SONA COLLEGE OF TECHNOLOGY, SALEM-5

(An Autonomous Institution)

M.E-Electrical and Electronics Engineering

(Power System Engineering)

CURRICULUM and SYLLABI

[For students admitted in 2018-2019]

M.E / M.Tech Regulation 2015

Approved by BOS and Academic Council meetings

Sona College of Technology, Salem
(An Autonomous Institution)
Courses of Study for ME I Semester under Regulations 2015
Electrical and Electronics Engineering
Branch: M.E. Power System Engineering

S. No	Course Code	Course Title	Lecture	Tutorial	Practical	Credit
		Theory				
1	P15PSE101	Applied Mathematics	3	2	0	4
2	P15PSE102	Computer Aided Power System Analysis	3	2	0	4
3	P15PSE103	Power System Operation and Control	3	2	0	4
4	P15PSE104	Electrical Transients in Power Systems	3	0	0	3
5	P15PSE105	Power Quality Engineering	3	0	0	3
6	P15PSE501	**Elective-**High Voltage Direct Current Transmission	3	0	0	3
		Practical				
7	P15PSE106	Power System Simulation Laboratory-I	0	0	4	2
					Total Credits	**23**

Approved by

Chairperson, Electrical and Electronics Engineering BOS
Dr.S.Padma

Member Secretary, Academic Council
Dr.R.Shivakumar

Chairperson, Academic Council & Principal
Dr.S.R.R.Senthil Kumar

Copy to:-
HOD/EEE, First Semester ME PSE Students and Staff, COE

Sona College of Technology, Salem
(An Autonomous Institution)
Courses of Study for ME II Semester under Regulations 2015
Electrical and Electronics Engineering
Branch: M.E. Power System Engineering

S. No	Course Code	Course Title	Lecture	Tutorial	Practical	Credit
Theory						
1	P15PSE201	Modern Power System Protection	3	0	0	3
2	P15PSE202	Flexible AC Transmission Systems	3	0	0	3
3	P15PSE203	Power System Dynamics and Stability	3	2	0	4
4	P15PSE204	High Voltage and Insulation Systems	3	0	0	3
5	P15PSE502	**Elective -** Computational Intelligence Applicable to Power Systems	3	0	0	3
6	P15PSE515	**Elective** - Solar and Energy Storage System	3	0	0	3
Practical						
7	P15PSE205	Power System Simulation Laboratory - II	0	0	4	2
					Total Credits	**21**

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Sona College of Technology, Salem
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Courses of Study for ME III Semester under Regulations 2015
Electrical and Electronics Engineering
Branch: M.E. Power System Engineering

S. No.	Course Code	Course Title	Lecture	Tutorial	Practical	Credit
Theory						
1	P15PSE521	**Elective -** Smart Grid Technology	3	0	0	3
2	P15PSE522	**Elective -** Energy Management and Auditing	3	0	0	3
3	P15PSE524	**Elective -** Power System Automation	3	0	0	3
Practical						
4	P15PSE301	Project Work Phase - I	0	0	16	8
					Total Credits	17

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Sona College of Technology, Salem
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Courses of Study for ME IV Semester under Regulations 2015
Electrical and Electronics Engineering
Branch: M.E. Power System Engineering

S. No	Course Code	Course Title	Lecture	Tutorial	Practical	Credit
Practical						
1	P15PSE401	Project Work Phase – II	0	0	24	12
					Total Credits	**12**

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Sona College of Technology, Salem
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Courses of Study for ME I Semester under Regulations 2015
Electrical and Electronics Engineering
Branch: M.E. Power System Engineering

S. No	Course Code	Course Title	Lecture	Tutorial	Practical	Credit
Theory						
1	P15PSE101	Applied Mathematics	3	2	0	4
2	P15PSE102	Computer Aided Power System Analysis	3	2	0	4
3	P15PSE103	Power System Operation and Control	3	2	0	4
4	P15PSE104	Electrical Transients in Power Systems	3	0	0	3
5	P15PSE105	Power Quality Engineering	3	0	0	3
6	P15PSE501	**Elective-**High Voltage Direct Current Transmission	3	0	0	3
Practical						
7	P15PSE106	Power System Simulation Laboratory-I	0	0	4	2
					Total Credits	**23**

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P15PED101 APPLIED MATHEMATICS 3 2 0 4

COURSE OUTCOMES:

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

1. Describe the concepts in calculus of variations, state different types of Euler's equation, solve variational and isoperimetric problems

