



# DETAIL TEACHING SCHEME

SCHOOL OF ENGINEERING  
ACADEMIC YEAR - 2021-22

PROGRAM: B. TECH - ELECTRICAL ENGINEERING  
SEMESTER - VI (Batch - 2019-23)

DEFINATION OF CREDIT: 1. Lecture (L): 1 hour/week/semester, 2. Practical (P): 2 hours/week/semester 3. Tutorial(T): 2 hours/week/semester

TEACHING SCHEME										
Course Code	Course Name	Teaching Hours			SSH	Credits	Audit course	CIE	PSEE	Remarks if any
		Theory	Tutorial	Practical						
EL616	Power Electronics-II	3	0	2	1.5	4	N	Y	Y	Revised-I
EL517	Microprocessor and Microcontroller	3	0	2	2	4	N	Y	Y	-
EL611	Comprehensive Viva-Voce	2*	0	0	1	5*	N	Y	Y	No Theory Exam
EL614	Switchgear and Protection of Power System	4	0	2	2	5	N	Y	Y	-
EL613	High Voltage Engineering	3	0	2	2	4	N	Y	Y	-
XXXXX	University Elective-IV	3	0	0	3/2	3	N	Y	N	-
ELXXX	Department Elective-V	3	0	0	3/2	3	N	Y	N	-
EL915	Power System Design and Practices	3	0	0	2	3	N	Y	N	
	<b>TOTAL</b>	<b>22</b>	<b>0</b>	<b>8</b>	<b>15.5/13.5</b>	<b>31</b>				
	<b>Total Teaching Hours</b>	<b>32</b>								
University Elective-IV										
CD615	Campus to Corporate Training- 2	3	0	0	3	3	N	Y	N	-
NEN004	Entrepreneurship Advanced	3	0	0	2	3	N	Y	N	-
Department Elective-V										
EL910	Special Electrical Machines	3	0	0	3	3	N	Y	N	
EL912	Energy Auditing and Conversation	3	0	0	2	3	N	Y	N	

HOD

Director



## DETAIL TEACHING SCHEME

N- No CIE - Continuous internal evaluation

Y - Yes PSEE - Practical semester end examination including ITD, Dissertation, Industrial project, Industrial training etc..

SSH - Self-study hours

\* Theory teaching hours are for training purpose; there will be no theory exam at the end of the semester.

HOD

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<b>Course Title</b>	<b>Power Electronics-II</b>
<b>Course Code</b>	<b>EL616</b>
<b>Course Credit</b>	Theory :03
	Practical :01
	Tutorial :00
	Credits :04

### Course Learning Outcomes:

At the end of the session student will be able to:

- **Understand** different types of inverters and operation of various inverter schemes.
- **Explain** the different types of modulation techniques to obtain a near sinusoidal output waveform and the techniques to eliminate the harmonics from the output.
- **Explain** the techniques for analyzing and for simulating inverters by using software tool.
- **Examine** the operation of current source inverters as a means of producing a variable frequency supply.
- **Describe** the techniques of zero voltage and zero current switching.
- **Determine** and **explain** techniques for multilevel inverter and their types.
- **Examine** the operation of single and three phase AC voltage regulators.
- **Develop** the general equations describing regulator behaviour.
- **Examine** the various operation of single phase to single phase and three phase half wave cycloconverter and develop the general equation describing the behaviour of it.

### Detailed Syllabus

Sr. No.	Name of chapter & details	Hours Allotted
<b>SECTION-I</b>		
1	<b>DC to AC Converters</b> Performance parameters of inverters, Classification of Inverters based on: Nature of input source, waveshape of the output voltage, method of commutation and according connection- Series, Parallel and Bridge. Single phase (half and full bridge) VSI- Operating principle, steady state analysis and Fourier analysis of output voltage. Forced Commutated, Line commutated and Self-Controlled Switches based Inverters. Three phase bridge inverter- 180 <sup>0</sup> conduction mode with R and RL loads and 120 <sup>0</sup> conduction mode with R and RL loads.	<b>10</b>

	Current Source Inverters: single phase and three phase ASCI and self-controlled switch-based inverters; Comparison of Voltage and Current source Inverters.	
2	<p><b>PWM inverters-</b> Principle of PWM control, Generalized classification of PWM- PWM with harmonic elimination and without Harmonic elimination.</p> <p>PWM Without harmonic elimination- Quasi square modulation, end pulse modulation, center pulse modulation, SPWM, PWM by phase modulation and SVM. PWM with harmonic elimination- Harmonic elimination with Multiple Notches and Staircase PWM.</p>	07
3	<p><b>Resonant Soft Switching Converter</b> Classification of resonant converter Class E converters, ZCS resonant switch converters, ZVS resonant switch converters.</p>	04
<b>Total</b>		<b>21</b>
<b>SECTION-II</b>		
4	<p><b>Multi-level inverters</b> Concept of multi-level, Topologies for Multi-level Inverter: Diode clamped, flying capacitor and cascaded multi-level Inverter (Configurations, Features and their relative comparison), Switching device current, DC-link capacitor voltage balancing, Multi-level inverter's features and its applications.</p>	06
5	<p><b>AC Voltage Regulators</b> Principle of On- Off control and Phase angle control, Single Phase AC regulator-Half wave, Full wave (bi-directional) controllers with R and RL loads. Sequence control of AC voltage regulators- 2 stage sequence control, Multistage sequence control, single phase Sinusoidal regulator. Gating requirements; Sequence Control of AC regulators; 3-phase full wave converter configurations with Y and <math>\Delta</math> connected loads and their analysis with R load.</p>	08
5	<p><b>Cycloconverter</b> Basic principle of operation, Single-phase to Single-phase Circuit- step-up and step down Cycloconverters- Mid-point Cycloconverter and Bridge-type Cycloconverter Three phase Half wave Cycloconverters- three phase to single phase and three phase to three phase, Output voltage equation; Output harmonics in cycloconverter; Comparison between cycloconverter and DC link Converter; Load Commutated cycloconverter.</p>	07
<b>Total</b>		<b>21</b>
<b>Instructional method and Pedagogy:</b>		

- Lectures will be conducted with the aid of multi-media projector, black board, OHP etc.
- Assignments based on course content will be given to the students at the end of each unit/topic and will be evaluated at regular interval.
- Surprise tests/Quizzes/Seminar/Tutorials will be conducted.
- The course includes a laboratory, where students have an opportunity to build an appreciation for the concepts being taught in lectures.
- Minimum ten experiments shall be there in the laboratory related to course contents.

