MATLAB/TLS/Power world/MiPower Simulator**

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

**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. |
| | |
| **Useful Links** | |
| 1 | http://nptel.ac.in |

**CO-PO Mapping**

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

**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.

# 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** | 5EL352 |
| **Course Name** | Control System Engineering Lab |
| **Desired Requisites:** | Engineering Mathematics III, Signals and Systems, Electrical Circuit Analysis |

| **Teaching Scheme** | | **Examination Scheme (Marks)** | | | |
|---|---|---|---|---|---|
| **Lecture** | - | **LA1** | **LA2** | **Lab ESE** | **Total** |
| **Tutorial** | - | 30 | 30 | 40 | 100 |
| **Practical** | 2 Hrs/Week | | | | |
| **Interaction** | - | **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,

| | | |
|---|---|---|
| **CO1** | Solve and analyze physical systems using simulation tools. | Apply |
| **CO2** | Assess the stability of systems using frequency domain techniques. | Analyze |
| **CO3** | Study transient analysis of physical systems. | Analyze |

## 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** | |
| 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** | | | | 3 | | | | | | | | | | 2 |
| **CO3** | | | | 3 | | | | | | | | | | 2 |
| **CO4** | | | | | | | | | | | | | | |
| 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. | | | | | | | | | | | | | | |

| **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. | | | | |

# 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** | 5EL345 |
| **Course Name** | Mini Project-I Lab: Digital Signal Processing Mini Project Lab |
| **Desired Requisites:** | Engineering Mathematics –III, Signals and Systems |

| **Teaching Scheme** | | **Examination Scheme (Marks)** | | | |
|---|---|---|---|---|---|
| **Lecture** | - | **T1/LA1** | **T2/LA2** | **ESE** | **Total** |
| **Tutorial** | - | 30 | 30 | 40 | 100 |
| **Practical** | 2 Hrs/Week | | | | |
| **Interaction** | - | **Credits: 1** | | | |

**Course Objectives**

| | |
|---|---|
| **1** | To develop basic knowledge of DSP systems and signal processing tools. |
| **2** | To develop basic knowledge of FFT and filter design for applications in Electrical Engineering. |
| **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,

| | | |
|---|---|---|
| **CO1** | Explain the signal processing tools and transforms. | Understanding |
| **CO2** | Apply different techniques for Filter design | Applying |
| **CO3** | Apply modern signal processing algorithms. | Applying |

**List of Experiments / Lab Activities**

List of mini-projects : DSP application based miniprojects which includes programming and case studies in the following areas:

1. Mini-project 1: Signal simulations, generation of mixed signals, sampling effects.
2. Mini-project 2: Difference equation and System responses, filtering by Convolution process.
3. Mini-project 3: Correlation between signals and Frequency responses for systems.
4. Mini-project 4: DFT/FFT, Circular convolution applications.
5. Mini-project 5: IIR Filter design and application.
6. Mini-project 6: FIR Filter design application.
7. Mini-project 7: Multirate signal processing.
8. Mini-project 8: DSP processor programming and application.
9.
10.

**Text Books**

| | |
|---|---|
| 1 | John G, Proakis' Digital Signal Processing Principles, Algorithms and Applications', Pearson Education, 2008. |
| 2 | Sanjeet Mitra, 'Digital Signal Processing', TMH Pub., 2006. |

**References**

| | |
|---|---|
| 1 | Oppenheim and R. W. Schafer, 'Discrete Time Signal Processing' PHI Pub., 2005. |
| 2 | Venkatramani, Bhaskar, 'Digital Signal Processors, TMH Pub., 2006. |
| 3 | Raghuveer Rao, Bopardikar, 'Wavelet Transform', Pearson Education, 2000. |

**Useful Links**

| | |
|---|---|
| 1 | http://nptel.ac.in/downloads/117105077 |
| 2 | http://www.nptelvideos.in/2012/12/digital-communication.html |
| 3 | https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-450-principles-of-digital-communications-i-fall-2006/video-lectures/ |

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

| 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. | | | | |

| Assessment Plan based on Bloom's Taxonomy Level | | | | | |
|---|---|---|---|---|---|
| **Bloom's Taxonomy Level** | **LA1** | **LA2** | **LA3** | **LA4** | **Total** |
| Remember | | | | | |
| Understand | 10 | 10 | 10 | 10 | **40** |
| Apply | 15 | 15 | 15 | 15 | **60** |
| Analyze | | | | | |
| Evaluate | | | | | |
| Create | | | | | |
| **Total** | **25** | **25** | **25** | **25** | **100** |

# Professional Elective (Theory) Courses

# 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** | 5EL312 |
| **Course Name** | Professional Elective I: Digital Signal Processing |
| **Desired Requisites:** | Engineering Mathematics –III, Signals and Systems |

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

**Course Objectives**

| | |
|---|---|
| **1** | To develop basic knowledge of DSP systems and signal processing. |
| **2** | To develop basic knowledge of FFT and filter design for applications in Electrical Engineering. |
| **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,

| | | |
|---|---|---|
| **CO1** | Explain the signal processing tools and transforms. | Understand |
| **CO2** | Apply different techniques for Filter design | Apply |
| **CO3** | Explain modern signal processing algorithms. | Understand |

| **Module** | **Module Contents** | **Hours** |
|---|---|---|
| I | **Digital Signals and Systems**<br>DSP system concept. Interconnection of DSP systems, sampling theorem, Z Transforms review, Digital transfer function and response to different inputs. | 3 |
| II | **Discrete Fourier Transform**<br>DFT, Relation between DFT & Z ¬transform, Circular convolution and DFT, FFT Algorithms, (DIT- FFT & DIF-FFT). Overlap save algorithm, overlap add algorithm | 6 |
| III | **IIR Filter Design**<br>Filter design using impulse invariant technique, bilinear transformation and Analog filter approximation (Butterworth) and Realization issues. | 5 |
| IV | **FIR Filter Design**<br>FIR Filter Design, Fourier series method, Windowing method, Filter design using window, frequency sampling methods, quantization and realization issues. | 5 |
| V | **Modern Signal processing**<br>Digital Signal Processors- Introduction, Architecture, important blocks, Programming Aspects, Multirate Signal Processing, time and frequency effects, filter design for aliasing and imaging effects. | 5 |

| | | |
|---|---|---|
| VI | **Wavelet and Applications of Digital Signal Processing**<br>Wavelet Transform- Introduction, continuous and discrete wavelet, application in DSP - Power system and control system applications. | 2 |

| **Text Books** | |
|---|---|
| 1 | John G, Proakis' Digital Signal Processing Principles, Algorithms and Applications', Pearson Education, 2008. |
| 2 | Sanjeet Mitra, 'Digital Signal Processing', TMH Pub., 2006. |

| **References** | |
|---|---|
| 1 | Oppenheim and R. W. Schafer, 'Discrete Time Signal Processing' PHI Pub., 2005. |
| 2 | Venkatramani, Bhaskar, 'Digital Signal Processors, TMH Pub., 2006. |
| 3 | Raghuveer Rao, Bopardikar, 'Wavelet Transform', Pearson Education, 2000. |

**Useful Links**

**CO-PO Mapping**

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

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

**Assessment**

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

# Walchand College of Engineering, Sangli

*(Government Aided Autonomous Institute)*

**AY 2022-23**

**Course Information**

| | |
|---|---|
| **Programme** | B.Tech. (Electrical Engineering) |
| **Class, Semester** | Third Year B. Tech., Sem V |
| **Course Code** | 5EL311 |
| **Course Name** | Professional Elective I: Illumination Engineering |
| **Desired Requisites:** | Basic Electrical Engineering , Basic Electronics Engineering |

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

**Course Objectives**

| | |
|---|---|
| **1** | To introduce the fundamentals of Illumination Engineering. |
| **2** | To provide lighting sources, standard practices for illumination levels & measurement calculations for designing a system. |
| **3** | To impart technology in the analysis & design of architectural lighting system. |

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

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

| | | |
|---|---|---|
| **CO1** | **Describe** basic terms and laws in illumination engineering. | Describe |
| **CO2** | **Classify** different types of lamps used for lighting**.** | Classify |
| **CO3** | **Identify** indoor and outdoor illumination system components, its controls & design aspects & **evaluate** different lighting designs & applications. | Evaluate |

| **Module** | **Module Contents** | **Hours** |
|---|---|---|
| I | **Illumination Engineering Basics**<br>Necessity of illumination, visible range of light, optical system of human eye, vision-visual acuity, contrast, sensitivity, visual perception, good & bad effects of lighting, perfect level of luminance, artificial lighting, colour temperature. Definition of luminous flux , luminous intensity, Lumen output, candela , laws of illumination , light distribution curve. Glare, Colour Rendering Index | 5 |
| II | **Light sources**<br>Lamp materials. Discharge Lamps: characteristics of low and high mercury and Sodium vapour lamps.<br>Low Vapour Pressure discharge lamps – Mercury Vapour lamp, Fluorescent Lamp, Compact Fluorescent Lamp (CFL)<br>High Vapour Pressure discharge lamps - Mercury Vapour lamp, Sodium Vapour lamp, Metal , Induction lamps.. | 4 |
| III | **Components of illumination system**<br>Ballast, igniters and dimmers for different types of lamps, Luminaries: types , factors , Lighting Fixture types, use of reflectors and refractors, physical protection of lighting fixtures , luminaries standard (IEC-598-Part I). | 4 |