2. State Z – transform, Discuss and prove the properties, state and apply convolution theorem to various functions, form and solve the difference equations

3. Classify random process, State autocorrelation and cross correlation and its properties, State properties of power spectral density, find autocorrelation and power spectral density, Describe Poisson process and its properties

4. Explain the algorithm of simplex method; two phase, Big-M and solve linear programming problems, state duality theory, apply dual simplex algorithm to LPP, find the optimal solutions to Transportation and Assignment problems

5. Formulate Non-linear programming problem, Describe optimization problems, state and apply Lagrangian method and Khun tucker conditions to Non-LPP, Describe and solve saddle point problems, solve Non-linear programming problem by using graphical method and Wolf's modified simplex method.

UNIT - I Calculus of Variation 15

Functional – Euler's equation – Variational problems involving one unknown function – Several unknown functions – Functional dependent on higher order derivatives – Several independent variables – Isoperimetric problems.

UNIT - II Z – Transform 15

Transform of standard functions – Convolution – Initial and Final value problems – Shifting Theorem – Inverse transform (Using Partial Fraction – Residues) – Solution of difference Equations using Z – Transform.

UNIT - III Random Processes 15

Classification – Auto correlation – Cross correlation – Ergodicity – Power spectral density function – Poisson processes.

UNIT - IV Linear Programming 15

Simplex algorithm – Two-phase and Big–M method – Duality theory – Dual simplex method -Transportation and Assignment problems.

UNIT - V Non - Linear Programming 15

Formulation of non–linear programming problem – Constrained optimization with equality constraints – Constrained optimization with inequality constraints – Saddle point problem – Graphical method of non–linear programming problem involving only two variables – Kuhn-tucker conditions with non-negative constraints – Wolfe's modified simplex method.

Lecture: 45, Tutorial: 30, Total: 75

REFERENCE BOOKS

1. M.K.Venkataraman , “Higher Mathematics for Engineering & Science”, National Publishing Company,2000
2. Kandasamy, “Engineering Mathematics Volume – II”, S.Chand & Co., 2001
3. P.K.Gupta , D.S.Hira, ”Operations Research”, S.Chand &Co ., 1999
4. T.Veerarajan,”Probability, Statistics & Random Processes”, Tata McGraw Hill., 2002

P15PED102 ADVANCED POWER SEMICONDUCTOR DEVICES 3 0 0 3

COURSE OUTCOMES:

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

1. Impart knowledge of basics of power semiconductor devices and its selection strategies to the application requirement.
2. Discuss static and dynamic characteristics of current controlled power semiconductor devices such as BJT and Thyristor.
3. Interpret performance parameters of power semiconductor devices from data sheet.
4. Explain the static and dynamic characteristics of voltage controlled power semiconductor devices
5. Discuss features of firing and protection circuit for different devices.

UNIT - I INTRODUCTION 9

Power switching devices overview – Attributes of an ideal switch, application requirements, circuit symbols; Power handling capability – (SOA); Device selection strategy – Features of MCT, SIT, IGCT On-state and switching losses – EMI due to switching–Power diodes-Types, static and switching characteristics – Voltage and current rating specification from data sheet .

UNIT – II CURRENT CONTROLLED DEVICES 9

Thyristors – Construction – Two transistor analogy – Static and switching characteristics – series and parallel operation, String efficiency - SOA. BJTs – Construction, static and switching characteristics – Breakdown voltages secondary breakdown – SOA – PSPICE model of Thyristor and BJT – Performance parameters of BJT and Thyristor from data sheet.

UNIT - IV VOLTAGE CONTROLLED DEVICES 9

Power MOSFETs – Construction , types , static characteristics and switching characteristics, SOA - IGBTs – construction, types, static and switching characteristics , SOA - Performance parameters of MOSFET and IGBT from data sheet.

UNIT – IV FIRING AND PROTECTING CIRCUITS 9

Necessity of isolation – pulse transformer – opto-coupler; Gate drive circuit for SCR, MOSFET, IGBT and base driving for power BJT – over voltage, over current and gate protection; Snubber circuit for Diode, Thyristor, Mosfet and BJT.

UNIT – V THERMAL PROTECTION 9

Heat transfer – conduction, convection and radiation; Cooling – liquid cooling, vapour – phase cooling; Guidance for hear sink selection – Thermal resistance and impedance - Electrical analogy of thermal components, heat sink types and design – Mounting types.

