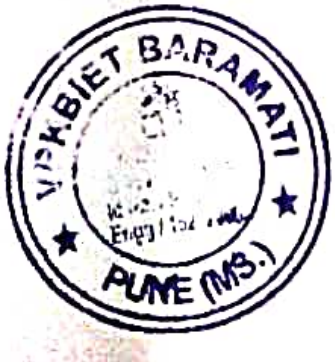
Vidya Pratishthan's
Kamalnayan Bajaj Institute
of
Engineering and Technology, Baramati.

Faculty of Science and Technology

Board of Studies
Electrical Engineering

Syllabus

S.Y. B. Tech.
Electrical Engineering
(Pattern: 2023)
(w.e.f. AY: 2024-25)



Syllabus: Second Year (SY B. Tech.) Electrical Engineering
w.e.f. AY:2024-2025

SEMESTER-I

Course Code	NEP Category	Courses Name	Teaching Scheme			Examination Scheme and Marks							Credits			
			TH	PR	TUT	Activity	ISE	ESE	TW	PR	OR	Total	TH	PR	TUT	Total
BS23206	PCC	Application of Mathematics in Electrical Engineering	3		1		20	70	20			110	3		1	4
EL23201	PCC	Electrical Measurement and Instrumentation	3	2	-	20	20	70	20	20		150	3	1	-	4
EL23202	PCC	Electrical Circuit Analysis	3	2	-	20	20	70	20		20	150	3	1	-	4
EL23203	PCC	Analog & Digital Electronics	3	2	-	20	20	70	20	20		150	3	1	-	4
EL23204	PCC	Power System Engineering	3	-	-	20	20	70				110	3	-	-	3
MDXX230XX	MDM	Multi-disciplinary minor	2	2	-	20	20	50	20			110	2	1	-	3
Total			17	8	1	100	120	400	100	40	20	780	17	4	1	22

SEMESTER-II

Course Code	NEP Category	Courses Name	Teaching Scheme			Examination Scheme and Marks							Credits			
			TH	PR	TUT	Activity	ISE	ESE	TW	PR	OR	Total	TH	PR	TUT	Total
EL23211	PCC	Electrical Machines - I	3	2	-	20	20	70	20	20		150	3	1	-	4
EL23212	PCC	Power System Analysis	3	2	-	20	20	70	20	20		150	3	1	-	4
EL23213	PCC	Power Electronics	3	2	-	20	20	70	20	20		150	3	1	-	4
EL23214	PCC	Electric Mobility	3	-	-	20	20	70				110	3	-	-	3
MDXX230XX	MDM	Multi-disciplinary minor	2	2	-	20	20	50	20			110	2	1	-	3
OE2300X	OE	(Open Electives)	2	-	-			50				50	2	-	-	2
EL23215	VSEC	Energy Audit (Vocational and Skill Enhancement course)	-	4	-				40		20	60		2	-	2
Total			16	12	0	100	100	380	120	60	20	780	16	6	0	22

Mrs. J. S. Kulkarni
Dept. Autonomy Coordinator
Department of Electrical Engineering

Mrs. S. D. Rokade
Dept. Academic Coordinator
Department of Electrical Engineerir

Mrs. P. N. Jaiswal
Head
Department of Electrical Engineering
VPKBIET, Baramati-413133

Dr. C. B. Nayak
Autonomy Coordinator
VPKBIET, Baramati

Dr. S.M.Bhosle
Dean, Academics
VPKBIET, Baramati

VPKBIET BARAMATI
Affiliated to S.P.P. U: Pune Id No./PU/PN/Engg./152/2000
PUNE (MS.)

Dr. R. S. Bichkar
Principal
Vidya Pratishthan's
Kamalnayan Bajaj Institute of
Engineering & Technology, Baramati
Vidyanagari, Baramati-413133

BS23206: Application of Mathematics in Electrical Engineering		
Teaching Scheme:	**Credits: 04**	**Examination Scheme:**
Theory: 3 Hrs./week		**In-Semester: 20 Marks**
Tut.: 1 Hr/week		**End-Semester: 70 Marks**
		Term Work: 20 Marks

Prerequisite Courses:
Differential & Integral calculus, Taylor series, Differential equations of the first order and first degree, Fourier series, Vector algebra and Complex numbers.

Course Objectives:
1. To familiarize the students with concepts and techniques in Ordinary differential equations, Fourier Transform & Z-Transform, Numerical methods, and Vector Calculus.
2. The aim is to equip them with the techniques to understand advanced-level mathematics and its applications that would enhance analytical thinking power, useful in their discipline.

Course Outcomes (COs): On successful completion of the course, the learner will be able to:
CO1: Solve higher-order linear differential equations using appropriate techniques for modeling and analyzing electrical circuits.
CO2: Apply Laplace transform to solve differential equations and problems related to signal processing and control systems.
CO3: Learn the concept of fourier transform and apply it to engineering problems.
CO4: Understand the concept of Z-transform and apply them to solve difference equations.
CO5: Perform vector differentiation & integration, to analyze the vector fields, and apply them to electromagnetic fields.
CO6: Analyze Complex functions, and conformal mappings, and perform contour integration in their study.

Course Content

Unit I: Linear Differential Equations (LDE) and Applications (7 Hrs)
Introduction, Solution of LDE, General method, short-cut method, Method of variation of parameters, Cauchy's, and Legendre's DE, Modeling of Electrical circuits.

Unit II: Laplace Transform (LT) (7 Hrs)
Properties and theorems of Laplace and Inverse Laplace transform. Laplace transform of standard functions and some special functions. Applications of LT for solving linear differential equations in Electrical systems.

Unit III: Fourier Transform (7 Hrs)
Fourier integral theorem, Fourier Sine & Cosine integrals, Fourier transform, Fourier Sine and Cosine transforms, and inverse transforms.

Unit IV: Z Transform (7 Hrs)
Introduction, Theorems and Properties of Z-transform, and Inverse Z-transform. Applications of Z-transforms to solve differential equations.

Unit V: Vector Calculus (7 Hrs)
Vector differentiation: Gradient, Divergence and Curl, Directional derivative, Solenoidal, Conservative fields, Scalar potential, and vector identities.
Vector Integration: Line, Surface, and Volume integrals, Work-done, Green's Lemma, Stoke's theorem, Gauss's Divergence theorem. Applications to problems in Electromagnetic fields.

Unit VI: Complex Variables (7 Hrs)
Functions of a Complex variable, Analytic functions, Cauchy-Riemann equations. Conformal mapping, Bilinear transformation. Cauchy's integral theorem, Cauchy's integral formula, Residue theorem, and applications.

Guidelines for termwork Marks and Assessment:
1. Tutorials for the subject shall be engaged in a minimum of three batches (batch size of 22 students) per division.
2. Term work shall consist of six assignments on each unit and is based on performance and continuous internal assessment.

Books and other Resources:
Textbooks:
1. Higher Engineering Mathematics by B.V. Ramana (Tata McGraw-Hill).
2. Higher Engineering Mathematics by B. S. Grewal (Khanna Publication, Delhi).

Reference Books:
1. Advanced Engineering Mathematics, 10e, by Erwin Kreyszig (Wiley India).
2. Advanced Engineering Mathematics, 2e, by M. D. Greenberg (Pearson Education).
3. Advanced Engineering Mathematics, 7e, by Peter V. O'Neil (Cengage Learning).
4. Differential Equations, 3e by S. L. Ross (Wiley India).
5. Introduction to Probability and Statistics for Engineers and Scientists, 5e, by Sheldon M. Ross (Elsevier Academic Press).
6. Complex Variables and Applications, 8e, by J. W. Brown and R. V. Churchill (McGraw-Hill)

MOOC/NPTEL Courses:
1. Course on "Integral & Vector Calculus" https://nptel.ac.in/courses/111/105/111105122/
2. Course on "Complex Analysis" https://nptel.ac.in/courses/111/103/111103070/
3. Course on "Transform Calculus and its applications in differential equations." https://nptel.ac.in/courses/111/105/111105123/

EL23201: Electrical Measurement and Instrumentation		
Teaching Scheme:	**Credits:04**	**Examination Scheme:**
TH: 03 Hrs/Week		**Course Activity: 20 Marks**
		In-Semester Exam: 20 Marks
		End-Semester Exam: 70 Marks
PR: 02 Hrs/Week		**Practical Exam: 20 Marks**
		Term-Work: 20 Marks

Prerequisite Courses:

Basic Electrical Engineering

Course Objectives:

1.To study the principle of operation and working of different types of instruments.

2.To understand the principle of operation and working of various types of bridges for measurement of parameters –resistance, inductance, capacitance.

3.To explain the construction, working principle of various types of instruments for measurement of electrical power.

4.To demonstrate construction, working principle of various types of instruments for measurement of energy.