## Reference Books:

1. M.H. Rashid "*Power Electronics*", P.H.I. /Pearson
2. Ned Mohan, Tore M. Undeland "*Power electronics: converters, applications, and design*" John Wiley & Sons
3. P. S. Bimbra "*Power Electronics*" Khanna Publishers.
4. M. D. Singh and Khanchandani K. B. "*Power Electronics*" T.M.H
5. L. Umanand, "Power Electronics- Essential and Application", Wiley.

## Additional Resources

### NPTEL Videos Lecture Series

- A Course on Power Semiconductor Devices- <http://nptel.ac.in/courses/108105066/>
- A Course on Power Electronics- <http://nptel.ac.in/courses/108101038/>

<b>Course Title</b>	<b>Microprocessor and Microcontroller</b>
<b>Course Code</b>	<b>EL517</b>
<b>Course Credit</b>	Theory :03
	Practical :01
	Tutorial :00
	Credits :04

### Course Learning Outcomes:

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

- **Understand** architecture and the operation of microcontroller and microprocessor.
- **Differentiate** between microprocessor and microcontroller.
- **Write** an assembly language program to solve basic binary math operations.
- **Apply** knowledge of the microcontroller's internal registers and operations by use of a PC based simulator.
- **Develop** the programming skill by converting assembly language program into machine code and test them on the training board.
- **Design** an interface that allows a microcontroller to control various peripherals.
- **Develop** the project after identifying proper application.

### Detailed Syllabus

Sr. No.	Name of chapter & details	Hours Allotted
<b>SECTION-I</b>		
1.	<b>Introduction to 8085 Microprocessor</b> 8085 Microprocessor Architecture, System Bus organization, 8085 Pin Diagram, 8085 Microprocessor Signals and functions, Difference between Microprocessor and Microcontroller, Machine Cycle of microprocessor.	<b>06</b>
2.	<b>8051 Microcontrollers:</b> Microcontrollers and embedded processors, Overview of the 8051 family	<b>02</b>
3.	<b>8051 Architecture and Programming model</b> Architecture of 8051, Introduction to 8051 assembly programming, assembling and running an 8051 program, The program counter and ROM space in the 8051, 8051 data types and directives, 8051 flag bits and the PSW register, 8051 register banks and stack	<b>03</b>
4.	<b>8051 Hardware Connection and Intel Hex File</b> Pin description of the 8051, Explaining the Intel hex file.	<b>02</b>

5.	<b>8051 Addressing Modes</b> Immediate and register addressing modes, accessing memory using various addressing modes, Bit addresses for I/O and RAM	02
6.	<b>LCD and Keyboard Interfacing</b> LCD interfacing, Keyboard interfacing with 8051	02
7.	<b>8051 Interfacing to External Memory</b> Memory address decoding, 8031/51 interfacing with Program ROM, Data ROM and RAM.	04
<b>Total</b>		<b>21</b>
<b>SECTION-II</b>		
8.	<b>Arithmetic and Logic Instructions and Programs</b> Arithmetic instructions, signed number concepts and arithmetic operations, Logic and compare instructions, Rotate instruction and data serialization, BCD, ASCII, and other application programs.	04
9.	<b>Jump, Loop, And Call Instructions</b> Loop and jump instructions, Call instructions time delay for various 8051 chips.	03
10.	<b>I/O Port Programming</b> 8051 I/O programming, I/O bit manipulation programming.	02
11.	<b>8051 Timer Programming in Assembly</b> Programming 8051 timers and counter in various modes.	04
12.	<b>8051 Serial Port Programming in Assembly</b> Basics of serial communication, 8051 connections to RS232, 8051 serial port programming in Assembly, Programming the second serial port	04
13.	<b>Interrupts Programming in Assembly</b> 8051 interrupts programming, Timer interrupts, Programming external hardware interrupts, Programming the serial communication interrupt, Interrupt priority in the 8051/52	04
<b>Total</b>		<b>21</b>

### Instructional method and Pedagogy:

- Lectures will be conducted with the aid of multi-media projector, black board, OHP etc.
- Assignments based on course content will be given to the students at the end of each unit/topic and will be evaluated at regular interval.
- Surprise tests/Quizzes/Seminar/ will be conducted.

### Reference Books:

1. The 8051 Microcontroller & Embedded Systems using Assembly and C by K. J. Ayala, D. V. Gadre (Cengage Learning , India Edition)
2. 8051 Microcontrollers: MCS51 Family and its Variants by Satish Shah, Oxford University Press
3. 8051 Microcontroller: Internals, Instructions, Programming and Interfacing by Subrata Ghoshal, Pearson Education
4. The 8051 Microcontrollers: Architecture, Programming and Applications by K Uma Rao, Andhe Pallavi, Pearson Education

## Additional Resources

- Website for Development Tools, Compilers & Books- [www.mikroe.com](http://www.mikroe.com)
- Website for 8051 Microcontroller Projects- <http://www.8051projects.net/>
- Website for 8051 Microcontroller Projects - <http://www.8051projects.info/>
- Website for 8051 Microcontroller Projects - <http://www.8051project.org/>



Course Title	<b>Comprehensive Viva Voce</b>			
Course Code	<b>EL611</b>			
Course Credit	Total Credit: 5			
	Lecture:00	Practical:00	Tutorial: 00	Self-study hours/week: 03
Semester	6 <sup>th</sup>			

### Course Description

The course is designed to test students' learning of domain-specific subjects they learned across till 6th-semester. The key objective of this course is to help students comprehending their engineering knowledge and refreshing fundamental concepts of various subjects. It will also prepare students to face interviews both technical/non-technical and academic/industrial.