Lecture : 45, Tutorial :00 , Total : 45

REFERENCE BOOKS

1. Ned Mohan., Undeland and Robbins, " Power Electronics: Converters, Applications and Design ", John Wiley and Sons (Asia) Pte Ltd, Singapore, 2003
2. B.W. Williams, "Power Electronics – Devices, Drivers, Applications and passive components", Macmillan, (2/e), 1992.
3. Rashid M.H., "Power Electronics circuits, Devices and Applications", Prentice Hall India, Third Edition, Newdelhi, 2004.
4. M.D. Singh and K.B.Khanchandani, "Power Electronics", Tata McGraw Hill, 2001.

15PED103 ANALYSIS OF POWER CONVERTERS 3 2 0 4

COURSE OUTCOMES:

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

6. Analyze the switching circuits.
7. Analyze and study about the controlled rectifiers.
8. Discuss the various modes of operation of Dc- Dc switch mode converters.
9. Analyze the various types of Choppers.
10. Explain the principles and operations of regulators and cycloconverters.

UNIT – I SINGLE PHASE AC-DC CONVERTER 15

Static Characteristics of power diode, SCR and GTO, half controlled and fully controlled converters with R-L, R-L-E loads and freewheeling diodes – continuous and discontinuous modes of operation - inverter operation – Sequence control of converters – performance parameters: harmonics, ripple, distortion, power factor – effect of source impedance and overlap-reactive power and power balance in converter circuits.-problems.

UNIT - II THREE PHASE AC-DC CONVERTER 15

Semi and fully controlled converter with R, R-L, R-L-E - loads and freewheeling diodes – inverter operation and its limit – performance parameters – effect of source impedance and overlap – 12 pulse converter-Problems.

UNIT - III DC-DC CONVERTERS 15

Principles of step-down and step-up converters – Analysis of buck, boost, buck-boost and Cuk converters – time ratio and current limit control – Full bridge converter – Resonant and quasi –resonant converters-Problems.

UNIT - IV AC VOLTAGE CONTROLLERS 15

Static Characteristics of TRIAC- Principle of phase control: single phase and three phase AC voltage controllers – various configurations – analysis with R and R-L loads-Problems.

UNIT - V AC- AC POWER CONVERTER 15

Principle of operation – Single phase and Three-phase Dual converters - Single phase and three phase cyclo-converters – power factor Control – Introduction to matrix converter.

Lecture: 45, Tutorial: 30, Total: 75

REFERENCE BOOKS

1. Dewan, S.B. and Straugher A., "Power Semiconductor Circuits", John Wiley and sons, 1975.
2. Dubey G.K., Doralda S.R., Joshi A., and sinha R.M.K., "Thyristorised power controllers", Wiley Eastern Limited, 1986.
3. Rashid M.H., "Power Electronics Circuits, Devices and Applications", PHI, (3/e), 2004.
4. Sen P.C., "Thyristor DC Drives", John Wiley and sons. 1981. Ned Mohan, Undeland and Robbins, "Power Electronics: concepts, applications and design", John wiley and sons, Singapore,2000.
5. Bimal K. Bose, "Modern Power Electronics and AC Drives", Pearson (2/e), 2003

P15PED104 ANALYSIS OF INVERTERS 3 0 0 3

COURSE OUTCOMES:

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

1. Explain the electrical circuit concepts behind the different working modes of inverters so as to enable deep understanding of their operation.
2. Deign different single phase and three phase inverters
3. Relate with required skills to derive the criteria for the current source inverters.
4. Design different types of multilevel inverters
5. Analysis and comprehend the various operating modes of different configurations of resonant inverters.

UNIT I SINGLE PHASE INVERTERS 12

Introduction to self commutated switches: MOSFET and IGBT – Principle of operation of half and full bridge inverters – Performance parameters – Voltage control of single phase inverters using various PWM techniques – various harmonic elimination techniques – forced commutated Thyristor inverters.

UNIT II THREE PHASE VOLTAGE SOURCE INVERTERS 9

180 degree and 120 degree conduction mode inverters with star and delta connected loads – voltage control of three phase inverters: single, multi pulse, sinusoidal, space vector modulation techniques.

UNIT III CURRENT SOURCE INVERTERS 9

Operation of six-step thyristor inverter – inverter operation modes – load – commutated inverters – Auto sequential current source inverter (ASCI) – current pulsations – comparison of current source inverter and voltage source inverters.