5.To explain the principles of oscilloscope, transducer and sensor for measurement of various electrical quantities.

6.To study various types of measurement techniques like level, displacement and flow measurement.

Course Outcomes

On completion of the course, learner will be able to:

CO-1: Understand various characteristics and classification of measuring instruments along with techniques of range extension.

CO-2: Apply measurement techniques for measurement of resistance, inductance, and capacitance.

CO-3: Demonstrate construction, working principle of various types of instruments for measurement of power.

CO-4: Demonstrate construction, working principle of various types of instruments for measurement of energy

CO-5: To apply knowledge of oscilloscope, transducer and sensor for measurement of various electrical quantities.

CO-6: To explain the level measurement, displacement measurement and flow measurement.

Course Contents

Unit I: Measuring Instruments **(7 Hrs)**

A. Classification of Measuring Instruments:

Characteristics of measuring instruments: static and dynamic, accuracy, linearity, speed of response, dead zone, repeatability, resolution, span, reproducibility, drifts. Necessity of calibration, standards and their classification, absolute and secondary instruments, types of secondary instruments: indicating, integrating, and recording, analog and digital. Laser distance meter, Laser tachometer, Ammeter, and Voltmeter Theory: Essentials of indicating instruments deflecting, controlling, and damping systems. Construction, working principle, torque equation, advantages, and disadvantages of Moving Iron (MI) instruments (attraction and repulsion). Block diagram and operation of digital ammeter & voltmeter.

B. Range Extension:

Instrument Transformers: Construction, connection of CT & PT in the circuit, advantages of CT / PT for range extension of MI Instruments, transformation ratio, turns ratio, nominal ratio, and burden, ratio, and phase angle error.

Unit II: Measurement of Resistance, Inductance and Capacitance **(7 Hrs)**

A. **Measurement of Resistance:** Measurement of low, medium, and high resistance. Wheatstone bridge, Kelvin's double bridge, ammeter-voltmeter method, Megger. Earth tester for earth resistance measurement.

B. **Measurement of Inductance:** Introduction, sources, and detectors for A.C. Bridge. General equation for bridge balances, Maxwell's inductance - Capacitance Bridge, Anderson's bridge.

C. **Measurement of Capacitance:** Introduction, types of capacitances, measurement of capacitance by Schering Bridge.

Unit III: Measurement of Power **(7 Hrs)**

Construction, working principle, torque equation, errors and their compensation, advantages and disadvantages of dynamometer type wattmeter, low power factor wattmeter, poly-phase wattmeter. Active & reactive power measurement in three phase system for balanced and unbalanced load using three wattmeter method, two wattmeter method & one wattmeter method.

Unit IV: Measurement of Energy **(7 Hrs)**

Construction, working principle, torque equation of single phase conventional (induction type) energy meter. Block diagram and operation of single phase and three phase static energy meter. Calibration of static energy meter, TOD meter, Digital energy meter, Bidirectional net meter.

Unit V: Oscilloscope, Transducers & Sensors **(7 Hrs)**

A. **Oscilloscope:** Introduction, various parts, front panel controls, use of CRO for measurement of voltage, current, period, frequency. Phase angle & frequency by Lissajous pattern. Introduction to DSO.
B. **Transducers:** Introduction, classification, types: resistive, inductive, capacitive, basic requirements for transducers.
C. **Sensors:** Position sensors, Pressure sensors, Temperature sensors, Force sensors, Vibration sensors, Piezo sensors, Humidity sensors, Fluid property sensors.

Unit VI: Level, Displacement and Flow Measurement **(7 Hrs)**

A. **Level Measurement:** Introduction and importance of level measurement, level measurement methods: mechanical, hydraulic, pneumatic, electrical, nucleonic, and ultrasonic.
B. **Displacement Measurement:** LVDT & RVDT construction, working, applications, specifications, advantages & disadvantages, effect of frequency on performance.
C. **Flow Measurement:** Introduction, characteristics, construction & working of solenoid valve and its applications.

Books & Other Resources:

Text Books:

1. A. K. Sawhney, "A Course in Electrical and Electronic Measurements & Instrumentation", Dhanpat Rai & Co.
2. J. B. Gupta, "A Course in Electronics and Electrical Measurements and Instrumentation", S. K. Kataria & Sons.
3. R. K. Jain, "Mechanical and Industrial Measurements", Khanna Publishers.
4. B. C. Nakra & K. K. Chaudhari, "Instrumentation Measurement and Analysis", Tata McGraw Hill.

Reference Books:

1. E. W. Golding & F. C. Widdies, "Electrical Measurements & Measuring Instruments", Reem Publications.
2. Dr. Rajendra Prasad, "Electronic Measurements & Instrumentation", Khanna Publishers.
3. Arun K. Ghosh, "Introduction to Measurements and Instrumentation", PHI Publication.
4. M. M. S. Anand, "Electronics Instruments and Instrumentation Technology", PHI Publication.

Guidelines for Laboratory - Term work Assessment:

1. The distribution of weightage of term work marks should be informed to students before the start of the semester.
2. Term work assessment should be on a continuous basis. At frequent intervals students are expected to inform about their progress/lagging.

Guidelines for Laboratory Conduction:

1. DO's and DON'TS, along with precautions, are needed to be displayed at prominent locations in the laboratory.
2. Students should be informed about DO'S and DON'T and precautions before performing.

Guidelines for Students Lab Journal:

The Student's Lab Journal should contain following related to every experiment –

1. Theory related to the experiment.
2. Apparatus with their detailed specifications.
3. Connection diagram /circuit diagram.
4. Observation table/ simulation waveforms.
5. Sample calculations for one/two readings.
6. Result table.
7. Graph and Conclusions.
8. There should be continuous assessment for the TW.
9. Assessment must be based on understanding of theory, attentiveness during practical, understanding Session, how efficiently the student is able to make connections and get the results, and timely submission of journals.

LIST OF PRACTICALS (Any 08 experiments to be performed by the student)

1. To perform measurement of medium resistance by Ammeter - Voltmeter method.
2. To perform measurement of low resistance using Kelvin's double bridge.
3. To perform demonstration of Power analyser and multifunction meter for measurement of various electrical quantities.
4. To perform extension of ammeter range using CT, voltmeter range using PT and watt meter range using CT / PT.
5. To perform calibration of single-phase wattmeter at different power factors.
6. To perform measurement of active & reactive power in three phase balanced circuit using one wattmeter method with a two-way switch.
7. To perform measurement of three phase active & reactive power by two wattmeter method for balanced as well as unbalanced load.
8. To perform measurement of reactive power by one wattmeter with all possible connections of current coil and pressure coil.
9. To perform measurement of active power in three phases, four wire system using three CTs & two wattmeter.
10. To perform calibration of single-phase energy meter at different power factors.
11. To perform measurement of the displacement by using LVDT and plotting its characteristics.
12. To perform measurement of Inductance, Capacitance and Resistance using LCR meter.
13. Recommended industrial visit to any manufacturing company.

Note : The list of experiments is not limited to the above, but a course coordinator may design few new experiments based on recent technologies/trends in the relevant Engineering Domain. However the course coordinator needs to get approval by the Program Assessment Committee and Chairman BOS/HOD well in time.

Course Activity (Any ONE of the following):

For the assessment of Course Activity, a student must complete at least ONE activity out of the following:

1. Chart Preparation
2. Powerpoint presentation

EL23202: Electrical Circuit Analysis		
Teaching Scheme:	**Credits:04**	**Examination Scheme:**
TH: 03 Hrs/Week		**Course Activity: 20 Marks**
		In-Semester Exam: 20 Marks
		End-Semester Exam: 70 Marks
PR: 02 Hrs/Week		**Oral Exam: 20 Marks**
		Term-Work: 20 Marks

Prerequisite Courses:

Engineering Physics, Engineering Mathematics I & II, Basic Electrical Engineering

Companion Course, if any: Laboratory Practical

Course Objectives:

1. To understand types of sources and to develop the ability to solve and analyse problems on electric circuits by application of the knowledge of Mesh Analysis, Nodal Analysis, Duality and Graph Theory.
2. To develop the ability to apply knowledge of various network theorems to electrical circuits to simplify, solve and analyse the electric circuit problems.
3. To understand and analyse transient and steady-state response of RLC circuits with time domain approach.
4. To be able to obtain Laplace Transformed networks and analyse transient and steady-state response of RLC circuits with Laplace Transform approach.
5. To understand and evaluate two port network parameters and their interrelationships and to design other circuit like passive filters.
6. To be able to determine network functions and to obtain time domain behaviour from the Pole-Zero plot to perform stability analysis.

Course Outcomes:

On completion of the course, learner will be able to:

CO-1: Solve and analyse problems on electric circuits by applying the knowledge of Mesh Analysis, Nodal Analysis, Duality and Graph Theory.