| | | |
|---|---|---|
| IV | **Indoor lighting**<br>Definitions of maintenance factor, Uniformity ratio, Direct ratio, Coefficients of utilisation and factors affecting it, Illumination required for various work planes, Space to mounting height ratio, Interior illumination: Types of fixtures, DLOR and ULOR, Selection of lamp and luminance, utilisation factor, reflection factor and maintenance factor<br>Determination of Lamp Lumen output, Calculation of wattage of each lamp and no of lamps needed, space to mounting height ratio. Layout of lamp luminaire. Indian standard recommendation and standard practices for illumination levels in various areas. | 5 |
| V | **Outdoor lighting**<br>Street Lighting : level of illumination required, Types of fixtures used and their suitable application, Various arrangements in street lighting, Selection of lamp and luminaire, Calculation of their wattage, Number and arrangement, space to mounting height ratio, illumination level available on road<br>Flood Lighting : Terms related to flood lighting, Types of fixtures and their suitable applications, Selection of lamp and projector, Calculation of their wattage and number and their arrangement, space to mounting height ratio, Recommended method for aiming of lamp | 5 |
| VI | **Modern trends in illumination**<br>LED luminary designs, Intelligent LED,OLED,QLED fixtures, Natural light conduiting, Organic lighting system, LASERS, characteristics, features and applications, non-lighting lamps, Optical fiber, its construction as a light guide, features and applications | 3 |

| **Text Books** | |
|---|---|
| 1 | Joseph B. Murdoch, “Illumination Engineering from Edison’s Lamp to Lasers” Publisher - York, PA: Visions Communications |
| 2 | H. S. Mamak, “Book on Lighting”, Publisher International lighting Academy |

| **References** | |
|---|---|
| 1 | Joseph B. Murdoch, “Illumination Engineering from Edison’s Lamp to Lasers” Publisher - York, PA: Visions Communications |
| 2 | M. A. Cayless, A. M. Marsden, “Lamps and Lighting”, Publisher-Butterworth-Heinemann(ISBN978-0-415-50308-2) |
| 3 | National Lighting code 2010(SP 72:2010) |

| **Useful Links** | |
|---|---|
| 1 | https://nptel.ac.in/courses/108/105/108105061/ |

**CO-PO Mapping**

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

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

**Assessment**

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

# 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** | 5EL313 |
| **Course Name** | Professional Elective I: Electromagnetic Field |
| **Desired Requisites:** | Electrical Circuits, DC Machines and Transformers |

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

| **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, | | |
| **CO1** | **Catch** the concepts of electrostatic and electromagnetic fields. | Understanding |
| **CO2** | **Apply** various laws in electromagnetics to identify the nature and strength of electric and magnetic fields. | Applying |
| **CO3** | **Test** the boundary value conditions in electromagnetic fields. | Analyzing |

| **Module** | **Module Contents** | **Hours** |
|---|---|---|
| I | **Vector Analysis**<br>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. | 5 |
| II | **Electrostatic Fields**<br>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. | 5 |
| III | **Electric Fields in Material Space**<br>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. | 4 |

| | | |
|---|---|---|
| IV | **Electrostatic Boundary-Value Problems**<br>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. | 4 |
| V | **Magneto Static Fields and Magnetic Forces**<br>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. | 4 |
| VI | **Maxwell's Equations**<br>Introduction, Faraday's Law, Transformer and Motional Electromotive Forces, Displacement Current, Maxwell's equations in Final Forms, Time-Varying Potentials, Time Harmonic Fields. | 4 |

| **Text Books** | |
|---|---|
| 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 | 3 |
| **CO1** | 3 | | | | | | | | | | | | | | |
| **CO2** | 3 | | | | | | | | | | | | 2 | | |
| **CO3** | | 2 | | | | | | | | | | | 2 | | |

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

**Assessment**

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

# Walchand College of Engineering, Sangli

*(Government Aided Autonomous Institute)*

**AY 2022-23**

**Course Information**

| | |
|---|---|
| **Programme** | B.Tech. (Electrical Engineering) |
| **Class, Semester** | Third Year B. Tech., Sem V |
| **Course Code** | 5EL315 |
| **Course Name** | Professional Elective II : Linear Algebra |
| **Desired Requisites:** | --------- |

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

**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,

| | | |
|---|---|---|
| **CO1** | Apply mathematical methods involving arithmetic, algebra, geometry, and graphs to solve problems. | Apply |
| **CO2** | Analyze the solution set of a system of linear equations | Analyze |
| **CO3** | Evaluate Engineering problems using the concept of Linear Algebra. | Evaluate |

| **Module** | **Module Contents** | **Hours** |
|---|---|---|
| I | **Solving Linear Equations**<br>Vectors, The Idea of Elimination, Elimination Using Matrices, Rules for Matrix Operations, Inverse Matrices, Elimination = Factorization: A = LU, Transposes and Permutations | 3 |
| II | **Vector Spaces and Subspaces**<br>Spaces of Vectors, The Nullspace of A: Solving Ax = 0 and Rx = 0, The Complete Solution to Ax = b, Independence, Basis and Dimension,<br>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, , | 5 |
| III | **The Singular Value Decomposition**<br>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 . | 5 |

| | | |
|---|---|---|
| IV | **Complex Vectors and Matrices**<br>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**.** | 5 |
| V | **Numerical Linear Algebra**<br>Gaussian Elimination in Practice , Norms and Condition Numbers, Iterative Methods and Preconditioners | 4 |
| VI | **Linear Algebra in Probability & Statistics**<br>Mean, Variance, and Probability, Covariance Matrices and Joint Probabilities, Multivariate Gaussian and Weighted Least Squares | 4 |

| **Text Books** | |
|---|---|
| 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 | 3 |
| **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** | 5EL314 |
| **Course Name** | Professional Elective II: Electrical Machine Design |
| **Desired Requisites:** | Electrical Machine |

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

## Course Objectives

| | |
|---|---|
| **1** | To provide basic knowledge of design process of Electrical machines. |
| **2** | To impart skills to perform and apply basics of Electrical Engineering for design of Electrical machines. |

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

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

| | | |
|---|---|---|
| **CO1** | **Summarize** the design procedure for electrical machine. | **Understand** |
| **CO2** | **Analyze** the performance of machine based on design details. | **Analyze** |
| **CO3** | **Design** transformer, induction motor and synchronous machine. | **Create** |

| **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. | 5 |
| II | **Performance Evaluation of Transformer**<br>Calculation of no-load current. Equivalent circuit and performance characteristics. Temperature rise. Design of tank and radiators. | 5 |
| 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. | 5 |
| 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. | 3 |
| 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. | 5 |

| | | |
|---|---|---|
| VI | **Computer Aided Design of Electrical Machines**<br>Spread spectrum principles, Pseudo-noise (PN) sequences, Direct-sequence and frequency hopping spread spectrum (DSSS and FHSS) systems, Orthogonality between PN-codes, Multiple access techniques - FDMA, TDMA, and CDMA, Commercial applications of spread spectrum - Cellular systems and GPS. | 3 |

| | |
|---|---|
| **Text Books** | |
| 1 | A. K. Sawhney, "A Course in Electrical Machine Design", 6th Edition, Dhanpat Rai and Sons, Delhi, 2006. |
| 2 | V.N. Mittle and A. Mittle, "Design of Electrical Machines", Standard Publications & Distributors, Delhi, 2002. |
| **References** | |
| 1 | R. K. Agarwal, "Principles of Electrical Machine Design", S.K. Kataria and Sons, Delhi, 2002. |
| 2 | S. K. Sen, "Principles of Electrical Machine Design with Computer Programmes", Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, 1987. |
| **Useful Links** | |
| 1 | http://nptel.ac.in. |
| 2 | http://www.nptelvideos.in. |
| 3 | https://ocw.mit.edu/courses/electrical-engineering. |

**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 | | | | | | | | | | | | |
| **CO3** | | | 3 | | | | | | | | | | | 3 |

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

**Assessment**

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

# Walchand College of Engineering, Sangli

*(Government Aided Autonomous Institute)*

**AY 2022-23**

| **Course Information** | |
|---|---|
| **Programme** | B.Tech. (Electrical Engineering) |
| **Class, Semester** | Third Year B. Tech., Sem V |
| **Course Code** | 5EL316 |
| **Course Name** | Professional Elective II: Energy Storage Systems for EV |
| **Desired Requisites:** | Power Electronics |