UNIT IV MULTILEVEL INVERTERS 9

Multilevel concept – diode clamped – flying capacitor – cascade type multilevel inverters - Comparison of multilevel inverters - application of multilevel inverters

UNIT V RESONANT INVERTERS 6

Series and parallel resonant inverters - voltage control of resonant inverters – Class E resonant inverter – resonant DC – link inverters.

Lecture : 45, Tutorial :00 , Total : 45

REFERENCE BOOKS

1. Rashid M.H., “Power Electronics Circuits, Devices and Applications ", Prentice Hall India, Third Edition, New Delhi, 2004.
2. Jai P.Agrawal, “Power Electronics Systems”, Pearson Education, Second Edition, 2002.
3. Bimal K.Bose “Modern Power Electronics and AC Drives”, Pearson Education, Second Edition, 2003.
4. Ned Mohan,Undeland and Robbin, “Power Electronics: converters, Application and design” John Wiley and sons.Inc,Newyork,1995.
5. Philip T. krein, “Elements of Power Electronics” Oxford University Press -1998.

P15PED105 SIMULATION OF POWER ELECTRONIC CIRCUITS 3 0 0 3

COURSE OUTCOMES

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

1. Relate the knowledge necessary to appreciate the MATLAB and PSPICE Models.
2. Discuss with required skills to derive the criteria for the PSPICE components.
3. Discuss with required skills to derive the criteria for the MATLAB components
4. Analyze , design and simulation of power electronic circuits with PSPICE software.
5. Analyze design and simulation of power electronic Drives with MATLAB software

UNIT - I INTRODUCTION 9

Need for Simulation - Challenges in simulation - Classification of simulation programs - Overview of PSPICE, MATLAB and SIMULINK. Mathematical Modeling of Power Electronic Systems - Static and dynamic models of power electronic switches.

UNIT - II PSPICE 9

File formats - Description of circuit elements - Circuit description – Output variables - Dot commands - SPICE models of Diode, Thyristor, BJT, Power MOSFET, IGBT.

UNIT - III MATLAB 9

Toolboxes of MATLAB - Programming and file processing in MATLAB - Model definition and model analysis using SIMULINK - S-Functions

UNIT - IV SIMULATION OF CONVERTERS USING PSPICE 9

Diode rectifiers -.Controlled rectifiers - AC voltage controllers - DC choppers - Voltage source and current source inverters - Resonant pulse inverters.

UNIT - V SIMULATION OF DRIVES USING MATLAB 9

Simulation of speed control schemes for DC motors – BLDC motor Drive – PMSM Drive Direct Torque control – PWM inverter fed Induction motor.

Lecture: 45, Tutorial: 00, Total: 45

REFERENCES

1. Muhammad H .Rashid , “ Spice for Power Electronics and Electric Power “, CRC Press, Taylor and Francies Group, 2006.
2. M.B.Patil “Simulation of Power Electronics Circuits “ Narosa Publishing house 2009.
3. Bimal K Bose, "Power Electronics and Variable Frequency Drives", IEEE Press, New Jersey, 1996.
4. Ramshaw. E., Schuuram D. C., “PSpice Simulation of Power Electronics Circuits- An Introductory Guide”, Springer, New York, 1996.
5. Ned Mohan, "Power Electronics: Computer Simulation Analysis and Education using PSPICE", Minnesota Power Electronics Research and Education, USA, 1992.

P15PED106 POWER ELECTRONICS SIMULATION LAB-I 0 0 4 2

COURSE OUTCOMES:

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

1. Apply the switching techniques of power semiconductor devices.
2. Analyze and simulate the ac voltage controllers.
3. Design and simulate the converter and inverter circuits.

LIST OF EXPERIMENTS

1. Modeling of simple PN Junction diode
2. Modeling of Silicon Controlled Rectifier.
3. Modeling of MOSFET
4. Modeling of IGBT .
5. Modeling of BJT .
6. Simulation of Single phase Semi converter

   (i) R Load (ii) RL Load (iii) RLE (motor) Load
7. Simulation of Single phase Fully controlled converter

   (i) R Load (ii) RL Load (iii) RLE (motor) Load
8. Simulation of Single phase Dual converter
9. Simulation of Three phase semi converter.
10. Simulation of Three phase fully controlled converter
11. Simulation of Single phase full bridge Inverter
12. Simulation of Three phase full bridge inverter.
    a) 180 degree mode operation
    b) 120 degree mode operation
13. Simulation of Three phase AC Voltage Controller.
    a) Lamp load
    b) Motor load

All the above experiments are performed using MATLAB

TOTAL: 60Hrs

P15PED 501 HIGH VOLTAGE DIRECT CURRENT TRANSMISSION 3 0 0 3

(Common to Power Electronics & Drives and Power System Engineering)

COURSE OUTCOMES

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

6. Discuss the general aspects of HVDC transmission and their power devices
7. Analyze the equivalent circuits and characteristics of thyristor converters
8. Explain the different modes of gate control of converters and discuss the reactive power control
9. Illustrate the protection, harmonics and filters of HVDC systems
10. Analyze the simulation tools of HVDC systems.