CO-2: Simplify, solve and analyse the electric circuit problems by applying knowledge of various network theorems.

CO-3: Analyse transient and steady-state response of RLC circuits in time domain.

CO-4: Apply Laplace transform to analyse transient and steady-state behaviour of RLC circuits.

CO-5: Evaluate two port network parameters and develop their interrelationships and design other circuit like passive filters.

CO-6: Determine network functions and obtain time domain behaviour from the Pole-Zero plot to perform stability analysis.

Course Contents

Unit I: Source Transformation, Mesh & Nodal Analysis, Duality, Graph Theory (7 Hrs)

Types of Sources: AC Sources, DC Independent (Ideal & Practical) and DC Dependent (controlled) voltage and current sources, Source Transformation, KVL & KCL, Mesh and Nodal Analysis of circuits with all types of sources, Concept of super node and super mesh, Concept of duality and dual networks, Dot convention for coupled circuits.

Graph Theory: Tree, Co-tree, Incidence matrix, F-cutest Matrix, Tie set B Matrix.

Unit II: Network Theorems (7 Hrs)

Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum power transfer theorem, Reciprocity theorem, Millman's theorem, Compensation theorem applied to electrical networks with all types of sources (AC & DC, DC independent and dependent).

Unit III: Transient Analysis in RLC Circuits – Time Domain Approach (7 Hrs)

Solution of first and second order differential equations for series and parallel R-L, R-C, RLC circuits, initial and final conditions in network elements, forced and free response, time constants, steady state and transient state response.

Unit IV: Transient Analysis in RLC Circuits – Laplace Transform Approach (7 Hrs)

Introduction to Laplace transform, Properties of Laplace transforms, step, pulse, impulse & ramp functions, Laplace Transform of Basic R, L and C components, Laplace transformed networks with initial conditions, Solutions of differential equations and network equations using Laplace transform method for R-L, R-C and R-L-C circuits (series and parallel), Application of initial and final value theorem, Inverse Laplace transforms.

Unit V: Two Port Networks and Passive Filters (7 Hrs)

One Port and Two port networks, Open Circuit Impedance (Z) Parameters, Short circuit Admittance (Y) Parameters, Transmission (ABCD) Parameters, Inverse Transmission (A'B'C'D') Parameters, Hybrid (h) Parameters, Inverse Hybrid (g) Parameters, inter-

relationships between all two port network parameters, Introduction to passive filters, low pass filters, high pass filters and m-derived LPF and HPF filters and design.

Unit VI: Network Functions **(7 Hrs)**

Driving Point functions for One and Two Port Networks, Transfer functions for two port network, Calculation of network functions, Poles and Zeros of network functions, Pole-Zero Plot, time domain behaviour from the Pole-Zero plot, Restrictions on poles and zeros locations for transfer functions and driving point functions, Parallel Resonance, Quality Factor.

Books & Other Resources:

Text Books:

1. Network Analysis, M. E. Van Valkenburg, Prentice Hall of India Private Limited.
2. Network Analysis & Synthesis, G. K. Mittal, Khanna Publication.
3. Network Analysis and Synthesis, Ravish R Singh, McGraw Hill.
4. Introduction to Electric Circuits, S. Charkraborty, Dhanpat Rai & Co.
5. Fundamentals of Electrical Networks, B. R. Gupta & Vandana Singhal, S. Chand Publications

Reference Books:

1. Introduction to Electric Circuits, Alexander & Sadiku, McGraw Hill.
2. Network Analysis, Cramer, McGraw Hill Publication.
3. Engineering Circuit Analysis, William H. Hayt, Jr. Jack E. Kemmerly, McGraw Hill Publication.

Guidelines for Laboratory - Term work Assessment:

1. The distribution of weightage of term work marks should be informed to students before the start of the semester.
2. Term work assessment should be on a continuous basis. At frequent intervals students are expected to inform about their progress/lagging.

Guidelines for Laboratory Conduction:

1. DO's and DON'TS, along with precautions, are needed to be displayed at prominent locations in the laboratory.
2. Students should be informed about DO'S and DON'T and precautions before performing.

Guidelines for Students Lab Journal:

The Student's Lab Journal should contain following related to every experiment –

1. Theory related to the experiment.
2. Apparatus with their detailed specifications.
3. Connection diagram /circuit diagram.
4. Observation table/ simulation waveforms.
5. Sample calculations for one/two readings.
6. Result table.
7. Graph and Conclusions.
8. There should be continuous assessment for the TW.
9. Assessment must be based on understanding of theory, attentiveness during practical, understanding Session, how efficiently the student is able to make connections and get the results, and timely submission of journals.

LIST OF PRACTICALS (Any 08 to be performed by the student)

1. Verification of Superposition theorem in A.C. circuits.
2. Verification of Thevenin's theorem in A.C. circuits.
3. Verification of Norton's theorem in A.C. circuits.
4. Verification of Reciprocity theorem in A.C. circuits.
5. Verification of Maximum Power Transfer theorem in A.C. circuits.
6. Verification of Millman's theorem.
7. Determination of time response of R-C circuit to a step D.C. voltage input. (Charging and discharging of a capacitor through a resistor)
8. Determination of time response of R-L circuit to a step D.C. voltage input. (Rise and decay of current in an inductive circuit)
9. Determination of time response of R-L-C series circuit to a step D.C. voltage input.
10. Determination of Z-parameters and Y-parameters of a Two Port Network.
11. Determination of h-parameters and ABCD parameters of a Two Port Network.
12. Determination of current under parallel Resonance condition.

Note: The list of experiments is not limited to the above, but a course coordinator may design few new experiments based on recent technologies/trends in the relevant Engineering Domain. However, the course coordinator needs to get approval by the Program Assessment Committee and Chairman BOS/HOD well in time.

Course Activity (Any ONE of the following):

For the assessment of Course Activity, a student must complete at least ONE activity out of the followings:

1. Concept Test
2. Simulation of Electrical Circuits

EL23203 : Analog and Digital Electronics		
Teaching Scheme:	**Credits:04**	**Examination Scheme:**
TH: 03 Hrs/Week		**Course Activity: 20 Marks**
		In-Semester Exam: 20 Marks
		End-Semester Exam: 70 Marks
PR: 02 Hrs/Week		**Practical Exam: 20 Marks**
		Term-Work: 20 Marks

Prerequisite Courses:

Basic Electronics Engineering

Course Objectives:

1. To design combinational circuits using fundamental logic gates, Boolean algebra & K-map to solve complex digital logic problems.
2. To construct sequential circuits including shift registers and counters using fundamental logic gates and Boolean algebra
3. To apply fundamental knowledge of diode rectifiers in power conversion of AC to DC.
4. To understand the fundamentals of operational amplifier.
5. Use basic principles of operational amplifiers to illustrate their various applications.
6. To understand the principles and types of multivibrators, filters and voltage regulators in electronic circuits.

Course Outcomes

Upon successful completion of this course, the students will be able to:

CO1: Design combinational circuits using fundamental logic gates, Boolean algebra & K-map

CO2: Construct sequential circuits including shift registers and counters using fundamental logic gates and Boolean algebra

CO3: Apply fundamental knowledge of diode rectifiers in power conversion of AC to DC

CO4: Understand the fundamentals of operational amplifier and illustrate its applications.

CO5: Understand the principles and types of multivibrators, filters and voltage regulators in electronic circuits.

CO6: Understand the principles and types of multivibrators, filters and voltage regulators in electronic circuits.

Course Contents

Unit I: Combinational circuits **(7 Hrs)**

Karnaugh map: Structure for two, three and four Variables, SOP and POS form reduction of boolean expressions by K-map, Reduction of boolean expressions not specified in standard SOP form and don't care conditions, Introduction to combinational circuits, Study of encoders : Priority encoder, 4:2 encoder, Decoders : 2:4, 3:8 decoder, Subtractor : Half subtractor and full subtractor, Multiplexer and Demultiplexer.

Unit II: Sequential circuits **(7 Hrs)**

Introduction to sequential circuit, Basic SR Latch, Review of RS flip flop, D FF, JK FF and T FF, Study of synchronous and asynchronous up and down counters (2-bit, 3-bit and 4-bit), Asynchronous up-down counter, Design of asynchronous MOD-N counter, Shift registers : SISO,SIPO,PISO,PIPO and universal shift register, Ring and twisted ring counters.

Unit III: Diode rectifier **(7 Hrs)**

Single phase half wave rectifier with RL load. Single phase full wave centre tapped and bridge rectifier supplying RL load, Performance parameters of single phase half wave and full wave rectifiers. Three phase half wave rectifier with R and RL load, Three phase full wave bridge rectifier with R load.

