Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

Course Contents (Syllabus) for

Final Year B. Tech (Electrical Engineering)
Sem. VII to VIII

AY 2020-21

ODD Semester

Professional Core (Theory) Courses

Title of the Course: Power System Harmonics and FACTS	L	T	P	Cr
Course Code: 3EL401	3	0	0	3

Pre-Requisite Courses: Basic Electrical Engineering (EE 101), Power Electronics

Textbooks:

1. Roger C. Dugan, Mark F. McGranton and H. Wayne Beety, *"Electrical Power Systems Quality"* McGraw Hill.
2. Mohan Mathur, R., Rajiv. K. Varma, "Thyristor – Based FACTS Controllers for Electrical Transmission Systems", IEEE press and John Wiley & Sons, Inc, 2002.

References:

1. George J. Wakileh, *"Power System Harmonics* - Fundamentals, Analysis & filter Design" Springer.
2. K.R.Padiyar," FACTS Controllers in Power Transmission and Distribution", New Age International (P) Ltd., Publishers, New Delhi, Reprint, 2008.

Course Objectives :

1. This course is intended to introduce terms and definitions of power quality disturbances, and their causes, detrimental effects and solutions.
2. It provides the insights of latest development in the field of flexible AC transmission systems and its applications to power systems.

Course Learning Outcomes:

CO	**After the completion of the course the student will be able to**	Bloom's Cognitive	
		level	Descriptor
CO1	**Explain** the symptoms of power quality problems, wiring and grounding issues, constraints on transmission line loading and Basic concepts of FACTs controllers.	2	Understanding
CO2	To **Study** and **Select** appropriate FACTS controller and harmonic filter for particular application.	4, 5	Analyzing, Evaluation
CO3	To **Design** and **Apply** harmonic filters to mitigate power quality problems.	3, 6	Applying, Creating

CO-PO Mapping :

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	1	1												
CO2		2			2									
CO3			3											

Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weightage respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment, oral, seminar, test (surprise/declared/quiz), and group discussion.[One assessment tool per ISE. The assessment tool used for ISE 1 shall not be used for ISE 2]
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with70-80% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1: Introduction to Power Quality	**Hrs.**

Introduction, Electromagnetic phenomena – Transients, Long and short duration voltage variations, wave form distortion.	**4**
Module 2: Fundamentals of Harmonics	**Hrs.**
Representation characteristic harmonics, Harmonic indices Harmonic sources-6&12 pulse related harmonics, harmonic effects on power apparatus and on measurements, interference with communications	**6**
Module 3: Harmonic Mitigation Techniques	**Hrs.**
Shunt passive filters, types, Design considerations and illustrative examples, Active filters: types, current and voltage source active filters, shunt, series & Hybrid active filters, Detuned filters.	**6**
Module 4: Reactive-Power Control in Electrical Power Transmission	**Hrs.**
Power flow in AC Systems. Definition of FACTS. Power Flow Control. Constraints of maximum transmission line loading. Benefits of FACTS Transmission line compensation: Uncompensated line, shunt compensation. Series compensation, Phase angle control.	**6**
Module 5: Principles of Conventional Reactive-Power Compensators	**Hrs.**
The Saturated Reactor (SR), The Thyristor-Controlled Reactor (TCR), Operating Characteristics of a TCR, The Thyristor-Controlled Transformer (TCT), The Fixed Capacitor–Thyristor-Controlled Reactor (FC–TCR), The Mechanically Switched Capacitor–Thyristor-Controlled Reactor (MSC–TCR), The Thyristor-Switched Capacitor (TSC), The Thyristor-Switched Capacitor–Thyristor-Controlled Reactor (TSC–TCR), A Comparison of Different SVCs.	**10**
Module 6: The Thyristor-Controlled Series Capacitor (TCSC)	**Hrs.**
Series Compensation, The TCSC Controller, Operation of the TCSC, Analysis of the TCSC, Capability Characteristics, Harmonic Performance, Losses.	**8**

Module wise Measurable Students Learning Outcomes :

After the completion of the course the student will be able to:

1. Comprehend fundamentals of Power Quality problems.
2. Explain the concept of harmonics and related problems.
3. Design harmonic mitigation systems to counter power quality problems.
4. Explain basic concepts of FACTs devises and controllers.
5. Explain the characteristics, applications and modelling of shunt FACTS controllers.
6. Explain the characteristics, applications and modelling of series FACTS controllers.

Title of the Course: HVDC Transmission	L	T	P	Cr
Course Code: 3EL402	3	0	0	3

Pre-Requisite Courses: Power Electronics**,** Power System Engineering

Textbooks:

1. K.R. Padiyar, "H.V.D.C. Power Transmission", Wiley Eastern, NewDelhi.
2. E.W. Kimbark, "Direct Current Transmission", Win publisher.

References:

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

Course Objectives :

1. This course intends the students to analyze concept of HVDC transmission system.
2. It provides the knowledge of appropriate control and protection systems in HVDC transmission systems.
3. It gives the overview of recent trends in HVDC transmission systems.

Course Learning Outcomes:

CO	**After the completion of the course the student will be able to**	Bloom's Cognitive	
		level	Descriptor
CO1	**Analyze** HVDC systems.	4	Analyzing
CO2	**Justify** various control and protection schemes for HVDC transmission system.	5	Evaluating
CO3	**Explain** recent trends in HVDC transmission system.	2	Understanding

CO-PO Mapping :

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1		3												
CO2		3												
CO3													3	

Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weightage respectively.

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ISE 1	10
MSE	30
ISE 2	10
ESE	50

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MSE: Assessment is based on 50% of course content (Normally first three modules)

ESE: Assessment is based on 100% course content with70-80% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1: Introduction to HVDC Transmission Technology	**Hrs.**
Comparison of EHVAC and HVDC Transmission, types of HVDC transmission systems, components of HVDC transmission system.	**6**
Module 2:Analysis of HVDC converter	**Hrs.**
Different modes of valve operation, o/p voltage waveforms and D C voltage in rectification, and inverter operation, valve voltages, equivalent electrical circuit, converter charts.	**6**
Module 3:HVDCTS control features	**Hrs.**
Control modes, control schemes and their comparisons, energization and de-energization of bridges, starting and stopping of D C link.	**6**
Module 4: Faults and over-voltages	**Hrs.**
Converter mal-operations, commutation failure, over-voltages in HVDCTS, protection of converters, D C reactor and damper circuits.	**6**
Module 5: Harmonics and their suppression in HVDCTS	**Hrs.**
Harmonic analysis, filter design, minimum cost tuned A C filters, reactive power requirements.	**6**
Module 6: Multi terminal HVDCTS	**Hrs.**
Series and parallel MTDCTS, their control, introduction to HVDC light, recent trends in HVDCTS.	**6**

Module wise Measurable Students Learning Outcomes :

After completion of the course students will be able to:

1. Explain need of HVDC and layout.
2. Analyze HVDC converters, and derive its equivalent circuit. They will be able to prepare and read converter charts of HVDCTS.
3. Classify different control modes of HVDCTS, and will be able to compare these to control schemes. They will be able to explain energization and de-energization and starting and stopping procedures for HVDC links.
4. Discuss various faults and causes of over-voltages. They will be able to suggest various methods to protect HVDCTS.
5. Classify causes of harmonics and will be able to design cost effective filter for harmonics suppression which will meet reactive power requirements of the system as well.
6. Discuss different types of Multi terminal HVDC system and compare them. They will be able to understand various control aspects of MTDC system.

Title of the Course: Solar and Wind Power Generation	L	T	P	Cr
Course Code: 3EL403	3	0	0	3

Pre-Requisite Courses: Power System Engineering and Power Electronics

Textbooks:

1. Boyle, Godfrey, "Renewable Energy", (2nd edition), Oxford University Press, 2004.
2. G.S.Sawhney, "Non-Conventional Resources of Energy", PHI Publication 2012.

References:

1. Gary-L. Johnson Wind Energy Systems Tata Mc-Graw-Hill Book Company.
2. James Manwell, J. F. Manwell Wind Energy Explained: Theory, Design and Application.
3. Paul Gipe Wind Power, Renewable Energy for Home, Farm, and Business.

Course Objectives :

1. To create awareness about the importance of renewable technology for sustainable future.
2. Impart the knowledge of solar power generation and wind power generation
3. To acquaint students with possible storage systems in renewable generation.
4. Introduce recent trends in renewable energy system to students.