UNIT - I GENERAL ASPECTS 9

Historical development of HVAC and DC links – HVDC station layout and components- HVDC projects in India and abroad – advantages and disadvantages of HVDC transmission - Applications of DC transmission – kinds of DC links – Modern trends in HVDC transmission systems. Development of power devices for HVDC transmission – thyristors – light activated thyristors – Cooling of Thyristors.

UNIT - II ANALYSIS OF HVDC CONVERTERS 9

Choice of best circuit for HVDC converters – Analysis of HVDC converters – Different modes of converter operations - operation as rectifiers and inverters – converter equivalent circuits – parameters and characteristics of rectifiers and inverters - voltage source converters.

UNIT - III CONTROL OF CONVERTERS AND REACTIVE POWER CONTROL 9

Gate control – basic means of control – desired features of control – control characteristics – system control hierarchy – firing angle control - constant current and extinction angle control - Starting and stopping of DC link – power control. Reactive Power Requirements – Reactive power control during steady state - sources of reactive power - reactive power control during Transients.

UNIT - IV PROTECTION OF HVDC SYSTEMS, HARMONICS AND FILTERS 9

Converter faults – protection against over currents – protection against over voltages – smoothing reactors –DC line – corona effects – DC line insulators - protection of DC line – DC breakers –types. Characteristics and uncharacteristic harmonics – troubles caused by harmonics – harmonic filters.

UNIT - V SIMULATION OF HVDC SYSTEMS 9

Introduction – System Simulation: Philosophy and Tools – HVDC System Simulation – Modeling of HVDC Systems for Digital Dynamic Simulation.

Lecture : 45, Tutorial : 00 , Total : 45

REFERENCES

1. KR Padiyar, "HVDC Power Transmission Systems", Willey Eastern Limited, Second edition.
2. Kimbark E.X., "Direct Current Transmission", Vol. I, Wiley Interscience, New York 1971.
3. Allan Greenwood, 'Electrical Transients in Power Systems', John Wiley and Sons New York, 1992
4. Kory(ed) B. J., " High Voltage Direct Current Converters and Systems". Macdonald & Co, London 1995
5. Adamson and Hingorani N.G., "High Voltage Direct Current Power Transmission", Garraway ltd., England, 1960.

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2	P15PSE202	Flexible AC Transmission Systems	3	0	0	3
3	P15PSE203	Power System Dynamics and Stability	3	2	0	4
4	P15PSE204	High Voltage and Insulation Systems	3	0	0	3
5	P15PSE502	**Elective -** Computational Intelligence Applicable to Power Systems	3	0	0	3
6	P15PSE515	**Elective** - Solar and Energy Storage System	3	0	0	3
Practical						
7	P15PSE205	Power System Simulation Laboratory - II	0	0	4	2
					Total Credits	**21**

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P15PSE201 MODERN POWER SYSTEM PROTECTION 3 0 0 3

COURSE OUTCOMES:

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

1. Describe the protection schemes for power system equipments
2. Evaluate static relays and their characteristics
3. Discuss different digital protection scheme
4. Illustrate modern trends in protective relaying
5. Evaluate various relay testing methods

UNIT I INTRODUCTION 9

General philosophy of protection – Characteristic functions of protective relays – Protection schemes for Transmission lines, Transformers, Generators, Motors – Bus bar protection – Back up protection.

UNIT II STATIC RELAYS AND THEIR CHARACTERISTICS 9

Static relays – Amplitude comparator, phase comparator – Static Over current relay – Synthesis of Impedance relay, MHO relay, Reactance relay, Quadrilateral relay, and Differential relay – Static frequency relay.

UNIT III DIGITAL PROTECTION 9

Numerical relay – Sampling frequency – Digital signal processing – Digital filtering in protective relays – Relays algorithms – Over current relays , Directional relay , Impedance relay , MHO relay , Differential relay - Quadrilateral relay .