Unit IV: Basics of operational amplifier **(7 Hrs)**

Introduction, Block Diagram and symbol of op-amp, Types of op-amp : Ideal op-amp and practical op-amp, Important characteristics of ideal and practical op-amp, Input modes of op-amp: single ended mode, Differential mode and common mode, Concept of virtual short and virtual ground, Open loop and closed loop configuration of op-amp : inverting, non inverting and differential amplifier.

Unit V: Applications of operational amplifier **(7 Hrs)**

Applications of op- amp : zero crossing detector, Schmitt trigger, V-I converter with grounded load and floating load, I-V converter, Peak Detector, Instrumentation amplifier, Waveform generation using op-amp : Sinewave, Squarewave and Triangular waveform generator.

Unit VI: Filters, Multivibrators and voltage regulators **(7 Hrs)**

Active filters : Its configuration with frequency response, Analysis of first order low pass and high pass filters using OPAMP, IC 555 –construction, working and modes of operation- Astable, Monostable and multivibrators, Voltage regulators using IC78xx, 79xx, LM 317.

Books & Other Resources:

Text Books:

1) Floyd and Jain, "Digital Fundamentals", Pearson Education.
2) R. P. Jain, "Digital Electronics", Tata McGraw Hill, New Delhi.
3) Malvino, "Digital Computer Electronics- An Introduction to Microcomputers," Tata McGraw Hill.
4) Gaikwad R., "Operational Amplifier", PHI New Delhi.
5) Floyd, "Electronics Devices", Pearson Education.
6) Muhammad H. Rashid, "Power Electronics: Circuits, Devices and Applications", 3rd edition, Pearsons Education.
7) Fundamental of digital circuits, 4th Edition, by A Anand Kumar, PHI learning private limited publication

Reference Books:

1) Tokheim, "Digital Electronics-Principles and Application", 6th edition, Tata McGraw Hill, New Delhi.
2) A Jaico and Charles H. Roth, "Fundamentals of Logic Design" Jr. Forth Edition.
3) K. R. Botkar, "Integrated Circuits", Khanna Publication, New Delhi.
4) James, "Operational Amplifier and Linear Integrated Circuits Theory and Application."

5) P John Paul, "Electronics Devices and circuits", New Age international Publications.
6) P. S. Bimbhra, "Power Electronics", Khanna Publications.

Guidelines for Laboratory - Term work Assessment:

1. The distribution of weightage of term work marks should be informed to students before the start of the semester.
2. Term work assessment should be on a continuous basis. At frequent intervals students are expected to inform about their progress/lagging.

Guidelines for Laboratory Conduction:

1. DO's and DON'TS, along with precautions, are needed to be displayed at prominent locations in the laboratory.
2. Students should be informed about DO'S and DON'T and precautions before performing.

Guidelines for Students Lab Journal:

The Student's Lab Journal should contain following related to every experiment –

1. Theory related to the experiment.
2. Apparatus with their detailed specifications.
3. Connection diagram /circuit diagram.
4. Observation table/ simulation waveforms.
5. Sample calculations for one/two readings.
6. Result table.
7. Graph and Conclusions.
8. There should be continuous assessment for the TW.
9. Assessment must be based on understanding of theory, attentiveness during practical, understanding Session, how efficiently the student is able to make connections and get the results, and timely submission of journals.

LIST OF PRACTICALS (Any 08 to be performed by the student)

1. To develop a logic circuit for 3:8 decoder and realize it using logic gates.
2. To develop a logic circuit for priority eecoder and realize it using logic gates.

3. To design three bit full adder to add two three digit numbers by using any open source software.

4. To develop a logical circuit to convert binary to EXCESS 3/Gray number system and implement it using logic gates.

5. To construct a toggle flip-flop using JK flip-flops and demonstrate its operation by connecting LEDs to the outputs.

6. To observe the output waveform of comparator.

7. To observe the output waveform of Schmitt Trigger.

8. To observe the output waveform of Monostable Multivibrator using IC 555.

9. To observe the output waveform of Astable Multivibrator using IC 555.

10. To observe the output waveform of single phase bridge rectifier using RL load.

Note :

The list of experiments is not limited to the above, but a course coordinator may design few new experiments based on recent technologies/trends in the relevant Engineering Domain. However the course coordinator needs to get approval by the Program Assessment Committee and Chairman BOS/HOD well in time.

Course Activity (Any one of the following)

For the assessment of course activity, a student must complete at least one activity out of the following

1.Unitwise objective test

2.Circuit simulation

EL23204: Power System Engineering		
Teaching Scheme:	**Credits:03**	**Examination Scheme:**
TH: 03 Hrs/Week		**Course Activity: 20 Marks**
		In-Semester Exam: 20 Marks
		End-Semester Exam: 70 Marks

Prerequisite Courses:

Basic knowledge of electrical engineering, physics and mathematics.

Companion Course, if any: Laboratory Practical

Course Objectives:

1. To introduce students to the fundamental principles of Thermal power plant.
2. To understand the technological aspects of nuclear and diesel plant.
3. To explain the technical qualities of hydro power plant
4. To understand the important aspects of wind and solar energy system.
5. To analyse the important aspects of economics of power generation.
6. To analyse the basic structure of electrical transmission system.

Course Outcomes

On completion of the course, learner will be able to:

CO-1: Identify components and elaborate working principle of thermal power plant.

CO-2: Explain the key components of diesel power plant and basic principles of nuclear physics, including fission and fusion processes.

CO-3: Describe the basic principles of hydropower generation, including the conversion of potential energy from water into mechanical and electrical energy.

CO-4: Understand the fundamental principles of wind energy and recognize the importance and opportunities of solar energy.

CO-5: Evaluate the economics of power generation and different factors associated with it.

CO-6: Analyse the basic structure of electrical transmission system and different electrical terms related to them.

Course Contents

Unit I: Thermal Power Plant **(7 Hrs)**

Thermal power plant site selection, Thermal power plant layout, Main parts and its working, Types of boilers (fire tube and water tube), Fuel handling, Ash disposal and collection, Basics of thermodynamic cycle.

Unit II: Nuclear and Diesel Power Plant **(7 Hrs)**

A. Nuclear Power Plant: Introduction, atomic physics, nuclear reaction, materials, site selection, nuclear reactors and working of each part, classification of nuclear reactor, nuclear waste disposal.

B. Diesel Power Plant: Main components and its working, Diesel plant efficiency and heat balance, Site selection of diesel power plant.

Unit III: Hydro Power Plant **(7 Hrs)**

Site selection, Hydrology, storage and pondage, general arrangements and operation of hydro power plant, Hydraulic turbines, turbine size, Pelton wheel turbine, Francis and Kaplan turbines, selection of turbines, Dams, Spillways, gates, intake and out take works, canals and layout of penstocks, water hammer and surge tank, Numerical based on total energy generated.

Unit IV: Wind and Solar Energy Systems **(7 Hrs)**

A. Wind Energy: Historical development of wind energy, types of wind turbine, Wind turbine generators, Environmental impacts of wind turbines. Change in wind turbine blades and its effect on generation. Control of wind turbine generator, Numerical based on wind energy.

B. Solar Energy: Photovoltaic effect. Solar thermal energy systems. Solar photovoltaic (PV) systems and PV current equation. Solar cell, solar module and solar array. Effect of series and parallel cells arrangement. Solar radiation and its measurement.

Unit V: Economics of Power Generation **(7 Hrs)**

Structure of Electrical Power System, Different factors associated with generating stations such as connected load, maximum demand, demand factor, average load, load factor, diversity factor, plant capacity factor, reserve capacity, plant use factor. Load curve, load duration curve, concept of base load and peak load stations, Interconnected grid system, Introduction to tariff, Numerical based on load curve and finding different factors.

Unit VI: Mechanical Design of Transmission System **(7 Hrs)**

A. Overhead Line Insulators: Types of insulators, its construction and their applications such as Pin type, Suspension type, Strain type, Shackle type, Post insulators, Bushing. Potential distribution over suspension insulators, String efficiency, Methods of improving string efficiency

B. Sag Calculations: Main components of overhead lines, Various types of line supports, Conductor spacing, Length of span, Calculation of sag for equal and unequal supports and effect of ice and wind loading, Numerical based on sag calculation.

Books & Other Resources:

Text Books:

1. P. K. Nag, "Power Plant Engineering", Tata McGraw Hill Publications.
2. Dr. P. C. Sharma, "Power Plant Engineering", S.K. Kataria Publications.
3. Chetan Singh Solanki "Solar Photovotaics: Fundamentals, Technology and Application" PHI Publications.
4. J. B. Gupta, "Transmission and Distribution", S. K. Kataria & Sons, New Delhi.
5. V. K Mehta, Rohit Mehta, "Principles of Power System", S Chand.