Course Learning Outcomes:

CO	**After the completion of the course the student will be able to**	Bloom's Cognitive	
		level	Descriptor
CO1	**Determine** need of RES.	2	Understanding
CO2	**Explain** solar and wind power generation and its utilization.	2	Understanding
CO3	**Comprehend** storage systems and SMART GRID system.	2	Understanding

CO-PO Mapping :

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1		3												
CO2													3	
CO3			3											

Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weightage respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment, oral, seminar, test (surprise/declared/quiz), and group discussion. [One assessment tool per ISE. The assessment tool used for ISE 1 shall not be used for ISE 2]

MSE: Assessment is based on 50% of course content (Normally first three modules)

ESE: Assessment is based on 100% course content with70-80% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1: Introduction to Renewable Energy Sources	**Hrs.**
Global and Indian scenario of RES, need for alternative energy sources, advantages &disadvantages of RES, classification of RES & comparison, key factors affecting RES.	**4**
Module 2: Solar Energy	**Hrs.**
Solar thermal power generation, solar photovoltaic power generation, basics of PV cell, materials used for PV cell, efficiency of PV cell, equivalent electrical circuit, open circuit voltage and short circuit current, I-V & P-V curves, effects of different electrical parameters on I-V & P-V curves, measurement of solar insolation, solar concentrator, flat plate	**7**

&concentrating collectors.	
Module 3: Solar Photovoltaic Energy Conversion & Utilization	**Hrs.**
Configuration of PV power generation system- off-grid system & grid-connected PV system, single stage & two stage converters for power transfer, single phase & three phase inverters for PV, control of grid connected PV system.	**6**
Module 4: Wind Resource Assessment	**Hrs.**
Power available in wind, wind turbine power & torque characteristics, types of rotors, characteristics of wind rotor, local effects, wind shear, turbulence & acceleration effects, measurement of wind, wind speed statistics, statistical model for wind data analysis, energy estimation of wind regimes, capacity factor, aerodynamics of wind turbines, airfoil, lift & drag characteristics, power coefficient & tip speed ratio characteristics, electrical generator machines in wind energy systems.	**9**
Module 5: Storage and Fuel Cell Technologies	**Hrs.**
Introduction, need for storage for RES, traditional energy storage system- battery, fuel cell, principle of operation, types of fuel cell.	**4**
Module 6: Emerging Trends in Renewable Energy	**Hrs.**
Introduction to SG, SG in Indian context, architecture of SG, advantages &disadvantages, key challenges for SG, SG technologies, AMI, PMU, WAMS, standards & codes for grid integration of DG systems.	**6**

Module wise Measurable Students Learning Outcomes :

After completion of the course students will be able to:

1. Explain the various renewable energy sources.
2. Compare the equivalent circuit of PV cell and its modeling.
3. Explain the grid-connected PV system.
4. Explain wind power generation & its mechanical aspects.
5. Describe energy storage systems.
6. Explainthe smart grid, recent trends in renewable system & standards for grid integration.

Professional Core (Lab) Courses

Title of the Course: Power System Harmonics and FACTS Lab	L	T	P	Cr
Course Code: 3EL451	0	0	2	1

Pre-Requisite Courses: Basic Electrical Engineering (EE 101), Power Electronics

Textbooks:

1. Roger C. Dugan, Mark F. McGranton and H. Wayne Beety, *"Electrical Power Systems Quality"* McGraw Hill.
2. Mohan Mathur, R., Rajiv. K. Varma, "Thyristor – Based FACTS Controllers for Electrical Transmission Systems", IEEE press and John Wiley & Sons, Inc, 2002.

References:

1. George J. Wakileh, *" Power System Harmonics* - Fundamentals, Analysis & filter Design" Springer
2. K.R.Padiyar," FACTS Controllers in Power Transmission and Distribution", New Age International (P) Ltd., Publishers, New Delhi, Reprint, 2008.

Course Objectives :

1. This course is intended to demonstrate Power Quality issues and their solutions. It also imparts skills to design harmonic filtering system suitable for particular application in power systems.
2. It imparts fundamental knowledge to model Series and Shunt FACTs devises and controllers. It develops the ability to identify suitable FACTS devises for the customized power system application.

Course Learning Outcomes:

CO	**After the completion of the course the student will be able to**	Bloom's Cognitive	
		level	Descriptor
CO1	**Identify** power quality problems and its solutions.	3	Applying
CO2	**Experiment** on FACTs devises to evaluate the performance based on analyzed data.	3	Applying
CO3	**Design** suitable harmonic filtering systems for particular application and analyze the results.	6	Synthesis

CO-PO Mapping :

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1		1												
CO2				3										
CO3			2											

Lab Assessment:

There are four components of lab assessment, LA1, LA2, LA3 and Lab ESE.
IMP: Lab ESE is a separate head of passing.

Assessment	Based on	Conducted by	Conduction and Marks Submission	Marks
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 4 Submission at the end of Week 5	25
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 5 to Week 8 Submission at the end of Week 9	25
LA3	Lab activities, attendance, journal	Lab Course Faculty	During Week 10 to Week 14 Submission at the end of Week 14	25
Lab ESE	Lab Performance and related documentation	Lab Course faculty	During Week 15 to Week 18 Submission at the end of Week 18	25

Week 1 indicates starting week of 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.

Course Contents:

1. Classification of Power Quality Disturbances.
2. Analysis of Power Component definitions in single phase circuits: linear and distorted current condition.
3. Analysis of Power Component definitions in single phase circuits: Nonlinear load.
4. Analysis of Power Component definitions in single phase circuits: Non Sinusoidal supply and Non-linear load.
5. Illustrate the understanding of harmonic sources and their distortion levels.
6. Predict the parallel resonance frequency and solve for the magnified currents and voltages in the circuit.
7. Design of Single Tuned Harmonic Filter for mitigation of Harmonics.
8. Simulate series and shunt FACTs controllers for mitigation of Power Quality problems.

Computer Usage / Lab Tool: MATLAB

Title of the Course: Project I	L	T	P	Cr
Course Code: 3EL491	0	0	8	4

Pre-Requisite Courses:

Textbooks: Suitable books based on the contents of the project selected.

References: Suitable books based on the contents of the project selected and research papers from reputed national and international journals/conferences.

Course Objectives:

1. To acquire the skills of electrical, electronic circuit design and mechanical assembly.
2. To develop the skills of analysis and fault diagnosis of the electrical, electronic circuit and mechanical assembly as per design.
3. To test the electrical, electronic circuit and mechanical assembly.

Course Learning Outcomes:

CO	**After the completion of the course the student will be able to**	Bloom's Cognitive	
		level	Descriptor
CO1	**Analyze** and infer the reference literature/ research papers critically and efficiently.	4	Analyzing
CO2	**Decide** the model of the project.	5	Evaluating
CO3	**Construct** the project and assess the performance of the project.	6	Creating
CO4	**Write** and Present the report of the project.	6	Creating

CO-PO Mapping :

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1												3	3	3
CO2			3						3		3			
CO3								3					3	3
CO4										3				

Assessment:

There are four components of project assessment, LA1, LA2, LA3 and Project ISE.

Assessment	Based on	Conducted by	Conduction and Marks Submission	Marks
LA1	Project Topic Selection and Literature Review	Project Panel	During Week 1 to Week 4 Submission at the end of Week 5	25
LA2	Simulation / Basic Project design	Project Panel	During Week 5 to Week 8 Submission at the end of Week 9	25
LA3	Software /Hardware Implementation	Project Panel	During Week 10 to Week 14 Submission at the end of Week 14	25
Project ISE	Presentation, Project report submission	Project Panel	During Week 15 to Week 18 Submission at the end of Week 18	25

Week 1 indicates starting week of Semester.ISE is based on performance of student in project reports, demonstration, presentation, oral, etc. The project guide/panel shall use at least two assessment tools as mentioned above for ISE.

Course Contents:

1. Students may visit to nearby industry for the study of problems.
2. Prepare the problem statement and design the Simulations/ Hardware.
3. Analyze the performance of project and results to meet desired specifications.
4. Students should maintain a project log book containing weekly progress of the project.
5. Project report should be submitted along with soft copy (with code, PPT, PDF, Text report document & reference material) at the end of semester.