UNIT IV MODERN TRENDS IN PROTECTIVE RELAYING 9

Carrier current pilot relaying – Phase comparison, carrier Aided distance protection – Travelling wave relays – Amplitude comparison relay , phase comparison relay – Fiber optic based relaying – SCADA architecture – Use of SCADA in interconnected power systems.

UNIT V TESTING OF PROTECTIVE SYSTEMS AND ADAPTIVE PROTECTION 9

Testing of protective current and potential transformers – Testing of relays – primary and secondary injection tests – Relay burden – Relay setting – Relay co – ordination – Fault locators – Adaptive protection – Fault analysis – Adaptive techniques – Intelligent Electronics devices.

Lecture: 45, Tutorial: 0, Total: 45

REFERENCE BOOKS:

1. Y.G .Paithankar, S.R.Bhide, " Fundamentals of Power System Protection" . Prentice – Hall India, 2004
2. Badri Ram and D.N. Vishwakarma , " Power System Protection and Switch Gear" Tata McGraw Hill, New Delhi, 2003
3. RavindraP.Singh , " Digital Power System Protection" , PHI , New Delhi ,2007.
4. T.S.M.Rao , "Digital / Numerical Relays" Tata McGraw Hill ,2005.
5. Sunil S. Rao "Switch Gear and Protection", Khanna Publishers Delhi, 1998 .
6. T.S. MadhavaRao , "Power System Protection Static Relays" , second Edition. Tata McGraw Hill, New Delhi

15PSE202 FLEXIBLE AC TRANSMISSION SYSTEMS 3 0 0 3

COURSE OUTCOMES:

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

6. Explain the basic FACTS controllers and their needs.
7. Describe the principle and control methods of various types of compensator.
8. Explain the basic principle of series compensators
9. Design the UPFC and IPFC controllers
10. Describe the special FACTS devices and interactions and design of controllers.

UNIT I INTRODUCTION 9

Transmission interconnections – Flow of Power in an AC system – Limits of the loading capability Power flow and Dynamic Stability considerations of a transmission inter connection – Relative importance of controllable parameters- Basic types of FACTS Controllers - Brief description and Definitions of FACTS Controllers.

UNIT II SHUNT AND PHASE ANGLE COMPENSATORS 9

Objectives of Shunt Compensation – methods of controllable Var generation - SVC and STATCOM Comparison - Objectives of phase angle regulators, Switching Converter based phase angle regulators.

UNIT III SERIES COMPENSATORS 9

Objectives of Series Compensation – Need for Variable Series Compensation - Advantage of TCSC, TCSC Controller - Operation of the TCSC – TSSC – Analysis of TCSC – Capability Characteristics – Harmonic performance – losses – Variable reactance Modelling of TCSC – Open and Closed loop control of TCSC – Switching Converter type Series Compensator.

UNIT IV UPFC AND IPFC 9

UPFC - Basic Operations Principles – Conventional transmission control capabilities – Independent real and reactive power flow control – Control Structure- IPFC – Basic Operations Principles and Characteristics – Control Structure.

UNIT V SPECIAL PURPOSE FACTS CONTROLLERS 9

NGH – SSR damping scheme and TCBR – Variable structure braking resistor control – variable structure series capacitor control – energy storage systems for advanced power applications, Co-ordination of FACTS controllers – Controller Interactions – Performance criteria for damping controller design – Basic procedure for controller design.

Lecture: 45, Tutorial: 0, Total: 45

REFERENCE BOOKS

1. Narain G. Hingorani and Laszlo Gyugyi, “Understanding FACTS concepts and technology of Flexible AC Transmission Systems”, Wiley India Pvt Ltd., 2011.
2. R Mohan Mathur, Rajiv K Varma, Mathur, “Thyristor-Based Facts Controllers for Electrical Transmission Systems”, Wiley India Pvt Ltd., 2011.
3. Yu Wang, W. Zhu, R.R. Mohler, and R. Spee, “VARIABLE-STRUCTURE CONTROL OF FLEXIBLE AC TRANSMISSION SYSTEMS” IEEE 1992.
4. Paulo F. Ribeiro, K.Johnson, Mariesa L. Crow, AysenArsoy and Yilu Liu, “Energy Storage Systems for Advanced Power Applications”, IEEE, 2001.