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

| **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 analyze 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, | | |
| **CO1** | **Examine** the operation of various energy storage systems used for engineering applications | **Applying** |
| **CO2** | **Analyze** the components and working of battery management system, fuel cells and supercapacitors to meet the performance criteria | **Analyzing** |
| **CO3** | **Investigate** the performance of different power electronic converters used in electric vehicles | **Analyzing** |

| **Module** | **Module Contents** | **Hours** |
|---|---|---|
| I | **Introduction to Energy Storage Systems**<br>Introduction and need for storage for EV, traditional energy storage systems, global market and scenario, battery, fuel cell, supercapacitors, compressed air, hydrogen storage, fly-wheels. | 3 |
| II | **Batteries**<br>Battery introduction, parameters of battery, battery cell electrical equivalent models, types of batteries, coulomb efficiency, electrode, battery manufacturing process, building block cells, battery modules and packs, working principle, operation, modeling and components- lithium polymer and lithium ion batteries, lead acid batteries, applications of batteries, future developments. | 6 |
| III | **Converters for Batteries**<br>Concept of vehicle to grid and grid to vehicle, DC-DC converters, SEPIC converters- topology and operation, interleaved converters- topology and operation, power flow between converters. | 4 |

| | | |
|---|---|---|
| IV | **Battery Management System**<br>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. | 4 |
| V | **Fuel Cells and its Classification**<br>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. | 5 |
| VI | **Supercapacitors and Hydrogen Storage Systems**<br>Supercapacitor: characteristics, components, schematic, classification, advantages, disadvantages, Hydrogen storage systems: Basics, working and applications. | 4 |

| **Text Books** | |
|---|---|
| 1 | Abu-Rub, Haitham, Mariusz Malinowski, and Kamal Al-Haddad. Power electronics for renewable energy systems, transportation and industrial applications. John Wiley & Sons, 2014. |
| 2 | Santhanagopalan, Shriram, et al. Design and analysis of large lithium-ion battery systems. Artech House, 2014. |
| 3 | Kiehne, H. A. "Battery Technology Handbook. Marcel Dekker Inc." (2003). |

| **References** | |
|---|---|
| 1 | Masters, Gilbert M. Renewable and efficient electric power systems. John Wiley & Sons, 2013. |
| 2 | Wakihara, Masataka, and Osamu Yamamoto, eds. Lithium ion batteries: fundamentals and performance. John Wiley & Sons, 2008. |
| 3 | Masters, Gilbert M. Renewable and efficient electric power systems. John Wiley & Sons, 2013. |

| **Useful Links** | |
|---|---|
| 1 | https://online.stanford.edu/courses/xeiet139-energy-storage |
| 2 | https://nptel.ac.in/courses/112/105/112105221/# |
| 3 | https://www.youtube.com/channel/UCLuAQrpzy0wjSHl2KFDT2kg |

**CO-PO Mapping**

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

# Professional Elective (Lab) Courses

# 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** | 5EL354 |
| **Course Name** | Linear Algebra Lab |
| **Desired Requisites:** | --------- |

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

**Course Objectives**

| | |
|---|---|
| **1** | To cover the analysis and implementation of algorithms used to solve linear algebra problems in practice. |
| **2** | Toenable students to acquire further skills in the techniques of linear algebra, as well as understanding of the principles underlying the subject. |
| **3** | To prepare students for further courses in mathematics and/or related disciplines (e.g. engineering, economics, etc.) |

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

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

| | | |
|---|---|---|
| **CO1** | Use visualization, spatial reasoning, as well as geometric properties and strategies to model, solve problems, and view solutions, especially in $R^2$ and $R^3$ , as well as conceptually extend these results to higher dimensions. (Geometric Skills). | Apply |
| **CO2** | Analyze computational techniques and algebraic skills essential for the study of systems of linear equations, matrix algebra, vector spaces, eigenvalues and eigenvectors, orthogonality and diagonalization. | Analyze |
| **CO3** | Discuss practical applications in fields like economics, computer science, physics, engineering, etc. | Evaluate |

**List of Experiments / Lab Activities**

**List of Experiments:**

1. Find solution to the system of linear equations using MATLAB.
2. Find Graphical solution to the system of linear equations using MATLAB.
3. Determination of Markov matrices using MATLAB.
4. Compute a spanning set for the subspace of solutions to a homogeneous system of linear equations using MATLAB.
5. Determining when a vector is in the subspace spanned by a set of vectors using MATLAB.
6. Compute Dimension of a Span using MATLAB.
7. Determining the Matrix of a Linear Mapping in Coordinates using MATLAB.
8. Determining Matrices of Linear Maps in Different Bases using MATALB.
9. Use Gram-Schmidt orthonormalization to find an orthonormal basis in MATLAB.
10. Implementation of Least Squares Fit in MATLAB.
11. Use MATLAB to compute an orthonormal basis for the subspaces spanned by the set of vectors.
12. Use MATLAB to find the eigenvalues and their algebraic and geometric multiplicities.
13. Determining the real Jordan normal form for matrix using MATLAB.

| **Text Books** | |
|---|---|
| 1 | Crista Arangala, "Exploring Linear Algebra: Labs and Projects with MATLAB", CRC, 1st Edition, 2019, ISBN : 1138063495 |
| 2 | Gilbert Strang, "Linear Algebra and its Applications", Cengage Learning, Fourth Edition, 2005, ISBN: 9788131501726 |

| **References** | |
|---|---|
| 1 | Martin Golubitsky, "Linear Algebra and Differential Equations Using MATLAB", Cengage Learning, First Edition, 1999, ISBN: 0534354254 |
| 2 | Kenneth M Hoffman, "Linear Algebra", Pearson Education, Second Edition, 2015, ISBN: 9332550077 |

| **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 | 3 |
| **CO1** | | | | | 3 | | | | | | | | | | |
| **CO2** | | | | | 3 | | | | | | | | | | |
| **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**

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. | | | | |

| Walchand College of Engineering, Sangli<br>*(Government Aided Autonomous Institute)* | | | | | |
|---|---|---|---|---|---|
| **AY 2022-23** | | | | | |
| **Course Information** | | | | | |
| **Programme** | B.Tech. (Electrical Engineering) | | | | |
| **Class, Semester** | Third Year B. Tech., Sem V | | | | |
| **Course Code** | 5EL353 | | | | |
| **Course Name** | Professional Elective II: Electrical Machines Design Lab | | | | |
| **Desired Requisites:** | Electrical Machine | | | | |
| **Teaching Scheme** | | **Examination Scheme (Marks)** | | | |
| **Lecture** | - | **LA1** | **LA2** | **Lab ESE** | **Total** |
| **Tutorial** | - | **30** | **30** | **40** | 100 |
| **Practical** | 2 Hrs./Week | | | | |
| **Interaction** | - | **Credits: 1** | | | |

| **Course Objectives** | |
|---|---|
| **1** | To provide basic knowledge of draw and design process of simple Electrical machines. |
| **2** | To impart skills to perform and apply basics of Electrical Engineering for draw and design of Electrical machines. |

| **Course Outcomes (CO) with Bloom's Taxonomy Level** | | |
|---|---|---|
| At the end of the course, the students will be able to, | | |
| **CO1** | **Summarize** the design procedure for electrical machine. | **Understand** |
| **CO2** | **Analyze** the performance of machine based on design details. | **Analyze** |
| **CO3** | **Design** and formulate transformer, induction motor and synchronous machine. | **Create** |

**List of Experiments / Lab Activities**

**List of Experiments:**

1. Design the transformer with given suitable data.
2. Calculate the radiators for transformer.
3. Design the Induction Motor stator parts 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.

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

| **References** | |
|---|---|
| 1 | R. K. Agarwal, "Principles of Electrical Machine Design", S.K. Kataria and Sons, Delhi, 2002. |
| 2 | S. K. Sen, "Principles of Electrical Machine Design with Computer Programmes", Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, 1987. |

| **Useful Links** | |
|---|---|
| 1 | http://nptel.ac.in. |
| 2 | http://www.nptelvideos.in. |
| 3 | https://ocw.mit.edu/courses/electrical-engineering. |

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

| Assessment | | | | |
|---|---|---|---|---|
| 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. | | | | |

# 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** | 5EL355 |
| **Course Name** | Energy Storage Systems for EV Lab |
| **Desired Requisites:** | Power Electronics |

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

## Course Objectives

| | |
|---|---|
| **1** | To help students to model and test different battery models using in Electric Vehicles. |
| **2** | To help in developing and executing programs on Matlab/Simulink environment. |
| **3** | To enable the student to execute programs for investigating the performance of power converters in Electric Vehicles |

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

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

| | | |
|---|---|---|
| **CO1** | **Develop** and test battery models using software tools | Applying |
| **CO2** | **Construct** the simulation models of power converters for electric vehicles | Applying |
| **CO3** | **Analyze** the performance of batteries and power converters used in Electric Vehicles. | Applying |

## List of Experiments / Lab Activities

**List of Experiments:**

1. Study the performance of various types of the batteries.
2. Demonstrate modeling of lead acid battery and observe various characteristics.
3. Execute modeling and characteristics of Lithium Battery.
4. Examine Super-capacitor charging and discharging characteristics.
5. Implement the electrical system of a vehicle.
6. Simulate and model different types of fuel cells.
7. Construct interleaved DC to DC converter for designing EV.
8. Implement SEPIC converter for designing EV.Etc.

## Text Books

| | |
|---|---|
| 1 | Abu-Rub, Haitham, Mariusz Malinowski, and Kamal Al-Haddad. Power electronics for renewable energy systems, transportation and industrial applications. John Wiley & Sons, 2014. |
| 2 | Santhanagopalan, Shriram, et al. Design and analysis of large lithium-ion battery systems. Artech House, 2014. |
| 3 | Kiehne, H. A. "Battery Technology Handbook. Marcel Dekker Inc." (2003). |

## References

| | |
|---|---|
| 1 | Masters, Gilbert M. Renewable and efficient electric power systems. John Wiley & Sons, 2013. |
| 2 | Wakihara, Masataka, and Osamu Yamamoto, eds. Lithium ion batteries: fundamentals and performance. John Wiley & Sons, 2008. |
| | |
| **Useful Links** | |
| 1 | http://vlab.amrita.edu/?sub=77&brch=270 |
| 2 | https://online.stanford.edu/courses/xeiet139-energy-storage |

**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 | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |

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<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.