### Course Learning Outcomes

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

- **Recall** the fundamentals of AC and DC Machines.
- **Sharpen** analytical skills of electrical networks and circuits.
- **Refresh** the understanding of Electrical Power Systems.
- **Review** the operational aspects of control systems and power electronics circuits.
- **Enhance** their interview facing skills.

### Syllabus Contents

Module	Name of Chapter and details
<b>Section-I</b>	
1.	<b>Fundamentals of AC and DC Machines</b> Classification of Electrical Machines, Operating Principles and applications of machines, Load Characteristics of transformers, generators, alternators, and motors, Numerical Examples.
2.	<b>Analysis of Electrical Networks and Circuits</b> KVL, KCL, Current-Voltage divider rules, Mesh analysis, Thevenin's theorem, Norton's theorem, Maximum Power Transfer theorem, Source Transformation

	(current source-voltage source) techniques, Frequency-Time domain response analysis.
3.	<p><b>Electrical Power Systems</b></p> <p>Generation Stations, One-line diagram of electrical power system, Components of electrical power system, Transmission and Distribution Systems, Underground Cables, Inductive and Capacitive effects, Configurations of transmission and distribution networks, Operation and Control of electrical power systems.</p>
<b>Section-II</b>	
4.	<p><b>Control Systems</b></p> <p>Types of Control Systems, Analogy between mechanical and electrical systems, Transfer Function Representation: System reduction, Signal Flow Graphs, Stability Analysis: Root Locus techniques and Frequency Response analysis</p>
5.	<p><b>Power Electronics</b></p> <p>Semiconductor devices and their characteristics, Converters and characteristic waveforms: AC-to-DC, DC-to-DC with different load configurations.</p>

### Assessment plan with CIE Marks Distribution:

- 50% internal exam will be based on MCQ & Overall attendance of the student.
  1. PCIE – 1 – 40 Question – 60 Min. – 40 Marks (Convert in 20 marks) (MCQ Pattern – Online Exam through Edmodo) (Covering subjects from semester – 1 to 3)
  2. PCIE – 2 – 40 Question – 60 Min. – 40 Marks (Convert in 20 marks) (MCQ Pattern – Online Exam through Edmodo) (Covering subjects from semester – 4 to 6)
  3. PCIE – 3 – 10 Marks – Overall Attendance of Student for the 6<sup>th</sup> semester.
- 50% external exam will be based on Viva Voce.
  1. Viva Voce exam will be conducted in form of an Interview
  2. Minimum 2 faculty members will be forming the panel to assess candidate during their Viva voce exam.
  3. Minimum 10 questions need to be asked to a student during Viva Voce. Preferably those questions should be as per below given weightage (20 % Questions of General Knowledge/Current affairs + 20% Questions on Soft skills + 60 % Questions based on Domain knowledge.)
  4. Grading of the candidates can be done on basis of Rubrics. – 50 Marks.

<b>Course Title</b>	<b>Switchgear and Protection of Power Systems</b>
<b>Course Code</b>	<b>EL614</b>
<b>Course Credit</b>	Theory :04
	Practical :01
	Tutorial :00
	Credits :05

### Course Learning Outcomes:

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

- **Identify** the main components and features of a protection scheme
- **Realize** operating parameters of circuit breakers.
- **Apprehend** the schematics of various circuit breakers.
- **Understand** arc interruption phenomena under abnormal conditions in different type of circuit breakers
- **Acquire** skill to design the feasible protection systems needed for each main part of a power system
- **Apply** conventional and numerical relays to the protection of rotating machines, bus-bars, transformers and transmission lines.

### Detailed Syllabus

Sr. No.	Name of chapter & details	Hours Allotted
<b>SECTION-I</b>		
1	<p><b>Introduction and philosophy of a protective relaying system:</b> Types of Faults, Abnormalities, Functions of Protective Relay Schemes, Basic Tripping Circuit, Testing and Maintenance of Relays, Zones of Protection, requirements of Protective Systems, Relay Operating Criteria, Main and Backup Protection, Historical Review of Protective Relay Technology.</p> <p><b>Different types of relays:</b> Electromagnetic relays: Classification, Thermal over load Relays, Types Over Current Relays, Differential Relay, Directional Relay, Impedance Relays.</p> <p><b>Static relays:</b> Advantages and Limitations, basic Elements, Static Relays Architecture.</p>	12

2	<p><b>Introduction to Circuit Breaker</b>  <b>Theory of Circuit Interruption:</b> Introduction, The duties of switchgear, Physics of arc phenomena, Maintenance of the arc, Arc interruption theories.  <b>Circuit parameters in relation to circuit breaking:</b> Introduction, Circuit breaker ratings, Circuit constants and circuit conditions, Re-striking voltage, Transient Characteristics of re-striking voltage, Interruption of capacitive currents, Current chopping, resistance switching.</p>	9
3	<p><b>Circuit breakers:</b>  Automatic switch, Air-break circuit breakers, Oil circuit breakers, Single and multi-break construction, Air-blast circuit breaker, Performance of circuit breakers and system requirements. Modern circuit breakers - Modern trends, Vacuum circuit breakers, Sulphur hexafluoride (SF6) circuit breakers DC circuit breaker.  Type tests and routine tests, Comparative merits of different types of circuit breakers.</p>	7
<b>Total</b>		<b>28</b>
<b>SECTION-II</b>		
4	<p><b>Generator Protection:</b>  Differential Protection, Inter-turn fault Protection, stator earth fault, Rotor earth fault, NPS, Field Failure, Over Load, Over Voltage, Reverse Power, Pole-Slipping, Under Frequency, Miscellaneous Protection.</p>	6
5	<p><b>Transformer protection:</b>  Faults in Transformer, Gas operated relays, Over Current Protection, Restricted Earth Fault Protection, Differential Protection, Protection against over fluxing, Protection of Grounding transformers, Protection Against Overheating, Protection for small transformers.</p>	6
6	<p><b>Induction motor protection:</b>  Starting of IM, Faults in IM, Abnormalities of Induction Motors, Protection of small IM, Protection of Large induction motors.</p>	4
7	<p><b>Protection of transmission lines:</b>  Protection of Lines by Over Current Relays-Protection of Lines by Distance Relays- introduction to Carrier Current Protection for lines.  <b>Bus zone protection:</b>  Protection Requirements-Non-unit protection-Unit protection schemes, Breaker Back-up Protection.</p>	6