Reference Books:

1. Arora and Domkundwar, "A Course in Power Plant Engineering", DhapatRai Publication.
2. Dr. S. P. Sukhatme, "Solar Energy", Tata McGraw Hill Publication.
3. Mukund Patel, "Wind and Solar Power Plants", CRC Press.
4. Nagrath & Kothari, "Power System Engineering", Tata McGraw Hill Publications.

Course Activities (Any ONE of the following):

For the assessment of Course Activity, a student must complete at least ONE activity out of the following:

1. Mini project/ working model/ prototype model of any power plant.
2. Case studies/ research paper reading of any power plant.

EL23211: Electrical Machine I		
Teaching Scheme:	**Credits:04**	**Examination Scheme:**
TH: 03 Hrs/Week		**Course Activity: 20 Marks**
		In-Semester Exam: 20 Marks
		End-Semester Exam: 70 Marks
PR: 02 Hrs/Week		**Practical Exam: 20 Marks**
		Term-Work: 20 Marks

Prerequisite Courses:

Basic Electrical Engineering

Course Objectives:

1. To understand the fundamental principles of single-phase transformers, including their construction, operation, and applications.
2. To understand the principle and applications of three-phase transformer and autotransformer.
3. To demonstrate the principles of DC machines, including their construction, types, and operational characteristics.
4. To apply the knowledge of DC machines to demonstrate the characteristics and applications of DC motors.
5. To explain the construction, working principles, and characteristics of three-phase induction motor.
6. To evaluate various performance parameters of 3 phase Induction Motor.

Course Outcomes

Upon successful completion of this course, the students will be able to:

CO1: Understand the fundamental principles of single phase transformers, including their construction, operation, and applications.

CO2: Understand the principle and applications of three-phase transformer and autotransformer.

CO3: Demonstrate the principles of DC machines, including their construction, types, and operational characteristics.

CO4: Apply the knowledge of DC machines to demonstrate the characteristics and applications of DC motors.

CO5: Explain the construction, working principles, and characteristics of three-phase induction motor.

CO6 : Evaluate various performance parameters of three phase Induction Motor.

Course Contents

Unit I: Single Phase Transformer **(7 Hrs)**

Single phase Transformer: Concept of ideal transformer. Construction of Corrugated core transformer. Toroidal core Transformer, various parts of transformer, Useful and leakage flux, its effects. Resistance, leakage reactance and leakage impedance of transformer windings & their effects on voltage regulation and efficiency. Exact and approximate equivalent circuits referred to L.V. and H. V. side of the transformer. Phasor diagrams for no-load and on load conditions. Transformer ratings. Losses in a transformer, their variation with load, voltage & frequency. Efficiency and condition for maximum efficiency. All day efficiency, Parallel operation of single-phase transformers, conditions to be satisfied, load sharing under various conditions.

Unit II: Three Phase Transformer and Autotransformer **(7 Hrs)**

Standard connections of three phase transformers(star-star, star-delta, delta-star, delta-delta), zigzag connection and their suitability for various applications, voltage phasor diagrams and vector groups. Descriptive treatment of Parallel operation of three phase transformers, Scott connection and V connections. Three winding (tertiary windings) transformers, welding transformer.comparison of power transformer and distribution transformer.

Auto transformers, their ratings and applications. Comparison with two winding transformers with respect to saving of copper and size.

Unit III: DC Machines **(7 Hrs)**

Construction, main parts, magnetic circuits, poles, yoke, field winding, armature core, Armature windings: Simple lap and wave winding, commutator and brush assembly. Generating action, E.M.F equation, types of DC Generator, magnetization curves, Flashing of Generator. Motoring action. Types of DC motors, significance of back E.M.F, torque equation, working at no-load and on-load. Losses, power flow diagram and efficiency. Descriptive treatment of armature reaction.

Unit IV: Starters and speed control of DC Motor **(7 Hrs)**

Starting of DC motors, Need of starter, study of starters for series and shunt motor : 2 point starter, 3 point starter and 4 point starter, solid state starters.

Speed control of various types of DC motors : Flux control method and armature voltage control method. Characteristics and applications of D.C. Shunt and Series Motors.

Brushless DC Motor : construction, working and applications.

Unit V: Three Phase Induction Motor **(7 Hrs)**

Construction: Stator, Squirrel cage & wound rotors. Production of rotating mmf. Principle of working, simplified theory with constant air gap flux; slip, frequency of rotor emf and rotor currents, mmf produced by rotor currents, its speed w.r.t. rotor and stator mmf. Production of torque, torque-slip relation, condition for maximum torque, torque-slip Characteristics, effect of rotor resistance on torque-slip characteristics. Relation between starting torque, full load torque and maximum torque. Losses in three phase induction motor, power-flow diagram, Relation between rotor input power, rotor copper loss & gross mechanical power developed, efficiency. Exact & approximate equivalent circuit.Computation of performance characteristics from the equivalent circuit and circle diagram.

Unit VI: Starters and speed control of Three Phase Induction Motor **(7 Hrs)**

Necessity of starter for three phase induction motors. Starters for slip-ring and cage rotor induction motors : DOL, stator resistance, star-delta, rotor resistance, autotransformer. Comparison of various types of starters. Speed control methods : Stator side and rotor side.Testing of three phase induction motor as per IS 325 & IS 4029.

Books & Other Resources:

Text Books:

1) Edward Hughes "Electrical Technology", ELBS, Pearson Education.
2) Ashfaq Husain, "Electrical Machines", Dhanpat Rai& Sons.
3) S. K. Bhattacharya, "Electrical Machine", Tata McGraw Hill publishing Co. Ltd, 2nd Edition.
4) Nagrath & Kothari, "Electrical Machines", Tata McGraw Hill.

5) Bhag S Guru, Husein R. Hiziroglu, "Electrical Machines", Oxford University Press.
6) K Krishna Reddy, "Electrical Machines- I and II", SCITECH Publications (India) Pvt. Ltd. Chennai.

Reference Books:

1) A.E. Clayton and N. N. Hancock, "Performance and Design of Direct Current Machines", CBS Publishers, Third Edition.
2) A.E. Fitzgerald, Charles Kingsley, Stephen D. Umans, "Electrical Machines", TataMcGraw Hill Publication Ltd., Fifth Edition.
3) A.S. Langsdorf, "Theory and performance of DC machines", Tata McGraw Hill.
4) M.G. Say, "Performance and Design of AC. Machines", CBS Publishers and Distributors.
5) Smarajit Ghosh, "Electrical Machines", Pearson Education, New Delhi.
6) Charles I Hubert, "Electrical Machines Theory, Application, & Control", Pearson Education, New Delhi, Second Edition.

Guidelines for Laboratory - Term work Assessment:

1. The distribution of weightage of term work marks should be informed to students before the start of the semester.
2. Term work assessment should be on a continuous basis. At frequent intervals students are expected to inform about their progress/lagging.

Guidelines for Laboratory Conduction:

1. DO's and DON'TS, along with precautions, are needed to be displayed at prominent locations in the laboratory.
2. Students should be informed about DO'S and DON'T and precautions before performing.

Guidelines for Students Lab Journal:

The Student's Lab Journal should contain following related to every experiment –

1. Theory related to the experiment.
2. Apparatus with their detailed specifications.
3. Connection diagram /circuit diagram.
4. Observation table/ simulation waveforms.

5. Sample calculations for one/two readings.
6. Result table.
7. Graph and Conclusions.
8. There should be continuous assessment for the TW.
9. Assessment must be based on understanding of theory, attentiveness during practical, understanding Session, how efficiently the student is able to make connections and get the results, and timely submission of journals.

LIST OF PRACTICALS (Any 08 to be performed by the student)

1. To perform O.C. and S.C. test on single phase Transformer
   a) To determine equivalent circuit parameters from the test data
   b) To determine voltage regulation and efficiency
2. To perform polarity test on single phase and three phase transformer.
3. To perform Parallel operation of two single phase transformers and study of their load sharing under various conditions of voltage ratios and leakage impedance.
4. To perform Sumpner's test.
5. To perform Brake test on D.C. Shunt motor.
6. To perform Load characteristics of D.C. series motor.
7. To perform speed control of D.C. Series motor by flux control method
8. To perform speed control of DC shunt motor by armature voltage control method.
9. To study of different types of starters of DC motor
10. To perform load test on three phase induction motor.
11. To perform No load & blocked-rotor test on 3-phase induction motor and determination of parameters of equivalent circuit.
12. To perform no load & blocked rotor test on 3-phase induction motor and plotting of circle diagram from the test data.

Note :

The list of experiments is not limited to the above, but a course coordinator may design few new experiments based on recent technologies/trends in the relevant Engineering Domain. However the course coordinator needs to get approval by the Program Assessment Committee and Chairman BOS/HOD well in time.