# Open Elective- I Courses

# MOOCs (SWAYAM/ NPTEL etc.)

# 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** | |
| **Course Name** | Open Elective I : Electrical Machine Technology |
| **Desired Requisites:** | Basic Electrical Engineering |

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

| **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, | | |
| **CO1** | Explain the construction and working principle of A.C. and D.C. Machines. | Understand |
| **CO2** | Examine the various characteristics of A.C. and D.C. machines. | Apply |
| **CO3** | Analyze the performance of A.C. and D.C. machines for various applications. | Analyze |

| **Module** | **Module Contents** | **Hours** |
|---|---|---|
| I | **DC Motors**<br>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. | 4 |
| II | **Single Phase Transformer**<br>Construction and type, EMF equation phasor diagram, equivalent circuit, efficiency, losses, regulation, Experimental determination of equivalent circuit parameters and calculation of efficiency and regulation, Introduction to three Phase Transformer, Connection of three Phase Transformer, Applications of Transformers | 5 |
| III | **Three Phase Induction Motor**<br>Construction, Types, Working, Speed equation, Torque equation, Starting torque, Concept of full load torque, torque speed characteristics, Power stages in motor, Induction Generator. | 4 |

| | | |
|---|---|---|
| IV | **Three Phase Induction Motor Control**<br>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. | 4 |
| V | **Synchronous Machines**<br>Alternator, Construction of Alternator, Synchronous Motor, Equivalent Circuit, Motor on load, Pull-Out Torque, Motor Phasor Diagram, Mechanical Power Developed by Motor, Power Factor of Synchronous Motor, Application of Synchronous Motor, Comparison of Synchronous Motor with Induction Motor. | 5 |
| VI | **Special-Purpose Electric Machines**<br>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. | 4 |

| **Text Books** | |
|---|---|
| 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 | 3 |
| **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)

# Open Elective- II Courses

# Walchand College of Engineering, Sangli

*(Government Aided Autonomous Institute)*

**AY 2022-23**

| **Course Information** | |
|---|---|
| **Programme** | B.Tech. (Electrical Engineering) |
| **Class, Semester** | Second Year B. Tech., Sem IV |
| **Course Code** | |
| **Course Name** | Open Elective II : Industrial Instrumentation |
| **Desired Requisites:** | Basic Electrical Engineering |

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

| **Course Objectives** | |
|---|---|
| **1** | To impart basic knowledge of instrumentation system. |
| **2** | To understand components for instrumentation systems design. |
| **3** | To learn basics of PLC programing. |

| **Course Outcomes (CO) with Bloom's Taxonomy Level** | | |
|---|---|---|
| **CO1** | **Explain** the various types of transducer and their application. | Understand |
| **CO2** | **Illustrate** the data acquisition methods & virtual instrumentation techniques. | Apply |
| **CO3** | **Demonstrate** the use of PLC for industry applications. | Apply |

| **Module** | **Module Contents** | **Hours** |
|---|---|---|
| I | **Instrumentation System**<br>Instrumentation system-overview, performance characteristics, Sensors and Transducers- overview, definition, classification, selection criteria, concept of error,. | 6 |
| II | **Transducers**<br>Transducers for pressure and strain measurement, Temperature measurement, Flow measurement, speed & force measurement. | 6 |
| III | **Virtual Instrumentation**<br>Introduction to graphical programming, data flow &graphical programming techniques, advantage of VI techniques, VIs and sub-VIs loops and charts , arrays, clusters and graphs, case and sequence structures, formula nodes, string and file I/O, Code Interface Nodes and DLL links. | 8 |
| IV | **Data Acquisition Methods**<br>Analog and Digital IO, Counters, Timers, basic ADC designs, interfacing methods of DAQ hardware, software structure, use of simple and intermediate VIs. Use of Data Sockets for Networked Communication and Controls. | 6 |
| V | **PC Hardware Review & Instrumentation Buses**<br>Structure, timing, interrupts, DMA, operating system, ISA, PCI, USB, PCMCIA buses. IEEE488.1 & 488.2 Serial Interfacing -RS232C, RS422, RS423, RS485; USB, VXI, SCXI, PXI. | 6 |

| | | |
|---|---|---|
| VI | **Programmable Logic Controller**<br>Introduction to discrete state process control, ladder diagram, relay logic controller, comparison of PLC with relay logic controller, architecture of PLC, operating modes of PLC, difference between PLC and PC, ladder diagram programming of various system, role of PLC in Industry. | 4 |

| | |
|---|---|
| | |
| **Text Books** | |
| 1 | A.K.Sawhney, *"A Course in Electrical and Electronics Measurement and Instrumentation",* Dhanapat Rai & Company, New Delhi, reprint, 17th Edition, 2005. |
| 2 | A.S. Moris, "*Principles of Measurement & Instrumentation"*, Prentice Hall, 1993. |
| 3 | C. D. Johnson, *"Process Control Instrumentation Technology",* Pearson Education. |
| | |
| **References** | |
| 1 | Doebelin, E.O., *"Measurement Systems",* McGraw Hill Book Co. |
| 2 | Patranabis, D*, "Sensors and Transducers",* Wheeler Publishing Co., Ltd. New Delhi. |
| 3 | G.C. Barney, "*Intelligent Instrumentation*", Prentice Hall, 1995. |
| 4 | S. Gupta , J.P. Gupta, *"PC interfacing for Data Acquisition & Process Control",* ISA, |
| 5 | Gary Johnson, *"Lab VIEW Graphical Programming",* II Edition, McGraw Hil 1997. |
| | |
| **Useful Links** | |
| 1 | https://nptel.ac.in/courses/108/105/108105064/ |

**CO-PO Mapping**

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

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

**Assessment**

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

# EVEN Semester

# Professional Core (Theory) Courses

# 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 VI |
| **Course Code** | 5EL321 |
| **Course Name** | Power System Protection |
| **Desired Requisites:** | Power System Engineering |

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

**Course Objectives**

| | |
|---|---|
| **1** | To teach need for power system protection and basic principles of circuit breakers and relays. |
| **2** | To discuss protection of feeders, transmission lines, transformers, generators and their implementation using electromagnetic & microprocessor based relays. |
| **3** | To discuss causes of over voltages in power system and protection against these over voltages. |

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

| | | |
|---|---|---|
| **CO1** | **Describe** basic principles & working of circuit breakers & fuses and select proper CB/fuse for a particular application. | Describe |
| **CO2** | **Classify** the requirements of protection for different parts of a power system and select proper relay scheme. | Classify |
| **CO3** | **Analyse** the performance of various protection devices and discuss digital relaying techniques. | Analyse |

| **Module** | **Module Contents** | **Hours** |
|---|---|---|
| I | **Over Current Relays**<br>Need of protection, Brief theory and construction of electromagnetic relays. Different time current characteristics of over current relay, Directional relay, Microprocessor based over current relay, Directional over current relay, drawbacks of over current schemes. | 6 |
| II | **Arc Interruption Process**<br>Line coding, Pulse shaping, Inter-symbol interference (ISI), Eye pattern, Scrambler, introduction to optimum filter and matched filter | 6 |
| III | **Circuit Breakers & Fuses**<br>Classification of circuit breakers, brief study of construction and working of Air break and Air Blast CB, SF6 and Vacuum CB, HVDC breakers, ratings of CB and testing of CB, Fuse –Rewirable and HRC fuse, fuse characteristics, application and selection of fuse | 7 |
| IV | **Protection of Transformer, Generator and Bus Bar**<br>Circulating current differential protection, percentage differential protection of power transformers, through fault stability, effect of magnetizing inrush, effect of over voltage inrush ,Buchholz relay, Differential protection of generator, stator and rotor protection schemes of generator, loss of excitation, prime mover failure protection, bus bar protection. | 6 |

| | | |
|---|---|---|
| V | **Protection of Transmission Line**<br>Principles of distance relays, Effect of arc resistance, and power swing on relay operation, Microprocessor based impedance, reactance and admittance relays, Quadrilateral characteristics, carrier aided protection of transmission line. Protection Against Over Voltages. | 8 |
| VI | **Recent Developments in Protection**<br>Introduction to numerical/digital relay techniques. New numerical /digital relaying algorithms, introduction of various transform techniques - Discrete Fourier Transform, Haar Transform etc. | 6 |
| | | |
| **Text Books** | | |
| 1 | S.S. Rao, *"Switchgear & Protection",* Khanna Pub., XI edition, 2005. | |
| 2 | B.Ram & Vishwakarma, *"Power System Protection & Switchgear",* TMH Pub., III edition, 2008. | |
| | | |
| **References** | | |
| 1 | Oza, Nair, Mehta & Makwana,*" Power System Protection & Switchgear",* MGH pub., 2011. | |
| 2 | C.R. Mason, *"Art & Science of Protective Relaying",* GE e-book | |
| 3 | Y.G. Paithankar & S.R. Bhide, *"Fundamentals of Power System Protection",* PHI pub., I edition,<br>2004. | |
| **Useful Links** | | |
| 1 | https://nptel.ac.in/courses/108/101/108101039/ | |

**CO-PO Mapping**

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

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

**Assessment**

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

# Walchand College of Engineering, Sangli

*(Government Aided Autonomous Institute)*

**AY 2022-23**

**Course Information**

| | |
|---|---|
| **Programme** | B.Tech. (Electrical Engineering) |
| **Class, Semester** | Third Year B. Tech., Sem VI |
| **Course Code** | 5EL322 |
| **Course Name** | Industrial Drives and Control |
| **Desired Requisites:** | DC Machines and Transformer, AC Machines and Power Electronics |