Module wise Measurable Students Learning Outcomes: It is expected that students should be able to analyze the problem, work on hardware circuits and prepare the report.
Computer Usage / Lab Tool:

Professional Elective (Theory) Courses

Title of the Course: Advanced Power Electronics	L	T	P	Cr
Course Code: 3EL411	3	0	0	3

Pre-Requisite Courses: Power Electronics

Textbooks:

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

References:

1. B. K. Bose, Modern Power Electronics & AC drives, PHIPL, New Delhi.
2. M. B. Patil, V. Ramayanan and V. T. Ranganathan, Simulation of Power Electronics circuits, Narosa publication.
3. IEEE Transaction papers.

Course Objectives :

1. This course intends to provide advanced knowledge of different power electronic converters, multi-level inverters and resonant converters.
2. It is aimed to impart skills of analysis for different types of advanced converters and shunt active power filters.
3. Make the students acquainted with control strategies of different types of advanced converters and shunt active power filters.

Course Learning Outcomes:

CO	**After the completion of the course the student will be able to**	Bloom's Cognitive	
		level	Descriptor
CO1	**Distinguish** configuration and working of different advanced power electronic converters.	2	Understanding
CO2	**Analyze** different advanced power electronic converters and systems.	4	Analyzing
CO3	**Evaluate** performance of different power electronic system using power electronic devices and converters.	5	Evaluating

CO-PO Mapping :

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	1	2												
CO2		2												
CO3			2		1									

Assessment:

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Course Contents:

Module 1:PWM rectifiers	**Hrs.**
Advantages & disadvantages of three phase thyristor converter, PWM converters working,	

types, Control of PWM rectifiers, analysis and application	**6**
Module 2:Multilevel inverters	**Hrs.**
Three phase two level inverter, Multilevel inverter, Types: Diode clamp multilevel inverter, flying capacitor multilevel inverter, cascaded multilevel inverter, applications of multilevel inverters, comparison of multilevel inverter. Control method: sinusoidal PWM, selective harmonic elimination, carrier PWM, space vector PWM.	**8**
Module 3:Resonant pulse inverters	**Hrs.**
Series resonant inverter with unidirectional and bi-directional switches, parallel resonant inverters, voltage control of resonant inverters, zero current and zero voltage switching resonant converters, two-quadrant ZVS resonant converters, resonant DC link inverters	**8**
Module 4:High power factor converters	**Hrs.**
Need of HPFC, converters employing Line commutation and forced commutation, Single phase active PFC, analysis of single phase boost rectifier, Voltage doubler PWM rectifier, Three phase PFC circuits.	**6**
Module 5: Matrix Converters and Z source inverters	**Hrs.**
Topology, working and control methods of Matrix converters, Various circuit topologies and control of Z source inverter, Application of Z source in induction motor control	**6**
Module 6:Active power filters	**Hrs.**
Power Quality Issues due to power Electronics, Introduction to active power filter, types of active power filters overall control of shunt active power filter, harmonic compensation & reactive power compensation	**6**

Module wise Measurable Students Learning Outcomes:

After completion of the course students will be able to:

1. Explain the PWM converters, their advantages and applications.
2. Control the multilevel inverters.
3. Design and simulate resonant converters.
4. Grasp the advantages of high power factor converters.
5. Simulate the z-source inverter.
6. Design active filter for non-linear load.

Title of the Course: Process Control	L	T	P	Cr
Course Code: 3EL412	3	0	0	3

Pre-Requisite Courses:

Textbooks:

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

References:

1. Thomas E. Marlin, "Process Control - Design Processes and Control System for Dynamic Performance, 2nd Edition", Mc Graw Hill publication.
2. F.G. Shinskey, "Process Control System – Application, Design and Tuning", McGraw-Hill Publication, 3rd Edition, 1988.
3. Curtis D. Johnson, "Process Control Instrumentation Technology", 7th Edition, Pearson Education, 7th Edition. 2003.

Course Objectives :

1. This course intends to provide basics for mathematical model of the process.
2. It imparts the knowledge of various types of controllers for single loop and multi loop control system.
3. It provides over view of advanced controllers used in process control and multivariable predictive control.

Course Learning Outcomes:

CO	After the completion of the course the student will be able to	Bloom's Cognitive	
		level	Descriptor
CO1	**Produce** the models of industrial processes.	3	Applying
CO2	**Analyze** the problems associated with open loop and close loop process control system.	4	Analyzing
CO3	**Evaluate** the performance of processes with various conventional and advanced controllers.	5	Evaluating
CO4	**Design** the processes with various conventional and advanced controllers.	6	Creating

CO-PO Mapping :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	2												
CO2		2												
CO3		2												
CO4			2											

Assessment:

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ESE: Assessment is based on 100% course content with70-80% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1:Introduction to Process Control	Hrs.

Introduction, Design aspects of a process control system, Hardware for a process control system. Mathematical modeling and analysis of processes, development of a mathematical model, Modeling considerations for control purposes, the input-output model, degree of freedom.	**6**
Module 2: Modelling of Process	**Hrs.**
Computer Simulation and linearization of nonlinear systems, Transfer functions and the Input-output models. Dynamic behavior of first-order systems, second-order system and higher order systems.	**5**
Module 3: Feedback Control of Process	**Hrs.**
Elements of feedback control system, types of feedback controllers, sensors, Transmission lines, final control elements. Dynamic behavior of feedback-controlled process, Effect of proportional (p) control, Integral (I) control and derivative (D) control on the response of controlled process, effect of composite control actions.	**6**
Module 4: Multi Loop Control	**Hrs.**
Feedback control of system with large dead time or inverse response, processes with large Dead time, Dead time compensation, and control of systems with inverse response. Control systems with multiple loops, cascade control, split-range control, feed forward control, Ratio-control, problem in designing feed forward controllers, practical aspects on the design of feed forward controllers, F/F – F/B control.	**7**
Module 5: MIMO Process	**Hrs.**
Multi-input, multi-output processes, degree of freedom and number of controlled and Manipulated variables, interaction and decoupling of control loops, relative gain array and selection of loops, design of non-interacting control loops. Overview of modern control methodologies: PLC, SCADA, DCS, Adaptive control, variable structure control.	**6**
Module 6: Centralized Multivariable Control	**Hrs.**
Multivariable model predictive control, single-variable dynamic matrix control (DMC) algorithm, multivariable dynamic matrix control, internal model control, smith predictive, model predictive control, process model based control, implementation guidelines. Process control design: sequence of design steps, statistical process control.	**6**

Module wise Measurable Students Learning Outcomes:

After completion of the course students will be able to:

1. Describe model the Process Control system.
2. Evaluate performance of process by conventional control techniques.
3. Analyze the process with conventional controllers for process control.
4. Analyze the process the advance controllers for process control.
5. Analyze the controllers for multi-input multi-output process and evaluate the performance of multi-input multi-output process.
6. Design advance digital controller based on model of the process.

Title of the Course: Power System Operation and Control	L	T	P	Cr
Course Code: 3EL413	3	0	0	3

Pre-Requisite Courses: Power System Engineering, Power System Analysis and Stability, Control System Engineering, Power Electronics.

Textbooks:

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

References:

1. Power System Operation and Control Robert Herschel Miller, McGraw Hill Professional, 1994.
2. Power System Operation and Control by DR. K. UMA RAO, Wiley India, 2010.
3. Power System Operation and Control by N.V.Ramana Pearson Education India, 2010.

Course Objectives :

1. This course provides the knowledge of Power System Operation.
2. It gives the knowledge of various controls in power systems.

Course Learning Outcomes:

CO	**After the completion of the course the student will be able to**	Bloom's Cognitive	
		level	Descriptor
CO1	**Explain** the concepts of operation of power system considering various constraints of power apparatus.	2	Understanding
CO2	**Analyze** different control methods used in power systems.	4	Analyzing
CO3	**Summarize** recent trends inPower System Operation.	2	Understanding

CO-PO Mapping :

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1		2												
CO2	1	2												
CO3					1								2	

Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weightage respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment, oral, seminar, test (surprise/declared/quiz), and group discussion.[One assessment tool per ISE. The assessment tool used for ISE 1 shall not be used for ISE 2]
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with70-80% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1: Introduction to Characteristics of Modern Power Systems	**Hrs.**
Physical Structure, Operation and Control Functions and Hierarchies, Design and Operating Criteria	**4**
Module 2: Equipment and Stability Constraints	**Hrs.**
Capabilities and Constraints of Generators/Exciters/Turbines/Network Elements (Lines, Transformers etc.),Constraints of Energy Supply Systems, Load Characteristics, Introduction to Angle/Voltage Instability phenomena, Stability Constraints.	**12**
Module 3: Frequency Control	**Hrs.**
Primary Control of Frequency : Governors, Secondary Control of Frequency : AGC	**8**
Module 4: Voltage control	**Hrs.**
Automatic Voltage Regulators (generators), Shunt Compensation, SVC	**8**
Module 5: Introduction to Power Flow Control	**Hrs.**
HVDC, FACTS, Load Curves, Unit Commitment, Introduction to the use of Optimization Methods	**6**
Module 6: Recent Trends in Power System Operation and Control	**Hrs.**
Power former, gas insulated transmission lines, deregulation in power systems.	**4**

Module wise Measurable Students Learning Outcomes:

After completion of the course students will be able to:

1. Explain the evolution and structure of power system and synchronization of power grids.
2. Identify the constraints of power system equipments.
3. Analyze the importance of maintaining the frequency constant.
4. Identify and explain various means of voltage control in power system.
5. Explain how real and reactive power scheduling is done in power systems.
6. Explain the role of load dispatch center.