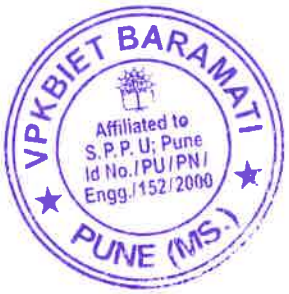
Industrial Visit: Minimum one compulsory visit to either transformer or DC Machine Manufacturing Industry

Course Activity (Any one of the following)

For the assessment of course activity, a student must complete at least one activity out of the following

1.Chart preparation

2.V-Lab



EL23212: Power System Analysis		
Teaching Scheme:	**Credits:04**	**Examination Scheme:**
TH: 03 Hrs/Week		**Course Activity: 20 Marks**
		In-Semester Exam: 20 Marks
		End-Semester Exam: 70 Marks
PR: 02 Hrs/Week		**Practical Exam: 20 Marks**
		Term-Work: 20 Marks

Prerequisite Courses:

Knowledge of Fundamentals of Electrical Circuit Components, Engineering Mathematics, Power and Energy calculation, Power System Engineering

Companion Course, if any: Laboratory Practical

Course Objectives:

1. To describe the concepts of resistance and inductance of transmission lines and their impact on the performance of lines
2. To discuss the concept of capacitance of transmission lines and their impact on the performance of lines
3. To analyse the performance of transmission line models
4. To analyse different power system component in per unit system and load flow analysis
5. To evaluate and demonstrate symmetrical fault analysis in power system
6. To evaluate and demonstrate unsymmetrical fault analysis in power system

Course Outcomes

On completion of the course, learner will be able to:

CO-1: Describe the concepts of resistance and inductance of transmission lines and their impact on the performance of lines
CO-2: Discuss the concept of capacitance of transmission lines and their impact on the performance of lines
CO-3: Analyse the performance of transmission line models
CO-4: Analyse different power system component in per unit system and load flow analysis
CO-5: Evaluation and Demonstration symmetrical fault analysis in power system
CO-6: Evaluation and Demonstration unsymmetrical fault analysis in power system

Course Contents

Unit I: Resistance and Inductance of Transmission Line **(7 Hrs)**

A) **Resistance of Transmission Line:** Skin effect, and Proximity effect, Factors responsible for these effects

B) **Inductance of Transmission Line:** Internal & external flux linkages of single conductor, Inductance of single phase two wire line, Three phase line with symmetrical and unsymmetrical spacing, Concept of G.M.R. and G.M.D, Necessity of transposition.

Unit II: Capacitance of Transmission Line **(7 Hrs)**

Electric potential at single charged conductor, Potential at conductor in a group of charged conductors, Capacitance of single phase line, Capacitance of single phase line with effect of earth's surface on electric field, Concept of G.M.R. and G.M.D for capacitance calculations, Capacitance of three phase line with symmetrical and unsymmetrical spacing.

Unit III: Transmission Line Models and Their Performance Analysis **(7 Hrs)**

Classification of lines based on length and voltage levels, Modelling of short, medium, and long transmission lines, Generalized constant of transmission line, Concept of complex power, Surge impedance loading of transmission line, Phenomenon of Corona, Ferranti effect.

Unit IV: Per unit system and Load Flow Analysis **(7 Hrs)**

A) **Per unit system:** Single line diagram, Impedance and reactance diagrams and their uses, per-unit (pu) quantities, relationships, Advantages and application of per unit system. Numerical based on network reduction by using per unit system.

B) **Load Flow Analysis:** Network topology, Driving point and transfer admittance, concept of Z-bus and formulation of Y-bus matrix using bus incidence matrix method, Numerical based on Y bus Matrix, power- flow equations generalization to n bus systems, Classification of buses, Newton- Raphson method (polar method) Decoupled and Fast decoupled load flow (Descriptive treatment only).

Unit V: Symmetrical Faults Analysis **(7 Hrs)**

Synchronous generators: Construction, Working, Generator model, Steady state characteristics, Method of symmetrical components (positive, negative and zero sequences), Synchronous machine transients, Determination of transient constants, DC component of stator currents. Selection of circuit-breakers and current limiting reactors and their location in power system (Descriptive treatment only), Numerical on symmetrical fault calculation.

Unit VI: Unsymmetrical Fault Analysis **(7 Hrs)**

Symmetrical component analysis of unsymmetrical faults, Balanced and unbalanced faults, Representation of generators, lines and transformers in sequence networks. Computation of fault currents, Neutral grounding, bus impedance matrix method for analysis of unsymmetrical faults. Numerical on unsymmetrical fault calculation.

Industrial Visit: Visit to HV/EHV substation

Books & Other Resources:

Text Books:

1. J. B. Gupta, "Transmission and Distribution", S. K. Kataria & Sons, New Delhi.
2. V. K. Mehta, Rohit Mehta, "Principles of Power System", S. Chand Publication
3. A Chakraborty, M. L. Soni, P. V. Gupta, U.S. Bhatnagar, "A textbook on Power System Engineering", Dhanpatrai & Co., Delhi.
4. Hadi Saadat, Power System Analysis, 5th reprint, Tata McGraw Hill publishing Company Ltd, New Delhi, 2004.
5. Ashfaq Hussain, Electrical power system fifth edition, CBS Publishers & Distributors Pvt Ltd.

Reference Books:

1. Nagrath & Kothari, "Power System Engineering", Tata McGraw Hill Publications.
2. D. Das, "Electrical Power System", New Age Publication.
3. J. Grainger and W. D. Stevenson, "Power System Analysis", McGraw Hill Education, 1994.
4. Nagrath & Kothari, "Power System Engineering", Tata McGraw Hill Publications.
5. Arthur R. Bergen, Vijay Vittal, Power Systems Analysis, Prentice Hall of India, Inc., 2nd Edition, 2000

NPTEL Course:

1. NPTEL Power System Analysis, Prof. Debapriya Das IIT Kharagpur https://youtube.com/playlist?list=PLRWKj4sFG7-6gWwDMLI0Wy5DDRqyKP1uQ

Guidelines for Laboratory - Term work Assessment:

Guidelines for Laboratory Conduction:

1. DO's and DON'TS, along with precautions, are needed to be displayed at prominent locations in the laboratory.
2. Students should be informed about DO'S and DON'T and precautions before performing.

Guidelines for Students Lab Journal:

The Student's Lab Journal should contain following related to every experiment –

1. Theory related to the experiment.
2. Apparatus with their detailed specifications.

3. Connection diagram /circuit diagram.
4. Observation table/ simulation waveforms.
5. Sample calculations for one/two readings.
6. Result table.
7. Graph and Conclusions.
8. There should be continuous assessment for the TW.
9. Assessment must be based on understanding of theory, attentiveness during practical, understanding Session, how efficiently the student is able to make connections and get the results, and timely submission of journals.

LIST OF PRACTICALS (Any 08 to be performed by the student)

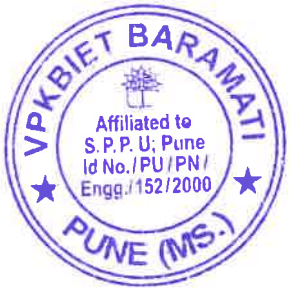
1. Measurement of ABCD parameters of a medium transmission line with magnitude and angle.
2. Measurement of ABCD parameters of a long transmission line with magnitude and angle.
3. Performance study of the effect of VAR compensation using capacitor bank on the transmission line.
4. Design of PI and T model of medium transmission line and calculate performance analysis.
5. To understand basic principle of corona and obtain audible and visible corona inception and extinction voltage under non uniform field.
6. Formulation and calculation of Y- bus matrix of a given system using software.
7. Plotting of receiving end circle diagram to evaluate the performance of medium transmission line.
8. Solution of a load flow problem using Newton-Raphson method using software.
9. Solution of a load flow problem using Decoupled/Fast decoupled method using software.
10. Static measurement of sub-transient reactance of a salient-pole alternator.
11. Measurement of sequence reactance of a synchronous machine (Negative and zero).
12. Simulation of Symmetrical fault of single machine connected to infinite bus.
13. Simulation of Unsymmetrical fault of single machine connected to infinite bus.

Note: The list of experiments is not limited to the above, but a course coordinator may design few new experiments based on recent technologies/trends in the relevant Engineering Domain. However the course coordinator needs to get approval by the Program Assessment Committee and Chairman BOS/HOD well in time.