P15PSE203 POWER SYSTEM DYNAMICS AND STABILITY 3 2 0 4

COURSE OUTCOMES:

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

1. Analyze the various mathematical modeling and calculations in synchronous machine.
2. Develop the transfer function model for excitation, speed governing and turbine systems.
3. Analyze the small signal stability analysis of SMIB and Multimachine power systems.
4. Analyze the small signal stability analysis of SMIB and Multimachine power systems with damping controllers.
5. Discuss feedback controllers for small signal stability enhancement in power systems.

UNIT I SYNCHRONOUS MACHINE MODELLING 15

Schematic Diagram, Physical Description: Armature and Field Structure, Machines with multiple pole pairs, mmf waveforms, Direct and Quadrature axes, Mathematical Description of a Synchronous Machine: Basic equations of a synchronous machine: stator circuit equations, stator self, stator mutual and stator to rotor mutual inductances, dq0 Transformation: flux linkage and voltage equations for stator and rotor in dq0 coordinates, electrical power and torque, Physical interpretation of dq0 transformation, Per Unit Representations- Power-invariant form of Park's transformation; Equivalent Circuits for direct and quadrature axes, Steady- state Analysis: Voltage, current and flux-linkage relationships, Phasor representation, Rotor angle, Steady-state equivalent circuit, Computation of steady-state values.

UNIT II MODELLING OF EXCITATION AND SPEED GOVERNINGSYSTEMS 15

Excitation System Requirements; Elements of an Excitation System, Types of Excitation Systems, Control and Protective functions, Modeling of Excitation system components, Modeling of IEEE type ST1A Excitation system model, Turbine and Governing System Modeling: Functional Block Diagram of Power Generation and Control, Schematic of a hydroelectric plant, Classical transfer function of a hydraulic turbine (no derivation), Special characteristics of hydraulic turbine, Electrical analog of hydraulic turbine, Governor for Hydraulic Turbine: Requirement for a transient droop, Block diagram of governor with transient droop compensation,: Modeling of Single reheat tandem compounded type Steam Turbine.

UNIT III SMALL SIGNAL STABILITY ANALYSIS WITHOUT CONTROLLERS 15

Classification of Stability, Basic Concepts and Definitions: Rotor angle stability, Stability Phenomena. Fundamental Concepts of Stability of Dynamic Systems: State- space representation, Stability of a Dynamic system, Eigen properties of the state matrix: Eigen values and Eigenvectors, Eigen value and stability, Participation factor. Single Machine Infinite Bus (SMIB) Configuration: Classical Machine Model stability analysis with numerical example, Effects of Field Circuit Dynamics: synchronous machine network and linearised system equations, Block diagram representation with K-constants; expression for K-constants (no derivation), effect of field flux variation on system stability.

UNIT IV SMALL SIGNAL STABILITY ANALYSIS WITH CONTROLLERS 15

Effects of Excitation System: Thyristor Excitation System with AVR, Block diagram representation with Exciter and AVR, Effect of AVR on Synchronizing and Damping torque components, Power System Stabilizer: Block diagram representation with AVR and PSS, System state matrix including PSS-Small Signal Stability of Multi machine systems.

UNIT V ENHANCEMENT OF SMALL SIGNAL STABILITY 15

Power System Stabilizer – Stabilizer based on shaft speed signal (delta omega) – Delta P-Omega stabilizer-Frequency-based stabilizers – Digital Stabilizer – Excitation control design – Exciter gain – Phase lead compensation – Stabilizing signal washout and stabilizer gain – Stabilizer limits, Selection of PSS location.

Lecture: 45, Tutorial: 30, Total: 75

REFERENCE BOOKS

1. Prabha Kundur, “Power System Stability and Control”, Tata McGraw-Hill, 2012.
2. P.M Anderson and A.A Fouad, “Power System Control and Stability”, Iowa State University Press, Ames, Iowa, 2008.
3. K.R.Padiyar, “Power System Dynamics Stability & Control”, BS Publications, Hyderabad, 2002.
4. Peter W.Sauer&M.A.Pai, “Power System Dynamics & Stability”, Pearson Education, 2002.

P15PSE204 HIGH VOLTAGE AND INSULATION SYSTEMS 3 0 0 3

COURSE OUTCOMES:

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

1. Describe the various insulating materials used in power system
2. Illustrate breakdown mechanism of solid, liquid and gaseous dielectrics
3. Explain the high voltage generation methods and measurements
4. Evaluate insulation testing of electrical equipments
5. Describe the various Non-destructive testing in high voltage.