Title of the Course: Microcontroller Applications in Electrical Engineering	L	T	P	Cr
Course Code: 3EL414	3	0	0	3

Pre-Requisite Courses: DC Machines and Transformers, Power Electronics, Control Systems Engineering, Analog and Digital Circuits.

Textbooks:

1. Massimo Banzi, "Getting Started with Arduino,", Shroff publications,3rd edition
2. https://www.arduino.cc/en/Tutorial/ Arduino Examples
3. M.H. Rashid "Power Electronics, Circuits, Devices and Applications", Pearson Education Inc., 3rd Edition

References:

1. Michael McRoberts,"Beginning Arduino", Apress, 1st edition
2. Norman Nise, 'Control System Engineering', John Wiley, Sixth Edition, 2011.
3. G. K. Dubey,"Fundamentals *of Electrical Drives*", Narosa publication, 2nd edition

Course Objectives :

1. To introduce students the use of microcontrollers for electrical systems.
2. To enable the students to understand the analysis of physical systems using microcontrollers.
3. To enable students to understand use of sensors and signal conditioning on microcontroller platform.
4. To introduce the use of Arduino for control of different electrical systems.

Course Learning Outcomes:

CO	**After the completion of the course the student will be able to**	Bloom's Cognitive	
		level	Descriptor
CO1	**Explain** the features and selection criteria of microcontroller for electrical systems.	2	Understanding
CO2	**Implement** basic microcontroller based applications for electrical engineering.	3	Applying
CO3	**Evaluate** the performance of microcontroller based electrical systems.	5	Evaluating

CO-PO Mapping :

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	2												
CO2			3											
CO3														2

Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weightage respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment, oral, seminar, test (surprise/declared/quiz), and group discussion.[One assessment tool per ISE. The assessment tool used for ISE 1 shall not be used for ISE 2]
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with70-80% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1: Development tools and Hardware Features	**Hrs.**
Open source microcontroller platforms, Choice of microcontroller, Development tools-Editors, Assemblers, Compilers, Linkers, Simulators, Emulators, Debugger Programmers, Introduction	**6**

to Arduino, Headers and Preprocessor Directives, Basic Programming in C.	
Module 2: Sensors and Signal Conditioning	**Hrs.**
Hall Effect Sensors for current and voltage measurement, Speed sensors, measurement of active and reactive power, flow and pressure measurement, temperature transducers, interfacing of sensors to Arduino.	**5**
Module 3:Embedded Control for DC machines	**Hrs.**
Speed control of dc motor using arduino, speed control using single phase controlled converter, three phase controlled converter, dc to dc chopper, and code for switching sequences.	**6**
Module 4: Embedded Control for dc to dc converters	**Hrs.**
Types of DC to DC converters- buck, boost, buck-boost, choice of components, implementation using Simulink, frequency control/ on time control for dc to dc converters.	**7**
Module 5:Inverter Control	**Hrs.**
3 phase PWM inverter design, choice of components, implementation of 120 degree and 180 degree mode of conduction methods, Selection of sampling period and Switching frequency, PWM control techniques.	**6**
Module 6:Control Systems Design	**Hrs.**
Controller Specifications, design of controller using arduino, P, PI and PID controller design, closed loop control of physical systems, temperature control systems, and use of DAQ in closed loop systems.	**6**

Module wise Measurable Students Learning Outcomes :

After completion of the course students will be able to:

1. Explain features of microcontroller and various development tools.
2. Demonstrate use of different sensors and signal conditioning using microcontrollers
3. Implement speed control techniques for dc motor using Arduino.
4. Understand and evaluate use of microcontrollers for dc to dc converters.
5. Implement basic power electronics circuits using microcontroller.
6. Use Arduino for implementing basic controllers viz. P,PI and PID

Title of the Course: Neural Network and Fuzzy Control	L	T	P	Cr
Course Code: 3EL415	3	0	0	3

Pre-Requisite Courses: Nil

Textbooks:

1. RajaskaranPai*' Neural networks, Fuzzy Logic and Genetic Algorithms,' PHI publications, 2003.*
2. Timothy J. ross, *'Fuzzy Logic with Engineering Applications'*, Pearson Publications, 2010

References:

1. Driankov,*'Fuzzy Control'*,Narosa Publications, 2000.
2. Deepa, Sivandanan, '*Introduction to Neural Networks'*, TMH publications, 2008.
3. M.Gopal,'*Modern Control System -State variable analysis and Neuro fuzzy control'*, TMH Publications, 2010.

Course Objectives :

1. Imparting Basic knowledge of neural network and fuzzy control.
2. To develop skills of design of neuro fuzzy and genetic algorithm.
3. It is intended to learn controller designusing neural and fuzzy system.

Course Learning Outcomes:

CO	**After the completion of the course the student will be able to**	Bloom's Cognitive	
		level	Descriptor
CO1	**Explain** modern algorithm in neural network and fuzzy control.	2	Understanding
CO2	**Apply** neuro fuzzy and genetic algorithm for various applications	3	Applying
CO3	**Analyze** hybrid controllers using combination of intelligent theories.	4	Analyzing

CO-PO Mapping :

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1			2											
CO2		2												
CO3			2											

Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weightage respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment, oral, seminar, test (surprise/declared/quiz), and group discussion.[One assessment tool per ISE. The assessment tool used for ISE 1 shall not be used for ISE 2]
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with70-80% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1: Introduction to Neural Network	**Hrs.**
Introduction, Need for Neural networks, AI and other intelligent systems, Biological neuron model, Artificial model for Neuron, Neuronal dynamics, applications.	**6**
Module 2: Architectures and Learning	**Hrs.**
Neural network architectures, learning, training and testing, perceptron learning rule, Training single layer network, convergence, supervised Hebb learning, performance surfaces and optimum points.	**6**
Module 3: Multilayer neural network	**Hrs.**

Performance optimization, steepest descent, Adeline network, mean square error, LMS algorithm, MLPs , back propagation, choice of network architecture, convergence, drawbacks & modification of BPN, Applications of BPN	**6**
Module 4: Unsupervised Networks	**Hrs.**
Associative learning- simple associative learning, unsupervised Hebb's rule, simple recognition network, Instars, outstar rule, competitive learning, applications.	**4**
Module 5: Fuzzy Logic	**Hrs.**
Introduction to fuzzy logic, need for fuzzy logic, crisp theory and fuzzy theory, Fuzzy mathematics, fuzzy mapping, fuzzy relations, fuzzy propagation, Implication rules, mamdani & sugeno models.	**8**
Module 6: Fuzzy Control	**Hrs.**
Fuzzy rule Base structure, FKBS systems, PID control, FKBC design,FKBC PID control design and applications, Neural-fuzzy combinations, Hybrid intelligent control, applications.	**6**

Module wise Measurable Students Learning Outcomes:

After completion of the course students will be able to:

1. Explainalgorithms in neural network.
2. Design neural network based applications.
3. Explain algorithms in unsupervised neural network.
4. Explain algorithms in fuzzy logic.
5. Design of controllers using fuzzy logic.
6. Design of hybrid controllers using combination of intelligent theories.

Outcomes as regards to improvement in Communication Skills: NIL

Computer Usage / Lab Tool: MATLAB

Laboratory Experiences: Simulations

Independent Learning Experiences: Case studies

Title of the Course: PLC and SCADA	L	T	P	Cr
Course Code: 3EL416	3	0	0	3

Pre-Requisite Courses: Electrical Measurement, Instrumentation

Textbooks:

1. John W. Webb, Ronald A. "Programmable Logic Controllers, Principles & Applications " PHI publication, Eastern Economic Edition
2. W.H. Bolton "Programmable Logic Controllers", Newness Publication.