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

**Course Objectives**

| | |
|---|---|
| **1** | To make students understand concept of fundamental knowledge in dynamics and control of Electric Drives. |
| **2** | To strengthen control principles of various DC and AC motors using solid state converters. |
| **3** | To cover principles of selection of Electric Motors and highlights the applications of Electrical Drives. |

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

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

| | | |
|---|---|---|
| **CO1** | **Explain** the various concepts used in Electric drives. | Understand |
| **CO2** | **Apply** the control techniques for Electric drives for speed control. | Apply |
| **CO3** | **Analyze** the performance of various control techniques used in speed control of electric drives and select a drive for particular application. | Apply Evaluate |

| **Module** | **Module Contents** | **Hours** |
|---|---|---|
| I | **Basics of drives**<br>Types & parts of the Electrical drives, Selection criteria of drives, motor rating, selection based on duty cycle, selection of converter rating, fundamental torque equation, speed torques characteristics DC motor & Induction motor, multi quadrant operation of the drive, classification of mechanical load torques, steady state stability of the drive, constant torque and constant HP operation of the drive, closed loop speed control. | **4** |
| II | **DC motor drives**<br>Methods of speed control, starting and braking operation, single phase and three phases full controlled and half controlled converter fed DC drives, Multi quadrant operation of separately excited DC shunt motor, dual converter fed DC drives, circulating and non – circulating mode of operation, converter fed DC series motor drive, chopper control of DC shunt and series motor drives, four quadrant operation of chopper fed DC shunt motor drive. | **6** |
| III | **Induction motor drives**<br>Torque equation,Speed control methods for three phase cage induction motor,braking methods, stator voltage control induction motor drive, VSI fed induction motor drive, constant torque (constant E/F and constant V/F), constant HP operation, closed loop speed control block diagram,Stator current control method,CSI fed induction motor drive, speed torque characteristics of | **6** |

| | | |
|---|---|---|
| | CSI fed drive, closed loop speed control block diagram, comparison of CSI fed and VSI fed induction motor drive. | |
| IV | **Slip Ring Induction Motor Drives**<br>Chopper controlled resistance in rotor circuit, slip power recovery using converter cascade in rotor circuit, sub synchronous and super synchronous speed control, Kramer speed control, cyclo - converter in rotor circuit. | **4** |
| V | **Synchronous motor drives and Brushless DC drives**<br>VSI fed synchronous motor drives, true synchronous and self-control mode, open loop and closed loop speed control of Permanent magnet synchronous machine, brushless DC motor drives. | **4** |
| VI | **Special Drives**<br>Construction and operating principle, Current / Voltage control of switched reluctance motors, torque equation, converter circuits, operating modes and applications of switched reluctance motors. Solar panel VI characteristics, solar powered pump, maximum power point tracking and battery-operated vehicles. | **4** |

| **Text Books** | |
|---|---|
| 1 | *"Fundamentals of Electrical Drives",* G. K. Dubey, Narosa publication, 2nd edition. |

| **References** | |
|---|---|
| 1 | *"Fundamentals of Electrical Drives",* NPTEL video lecture series by Prof. Shyama Prasad Das, Department of Electrical Engineering, IIT Kanpur. |
| 2 | "*Power Electronics - Converter Application",* By N. Mohan T.M. Undel and W. P. Robbins, John Wiely and sons. |
| 3 | "*Electrical Drives - Concept and application*", Vedam Subramanyam. |

| **Useful Links** | |
|---|---|
| 1 | https://nptel.ac.in/courses/108/104/108104140/ |

**CO-PO Mapping**

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

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

**Assessment**

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

# Walchand College of Engineering, Sangli

*(Government Aided Autonomous Institute)*

**AY 2022-23**

| **Course Information** | |
|---|---|
| **Programme** | B.Tech. (Electrical Engineering) |
| **Class, Semester** | Third Year B. Tech., Sem VI |
| **Course Code** | 5EL323 |
| **Course Name** | Microcontroller and Applications |
| **Desired Requisites:** | Analog and Digital Circuits |

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

| **Course Objectives** | |
|---|---|
| **1** | To develop basic knowledge of microcontrollers and their features. |
| **2** | To provide skills for programming microcontroller for applications in Electrical Engineering. |
| **3** | To enable students to interface and program different peripherals to microcontrollers. |

| **Course Outcomes (CO) with Bloom's Taxonomy Level** | | |
|---|---|---|
| At the end of the course, the students will be able to, | | |
| **CO1** | Explain the architecture and features of microcontrollers. | Understanding |
| **CO2** | Apply programming techniques to implement counters, timers, interrupts and other peripherals. | Applying |
| **CO3** | Implement the applications related to interface microcontroller with electrical and electronics systems. | Applying |
| **CO4** | Construct a microcontroller based application. | Applying |

| **Module** | **Module Contents** | **Hours** |
|---|---|---|
| I | **Microcontroller Basics**<br>Overview of 8051/Arduino, features, Architecture, Pin out and pin functions, program memory, data memory, SFR area, PSW, Code memory space, (Internal/External), Port structure, clock circuit. | 4 |
| II | **Programming ports and timers**<br>Introduction to Embedded C programming, ,I/O programming, Development tools for 8051 programs, Programming Timers and counters Timer block diagram and function, Timer modes 0, 1, 2 and their Applications, Timer and Counter Programming | 5 |
| III | **Interrupts and Serial Communication**<br>Interrupt structure, Writing ISR, interrupt, Interrupt priorities, Programming for external interrupt. Programming timer interrupts.<br>Serial Communication :Serial communication modes, RS232 signals of PC, Programming through Serial communication | 5 |
| IV | **Peripheral Interfacing- I**<br>Interfacing of microcontrollers to external peripherals and programming, LCD interfacing, Interfacing of Analog to Digital Converters and Digital to Analog Converters, Stepper motor interfacing | 4 |

| | | |
|---|---|---|
| V | **Peripheral Interfacing- II**<br>DC motor interfacing, PWM programming using microcontrollers, Use of Arduino in Power Electronics Applications, Interfacing Temperature Sensors, Introduction to CAN protocol and its interfacing. | 4 |
| VI | **Introduction to PIC microcontrollers**<br>PIC microcontrollers, overview, Features, concepts of brown out reset, watch dog timers, configurations registers, concept of hardware-in-loop simulation, programming examples | 4 |

| **Text Books** | |
|---|---|
| 1 | Muhammad Mazidi, Janice Mazidi and Rolin McKinlay, 'The 8051 Microcontroller and Embedded systems using Assembly and C', Pearson Education, 2nd Edition, 2007 |
| 2 | Kenneth Ayala ,'8051 Architecture, Programming and Applications', 3rd Edition, 2007 |
| 3 | Massimo Banzi and Michael Shiloh, Make: Getting Started With Arduino - The Open Source Electronics Prototyping Platform, Shroff/Maker Media; 3rd edition, 2014 |

| **References** | |
|---|---|
| 1 | Subrata Ghoshal, 'Embedded Systems and Robots- Projects using the 8051 Microcontroller', Cengage Learning, 1st Edition, 2009 |
| 2 | Michael Margolis, 'Arduino Cookbook', Shroff/ O'Reilly,2nd Edition,2012 |
| 3 | Mazidi, RolinMc Kinlay and Danny Causey, 'PIC Microcontroller and Embedded Systems using Assembly and C for PIC18', Pearson Education. |

| **Useful Links** | |
|---|---|
| 1 | https://nptel.ac.in/courses/106/108/106108100/ |
| 2 | https://nptel.ac.in/courses/117/104/117104072/ |
| 3 | https://nptel.ac.in/courses/108/102/108102045/ |

**CO-PO Mapping**

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

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

**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) Courses

**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 VI |
| **Course Code** | 5EL371 |
| **Course Name** | Power System Protection Lab |
| **Desired Requisites:** | Power System Engineering |

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

**Course Objectives**

| | |
|---|---|
| **1** | To develop hands on skills to test and verify protective relay operation, used in power system protection. |
| **2** | To demonstrate electromagnetic and digital relays to illustrate their operating characteristics. |
| **3** | To experience to use power system analysis software for developing protection schemes for simple electrical systems. |

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

| | | |
|---|---|---|
| **CO1** | **Demonstrate** the working of over current, earth fault relays and plot the I-t characteristics. | **Apply** |
| **CO2** | **Execute** experimental study of a microcontroller based relays. | **Apply** |
| **CO3** | **Design** a scheme for over current relay co-ordination using simulation software / hardware. | **Create** |

**List of Experiments / Lab Activities**

**List of Experiments:**

1. Arrange the set-up & perform an experiment to verify the Current-Time characteristics of a shaded pole type over current relay.
2. Arrange the set-up & perform an experiment to verify the Current-Time characteristics of a shaded pole type earth fault relay.
3. Arrange the set-up & perform an experiment to demonstrate the operation & use of Directional over current relay.
4. Assemble a circuit to obtain & verify various Current-Time curves for Digital over Current Relay.
5. Demonstrate the application of Quadrilateral Distance relay for detection of fault on transmission lines.
6. Conduct a simulation study to develop relay co-ordination scheme of over current relays for a simple radial feeder system.
7. Conduct an experiment to illustrate the over current relay co-ordination on the Transmission Line Simulator.
8. Conduct a simulation study to explain the Circuit Breaker operation under fault condition.