<b>8</b>	<p><b>Numerical protection:</b> Introduction- block diagram of numerical relay, sampling theorem, correlation with reference wave, Fourier analysis of analog signals, least error squared (LE) technique, digital filtering, simple low pass filter, simple high pass filter, finite impulse response filters, infinite impulse filters, comparison between FIR &amp; IIR filters- block diagram in details for few relays.</p>	<b>6</b>
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<b>Total</b>	<b>28</b>
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### Instructional method and Pedagogy:

- Lectures will be conducted with the aid of multi-media projector, black board, OHP etc.
- Assignments based on course content will be given to the students at the end of each unit/topic and will be evaluated at regular interval.
- Surprise tests/Quizzes/Seminar/ will be conducted.

### Reference Books:

1. S. S. Rao, "Switchgear And Protection" Khanna publication.
2. Oza, Nair, Mehta, Makwana, "Protection and switchgear",
3. B. Ravindranath And M. Chander, "Power System Protection and Switchgear"
4. B. Ram, "Power System Protection" TMH Publication.
5. Y. G. Parithankarand S. R. Bhide, "Fundamentals of Power System Protection", 2<sup>nd</sup> edition, PHI.
6. M.L. Soni, P.V. Gupta, V.S. Bhatnagar, A. Chakrabarti, "A Text Book on Power System Engineering", Dhanpat Rai & Co., 1998.
7. C. Russell Masson, "Art and Science of Protective Relaying"
8. A. G. Phadke, J. S. Thorp, "Computer Relaying for Power System" Research Studies Press LTD, England (John Willy & Sons Inc New York).
9. DivyeshOza, "Modern Power System Protection" TMH Publication.  
Bhavesh Bhalja, Nilesh Chothani, "Protection and switchgear", Oxford Publication 2011

### Additional Resources

- A Course on Power System Protection Introduction-  
<http://nptel.ac.in/courses/108101039/>
- <https://www.youtube.com/watch?v=uizZgjY71e0>
- <https://www.youtube.com/watch?v=duyC2OFie5E&list=PLFBC2BB88F464F46>
- <https://www.youtube.com/playlist?list=PLpa4bnBeZjvOUUyPT1JJ-Jub645zR-AM1>
- [http://www.ieee.li/pdf/viewgraphs/substation enclosed switchgear pcc fundamentals](http://www.ieee.li/pdf/viewgraphs/substation_enclosed_switchgear_pcc_fundamentals)
- A Course on the basic functions of LV switchgear-  
[http://www.electricalinstallation.org/enwiki/The basic functions of LV switchgear](http://www.electricalinstallation.org/enwiki/The_basic_functions_of_LV_switchgear)

<b>Course Title</b>	<b>High Voltage Engineering</b>
<b>Course Code</b>	<b>EL613</b>
<b>Course Credit</b>	Theory :03
	Practical :01
	Tutorial :00
	Credits :04

### Course Learning Outcomes:

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

- **Recall** importance of high voltage technology.
- **Discuss** breakdown phenomena in different dielectrics.
- **Demonstrate** generation and measurement of high voltages.
- **Examine** testing methods used for different HV apparatus.
- **Evaluate** insulation coordination among different HV apparatus.
- **Plan** high voltage laboratory layout.

### Detailed Syllabus

Sr. No.	Name of chapter & details	Hours Allotted
<b>SECTION-I</b>		
1.	<b>Basics of High voltages Technology</b> Definitions, need for generating high voltages, Important applications of high voltage technology, Methods for estimation of electric stress.	<b>02</b>
2.	<b>Breakdown in gases</b> Classification of HV insulating media, Properties of HV insulating media, Types of Gases, Collision and ionization process of Gaseous dielectrics: Primary and Secondary ionization processes, Townsend's current growth equation, Experimental determination of coefficients $\gamma$ and $\alpha$ , Criteria for gaseous insulation breakdown based on Townsend's theory, Limitations of Townsend's theory, Streamer's theory breakdown in non-uniform fields, Corona discharges, Panchen's law and its significance, Time lags of breakdown.	<b>07</b>

3.	<p><b>Breakdown in Solid &amp; liquid</b> Types of solids, Properties of solids, Intrinsic and extrinsic breakdown, Mechanism of breakdown in solids: Electromechanical breakdown, Treeing and tracking breakdown and Thermal breakdown. Types of liquids, Properties of liquids, Liquid purification processes, Conduction and breakdown mechanism in liquids: Suspended solid particle mechanism, Cavitation and bubble theory.</p>	06
4.	<p><b>High Voltage Generation</b> Classification of High voltages, Generation of High DC voltages: Half wave and full wave circuits, HVDC Voltage doubler circuits, Voltage multiplier circuits, Cockcroft-Walton type high voltage DC set. Generation of High AC voltages: Need for cascade connection and working of transformers units connected in cascade, Tesla coil. Impulse voltage generation: Impulse voltage waveform and its terms and equation, Basic impulse circuit, Mark's multistage impulse generator, Tripping, and control of impulse generators.</p>	06
<b>Total</b>		<b>21</b>
<b>SECTION-II</b>		
5.	<p><b>Measurement of High voltages</b> Series resistance micro ammeter for HV DC measurements, Standard sphere gap measurements of HV AC, HV DC, and impulse voltages; Factors affecting the measurements, Potential dividers, resistance dividers capacitance dividers mixed RC potential dividers.</p>	06
6.	<p><b>Overvoltage, testing procedures and insulation coordination</b> Natural causes of over voltages- Lightning phenomenon: Charge formation in clouds, Rate of charging of clouds, the lightning mechanism: Parameters and characteristic of lightning strokes, mathematical model for lightning, Energy in lightning, Switching surges: Origin and characteristic, Power frequency over voltages in power systems, Surge arrester and Insulation coordination.</p>	07
7.	<p><b>Non-Destructive Testing of dielectrics</b> Measurement of direct current resistivity, Measurement of dielectric constant and loss factor, Partial discharge phenomenon and measurements.</p>	03