References:

1. John R. Hackworth and Peterson, "PLC Controllers Programming Methods and Applications", Pearson Publication
2. Gary dunning, "Introduction to PLC" Cengage Learning.

Course Objectives :

1. To provide basics knowledge of PLC and SCADA.
2. To impart programming knowledge for PLC and SCADA based systems.
3. To develop skills for use of PLC and SCADA systems in automation.

Course Learning Outcomes:

CO	After the completion of the course the student will be able to	Bloom's Cognitive	
		level	Descriptor
CO1	**Explain** basics components used in PLC and SCADA based systems.	2	Understanding
CO2	**Apply** ladder logic programming technique for various PLC applications.	3	Applying
CO3	**Use** different PLC functions like timers, counters, etc. for different applications.	3	Applying
CO4	**Evaluate** the performance of PLC and SCADA based systems.	5	Evaluating

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1			2											
CO2	2		2											
CO3		2												
CO4				3	2									

Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weightage respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment, oral, seminar, test (surprise/declared/quiz), and group discussion.[One assessment tool per ISE. The assessment tool used for ISE 1 shall not be used for ISE 2]
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with70-80% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1: Introduction to PLC	**Hrs.**
Introduction, advantages, disadvantages, Input module, Output Module, memory and interfacing, Power Supplies for PLC, Architecture of PLC, Introduction to input-output devices.	6
Module2: PLC programming	**Hrs.**
Introduction to Ladder logic programming, on – off switching devices, input analog devices,	6

programming on/ off inputs to produce on/off outputs, relation of digital gate logic to contact / coil logic, creating ladder diagrams from process control description.	
Module3: PLC Timers and Counters	**Hrs.**
PLC timer functions, Types of timers, Programming for On delay timers, off delay timers and Pulse timers, Retentive Timers, PLC counter functions, Up/down counters and their programming, PLC applications with timers and counters.	**6**
Module 4: PLC Intermediate and Data Handling Functions	**Hrs.**
PLC Arithmetic functions, PLC trigonometric and log functions, PLC basic comparison functions, PLC advanced comparison functions, Master control relay functions, Programming PLC for fail safe operation using Master Control Relay, PLC Jump functions, Jump with return and non-return, PLC data move system, Moving large blocks of PLC data, data handling functions.	6
Module5: PLC Bit Functions and PLC Networking	**Hrs.**
Digital bit functions and applications, Bit patterns in register, Shift Register Functions and applications, Analog PLC operations, Networking of PLCs-Levels of Industrial Control, Types of Networking, Network Communications.	**6**
Module 6: Introduction to SCADA	**Hrs.**
Components of SCADA, SCADA functions, co-ordination and control, advantages, Power System Automation using SCADA.	**6**

Module wise Measurable Students Learning Outcomes

After completion of the course students will be able to:

1. Describe the basics of PLC systems.
2. Develop basic programs in PLC by using ladder diagrams.
3. Describe various timer and counter functions in PLC.
4. Applyintermediate and data handling functions for different applications.
5. Use different bit handling functions and understand networking of PLC.
6. Outline the basics of SCADA components and functions.

Outcomes as regards to improvement in Communication Skills:

Computer Usage / Lab Tool: PLC trainer kit, RSMicrologix, RSLinx, RSEmulate 500

Laboratory Experiences: 2 Hrs./week

Independent Learning Experiences: Students will work in groups to design practical system.

Professional Elective (Lab) Courses

Title of the Course: Advanced Power Electronics Lab	L	T	P	Cr
Course Code: 3EL452	0	0	2	1

Pre-Requisite Courses: Power Electronics

Textbooks:

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

References:

1. B. K. Bose, Modern Power Electronics & AC drives, PHIPL, New Delhi
2. M. B. Patil, V. Ramayanan and V. T. Ranganathan, Simulation of Power Electronics circuits, Narosapublication.

Course Objectives :

1. To provide the advance knowledge in the field of power electronics.
2. To understand the working of different power electronic converter through simulation and experimentation.
3. To develop the skills of simulation, analysis and design of power electronics system.

Course Learning Outcomes:

CO	**After the completion of the course the student will be able to**	Bloom's Cognitive	
		level	Descriptor
CO1	**Articulate** working of different advanced power electronic converters.	2	Understanding
CO2	**Analyze** different advanced power electronic converters and systems.	4	Analyzing
CO3	**Evaluate** the performance of different advanced power electronic converters using hardware and simulation software.	5	Evaluating

CO-PO Mapping :

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1				3										
CO2			2											
CO3					1									1

Lab Assessment:

There are four components of lab assessment, LA1, LA2, LA3 and Lab ESE.
IMP: Lab ESE is a separate head of passing.

Assessment	Based on	Conducted by	Conduction and Marks Submission	Marks
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 4 Submission at the end of Week 5	25
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 5 to Week 8 Submission at the end of Week 9	25
LA3	Lab activities, attendance, journal	Lab Course Faculty	During Week 10 to Week 14 Submission at the end of Week 14	25
Lab ESE	Lab Performance and related documentation	Lab Course faculty	During Week 15 to Week 18 Submission at the end of Week 18	25

Week 1 indicates starting week of 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.

Course Contents:

1. Development of Simulink model and analysis of performance of Single Phase Full and Half controlled converter.
2. Development of Simulink model and analysis of performance of Three Phase Full and Half controlled converter
3. Development of Simulink model and analysis of performance of Cascade type Multilevel Inverter.

4. Development of Simulink model and analysis of performance of Diode clamped Multilevel Inverter.
5. Experimental study of cascade type Multilevel inverter
6. Development and performance analysis of Active power Filter
7. Development of Simulink model and analysis of performance of Z source inverter
8. Study and performance analysis of Matrix converter.

Computer Usage / Lab Tool: Simulation Lab and Power Electronics Lab

Title of the Course: Process Control Lab	L	T	P	Cr
Course Code: 3EL453	0	0	2	1

Pre-Requisite Courses: Control Systems Engineering Lab

Textbooks:

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

References:

1. Thomas E. Marlin, "Process Control - Design Processes and Control System for Dynamic Performance, 2nd Edition", Mc Graw Hill publication.
2. F.G. Shinskey, "Process Control System – Application, Design and Tuning", McGraw-Hill Publication, 3rd Edition, 1988.
3. Curtis D. Johnson, "Process Control Instrumentation Technology", 7th Edition, Pearson Education, 7th Edition. 2003.

Course Objectives:

1. This course intends to provide mathematical model of the process and verification with experimentation.
2. It demonstrate the various types of controllers for SISO system.
3. It provide simulation of various advanced controllers used in process control and multivariable predictive control.

Course Learning Outcomes:

CO	After the completion of the course the student will be able to	Bloom's Cognitive	
		level	Descriptor
CO1	**Experiment** on various Process Control systems to evaluate performance.	3	Applying
CO2	**Apply** the tuning techniques for the controllers.	3	Applying
CO3	**Evaluate** the performance of given Process Control system.	5	Evaluating
CO4	**Demonstrate** the use of advance controller.	3	Applying

CO-PO Mapping :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1				2										
CO2				2										
CO3				3										
CO4				3	2									

Lab Assessment:

There are four components of lab assessment, LA1, LA2, LA3 and Lab ESE.
IMP: Lab ESE is a separate head of passing.

Assessment	Based on	Conducted by	Conduction and Marks Submission	Marks
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 4 Submission at the end of Week 5	25
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 5 to Week 8 Submission at the end of Week 9	25
LA3	Lab activities, attendance, journal	Lab Course Faculty	During Week 10 to Week 14 Submission at the end of Week 14	25
Lab ESE	Lab Performance and related documentation	Lab Course faculty	During Week 15 to Week 18 Submission at the end of Week 18	25

Week 1 indicates starting week of 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.

Course Contents:

List of Experiment

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

Computer Usage / Lab Tool:

Matlab simulation experiments.

Title of the Course: Power System Operation and Control Lab	L	T	P	Cr
Course Code: 3EL 454	0	0	2	1

Pre-Requisite Courses:

1. Power System Engineering, Power System Analysis and Stability, Control System Engineering, Power Electronics.

Textbook:

1. Power System Analysis: by Hadi Saadat, McGraw-Hill, International edition, 1999.

References:

1. Power System Analysis & Design by Glover, Sarma & Overbye, Thomson, IV edition, 2007
2. User manuals – MiPower Power System Analysis software, PRDC, Bengaluru.