Course Activity (Any ONE of the following):

For the assessment of Course Activity, a student must complete at least ONE activity out of the following:

1. MATLAB program/simulation
2. Case study



EL23213: Power Electronics		
Teaching Scheme:	**Credits:04**	**Examination Scheme:**
TH: 03 Hrs/Week		**Course Activity: 20 Marks**
		In-Semester Exam: 20 Marks
		End-Semester Exam: 70 Marks
PR: 02 Hrs/Week		**Practical Exam: 20 Marks**
		Term-Work: 20 Marks

Prerequisite Courses:

Knowledge of semiconductor material, basic electronics, diode, BJT and its characteristics, diode, rectifier, concept of rms and average value

Companion Course, if any: Laboratory Practical

Course Objectives:

1. To demonstrate circuits using Thyristor Power Devices and understand their operational characteristics and protection requirements.
2. To design AC to DC Converters including single-phase and three-phase configurations with various load types.
3. To apply DIAC and TRIAC in practical AC voltage control circuits and implement protection strategies for power circuits.
4. To evaluate Transistor Power Devices (MOSFET, IGBT, MCT) and determine suitable applications based on their characteristics and specifications.
5. To analyze DC to DC Converters using different control techniques and understand their operational principles and filtering requirements.
6. To analyze single-phase and three-phase inverter principles, VSI, and CSI configurations.

Course Outcomes:

Upon successful completion of this course, the students will be able to:-

CO1: demonstrate circuits using Thyristor Power Devices and understand their operational characteristics and protection requirements.

CO2: Design AC to DC Converters, including single-phase and three-phase configurations with various load types.

CO3: Apply DIAC and TRIAC in practical AC voltage control circuits and implement protection strategies for power circuits.

CO4: Evaluate Transistor Power Devices (MOSFET, IGBT, MCT) and determine suitable applications based on their characteristics and specifications.

CO5: Analyze DC to DC Converters using different control techniques and understand their operational principles and filtering requirements.

CO6: analyze single-phase and three-phase inverter principles, VSI and CSI configurations.

Unit I: Thyristor Power Devices: **(7 Hrs)**

SCR: Static and dynamic Characteristics, specifications (Latching current, Holding current, dv/dt, di/dt, I2 t rating), Two-Transistor Analogy, Gate Characteristics, Trigering Circuits (R, R-C, UJT), Commutation, GTO.

Unit II: AC to DC Converters (1 phase & 3 phase) **(7 Hrs)**

Single-phase Converter (Half wave, Semi-converter, Full wave), three-phase (semi-controlled and fully controlled) converter with R, R-L, and RLE loads. Rectification and Inversion mode of operation, Concept of overlap Angle, and associated Voltage drop calculation. Dual converter. Selection of transformers and semiconductor devices for Converters. Numerical for R and RL Load only. Areas of application.

Unit III: AC Voltage Controllers & Protection of Power Circuits **(7 Hrs)**

(a) DIAC, TRIAC- four mode operation, triggering of TRIAC using DIAC; AC Voltage regulator principle, Single phase & three phase, analysis with R & RL Load, applications of two-stage, three-stage & multi-stage Voltage Controllers.

(b) Protection of Power Circuit: Protection from over voltage, over current, thermal, design of snubber circuit.

Unit IV: Transistor Power Devices **(7 Hrs)**

Characteristics, Specifications, Safe Operating Areas (SOA) Protection and Switching action of Power MOSFET, IGBT, MCT and their control circuit requirement. Comparison and Area of application of these devices.

Unit V: DC to DC Converter **(7 Hrs)**

The chopper's operation principle is a classification based on operating quadrants. Buck, Boost, Buck-Boost converter, their working, output waveforms, performance analysis, continuous conduction mode, Control techniques: CLC, TRC, PWM, and FM Techniques. Analysis of Step-up Chopper, Numericals with RLE load. Areas of application.

Unit VI: DC to AC Converters (Inverter) **(7 Hrs)**

Single phase & three phase inverters, Principle of operation, VSI and CSI inverters, applications, their operating frequency range. PWM inverters: Single Pulse, Multiple Pulse and Sinusoidal Pulse modulation PWM Techniques for voltage control and harmonic elimination. Three phase VSI for 120^0 and 180^0 modes of operation and their comparison,

Books & Other Resources:

Text Books:

1. M.H.Rashid - Power Electronics 2nd Edition, Pearson publication
2. Ned Mohan, T.M. Undeland, W.P. Robbins - Power Electronics,3rd Edition, John Wiley & Sons (International) student edition.
3. B.W. Williams: Power Electronics 2nd edition, Macmillan publication
4. Ashfaq Ahmed- Power Electronics for Technology, LPE Pearson Edition.
5. Dr. P.S. Bimbhra, Power Electronics, Third Edition, Khanna Publication.
6. K. Hari Babu, Power Electronics , Scitech Publication.

Reference Books:

1. Vedam Subramanyam - Power Electronics , New Age International , New Delhi
2. Dubey, Donalda, Joshi,Sinha, Thyristorised Power controllers, Wiely Eastern New Delhi.
3. M. D. Singh and K. B. Khandchandani, Power Electronics, Tata McGraw Hill
4. Jai P. Agrawal, Power Electronics systems theory and design LPE, Pearson Education. Asia.

5. L. Umanand, Power Electronics – Essentials & Applications Wiley Publication.
6. Randall Shaffer – Fundamentals of Power Electronics with Matlab.

Guidelines for Laboratory - Term work Assessment:

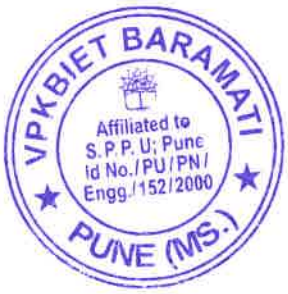
1. The distribution of weightage of term work marks should be informed to students before the start of the semester.
2. Term work assessment should be on a continuous basis. At frequent intervals, students are expected to share their progress/lagging.

Guidelines for Laboratory Conduction:

1. DO's and DON'TS, along with precautions, need to be displayed at prominent locations in the laboratory.
2. Students should be informed about DO'S and DON'T and precautions before performing.

LIST OF PRACTICALS (Any 8 experiments, however, three (03) simulation experiments should be covered using any professional software)

1. To study V-I characteristics of SCR, DIAC, TRIAC (any two)
2. To study V-I characteristics of power semiconductor devices: GTO, MOSFET, IGBT (any two)
3. To analyze the performance of the controlled converter with R and RL load
4. To analyze the Three-phase AC-DC fully controlled bridge converter R and RL load performance.
5. To perform Power Quality Analysis (Harmonic and PF measurement) at the AC side of a phase-controlled Converter.
6. To perform Power Quality Analysis (Harmonic and PF measurement) at the AC side of the Three-phase phase-controlled Converter.
7. To study DC step-down chopper (PWM technique).
8. To study Single-phase A.C. voltage regulators with R and RL loads.
9. To study PWM controls of a single-phase inverter.
10. To verify the performance of the Three-phase voltage source inverter using 120^0 and 180^0 modes.
11. To verify the performance of a three-phase cascaded H-Bridge Multilevel inverter.



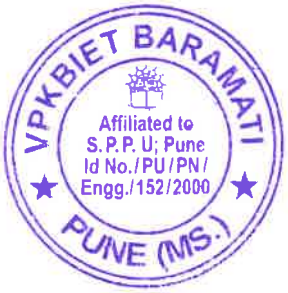
12. Arrange an Industrial Visit to the Power Electronics manufacturing unit/Renewable energy power plant.

(Note: The list of experiments is not limited to the above, but a course coordinator may design a few new experiments based on recent technologies/trends in the relevant Engineering Domain. However, the course coordinator needs to get approval from the Program Assessment Committee and Chairman BOS/HOD well in time.)

Course Activities (Any ONE of the following):
For the assessment of Course Activity, a student must complete at least ONE activity out of the following:

1) Poster Presentation

2) Circuit Simulation/Modelling



EL23214: Electric Mobility		
Teaching Scheme:	**Credits:03**	**Examination Scheme:**
TH: 03 Hrs/Week		**Course Activity: 20 Marks**
		In-Semester Exam: 20 Marks
		End-Semester Exam: 70 Marks

Prerequisite Courses:

Engineering Physics, Basic Electrical Engineering

Course Objectives:

1. To recognize the need and importance of Electric Vehicles and understand the components of EV system.
2. To understand battery parameters, types of batteries for EVs & battery management system.
3. To understand and distinguish between various motor drives used in EVs as an Electric Propulsion Unit.
4. To describe EV battery testing procedure and discuss different aspects of battery recycling.
5. To distinguish between different EV charging standards and understand requirements and components of EV Charging Infrastructure.
6. To understand the concept and applications of Vehicle to Home, Vehicle to Grid and Vehicle to Vehicle infrastructure.

Course Outcomes:

On completion of the course, learner will be able to:

CO-1: Recognize the need and importance of Electric Vehicles and explain the components of EV system.

CO-2: Summarize battery parameters, types of batteries for EVs and battery management system.