<b>8.</b>	<p><b>High voltage tests on electrical apparatus</b>          Testing of insulators: Power frequency tests, Impulse tests, Testing of bushings: Power frequency tests, Impulse tests, Thermal tests.          Testing of cables: Dielectric test, Impulse tests, and Partial discharge tests.          Testing of transformers: Induced over voltage test, Impulse voltage tests, Partial discharge tests.          Testing of surge arrester: High voltage impulse tests, Mechanical tests.          Radio interference voltage test          Design, planning and layout of high-voltage laboratory.</p>	<b>05</b>
<b>Total</b>		<b>21</b>

### Instructional method and Pedagogy:

- Lectures will be conducted with the aid of multi-media projector, black board, OHP etc.
- Assignments based on course content will be given to the students at the end of each unit/topic and will be evaluated at regular interval.
- Surprise tests/Quizzes/Seminar/ will be conducted.

### Reference Books:

1. M S Naidu & V Kamaraju, "*High Voltage Engineering*", Tata Mc Graw Hill Publications, 5<sup>th</sup>edition, ISBN: 978-1-25-906289-6, 2014.
2. C.L. Wadhwa, "*High Voltage Engineering*", New age International Publishers, 3<sup>rd</sup> edition, ISBN: 978-81-224-3090-5, 2013.
3. E Kuffel & W.S. Zaengl, "*High Voltage Engineering Fundamentals*", Newnes Publication, 2<sup>nd</sup> edition, ISBN: 978-81—8147-736-1, 2012.

### Additional Resources

- Reference books, IEEE, Elsevier- Journals and Conference papers and internet sources.
- A Course On High Voltage Engineering-  
<http://nptel.ac.in/courses/108104048/ui/TOC.htm>

<b>Course Title</b>	<b>Campus to Corporate Training – 2</b>
<b>Course Code</b>	<b>CD615</b>
<b>Course Credit</b>	Theory :03
	Practical :00
	Tutorial :00
	Credits :03

### Course Learning Outcomes:

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

- **Prepare** professional Resume.
- **Solve** different verbal and non-verbal problems and puzzles.
- **Develop** their comprehensive approach on job skills & they will be ready for placements.
- **Understand** the importance of Portfolio preparation and apply the techniques to develop their individual documents.
- **Assess** their individual skills and develop techniques on the basis of their strength areas.
- **Perform** in group discussion.
- **Cultivate** Public Speaking Skills and overcome stage fear.
- **Employ** with interview facing skills.

### Detailed Syllabus

Module	Name of chapter & details	Hours Allotted
<b>Verbal Ability</b>		
1.	Verbal Ability: (Spotting errors, selecting words, ordering of words, Idioms and phrases, Verbal analogies, synonyms, spellings, Antonyms.)	<b>06</b>
2.	Essay Writing: Types of Essays/Paragraph writing, Structure of Essays	<b>03</b>
<b>Interview Readiness</b>		
3.	Resume Building: Formats of Resume, Difference between Resume and CV, Online Resume, Drafting resume	<b>03</b>

4.	Cover Letter: Structure of Cover Letters, Importance of Cover Letter	02
5.	Department or Grooming: Components of Department, importance of grooming, Do's and Don'ts of grooming	02
6.	Group Discussion: Basics of GD, Different Formats to conduct GD, Do's and Don'ts of GD, Mock GD	05
7.	Interview Skills: About Interview, Types of Interviews, frequently asked interview questions, Blunders to be avoided during Interviews	05
8.	Info-Graphics Analysis: About Info-graphics, how to analyse info-graphics, Info-graphics and daily life	03
9.	Presentation on Scope and opportunities in different industries: Brief about different sectors and industries, job opportunities and scope of growth in different sectors and industries.	05
10.	Creating Online Profile on different Digital Media Platforms: Different job portals, professional networking sites, how to create profile online. Thing to remember while creating online profiles, concept of video resumes.	05
11.	Non-Verbal Reasoning: (Series, Analytical Reasoning, Paper Folding, Image Analysis, Mirror Images, Analogy, Pattern Completion, Paper Cutting, Cubes and Dice, Classification, Water Images, Figure Matrix)	06
<b>Total Hours</b>		<b>45</b>

### Instructional method and Pedagogy:

- Participative – Student Centric Learning Method
- Activities and Role Plays and Audio-Visual tools will be used to enhance student participation.
- Use of Online application to make classroom participation more active. Like (Kahoot, Edmodo, Etc.)