Course Objectives :

1. This course provides the knowledge of Power System Operation.
2. It gives the knowledge of various control techniques used in Power Systems.

Course Learning Outcomes:

CO	After the completion of the course the student will be able to	Bloom's Cognitive	
		level	Descriptor
CO1	**Illustrate** the use of different techniques for power system operation, in simulated environment.	3	Applying
CO2	**Analyze** the performance of power system under various operating constraints, through simulation.	4	Analyzing
CO3	**Evaluate** different power flow control methods through simulation.	5	Evaluating

CO-PO Mapping :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1				3										
CO2				3	2									
CO3		3				2								

Lab Assessment:

There are four components of lab assessment, LA1, LA2, LA3 and Lab ESE.
IMP: Lab ESE is a separate head of passing.

Assessment	Based on	Conducted by	Conduction and Marks Submission	Marks
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 4 Submission at the end of Week 5	25
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 5 to Week 8 Submission at the end of Week 9	25
LA3	Lab activities, attendance, journal	Lab Course Faculty	During Week 10 to Week 14 Submission at the end of Week 14	25
Lab ESE	Lab Performance and related documentation	Lab Course faculty	During Week 15 to Week 18 Submission at the end of Week 18	25

Week 1 indicates starting week of 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.

Course Contents:

Using MATLAB / Power world Simulator / MiPower softwares,

1. Computation of Complex Power flow and verification of effect of load angle on active power flow.
2. Computation of power delivered by a generator connected to infinite bus.
3. Computation of maximum power capacity of lossless line and loadability limits.
4. Load flow study of IEEE-30 bus system using Gauss-Seidel, Newton-Raphson and fast decoupled methods.

5. Computation of Optimal dispatch of power for generator units in a plant. Computation of Optimal dispatch of power for generator units in a plant. 6. Computation of Optimal dispatch of power for generator units in a plant by considering losses & generator limits. 7. Short circuit study of generator under faults. 8. Computation of steady state stability under small disturbances. 9. Transient stability study for single machine and multi-machine systems.
Computer Usage / Lab Tool: MATLAB, Power world Simulator, etc.
PO-b: Design and conduct experiments, analyze and interpret data**.**
PO-e: Identify, formulate and solve issues in electrical engineering.
PO-h: Understand the impact of engineering solutions.
PO-k: Use the techniques, skills and modern engineering tools necessary for Electrical Engineering.

Title of the Course: Microcontroller Applications in Electrical Engineering Lab	L	T	P	Cr
Course Code: 3EL455	0	0	2	1

Pre-Requisite Courses: DC Machines and Transformers, Power Electronics, Control Systems Engineering, Analog and Digital Circuits

Textbooks:

1. Massimo Banzi, "Getting Started with Arduino,", Shroff publications,3rd edition
2. https://www.arduino.cc/en/Tutorial/ Arduino Examples
3. M.H. Rashid "Power Electronics, Circuits, Devices and Applications", Pearson Education Inc., 3rd Edition

References:

1. Michael McRoberts,"Beginning Arduino", Apress, 1st edition
2. Norman Nise, 'Control System Engineering', John Wiley, Sixth Edition, 2011.
3. G. K. Dubey,"Fundamentals *of Electrical Drives*", Narosa publication, 2nd edition

Course Objectives :

1. Introduce students the use of microcontrollers for electrical systems.
2. Enable the students to understand the analysis of physical systems using microcontrollers.
3. Enable students to understand use of sensors and signal conditioning on microcontroller platform.
4. Introduce the use of Arduino for control of different electrical systems.

Course Learning Outcomes:

CO	**After the completion of the course the student will be able to**	Bloom's Cognitive	
		level	Descriptor
CO1	**Implement** control circuits for electrical systems using microcontroller	3	Applying
CO2	**Use** microcontroller for control system applications	3	Applying
CO3	**Evaluate** the performance of microcontroller based electrical systems using simulation study	5	Evaluating

CO-PO Mapping :

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1				3										
CO2			2											
CO3		2			1									

Lab Assessment:

There are four components of lab assessment, LA1, LA2, LA3 and Lab ESE.
IMP: Lab ESE is a separate head of passing.

Assessment	Based on	Conducted by	Conduction and Marks Submission	Marks
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 4 Submission at the end of Week 5	25
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 5 to Week 8 Submission at the end of Week 9	25
LA3	Lab activities, attendance, journal	Lab Course Faculty	During Week 10 to Week 14 Submission at the end of Week 14	25
Lab ESE	Lab Performance and related documentation	Lab Course faculty	During Week 15 to Week 18 Submission at the end of Week 18	25

Week 1 indicates starting week of 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.

Course Contents:

1. Interfacing Hall Effect current sensors to Arduino.
2. Interfacing Hall Effect voltage sensors to Arduino.

3. Measurement of power using Arduino.
4. Speed control of DC motor using Arduino (single phase controlled converter method)
5. Speed control of DC motor using Arduino (DC to DC chopper method)
6. Buck converter using Arduino.
7. Boost converter using Arduino.
8. Pulse generation for PWM inverter using 120 degree mode of conduction.
9. Pulse generation for PWM inverter using 180 degree mode of conduction.
10. Study of P, PI, PID controllers using Arduino

Computer Usage / Lab Tool:

Use of software simulation tools like MATLAB/Simulink, LABVIEW, Arduino compiler

Title of the Course: Neural Network and Fuzzy Control lab	L	T	P	Cr
Course Code: 3EL456	0	0	2	1

Pre-Requisite Courses: Nil

Textbooks:

1. Rajaskaran, Pai*' Neural networks, Fuzzy Logic and Genetic Algorithms,' PHI publications, 2003.*
2. Timothy J. ross, *'Fuzzy Logic with Engineering Applications'*, Pearson Publications, 2010

References:

1. Driankov, *'Fuzzy Control'*,Narosa Publications, 2000.
2. Deepa, Sivandanan, '*Introduction to Neural Networks'*, TMH publications, 2008.
3. M.Gopal,'*Modern Control System -State variable analysis and Neuro fuzzy control'*, TMH Publications, 2010.

Course Objectives :

1. Imparting Basic knowledge of neural network and fuzzy control.
2. To develop skills of design of neuro fuzzy and genetic algorithm.
3. It is intended to learn controller design using neural and fuzzy system.

Course Learning Outcomes:

CO	**After the completion of the course the student will be able to**	Bloom's Cognitive	
		level	Descriptor
CO1	**Demonstrate** the Neural Networks and Fuzzy Control techniques.	3	Applying
CO2	**Analyze** different Neural Networks and Fuzzy Control	4	Analyzing
CO3	**Evaluate** different Neural Networks and Fuzzy Control	5	Evaluating

CO-PO Mapping :

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1				3										
CO2				2										
CO3				2	1									

Lab Assessment:

There are four components of lab assessment, LA1, LA2, LA3 and Lab ESE.
IMP: Lab ESE is a separate head of passing.

Assessment	Based on	Conducted by	Conduction and Marks Submission	Marks
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 4 Submission at the end of Week 5	25
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 5 to Week 8 Submission at the end of Week 9	25
LA3	Lab activities, attendance, journal	Lab Course Faculty	During Week 10 to Week 14 Submission at the end of Week 14	25
Lab ESE	Lab Performance and related documentation	Lab Course faculty	During Week 15 to Week 18 Submission at the end of Week 18	25

Week 1 indicates starting week of 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.

Course Contents:

1. To study the Neuron model and architectures using NN toolbox.
2. Development of the simulation for steepest descent NN algorithm.
3. Development of the simulation for LMS NN algorithm.
4. Development of the simulation for back propagation -momentum NN algorithm.
5. Development of the simulation for variable learning rate.
6. Development of FKBS systems -FKBC Proportional control.
7. Development of FKBS systems -FKBC PD control.

8. Development of FKBS systems -FKBC PID control.
Computer Usage / Lab Tool: Use of software simulation tools like MATLAB/Simulink

Title of the Course: PLC and SCADA Lab	L	T	P	Cr
Course Code: 3EL457	0	0	2	1

Pre-Requisite Courses: Electrical Measurement, Instrumentation

Textbooks:

1. John W. Webb, Ronald A. "Programmable Logic Controllers, Principles and Applications"PHI publication, Eastern Economic Edition.
2. W.H. Bolton" Programmable Logic Controllers", Newness Publication.