CO-3: Discuss and distinguish between various motor drives used in EVs as an Electric Propulsion Unit.

CO-4: Describe EV battery testing procedure and discuss different aspects of battery recycling.

CO-5: Distinguish between different EV charging standards and discuss requirements and components of EV Charging Infrastructure.

CO-6: Describe the concept and applications of Vehicle to Home, Vehicle to Grid and Vehicle to Vehicle infrastructure.

Course Contents

Unit I: Basics of EV and Components of EV System **(7 Hrs)**

Need & Importance of EVs, Advantages & Challenges, Components of EV system: Battery pack, Motor, Controller, Converter Requirement of EV motors, Motors used in EVs: Construction & working Principles of DC Series Motor, Brushless DC Motor, Permanent Magnet Synchronous Motor (PMSM), 3 Phase Induction Motor, Switched Reluctance Motor.

Unit II: Battery Parameters, Types of Batteries for EVs and BMS **(7 Hrs)**

Concept of C rating, Wh and Ah rating, SOH, SOC, DOD ratings, Importance of power density and energy density, active and Passive cell balancing methods, Lithium-ion battery, Aluminium Air battery and Aluminium-ion battery ,Block Diagram and functions of BMS, SoC Estimation methods, Thermal Management of Battery.

Unit III: Electric Propulsion Unit **(7 Hrs)**

Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive efficiency.

Unit IV: Battery Testing and Recycling **(7 Hrs)**

Battery power testing for various Vehicles such as car, bus, truck, Battery capacity tester, Battery testing for urban and high way driving cycles, Technology and economic aspects of battery recycling, Battery Applications for Stationary and Secondary Use, Introduction of lithium recycling.

Unit V: EV Chargers and Charging Infrastructure **(7 Hrs)**

Battery Charging Methods: CC Method, CV Method, CCCV Method, Charging Levels: 01,02 & 03, Charging Standards: CCS, CHAdeMO, SAE J1772, IEC 60309, Bharat DC 001, Bharat AC 001. EV Charging Station: System block diagram, Topologies, Requirement of system, Working principle of EV charging, Types of EV charging systems & main components of EV chargers.

Unit VI: V2H, V2V and V2G **(7 Hrs)**

Vehicle to Home: Introduction, applications, V2H with demand response, Case Study of V2H. Vehicle to Grid: Introduction of V2G, V2G infrastructure in the smart grid, Role of aggregator for V2G, Case study of V2G, Vehicle to Vehicle: Introduction of V2V, Concept & structure.

Books & Other Resources:

Text Books:

1. "Electrical Vehicle", James Larminie and John Lowry, John Wiley & Sons, 2012
2. "Electric and Hybrid-Electric Vehicles", Ronald K. Jurgen, SAE International Publisher
3. "Power Electronics: Circuits, Devices and Applications" M. H. Rashid, Pearson Education, PHI 3rd Edition, New Delhi 2004
4. "Power Electronics", M. D. Singh, K. B. Khanchandani Tata McGraw-Hill Education,
5. "Fundamentals of Electrical Drives", G. K. Dubey, New Age International Publication

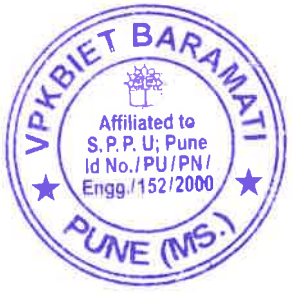
Reference Books:

1. "Electric and Hybrid Vehicles: Design Fundamentals", Iqbal Hussein, CRC Press.
2. "Electric Vehicle Technology Explained", James Larminie, John Lowry, Wiley, 2003
3. "Permanent Magnet Brushless DC Motor Drives and Controls", Chang Liang Xia, Wiley, 2012
4. "Permanent Magnet Synchronous and Brushless DC Motor Drives", Ramu Krishnan, CRC Press, 2009
5. "Electric Motors and Drives Fundamentals Types and Applications", Austin Hughes and Bill Drury, Elsevier, 2019
6. "Power Electronics Converters Applications and Design", Ned Mohan, T. Undeland & W. Robbins, John Willey & sons, Singapore, 2nd Edition Oxford University Press, New Delhi, 2005
7. "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals", Mehrdad Ehsani, Yimin Gao, Ali Emadi CRC Press, 2010

Course Activity (Any ONE of the following):

For the assessment of Course Activity, a student must complete at least ONE activity out of the followings:

1. Case Study
2. Poster Presentation



EL23215: Energy Audit		
Teaching Scheme:	**Credits:02**	**Examination Scheme:**
PR: 04 Hrs/Week		**OR Exam: 20 Marks**
		Term-Work: 40 Marks

Prerequisite Courses:

Concept of power and energy in three phase and single phase, Various electrical equipments and specifications

Companion Course, if any: Laboratory Practical

Course Objectives:

1. To enhance skill in implementing energy efficiency programs and monitoring systems, organizational setup, and responsibilities.
2. To explore demand management techniques, including supply and demand-side strategies, tariff mechanisms, renewable energy integration.
3. To Execute knowledge of energy audit methodologies, data analysis techniques, energy-saving potential assessment, and industry benchmarking.

Course Outcomes:

Upon successful completion of this course, the students will be able to:-

CO1: Enhance skills in implementing energy efficiency programs and monitoring systems, organizational setup, and responsibilities.

CO2: Explore demand management techniques, including supply and demand-side strategies, tariff mechanisms, and renewable energy integration.

CO3: Execute knowledge of energy audit methodologies, data analysis techniques, energy-saving potential assessment, and industry benchmarking.

Guidelines for Laboratory - Term work Assessment:

1. The distribution of weightage of term work marks should be informed to students before the start of the semester.
2. Term work assessment should be on a continuous basis. At frequent intervals, students are expected to share their progress/lagging.

Guidelines for Laboratory Conduction:

1. DO's and DON'TS, along with precautions, are needed to be displayed at prominent locations in the laboratory.
2. Students should be informed about DO'S and DON'T and precautions before performing.

LIST OF PRACTICALS (Any 14 experiments to be performed by the student)

1. To study of Clean Development mechanism.
2. To study of building codes (green building).
3. To study of energy management tool.
4. To study of force field analysis from energy management point of views.
5. To analysis and interpretation of Electricity Bills Students should calculate electricity charges for
   a) Residential consumer
   b) Commercial Consumer (College campus).
6. To perform assessment and calculations of energy generated by Solar PV or Diesel Generator available in college campus.
7. To study use of Power Analyser for measurement of electrical parameters useful for energy audit or power quality audit.
8. To perform adequacy assessment of Illumination systems by using Lux Meter
9. To study use of temperature measuring devices for analysis of heating systems.
10. To study use of other transducers (any one)
    a) Assessment of performance of fans and blowers by using Annemo Meter.
    b) Use of Flow Meters for Pumping system analysis.
    c) Use of pressure measuring equipment's useful in audit study.
    d) Smart meters and advanced energy meters
11. To execute Preliminary Energy Audit for (Any One) (Preferably this activity should be carried out with student group not exceeding 5)
    a. Laboratory
    b. Educational Institute
    c. Commercial Establishment
12. To execute Preliminary Energy Audit for (Any One) (Preferably this activity should be carried out with student group not exceeding 5)
    a. Small scale industry
    b. Residential Building
    c. Municipal Corporations
13. To perform Calculation of energy savings for following (Minimum one)
    a. Illumination
    b. Air conditioning System
    c. Pumping Systems
14. To perform Calculation of energy savings for following (Minimum one)

a. DG Sets
b. UPS and Inverter Systems
c. Lifts and elevators

15. To study energy audit success stories (any one)
    a) Paper and Pulp Industry
    b) Sugar Industry
    c) Steel Industry
    d) Commercial Establishment
    e) Electrical Generation Plant
16. To study of Ethical Practices in Energy audit.

Books & Other Resources:

Text Books:

1. Guide books for National Certification Examination for Energy Managers/Energy Auditors Book , 1-General Aspects (available on line)
2. Guide books for National Certification Examination for Energy Managers/Energy Auditors Book 2 – Thermal Utilities (available on line)
3. Guide books for National Certification Examination for Energy Managers/Energy Auditors Book 3- Electrical Utilities (available on line)
4. Guide books for National Certification Examination for Energy Managers/Energy Auditors Book 4 (available on line)

Reference Books:

1. Success stories of Energy Conservation by BEE (www. Bee-india.org)
2. Utilization of electrical energy by S.C. Tripathi, Tata McGraw Hill.
3. Energy Management by W.R. Murphy and Mackay, B.S. Publication.
4. Generation and utilization of Electrical Energy by B.R. Gupta, S. Chand Publication.
5. Energy Auditing made simple by Balasubramanian, Bala Consultancy Services.