### Reference Books/ Websites

1. [www.indiabix.com](http://www.indiabix.com)
2. [www.freshersworld.com](http://www.freshersworld.com)

<b>Course Title</b>	<b>Entrepreneurship Advanced</b>
<b>Course Code</b>	<b>NEN004</b>
<b>Course Credit</b>	Theory :03
	Practical :00
	Tutorial :00
	Credits :03

### Course Learning Outcomes:

After Successful completion of the above course, students will be able to:

- **Understand** the importance of growth and to be able to chart a path towards growth
- **Ability** to pitch effectively, venture to potential stakeholders
- **Create** a product fit to market
- **Create** a Pitch deck

### Detailed Syllabus

Sr. No.	Name of chapter & details	Hours Allotted
<b>SECTION-I</b>		
1.	<b>ORIENTATION TO GROWTH:</b> Getting Ready for Growth Why growth stage is different compared to startup phase, why product-market fit is not enough, case study, To assess readiness for growth, To chart a growth path.	<b>3</b>
2.	<b>CUSTOMERS:</b> Expanding Customer Base <ul style="list-style-type: none"> <li>• Revisit your business model and develop few variants (more business model types).</li> <li>• Identify additional customer segments that your solution can address.</li> <li>• Evaluate business models for the new customer segments.</li> <li>• Relook at the Problem Statement (can you expand the scope and scalability of your business by repositioning your problem statement?).</li> <li>• Explore additional ways to monetize.</li> </ul>	<b>3</b>
3.	<b>TRACTION:</b> Scaling <ul style="list-style-type: none"> <li>• How to gain traction beyond early customers.</li> <li>• Defining traction (in quantifiable terms) and identifying the most important metrics to measure traction.</li> </ul>	<b>12</b>

	<ul style="list-style-type: none"> <li>• Calculate cost of new customer acquisition.</li> <li>• Estimate your customer lifetime value (LTV).</li> <li>• Identifying waste in your operations and focusing your team on what is important for traction.</li> </ul> <p>Channels and Strategy</p> <ul style="list-style-type: none"> <li>• The Bullseye framework.</li> <li>• Identify Channels using Bulls Eye Framework.</li> <li>• Measuring the effectiveness of selected channels.</li> <li>• Budgeting and planning.</li> </ul>	
<p><b>4.</b></p>	<p><b>MONEY: Growing Revenues</b></p> <ul style="list-style-type: none"> <li>• Stabilizing key revenue streams</li> <li>• Developing additional revenue streams (licensing, franchising)</li> <li>• Exploring new channels and partnerships</li> </ul> <p>Sales Planning</p> <ul style="list-style-type: none"> <li>• Understanding why customers buy and how buying decisions are made; Listening skills.</li> <li>• Sales planning, setting targets</li> <li>• Unique Sales Proposition (USP); Art of the sales pitch (focus on customers needs, not on product features)</li> <li>• Follow-up and closing a sale; Asking for the sale</li> </ul> <p>Strengthening Sales</p> <ul style="list-style-type: none"> <li>• Building a professional sales team</li> <li>• Sales compensation and incentives</li> <li>• Sales planning, setting targets</li> </ul> <p>Improving Margins</p> <ul style="list-style-type: none"> <li>• Testing price elasticity</li> <li>• Optimizing costs and operational expenses</li> <li>• Advanced concepts of unit costing</li> </ul> <p>Financial Modeling</p> <ul style="list-style-type: none"> <li>• Financial modeling of your venture's growth</li> <li>• Analyzing competitor and peer's financial models</li> </ul>	<p><b>22</b></p>

5.	<p><b>SUPPORT:</b> Legal          Overview of legal issues and their impact on entrepreneurs</p> <ul style="list-style-type: none"> <li>• Importance of getting professional help (legal and accounting)</li> <li>• Importance of being compliant and keeping proper documentation</li> <li>• Patents and Intellectual property</li> <li>• Trademarks</li> </ul> <p>Mentors, Advisors, and Experts</p> <ul style="list-style-type: none"> <li>• The importance of a Mentor and how to find one</li> <li>• Role of business advisors and experts for specific targets in your growth plan</li> </ul>	5
6.	Capstone Project: Pitch Your Venture	
<b>Total</b>		<b>27</b>
<b>Instructional method and Pedagogy:</b>		
<ul style="list-style-type: none"> <li>• At the start of course, the course delivery pattern, prerequisite of the subject will be discussed.</li> <li>• Lectures will be conducted with the aid of multi-media projector, use of White Board, OHP etc.</li> <li>• Attendance is compulsory in lectures and laboratory.</li> <li>• Assignments based on course content will be given to the students at the end of each unit/topic and will be evaluated at regular interval.</li> <li>• Quizzes will be conducted.</li> </ul>		
<b>Reference Books:</b>		
<ol style="list-style-type: none"> <li>1. Traction : A Startup Guide to Getting Customers by Gabriel Weinberg and Justin Mares</li> <li>2. Six Keys to Release Ideas for Profitable Growth: Corporate Entrepreneurship by Hakan Ener, HBR, December 2014</li> <li>3. Case: Creating Revenue Streams for VOSS by Mona Anita K. Olsen; Katie Chan; Johnny Van Cora</li> </ol>		
<b>Additional Resources</b>		
<ul style="list-style-type: none"> <li>• <a href="https://www.mindtools.com/pages/article/newTMC_90.htm">https://www.mindtools.com/pages/article/newTMC_90.htm</a> Reinventing Your Business Model by Mark W. Johnson, Clayton M. Christensen, and Henning Kagermann, HBR</li> <li>• Case: 1366 Technologies: Scaling the Venture by Joseph B. Lassiter; Ramana Nanda; David Kiron; Evan Richardson</li> <li>• <a href="https://hbr.org/2003/12/growth-outside-the-core">https://hbr.org/2003/12/growth-outside-the-core</a></li> <li>• <a href="https://www.boardofinnovation.com/business-revenue-model-examples/">https://www.boardofinnovation.com/business-revenue-model-examples/</a></li> </ul>		

## Assessment Model

- Assignments and Class Participation-30%
- Quizzes - 10%
- Final Exam – 30%
- Capstone Project – 30%

<b>Course Title</b>	<b>Special Electrical Machines</b>
<b>Course Code</b>	<b>EL910</b>
<b>Course Credit</b>	Theory :03
	Practical :00
	Tutorial :00
	Credits :03

### Course Learning Outcomes:

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

- **Illustrate** the construction, connection of permanent magnet, fractional horse power, reluctance and linear induction motors.
- **Explain** the working of wound rotor synchronous generator and doubly fed induction generator used in renewable energy applications with sketches.
- **Analyze** theoretically, the performance characteristics for different special electrical machines and obtain simple equivalent circuit for the machines.
- **Analyze** theoretically various control schemes of special electrical machines.
- **Select** the special electrical machine for a particular application.