References:

1. John R. Hackworth and Peterson, "PLC Controllers Programming Methods and Applications", Pearson Publication.
2. Gary dunning, "Introduction to PLC" Cengage Learning.

Course Objectives :

1. To provide basics of PLC and SCADA.
2. To impart programming knowledge for PLC and SCADA based systems.
3. To develop skills for use of PLC and SCADA systems in automation.

Course Learning Outcomes:

CO	After the completion of the course the student will be able to	Bloom's Cognitive	
		level	Descriptor
CO1	**Execute** experiments based on PLC and SCADA systems.	3	Applying
CO2	**Apply** ladder logic programming technique for various PLC applications.	3	Applying
CO3	**Use** different PLC functions like timers, counters, etc. for different applications.	3	Applying

CO-PO Mapping :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		2		3										
CO2				3					2					
CO3				3					1					

Lab Assessment:

There are four components of lab assessment, LA1, LA2, LA3 and Lab ESE.
IMP: Lab ESE is a separate head of passing.

Assessment	Based on	Conducted by	Conduction and Marks Submission	Marks
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 4 Submission at the end of Week 5	25
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 5 to Week 8 Submission at the end of Week 9	25
LA3	Lab activities, attendance, journal	Lab Course Faculty	During Week 10 to Week 14 Submission at the end of Week 14	25
Lab ESE	Lab Performance and related documentation	Lab Course faculty	During Week 15 to Week 18 Submission at the end of Week 18	25

Week 1 indicates starting week of 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.

Course Contents:

1. Study of components of Relay logic and PLC logic.
2. Development of Ladder Diagram for ON/OFF and latching functions.
3. Development of PLC programming for Motor Reversal control.
4. Development of PLC programming for Stair case lighting.
5. Development of PLC programming for Running Lighting.
6. Development of PLC programming for Arithmetical Functions.

7. Development of PLC programming for Traffic control system. 8. Development of PLC programming by using Timer functions. 9. Development of PLC programming for Counter function.
Computer Usage / Lab Tool PLC Trainerkit, Control and Instrumentation Lab
Laboratory Experiences: 2 Hrs/week

Open Elective Courses

Title of the Course: Open Elective III: Industrial Automation	L	T	P	Cr
Course Code: 1OE 443	3	0	0	3

Pre-Requisite Courses: Nil

Textbooks:

1. John W. Webb, Ronald A. Reis "*Programmable logic controllers, principles & applications"* by PHI publication, Eastern Economic Edition.
2. C. D. Johnson, "Process control & instrumentation techniques".

References:

1. George Stephanopoulos, "Chemical Process Control - An introduction to Theory and Practice", Prentice-Hall of India, 1st Edition 1984.
2. "*Fundamentals of Electrical Drives*", G. K. Dubey, Narosa publication, 2nd edition.

Course Objectives :

1. This course intends to develop basics of ladder logic programming for PLC.
2. It provides the foundation level knowledge of SCADA System.
3. It gives overview of various types of controller for closed loop control.
4. It provides the applications of variable speed drives in industries.

Course Learning Outcomes:

CO	After the completion of the course the student will be able to	Bloom's Cognitive	
		level	Descriptor
CO1	**Compare** the various types of controllers for Industrial Automation.	2	Understanding
CO2	**Apply** the knowledge of PLC and SCADA for Industrial Automation.	3	Applying
CO3	**Explain** the use of variable speed drives for Industrial Automation.	2	Understanding

CO-PO Mapping :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		2												
CO2		2			2									
CO3						2								2

Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weightage respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment, oral, seminar, test (surprise/declared/quiz), and group discussion.[One assessment tool per ISE. The assessment tool used for ISE 1 shall not be used for ISE 2]
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with70-80% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1: Measurement of Various Process Parameters	**Hrs.**
Measurement of quantities such as temperature, pressure, force, displacement, speed, flow, level, humidity, pH etc., signal conditioning, estimation of errors and calibration.	**6**
Module 2: Process Control and Various Controllers	**Hrs.**
Introduction to process control, PID controller and tuning, various control configurations such as cascade control, feed forward control, split range control, ratio control, override control and selective control.	**6**

Module 3: Actuators	**Hrs.**
Introduction to various actuators such as flow control valves, Hydraulic and pneumatic, servo motors, symbols and characteristics.	**6**
Module 4: PLC	**Hrs.**
Introduction to sequence control and relay ladder logic, basic PLC system, I/O modules, scan cycle, programming of timers, counters and I/O programming.	**6**
Module 5: SCADA for Industrial Automaton	**Hrs.**
Components of SCADA systems, functions, classification of SCADA, networking and communication protocols.	**6**
Module 6: Variable Speed Drives	**Hrs.**
Role of variable speed drives in automation, DC drives, AC drives and synchronous motor drives applications of variable speed drives.	**6**

Module wise Measurable Students Learning Outcomes :

After the completion of the course the student should be able to

1. Demonstrate the use of various transducers for Industrial Automation.
2. Select and tune the controllers for various closed loop systems.
3. Explain the use of actuators in Industrial Automation.
4. Apply ladder logic techniques to solve the problems in Industrial Automation.
5. Explain the functions of SCADA systems.
6. Select the appropriate drive for specific application.

Minor Specialization Courses

Final Year B. Tech. (Electrical) for 2020-21

Walchand College of Engineering, Sangli

(An Autonomous Institute)

Minor in Electrical Engineering Structure

Semester	Course Name		Credits	Faculty and its Address	Available on
Semester- III	Electrical Machines		3	Prof. Bhuvaneshwari IIT, Delhi.	Swayam
Semester- IV	Power System Generation, Transmission and Distribution		3	Prof. D.P. Kothari IIT, Delhi.	NPTEL
Semester- V	Control Engineering		3	Prof. Ramkrishna Pasumarthy IIT, Madras.	NPTEL
Semester- VI	Industrial Drives - Power Electronics		3	Prof. K. Gopakumar IISc, Bangalore.	NPTEL
Semester- VII	**Elective I**	Microprocessors and Microcontrollers	3	Prof. Santanu Chattopadhyay IIT, Kharagpur.	NPTEL
		Electrical Measurement and Electronic Instruments	3	Prof. Avishek Chatterjee IIT, Kharagpur.	NPTEL
		Seminar I	1	----	---
Semester- VIII	**Elective II**	Industrial Automation and Control	3	Prof. S. Mukhopadhyay IIT, Kharagpur.	NPTEL
		Electric Vehicle	3	Prof. Amit Kumar Jain IIT, Delhi.	NPTEL
		Seminar II	1	----	---

Semester	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**Total**
Credits	**3**	**3**	**3**	**3**	**4**	**4**	**20**

Honors Specialization Courses

Final Year B. Tech. (Electrical) for 2020-21

Walchand College of Engineering, Sangli
(An Autonomous Institute)
Teaching and Evaluation Scheme effective from 2020-21
B. Tech in Electrical Engineering with Specialization Electrical Vehicle Technology

Course			Teaching Scheme				Evaluation Scheme			
								Marks		
Semester	Code	Name	L	T	P	Credits	Component	Max		Min for Passing
5th		Core 1: Energy Storage Systems for EV.	4	--	--	4	ISE 1	10		40
							MSE	30		
							ISE 2	10		
							ESE	50	20	
6th		Core 2: Introduction to Electrical Vehicles	4	--	--	4	ISE 1	10		40
							MSE	30		
							ISE 2	10		
							ESE	50	20	
7th		Elective 1 Power Electronics in Electrical Vehicle / Case studies in EV Development,	4	--	--	4	ISE 1	10		40
							MSE	30		
							ISE 2	10		
							ESE	50	20	
8th		Elective 2 EV Technology and Grid management / Artificial Intelligence in EV / Computer aided Vehicle design.	4	--	--	4	ISE 1	10		40
							MSE	30		
							ISE 2	10		
							ESE	50	20	
8th		Mini Project	2		--	2	ISE	50	**20**	40
							ESE	50	20	
Total			18	---	---	18	**Total Credits: 18 Total Contact Hrs:18**			

EVEN Semester

Professional Core (Theory) Courses

Professional Core (Lab) Courses

Title of the Course: Engineering Management, and Ethics 3IC 401	L	T	P	Cr
	4	0	0	4

Textbooks:

1. Management: Theory and Practice; A.I.T.B.S. Publishers, Delhi. - N.C. Jain, Saakhshi
2. Principles and Practice of Management - L.M. Prasad
3. Principles of Management; Himalaya Publishing House - T. Ramasamy
4. Modern micro economic theory – H.L. Ahuja, S.Chand.
5. Engineering economics – Sullivan, Wicks, Koelling – Pearsons.