**Text Books**

| | |
|---|---|
| 1 | S.S. Rao, *"Switchgear & Protection",* Khanna Pub., XI edition, 2005 |
| 2 | B.Ram and Vishwakarma, *"Power System Protection & Switchgear",* TMH Pub., III edition, 2008. |

**References**

| | |
|---|---|
| 1 | Oza, Nair, Mehta and Makwana, *"Power System Protection and Switchgear",* MGH pub., 2011. |
| 2 | C.R. Mason, *"Art and Science of Protective Relaying",* GE e-book. |
| 3 | Y.G. Paithankar and S.R. Bhide, *"Fundamentals of Power System Protection",* PHI pub., I edition, 2004. |
| | |
| **Useful Links** | |
| 1 | https://nptel.ac.in/courses/108/101/108101039/ |

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

| **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 (for 26-week Sem)** | **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. | | | | |

# 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 VI |
| **Course Code** | 5EL348 |
| **Course Name** | Industrial Drives and Control Lab Mini Project IV |
| **Desired Requisites:** | DC Machines and Transformer, AC Machines and Power Electronics |

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

**Course Objectives**

| | |
|---|---|
| **1** | To impart knowledge on performance of the fundamental control practices associated with AC and DC machines (starting, reversing, braking, plugging, etc.) using solid state converters. |
| **2** | To develop the skills for the use of computer-based analysis tools to review the major classes of machines and their physical basis for operation and suitability for a particular operation |

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

| | | |
|---|---|---|
| **CO1** | **Demonstrate** experiments on basics of DC and AC drives. | **Apply** |
| **CO2** | **Analyze** the performance of drives using hardware circuits and simulation. | **Analyze** |
| **CO3** | **Evaluate** performance of drives using hardware circuits and simulation**.** | **Evaluate** |

**List of Experiments / Lab Activities**

**List of Experiments:**

1. To verify Speed – Torque characteristics of chopper fed D. C. series motor. (Hardware)
2. To analyze the performance of chopper fed D. C. drive for closed – loop speed control (simulation).
3. To demonstrate operation and application of single phase full wave, half controlled converter for open loop speed control of D. C. shunt motor. (Hardware).
4. To demonstrate operation and application of single phase full wave, full controlled converter for open loop speed control of D. C. shunt motor. (Hardware).
5. To analyze the performance of converter fed D. C. drive for closed loop speed control. (Simulation).
6. To study the operation of two quadrant single phase converter fed 5 HP DC drive (Simulation).
7. To study the four-quadrant operation of 5 HP DC motor using single phase converter. (Simulation).
8. To study the operation of four quadrant chopper fed DC drive (simulation).
9. To assess the performance of rotor resistance control method for speed control of Slip – Ring Induction motor. (Simulation)
10. To demonstrate speed control of Induction motor using V/f method. (Hardware)
11. To analyze the operation of Induction motor drive with Six – step VSI control (Simulation).
12. To demonstrate the operation of brushless DC motor drive with software Simulation. (Simulation)
13. To demonstrate speed control of Induction motor using Kramer speed control method. (Hardware)

**Text Books**

| | |
|---|---|
| 1 | *"Fundamentals of Electrical Drives", G. K. Dubey, Narosa publication, 2nd edition.* |

| References | |
|---|---|
| 1 | "Modern Power Electronics and AC drives" by B. K. Bose, Prentice Hall of India Pvt. India |
| 2 | "*Power Electronics - Converter application*" By N. Mohan T.M. undeland and W. P. Robbins, John Wiely and sons |
| 3 | "*Electrical Drives - Concept and application*" Vedam Subramanyam. |
| | |
| **Useful Links** | |
| 1 | https://nptel.ac.in/courses/108/104/108104140/ |

**CO-PO Mapping**

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

The strength of mapping is to be written as 1,2,3; Where, 1: Low, 2: Medium, 3: High

Each CO of the course must map to at least one PO.

**Assessment**

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

| Assessment | Based on | Conducted by | Typical Schedule | Marks |
|---|---|---|---|---|
| LA1 | Lab activities, attendance, journal | Lab Course Faculty | During Week 1 to Week 8<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.

**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 VI |
| **Course Code** | 5EL372 |
| **Course Name** | Microcontroller and Applications Lab |
| **Desired Requisites:** | Analog and Digital Circuits Lab |

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

**Course Objectives**

| | |
|---|---|
| **1** | To develop the necessary skills required for programming 8051 and Arduino microcontroller implement real world applications. |
| **2** | To understand the practical problems in electrical systems and implement programs for same. |
| **3** | To introduce various programming softwares and implement microcontroller based applications. |

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

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

| | | |
|---|---|---|
| **CO1** | **Use** simulation tools to analyze microcontroller based systems. | Applying |
| **CO2** | **Apply** programming techniques to implement counters, timers, interrupts and other peripherals. | Applying |
| **CO3** | **Execute** programs to interface microcontrollers with electrical and electronics systems. | Applying |
| **CO4** | **Construct** programs for electrical applications using microcontrollers. | Applying |

**List of Experiments / Lab Activities**

**List of Experiments:**

1. Introduction to different Development Boards, Keil/Arduino IDE, Using Keil/Arduino IDE to assemble a program, Hex file format, Downloading and running the program
2. Demonstrate the flashing of GPIO ports of using delay.
3. Implement a 8-bit up and down counter using microcontroller.
4. Devise a running light scheme using GPIO pins of microcontroller.
5. Demonstrate the process of serial communication using 8051 and Arduino microcontroller
6. Construct a C program using 8051 to generate pulses using various timer modes
7. Execute programs to demonstrate interrupts for 8051.
8. Construct a C program to interface LCD with Arduino.
9. Devise a Arduino based relay control for single phase ac loads.
10. Construct a C program to interface stepper motor with Arduino.
11. Construct a temperature control system using Arduino
12. Demonstration of Hardware-in-loop simulation using Arduino and Matlab /Simulink

**Text Books**

| | |
|---|---|
| 1 | Muhammad Mazidi, Janice Mazidi and Rolin McKinlay, "*The 8051 Microcontroller and Embedded systems using Assembly and C"*, Pearson Education, 2nd Edition, 2007 |
| 2 | Kenneth Ayala , "*8051 Architecture, Programming and Applications",* 3rd Edition, 2007 |
| 3 | Massimo Banzi and Michael Shiloh, Make: Getting Started With Arduino - The Open Source Electronics Prototyping Platform, Shroff/Maker Media; 3rd edition, 2014 |
| | |
| **References** | |
| 1 | Subrata Ghoshal, "*Embedded Systems and Robots- Projects using the 8051 Microcontroller"*, Cengage Learning, 1st Edition, 2009 |
| 2 | Michael Margolis, "*Arduino Cookbook"*, Shroff/ O'Reilly,2nd Edition,2012 |
| 3 | Mazidi, RolinMc Kinlay and Danny Causey, "*PIC Microcontroller and Embedded Systems using Assembly and C for PIC18*", Pearson Education. |
| | |
| **Useful Links** | |
| 1 | https://nptel.ac.in/courses/106/108/106108100/ |
| 2 | https://nptel.ac.in/courses/117/104/117104072/ |
| 3 | https://nptel.ac.in/courses/108/102/108102045/ |

**CO-PO Mapping**

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

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

**Assessment**

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 (for 26-week Sem) | 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.

# Professional Elective (Theory) Courses

# 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 VI |
| **Course Code** | 5EL331 |
| **Course Name** | Professional Elective III: Artificial Neural Network |
| **Desired Requisites:** | Nil |

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

| **Course Objectives** | |
|---|---|
| **1** | To develop basic knowledge of neural networks and their features. |
| **2** | To provide skills for programming ANN for applications in Electrical Engineering. |
| **3** | The course aims to enable students to understand and program different neural network algorithms. |

| **Course Outcomes (CO) with Bloom's Taxonomy Level** | | |
|---|---|---|
| At the end of the course, the students will be able to, | | |
| **CO1** | **Explain** the architecture and features of neural networks | Understanding |
| **CO2** | **Explain** programming techniques to implement neural networks | Understanding |
| **CO3** | **Implement** the applications related to electrical and electronics systems using of neural networks. | Applying |

| **Module** | **Module Contents** | **Hours** |
|---|---|---|
| I | **Neural Networks and Architecture**<br>Fundamentals of Neural Networks: What is Neural Network, Model of Artificial Neuron, Learning rules and various activation functions, Single layer Feed-forward networks, Perceptron learning, MLP structures. | 5 |
| II | **Back propagation Networks**<br>Delta and LMS rules, Back propagation Networks, Architecture of Back-propagation (BPN) Networks, Back-propagation Learning, Variation of Standard Back propagation algorithms. | 4 |
| III | **Unsupervised networks**<br>Associative Memory: Auto correlators, Heterocorrelators, Multiple Training Encoding Strategy, Exponential BAM, and Associative Memory for Real coded pattern pairs, Applications | 4 |
| IV | **Adaptive Resonance Networks**<br>Adaptive Resonance Theory: Cluster Structure, Vector Quantization, Classical ART Network, Simplified ART Architecture, ART1 and ART2 Architecture and algorithms, Applications, Sensitivities of ordering of data. | 4 |
| V | **Radial and Convolution Networks**<br>Convolution networks, pooling, working and design, Radial basis function network, working | 4 |

| | | |
|---|---|---|
| VI | **Application to Electrical**<br>Control system design with neural network- controller design, tuning and learning, Power system applications, Load forecasting and fault analysis | 4 |

| **Text Books** | |
|---|---|
| 1 | Simon Haykin, "Neural Network", Pearson Publications, 2005. |
| 2 | Bishop, C. M., "Neural Networks for Pattern Recognition", Oxford University Press. 1995. |
| 3 | S.Rajasekaran and G.A. Vijayalakshmi Pai., "Neural Networks, Fuzzy Logic and Genetic Algorithms", PHI publications,2012. |

| **References** | |
|---|---|
| 1 | Chin Teng Lin, C. S. George Lee , "Neuro-Fuzzy Systems" , PHI.pub. 2007. |

| **Useful Links** | |
|---|---|
| 1 | https://onlinecourses.nptel.ac.in/noc21_ge07/preview |