### Detailed Syllabus

Sr. No.	Name of chapter & details	Hours Allotted
<b>SECTION-I</b>		
1.	<b>Permanent Magnet Brushless D.C. Motors</b> Principle of operation – Types – Magnetic circuit analysis – EMF and torque equations – Power controllers – Motor characteristics and control <b>Permanent Magnet Synchronous Motor</b> Principle of operation – EMF and torque equations – Reactance – Phasor diagram – Power controllers - Converter - Volt-ampere requirements – Torque speed characteristics - Microprocessor based control.	<b>09</b>
2.	<b>Switched Reluctance Motor</b> Introduction, construction and operating principle of switched reluctance motor, selection of number of phases, poles and types of winding for SRM, static torque production, partition, energy and the effect of saturation dynamic torque production, converter circuit, torque speed characteristics and control of SRM.	<b>08</b>
3.	<b>Linear Induction Motor</b>	<b>04</b>



	Introduction, construction, advantages and disadvantages, classification, basic terminology, operation, performance analysis, control & applications.	
	<b>Total</b>	<b>21</b>
<b>SECTION-II</b>		
<b>4.</b>	<b>Wind Mill Generator</b> Comparison with all type of generator and its topologies, Constant-Voltage, Constant frequency generation, Reactive power compensation, Variable-voltage, Variable frequency generation, Effect of a wind generator on the network, DFIG, DDSG, SCIG	<b>06</b>
<b>5.</b>	<b>Repulsion motor</b> -construction, types torque equation, characteristics, and phasor diagram. <b>AC series motor</b> -Construction, principle of working, EMF and torque equation, phasor diagram, torque –speed characteristics. <b>Universal motor</b> -types and construction, principle of operation speed control of universal motor.	<b>07</b>
<b>6.</b>	<b>Stepper Motor &amp; Servo Motor</b> Construction – Principle of operation – Theory of torque production – Hybrid stepping motor – Variable reluctance stepping motor – Open loop and closed loop control. Construction and working of servo motor, Types of servo motor and its application.	<b>06</b>
<b>7.</b>	<b>Submersible Pumps</b> Operating principle, construction, applications, modern trends	<b>02</b>
	<b>Total</b>	<b>21</b>
<b>Instructional method and Pedagogy:</b>		
<ul style="list-style-type: none"> <li>● Lectures will be conducted with the aid of multi-media projector, black board, OHP etc.</li> <li>● Assignments based on course content will be given to the students at the end of each unit/topic and will be evaluated at regular interval.</li> <li>● Surprise tests/Quizzes/Seminar/ will be conducted.</li> </ul>		
<b>Reference Books:</b>		
<ol style="list-style-type: none"> <li>1. K. Venkata Ratnam, “Special electrical Machines”, University press, 2009, New Delhi.</li> <li>2. T.J.E. Miller, “Brushless Permanent magnet and reluctance motor drives”, Clarendon press, 1989, Oxford.</li> <li>3. E.G. Janardhanan, “Special electrical machines”, PHI learning private limited, 2014.</li> <li>4. Dubey. G .K. “Fundamentals of Electric Drives”, Alpha Science International Limited, Second revised edition, 2008.</li> <li>5. Cyril G. Veinott, “Fractional and Sub-fractional horse power electric motors”, McGraw Hill International Limited, Fourth edition, 1986.</li> </ol>		

6. Say. M.G “Alternating current Machines”, John Willey & Sons, Fifth edition 1983.
7. Rai. H.M “Electrical Machine Design”, Satya Prakashan Publications, Third edition, 2004.

8.

<b>Course Title</b>	<b>Energy Auditing and Conservation</b>
<b>Course Code</b>	<b>EL912</b>
<b>Course Credit</b>	Theory :03
	Practical :00
	Tutorial :00
	Credits :03

### Course Learning Outcomes:

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

- **Relate** and **discuss** energy management, audit and conservation.
- **Select** appropriate energy conservation method to reduce the wastage of energy
- **Calculate** the payback period for a given energy conservation equipment
- **Categorize** different electric motor based on requirement and application
- **Select** efficient technology in electric systems.
- **Organize** a structure of an energy audit for a case study.

### Detailed Syllabus

Sr. No.	Name of chapter & details	Hours Allotted
<b>SECTION-I</b>		
1.	<b>Energy Scenario:</b> Commercial and Non-Commercial Energy, Primary Energy Resources, Commercial Energy Production, Final Energy Consumption, Energy Needs of Growing Economy, Long Term Energy Scenario, Energy Pricing, Energy Sector Reforms, Concept of smart grid, Tariff.	<b>06</b>
2.	<b>Energy Conservation Act-2001 and related policies:</b> Energy Conservation Act-2001 and its features, Notification Under the act, Designated agencies, Schemes of Bureau of Energy Efficiency (BEE)-ECBC, S & L, DSM, BLY, SME's, Designated Consumers, Electricity Act 2003, Integrated Energy Policy.	<b>07</b>