References:

1. Principles of Management; P.C. Tripathi and P.N. Reddy, Tata McGraw Hills Pub. Company Ltd.,
2. Business Management; - J. C. Sinha, V. N. Mugata, S. Chand & Co., New Delhi
3. Principles of Management - Koontz and O'Donnell
4. Management: A Functional Approach - Joseph M. Putti
5. Stonier & Hague – A text book of economic theory, Pearson
6. Industrial organization and engineering economics – Banga and Sharma

Course Objectives :

1. To provide insight into management, economics and ethics.
2. To manage effectively business operations and project management teams.
3. To meet the challenges for contemporary professional practice; be able to adapt and solve the increasingly complex management problems faced by industry.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive	
		Level	Descriptor
CO1	Perceive and describe key management theories and approaches, economics terminologies and organizational / business ethics.	**2**	**Understanding**
CO2	Grasp the market scenario and apply the principles of financial, production and Human Resource management.	**3**	**Apply**
CO3	Examine various cost factors for different alternatives in project situations and make optimal economic decisions.	**4**	**Analyzing**

CO-PO Mapping: Common to all branches**.**

Teacher Assessment: Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	**Marks**
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar etc.

MSE: Assessment is based on 50% of course content (Normally first three modules)

ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1: Basics of Management	**Hrs.**
Management: Definition, objectives, Nature & importance of management, management approaches, principles of management, managerial roles & skills, Recent trends & challenges of management in Global scenario. Taylor's Scientific Management, Fayol's Principles of Management, Douglas Mc-Gregor's Theory, X and Theory Y, Mayo's Hawthorne Experiments, Hertzberg's Two Factor Theory of Motivation, Maslow's Hierarchy of Human Needs	**7**
Module 2: Principles of Management	**Hrs.**
Planning: Meaning, Importance, Planning process; Types of Plans - Objectives, Strategy, Policy, Procedure, Method, Plan vs. Programme, Decision making, types of decision, Decision-Making steps Forecasting methods **Organizing:** Definition, Nature & purpose, Principles, Process, Types and structure of organization **Staffing:** Nature & purpose, recruitment policies and selection procedure, Induction/orientation, carrier development, carrier stages & performance appraisal **Directing and Co-ordination:** Directing: Concept and importance, creativity & innovation, Elements of Directing - Supervision, Motivation (Theories), Leadership (styles & theories), Communication (Barriers to effective communication) Co-ordination: Concept and Importance, Limitations; Types- Internal and External; Co-ordination- the Essence of Management **Controlling:** Concept and importance, Limitations, process of controlling, Requirements of good control system, Types of control, Techniques of Control, Relationship between Planning and Controlling; Change Management	**12**
Module 3: Introduction to Functional areas as Marketing Management	**Hrs.**
Financial Management: Scope, Sources of finance, capital types, financial statements, balance sheets, Profit & Loss A/C **Production Management:** Objectives, Site selection & factors affecting site selection , plant layout (objectives, principles, merit & demerit of each type) **Human Resource Management:** Introduction, Importance, Functions of H.R.M, Job	**7**

Title of the Course: Project – II SPAI/ Institute	L	T	P	Cr
Course Code: 3EL492	0	0	16	8

Pre-Requisite Courses:

Textbooks: Suitable books based on the contents of the project selected.

References: Suitable books based on the contents of the project selected and research papers from reputed national and international journals and conferences.

Course Objectives:

1. To acquire the skills of electrical, electronic circuit design and mechanical assembly.
2. To develop the skills of analysis and fault diagnosis of the electrical, electronic circuit and mechanical assembly as per design.
3. To test the electrical, electronic circuit and mechanical assembly.

Course Learning Outcomes:

CO	After the completion of the course the student will be able to	Bloom's Cognitive	
		level	Descriptor
CO1	**Analyze** and infer the reference literature/ research papers critically and efficiently.	4	Analyzing
CO2	**Decide** the model of the project.	5	Evaluating
CO3	**Construct** the project and assess the performance of the project.	6	Creating
CO4	**Write** and Present the report of the project.	6	Creating

CO-PO Mapping :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1												3	3	3
CO2			3						3		3			
CO3								3					3	3
CO4										3				

Assessment:

There are four components of project assessment, LA1, LA2, LA3 and Project ISE.

Assessment	Based on	Conducted by	Conduction and Marks Submission	Marks
LA1	Simulation / Basic Project design	Project Panel	During Week 1 to Week 4 Submission at the end of Week 5	25
LA2	Software /Hardware Implementation	Project Panel	During Week 5 to Week 8 Submission at the end of Week 9	25
LA3	Finalize Software /Hardware Model	Project Panel	During Week 10 to Week 14 Submission at the end of Week 14	25
Project ISE	Presentation, Project report submission	Project Panel	During Week 15 to Week 18 Submission at the end of Week 18	25

Week 1 indicates starting week of Semester. ISE is based on performance of student in project reports, demonstration, presentation, oral, etc. The Project guide/panel shall use at least two assessment tools as mentioned above for ISE.

Course Contents:

1. Visit to a local industry for the study of problems of industry.
2. Prepare the problem based hardware Mini project.
3. Prepare a report on the same.

Module wise Measurable Students Learning Outcomes:

It is expected that students should be able to analyze the problem, work on hardware circuits and prepare the report.

Computer Usage / Lab Tool:

Minor Specialization Courses

Walchand College of Engineering, Sangli

(An Autonomous Institute)

Minor in Electrical Engineering Structure

Semester	Course Name		Credits	Faculty and its Address	Available on
Semester- III	Electrical Machines		3	Prof. Bhuvaneshwari IIT, Delhi.	Swayam
Semester- IV	Power System Generation, Transmission and Distribution		3	Prof. D.P. Kothari IIT, Delhi.	NPTEL
Semester- V	Control Engineering		3	Prof. Ramkrishna Pasumarthy IIT, Madras.	NPTEL
Semester- VI	Industrial Drives - Power Electronics		3	Prof. K. Gopakumar IISc, Bangalore.	NPTEL
Semester- VII	**Elective I**	Microprocessors and Microcontrollers	3	Prof. Santanu Chattopadhyay IIT, Kharagpur.	NPTEL
		Electrical Measurement and Electronic Instruments	3	Prof. Avishek Chatterjee IIT, Kharagpur.	NPTEL
		Seminar I	1	----	---
Semester- VIII	**Elective II**	Industrial Automation and Control	3	Prof. S. Mukhopadhyay IIT, Kharagpur.	NPTEL
		Electric Vehicle	3	Prof. Amit Kumar Jain IIT, Delhi.	NPTEL
		Seminar II	1	----	---

Semester	III	IV	V	VI	VII	VIII	Total
Credits	3	3	3	3	4	4	20

Honors Specialization Courses

Walchand College of Engineering, Sangli
(An Autonomous Institute)
Teaching and Evaluation Scheme effective from 2020-21
B. Tech in Electrical Engineering with Specialization Electrical Vehicle Technology

Course			Teaching Scheme				Evaluation Scheme			
								Marks		
Semester	Code	Name	L	T	P	Credits	Component	Max		Min for Passing
5th		Core 1: Energy Storage Systems for EV.	4	--	--	4	ISE 1	10		40
							MSE	30		
							ISE 2	10		
							ESE	50	20	
6th		Core 2: Introduction to Electrical Vehicles	4	--	--	4	ISE 1	10		40
							MSE	30		
							ISE 2	10		
							ESE	50	20	
7th		Elective 1 Power Electronics in Electrical Vehicle / Case studies in EV Development,	4	--	--	4	ISE 1	10		40
							MSE	30		
							ISE 2	10		
							ESE	50	20	
8th		Elective 2 EV Technology and Grid management / Artificial Intelligence in EV / Computer aided Vehicle design.	4	--	--	4	ISE 1	10		40
							MSE	30		
							ISE 2	10		
							ESE	50	20	
8th		Mini Project	2		--	2	ISE	50	**20**	40
							ESE	50	20	
Total			18	---	---	18	**Total Credits: 18 Total Contact Hrs:18**			

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