**CO-PO Mapping**

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

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 VI |
| **Course Code** | 5EL333 |
| **Course Name** | Professional Elective III: Introduction to Electric Vehicle |
| **Desired Requisites:** | Electrical Machines, Power Electronics |

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

| **Course Objectives** | |
|---|---|
| **1** | To develop basic knowledge related to architecture of Electric Vehicles |
| **2** | To provide knowledge related to design aspects and dynamics of Electric vehicles |
| **3** | The course aims at enabling students to understand the motor specifications and charging standards for Electric vehicles. |

| **Course Outcomes (CO) with Bloom's Taxonomy Level** | | |
|---|---|---|
| At the end of the course, the students will be able to, | | |
| **CO1** | Explain the architecture and features of Electric Vehicles | Understanding |
| **CO2** | Interpret the topologies and various design considerations for Electric vehicles | Understanding |
| **CO3** | Calculate the vehicle dynamics for Electric propulsion systems | Applying |

| **Module** | **Module Contents** | **Hours** |
|---|---|---|
| I | **Introduction to Electric Vehicles**<br>Background of Electric Vehicles, Electric Vehicle System, Components of Electric Vehicles, Advantages of Electric Vehicles, Efficiency, Pollution Comparison with conventional vehicles, Fundamentals of Electric Vehicles | 4 |
| II | **Types of Electric Vehicles and Architecture of EVs**<br>Concept of Electric, Hybrid and Plug-in Electric Vehicles, Typical configuration of Hybrid Electric Vehicle, Topologies of HEVs: Series, Parallel and Series-Parallel Configuration, Topologies of Plug-in Hybrid Electric Vehicles, Fuel Cell Electric Vehicles, Solar Powered Electric Vehicles | 5 |
| III | **Design Considerations for Electric Vehicles**<br>Introduction to EV design fundamentals, Aerodynamic Consideration, Rolling resistance, Transmission efficiency, Consideration of vehicle mass, Basics of Electric vehicle chassis and body design, general issues in Electric vehicle design | 4 |
| IV | **Vehicle Dynamics**<br>Roadway fundamentals, Vehicle Kinetics, Dynamics of Vehicle Motion, Propulsion power: Force velocity characteristics, Vehicle gradability,<br>Velocity and Acceleration: Velocity Profile, Distance traversed, tractive power, Energy Required, Propulsion System Design for EV systems | 5 |

| | | |
|---|---|---|
| V | **Electric Machines in EV systems**<br>Motor and Engine ratings, EV and HEV motor requirements, Three phase AC machines for Electric vehicles: Induction Machines, SRM machines, PMSM machines, Design aspects for EV systems, Numericals | 4 |
| VI | **Electric Vehicle Chargers and Charging Standards**<br>EV charging: requirements and Classification, Charging standards for Electric vehicles, Introduction to AC and DC chargers for EV systems, Working of Electric Vehicle Supply Equipment (EVSE), Fast Chargers for EV systems | 4 |

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

**CO-PO Mapping**

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

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

**Assessment**

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

# Walchand College of Engineering, Sangli

*(Government Aided Autonomous Institute)*

**AY 2022-23**

**Course Information**

| | |
|---|---|
| **Programme** | B.Tech. (Electrical Engineering) |
| **Class, Semester** | Third Year B. Tech., Sem VI |
| **Course Code** | 5EL332 |
| **Course Name** | Professional Elective III: Nonlinear and Digital Control System |
| **Desired Requisites:** | Control System Engineering |

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

**Course Objectives**

| | |
|---|---|
| **1** | To make students identify various characteristics of nonlinear systems. |
| **2** | To develop skills for analyzing nonlinear systems. |
| **3** | To make students familiar with digital control system. |

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

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

| | | |
|---|---|---|
| **CO1** | Construct mathematical models of digital control system. | Apply |
| **CO2** | Analyze the nonlinear systems using various basic and commonly used tools. | Analyze |
| **CO3** | Calculate the compensators and controllers for digital control system. | Evaluate |

| **Module** | **Module Contents** | **Hours** |
|---|---|---|
| I | **Nonlinear System**<br>Properties of nonlinear system, Multiple Equilibrium States, Chaos, Sensitive to input amplitude, Limit Cycle, Bifurcation, Jump Phenomenon, Common Physical Nonlinearities, Dead Zone, Saturation, Hysteresis, Backlash, Classification of Nonlinearities | 3 |
| II | **Analysis of Nonlinear System**<br>Linearization, Phase Plane Analysis, Classification of Equilibrium States, Node, Focus, Saddle Point, Centre, Prediction of Limit Cycle using Phase Plane, Describing Function Method, Lyapunov Stability for Non-linear and Linear Systems. | 5 |
| III | **Digital Control System**<br>Review of Z transforms, Z transform method for solving difference equation, Impulse Sampling and Data Hold, Pulse Transfer Function, Sampling Theorem, Mapping between S Plane and Z Plane, Stability Analysis, Transient and Steady State Analysis. | 5 |
| IV | **Design of Digital Control System**<br>Construction of Root Locus, Design based on Root Locus, P,PI,PD,PID Controllers, Lead, Lag, Lead-Lag Compensators, Frequency Response Analysis, Bode Diagram. | 5 |

| | | |
|---|---|---|
| V | **State Space Analysis of Digital Control System**<br>State Space representation of Digital System, Controllable Canonical form, Observable Canonical form, Diagonal form, Jordan form, Solving State<br>Space Equations, State Transition Matrix, Properties of State Transition Matrix, Pulse Transfer Function Matrix. Discretization of Continuous Time State Space Equation. | 4 |
| VI | **State Space Design of Digital Control System**<br>Controllability, Controller Design in State Space, Design via Pole Placement for Controller Design, Ackermann's Formula for Controller Design, Observability, Observer Design, Design via Pole Placement for Observer Design, Ackermann's Formula for Observer Design, Deadbeat Design, Design for Deadbeat Response | 4 |

| **Text Books** | |
|---|---|
| 1 | K. Ogata, "Discrete Time Control Systems", Second Edition, Pearson Education, 2005, ISBN: 9788120327603 |
| 2 | C.L. Phillips, J.M. Parr, "Feedback Control Systems", Fifth Edition, Pearson Education,2013, ISBN: 9789332507609 |

| **References** | |
|---|---|
| 1 | I.J. Nagrath, M.Gopal "Control Systems Engineering", New Age International, Sixth Edition, 2018, ISBN: 9789386070111 |
| 2 | B.C. Kuo, "Digital Control Systems", Oxford University Press, Second Edition, 2012, ISBN: 9780198083542 |

| **Useful Links** | |
|---|---|
| 1 | https://nptel.ac.in/courses/108/106/108106162/ |
| 2 | https://nptel.ac.in/courses/108/102/108102113/ |

**CO-PO Mapping**

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

# Open Elective -III Courses

| Walchand College of Engineering, Sangli<br>*(Government Aided Autonomous Institute)* | | | | | | |
|---|---|---|---|---|---|---|
| **AY 2022-23** | | | | | | |
| **Course Information** | | | | | | |
| **Programme** | | B.Tech. (Electrical Engineering) | | | | |
| **Class, Semester** | | Third Year B. Tech., Sem VI | | | | |
| **Course Code** | | | | | | |
| **Course Name** | | Open Elective III: Renewable Energy | | | | |
| **Desired Requisites:** | | Basic Mechanical Engineering, Basic Electrical Engineering. | | | | |
| | | | | | | |
| **Teaching Scheme** | | **Examination Scheme (Marks)** | | | | |
| **Lecture** | 2 Hrs/week | **MSE** | **ISE** | **ESE** | **Total** | |
| **Tutorial** | - | 30 | 20 | 50 | 100 | |
| **Practical** | - | | | | | |
| **Interaction** | - | **Credits: 3** | | | | |

| **Course Objectives** | |
|---|---|
| **1** | To create awareness about the importance of renewable resources and their classification for sustainable future. |
| **2** | To impart the knowledge of solar power generation and wind power generation. |
| **3** | To introduce other renewable resources and their technologies. |
| **4** | To study energy storage systems in renewable generation. |

| **Course Outcomes (CO) with Bloom's Taxonomy Level** | | |
|---|---|---|
| At the end of the course, the students will be able to, | | |
| **CO1** | Describe need and types of renewable energy resources with sustainability. | Understand |
| **CO2** | Interpret working of solar and wind power generation and its utilization. | Apply |
| **CO3** | Distinguish various renewable energy sources like biogas, geothermal and MHD | Apply |
| **CO4** | Explain need and operation of various energy storage technologies. | Apply |

| **Module** | **Module Contents** | **Hours** |
|---|---|---|
| I | **Introduction to Renewable Energy Sources**<br>Energy sources: classification of energy sources, introduction to renewable energy, renewable energy trends, and 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. | 4 |
| 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. | 5 |
| III | **PV System Design**<br>PV power generation, basic principle of power generation in PV cell, solar cell and its parameters, module and array, 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. | 5 |

| | | |
|---|---|---|
| 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, electrical generator machines in wind energy systems | 5 |
| V | **Biomass Energy and other renewable energy systems**<br>Overview of biomass as energy source, physicochemical and thermal characteristics of biomass as fuel, biochemical conversion of biomass for energy production, gasification, bio-refinery and bio-diesel, geothermal energy different components, advantages, limitations | 4 |
| VI | **Energy Storage 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. | 5 |

| **Text Books** | |
|---|---|
| 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. |
| 4 | |

| **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. |
| 3 | |

| **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** | 1 | | | | | | 3 | | | | | | | | |
| **CO2** | 3 | | | | | | | | | | | | | | |
| **CO3** | | | 3 | | | | | | | | | | | | |
| **CO4** | 3 | | | | | | | | | | | | | | |