3.	<b>Energy management, Audit and Conservation</b> Definition and objectives of energy management, Energy Audit: Types and Methodology-Need for energy audit, Type of energy audit, Preliminary energy audit methodology, Detailed energy audit methodology, Energy conservation concept, Identification of Energy Conservation Opportunities, Classification of Energy Conservation Measures. Energy Audit Reporting form, Understanding of Energy costs, Benchmarking and Energy performance, Fuel and Energy Substitution, Energy audit instruments.	08
<b>Total</b>		<b>21</b>
<b>SECTION-II</b>		
4.	<b>Energy efficiency in thermal utilities</b> <b>Cogeneration:</b> Need for cogeneration, Principle of Cogeneration, Advantages and disadvantages of cogeneration system. <b>Waste and Heat Recovery system:</b> Heat losses quantity and quality, Classification and application, Benefits of waste heat recovery, Commercial waste heat recovery devices - Recuperates	07
5.	<b>Energy efficiency and conservation in electric motors</b> Motor types, Motor characteristics and efficiency, Motor selection, Energy efficient motors, Factors affecting energy efficiency and minimizing motor losses in operation, Technical aspects of energy efficient motors, Rewinding effects on motor efficiency, Motor load survey methodology.	04
6.	<b>Energy efficient technologies in electrical systems</b> Maximum demand controllers, Automatic power factor controllers (Voltage control, KiloVAR control, Automatic power factor control relay, Intelligent power factor controller), Energy efficient transformers, Electronic ballast (Role of ballast, Conventional Vs. Electronic Ballast), Soft starters, Energy efficient lighting controls (Occupancy Sensors, Time based control: Types and Features, Daylight linked Control, Localized switching).	07
7.	<b>Energy Efficiency and Climate changes:</b> Energy and environment, Air pollution, Climate change, United Nations Framework Convention on climate change (UNFCCC), Kyoto Protocol, Clean Development Mechanism (CDM), CDM methodology and Procedures.	03
<b>Total</b>		<b>21</b>

## Instructional method and Pedagogy:

- Lectures will be conducted with the aid of multi-media projector, black board, OHP etc.
- Assignments based on course content will be given to the students at the end of each unit/topic and will be evaluated at regular interval.
- Surprise tests/Quizzes/Seminar/ will be conducted.

## Reference Books:

1. Y P Abbi & Shashank Jain, "Handbook on Energy Audit and Environment Management", TERI, ISBN: 81-7993-092-0, 2006.
2. Giovanni Petrecca, Industrial "Energy Management: Principles and Applications", The Kluwer international series, ISBN: 978-1-4615-3160-9, 1993.
3. Howard E Jordan, "Energy Efficient Electric motors and their applications", Springer Publications, 1st edition, 978-1-4899-1465-1, 1994.
4. IEEE Bronze Book, "Recommended Practice for energy conservation and cost-effective planning in industrial facilities", IEEE Inc, USA, ISBN: 978-0471820376, 2008.

## Additional Resources

- Reference books, IEEE, Elsevier- Journals and Conference papers and internet sources.
- [www.teriin.org](http://www.teriin.org)
- [www.teriuniversity.ac.in](http://www.teriuniversity.ac.in)
- [www.beeindia.in](http://www.beeindia.in)

<b>Course Title</b>	<b>Power System Design and Practices</b>
<b>Course Code</b>	<b>EL915</b>
<b>Course Credit</b>	Theory :03
	Practical :00
	Tutorial :00
	Credits :03

### Course Learning Outcomes:

At the end of the semester students will be able to:

- **Develop** fundamental understanding of concepts and techniques for analysis, design and operation of power systems.
- **Explain** the students with the basic knowledge of power system planning, transmission line Design, Distribution system design and economics of distribution system, planning of power system.
- **Learn** practical aspects of the subject that will make the students capable to design system and improve system performance.

### Detailed Syllabus

Sr. No.	Name of chapter & details	Hours Allotted
<b>SECTION-I</b>		
1.	<b>Design of Power System:</b> Introduction, selection of sizes and location of generating stations, selection and specifications of transmission lines, sizes and location of sub-stations, Interconnections.	<b>02</b>
2.	<b>Design of transmission lines:</b> <b>Electrical Design:</b> Requirements of transmission lines, selection of voltage, choice of conductors, spacing of conductors, corona, insulators, specifications of transmission lines, surge-impedance loading, design problem, overview of EHV-AC and HVDC transmission line design <b>Mechanical Design:</b> Main considerations, loading on conductors, span, sag and tension, clearance from ground, stringing, design of towers, design problem.	<b>10</b>

3.	<p><b>Design of Substation:</b> Introduction, classification, selection and location of site for substations, site acquisition, selection and rating of various equipments used in a substation, key diagrams of typical substations, gas-insulated substation, design, construction and commissioning process.</p> <p><b>Distribution Substation:</b> Calculation of distributor size, calculation of voltage drops and size of distributor in ring system, voltage regulation and lamp flicker.</p>	09
<b>Total</b>		<b>21</b>
<b>SECTION-II</b>		
4.	<p><b>Design of Distribution System:</b> Types of distribution systems arrangements, selection and size of feeders using Kelvin's law, design of cables in distribution systems considering ampere capacity, voltage drop during starting and running load, primary distribution design, secondary distribution design, HV distribution design concept, load balancing, design of rural distribution, planning and design of town electrification scheme, design of industrial distribution systems.</p> <p><b>Economics of Distribution Systems:</b> Economic selection of a distribution system, transmission and distribution costs, energy losses in a distribution system</p>	09
5.	<p><b>Power System Grounding (Power Station and Sub-Station Grounding):</b> Objectives, definitions, tolerable limits of body currents, soil resistivity, measurement of soil resistivity, earth resistance, measurement of earth resistance, step and touch voltages, design of earthing grid and behavior of earthing systems.</p>	08
6.	<p><b>Power System Improvement:</b> Introduction, methods of power system improvement, power system improvement scheme, determination of voltage regulation and losses in a power system, shifting of distribution transformer center, financial aspects of the power system improvement scheme.</p>	04
<b>Total</b>		<b>21</b>
<b>Instructional method and Pedagogy:</b>		

- Lectures will be conducted with the aid of multi-media projector, black board, OHP etc.
- Assignments based on course content will be given to the students at the end of each unit/topic and will be evaluated at regular interval.
- Surprise tests/Quizzes/Seminar/ will be conducted.

### Reference Books:

1. M. V. Despande - Electrical Power System Design, Tata McGraw-Hill Co Ltd., 1st Ed. 2008
2. B. R. Gupta - Power System Analysis and Design, S. Chand, 3rd Ed. 1998
3. Satnam and Gupta - Substation Design and Equipments, Dhanpat Rai Publications, 3<sup>rd</sup>Ed. 2008.
4. A. S. Pabla, "Electrical Power System Planning", TMH publication.