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

| Assessment |
| --- |
| The assessment is based on MSE, ISE and ESE.<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) |

# Open Elective -IV Courses

| Walchand College of Engineering, Sangli<br>*(Government Aided Autonomous Institute)* | | | | | |
|---|---|---|---|---|---|
| **AY 2022-23** | | | | | |
| **Course Information** | | | | | |
| **Programme** | B.Tech. (Electrical Engineering) | | | | |
| **Class, Semester** | Third Year B. Tech., Sem VI | | | | |
| **Course Code** | | | | | |
| **Course Name** | Energy management | | | | |
| **Desired Requisites:** | NIL | | | | |
| | | | | | |
| **Teaching Scheme** | | **Examination Scheme (Marks)** | | | |
| **Lecture** | 2 Hrs/week | **MSE** | **ISE** | **ESE** | **Total** |
| **Tutorial** | - | 30 | 20 | 50 | 100 |
| **Practical** | - | | | | |
| **Interaction** | - | **Credits: 2** | | | |

| **Course Objectives** | |
|---|---|
| **1** | To provide students with a general awareness on the importance of energy and its conservation, its impact on society, various energy sources, energy conversion processes and energy management. |

| **Course Outcomes (CO) with Bloom's Taxonomy Level** | | |
|---|---|---|
| **CO1** | **Understand** the Need, importance and scope of energy management and energy conservation. | Understand |
| **CO2** | **Evaluate** the financial analysis for energy efficiency importance | Evaluate |

| **Module** | **Module Contents** | **Hours** |
|---|---|---|
| I | **Energy Scenario**<br>Global and Indian –Impact of Energy on economy, development and environment, Energy policies, Energy strategy for future, Energy resources | 4 |
| II | **Energy storage and Distribution**<br>Electrical energy route – Load curves – Energy conversion plants for Base load, Intermediate load, Peak load and Energy displacement – Energy storage plants. | 5 |
| III | **Energy Management**<br>Definitions and significance, Objectives and Principles of Energy Management, Characterising of energy usage, Energy Management program Energy strategies and energy planning, Computer applications in Energy management. | 5 |
| IV | **Energy Action Planning, Monitoring And Targeting**<br>Energy action Planning Steps, Top Management Support, Energy Manager Duties & responsibilities, Evaluating Energy Performance, Energy monitoring & Targeting – Set up, Key Elements, Data & Information Analysis, Relating Energy Consumption & Production | 5 |
| V | **Energy conservation**<br>Energy Conservation and its importance, Energy strategy for future, Energy Conservation Act2001 and its features, Energy Pricing, Energy Sector Reforms, Energy And Environment, Energy Security | 4 |

| | | |
|---|---|---|
| VI | **Energy Economics**<br>Financial Analysis Techniques – Pay Back Period, Net Present Value, Return on Investment, Internal Rate Of Return, Time Value Of Money, Cash Flow, Risk & Sensitivity analysis. | 4 |

| | |
|---|---|
| | |
| **Text Books** | |
| 1 | Amlan Chakrabarti, "Energy Engineering and Management", PHI, 2011 |
| 2 | Bureau of Energy Efficiency, "General Aspects of Energy Management & Energy Audit1.1, 1.2 &1.3", BEE, e-books |
| 3 | |
| 4 | |
| | |
| **References** | |
| 1 | NIL |
| 2 | |
| 3 | |
| 4 | |
| | |
| **Useful Links** | |
| 1 | https://beeindia.gov.in/content/energy-auditors |
| 2 | |
| 3 | |
| 4 | |

**CO-PO Mapping**

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

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

**Assessment**

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

| Walchand College of Engineering, Sangli<br>*(Government Aided Autonomous Institute)* | | | | | | |
|---|---|---|---|---|---|---|
| **AY 2022-23** | | | | | | |
| **Course Information** | | | | | | |
| **Programme** | | B.Tech. (Electrical Engineering) | | | | |
| **Class, Semester** | | Third Year B.Tech., Sem VI | | | | |
| **Course Code** | | | | | | |
| **Course Name** | | Open Elective IV-Power plant Engineering | | | | |
| **Desired Requisites:** | | Nil | | | | |
| | | | | | | |
| **Teaching Scheme** | | **Examination Scheme (Marks)** | | | | |
| **Lecture** | 3 Hrs/week | **MSE** | **ISE** | **ESE** | **Total** | |
| **Tutorial** | - | 30 | 20 | 50 | 100 | |
| **Practical** | - | | | | | |
| **Interaction** | - | **Credits: 3** | | | | |

| **Course Objectives** | |
|---|---|
| **1** | To introduce the students about different power plants, energy audit and economics. |
| **2** | To prepare the students to analyse the power plants and its various parameters. |
| **3** | To develop the skill to select, analyse the power plant system and allied parameters. |

| **Course Outcomes (CO) with Bloom's Taxonomy Level** | | |
|---|---|---|
| At the end of the course, the students will be able to, | | |
| **CO1** | **Describe** energy harvesting from water, fuels like coal, nuclear, diesel and hydrocarbon | Remembering |
| **CO2** | **Distinguish and interpret** the parameters related to power plants | Understanding |
| **CO3** | **Select** the appropriate systems, instruments and allied parameters based on performance, energy consumption and economics. | Applying |

| **Module** | **Module Contents** | **Hours** |
|---|---|---|
| I | **Introduction**<br>Energy resources and their availability, types of power plants, selection of the plants, review of basic thermodynamic cycles used in power plants | 5 |
| II | **Hydro electric power plants**<br>Rainfall and Run-off measurements and plotting of various curves for estimating stream flow and size of reservoir, power plants design, construction and operation of different components of hydro-electric power plants, site selection, comparison with other types of power plants | 7 |
| III | **Steam power plants**<br>Flow-sheet and working of modern thermal power plants, super critical pressure steam stations, site selection, coal storage, preparation, coal handling systems, feeding and burning of pulverized fuel, ash handling systems, dust collection-mechanical dust collector and electrostatic precipitator | 7 |

| | | |
|---|---|---|
| IV | **Other power plants**<br>Basic principles and types of diesel plants, advantages and disadvantages of diesel plants, operation performance of a diesel engine, construction and working principle of gas turbine power plants, basic components and auxiliary system used in gas turbine power plants, different types of fuels and materials used in gas turbine power plants. Principles of nuclear energy, basic nuclear reactions, nuclear reactors-PWR,BWR, advantages and limitations | 7 |
| V | **Power plant instrumentation and Energy Audit**<br>Steam pressure and steam temperature measurement, flow measurement of feed water, fuel, air and steam with correction factor for temperature, speed measurement, level recorders, smoke density measurement, dust monitor, flue gas oxygen analyser- analysis of impurities in feed water and steam, dissolved oxygen analyser, pH meter-fuel analyser and pollution monitoring instruments, current simple methods of energy auditing | 6 |
| VI | **Power plant economics**<br>Load curves, different terms and definitions, cost of electrical energy, tariffs methods of electrical energy, performance and operating characteristics of power plants- incremental rate theory, input-output curves, efficiency, heat rate, economic load sharing and simple numerical | 7 |

| **Text Books** | |
|---|---|
| 1 | EL-Wakil, "Power plant Technology", M.M.McGraw Hill, 1st edition, 2017. |
| 2 | P.K.Nag, "Power plant Engineering", TATA McGraw hill, 4th edition,2017. |
| 3 | Domkundwar, Arora, "Power plant Technology", Dhanpat Rai and Co.6th edition, 2013. |

| **References** | |
|---|---|
| 1 | Weisman J. and Eckert L. ,"Modern Power plant Engineering", Prentice hall, 1st edition, 1999. |
| 2 | Kam W. Li. and A. Paul Priddy, "Power plant system design", John Wiley, 1st edition, 2018. |
| 3 | Recent report of agencies: International Energy Agency (IEA), Ministry of New and Renewable Energy(MNRE), Technology and Action for Rural Advancement (TARA) |

| **Useful Links** | |
|---|---|
| 1 | - |
| 2 | - |
| 3 | - |
| 4 | - |

**CO-PO Mapping**

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

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

| Assessment |
| --- |
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