UNIT I INSULATING MATERIALS IN POWER SYSTEM 9

Review of insulating materials Gases, Vacuum, liquids and solids- characterization of insulation condition – permittivity, capacitance, resistivity and insulation resistance, dielectric dissipation factors- partial discharges sources, forms and effects- ageing effects- electrical breakdown and operating stresses- standards relating to insulating materials.

UNIT II BREAKDOWN MECHANISMS OF SOLID, LIQUID AND GASEOUS DIELECTRICS 9

Introduction to insulation systems used in high voltage power apparatus - breakdown mechanisms of solid, liquid, gas and vacuum insulation.

UNIT III BASIC METHODS OF GENERATION AND MEASUREMENT OF TEST HIGH VOLTAGES 9

Generation of high alternating voltages: cascaded transformers and series resonant circuit- Generation of high dc voltages: rectifier circuit and voltage multiplier circuit- Generation of impulse voltages: multistage impulse generator circuit- Generation of impulse currents – Measurement of high ac, dc and impulse voltages: voltage divider circuits- Digital Storage Oscilloscope for impulse voltage and current measurements.

UNIT IV INSULATION TESTING OF ELECTRICAL EQUIPMENTS 9

Necessity for high voltage testing - testing of distribution and power transformers - voltage transformers - current transformers - bushings – overhead line and substation insulators - surge arresters – high voltage cables - circuit breakers and isolators – IEC and Indian standards.

UNIT V NON-DESTRUCTIVE TESTING 9

Insulation resistance measurement- Measurement of tan delta and capacitance of dielectrics - grounded objects like transformers and alternators – Measurement of Partial discharges - location and measurement of discharges in electrical equipment –Dissolved gas in oil measurement.

Lecture: 45, Tutorial: 0, Total: 45

REFERENCE BOOKS:

1. Adrianus,J.Dekker, Electrical Engineering Materials, Prentice Hall of India Pvt. Ltd., New Delhi, 1979.
2. Kuffel,E. and Zaengl, W.S., High Voltage Engineering Fundamentals, Pergamon Press, Oxford,New York 1984.
3. Naidu,M.S. and Kamaraju,V., High Voltage Engineering, Tata McGraw Hill Publishing Company Ltd., New Delhi, 1983.
4. R.E.James and Q.Su, Condition assessment of high voltage insulation in power system equipment, IET Power and Energy Series 53, 2008
5. Gallagher,T.J., and Permain,A., High Voltage Measurement, Testing and Design, John Wiley Sons, New York, 1983.
6. IEC & IS Standards on testing.

P15PSE502 COMPUTATIONAL INTELLIGENCE APPLICABLE TO POWER SYSTEMS 3 0 0 3

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

1. Model and design the Fuzzy Logic Controller.
2. Describe in-depth knowledge on basic concepts and different learning methods of Artificial Neural Networks.
3. Model and design inference systems of Neuro fuzzy Controllers.
4. Describe the impart in-depth knowledge on basics and design issues of different genetic algorithms.
5. Apply fuzzy logic, Neural Network and Genetic Algorithm for power system problems.

UNIT I FUZZY LOGIC 9
Introduction to Computational Intelligence, Classic set-Fuzzy set theory–Basic Definition and Terminology-Set Theoretic operations and properties, Membership functions –formulation and parameterization,Linguistic variable, formation of Fuzzy IF-THEN rules, Fuzzy Logic and Approximate Reasoning, Structure of Fuzzy Logic Controller and design procedures,Fuzzy Models- Sugeno and Mamdani

UNIT II ARTIFICIAL NEURAL NETWORKS 9
History –Relation between BNN and ANN- Basic functions and terminologies, Basic Learning Laws, Different types of Learning Methods, Mc-Culloh Pits Neuron model, Single and Multiple Perceptron Model, Back Propagation algorithm and its variant, Hopfield Networks,Kohonenon Networks, Radial Basis Networks, ART-I,ART-II, Recurrent Networks.

UNIT III NEURO-FUZZY 9
Neuro Fuzzy Modeling - Adaptive Neuro fuzzy Inference Systems- Neuro fuzzy controllers.

UNIT IV GENETIC ALGORITHM 9
Genetic Algorithm – Basics of Genetic Algorithm, Design issues in Genetic Algorithm, Genetic Modeling, Hybrid Approach-Neuro-Genetic Hybrid and Fuzzy-Genetic Hybrid.

UNIT V APPLICATIONS 9
Application of Fuzzy Logic, Neural networks and Genetic Algorithm to Load forecasting, contingency analysis,VAR compensation, Power System optimization-Economic Load Dispatch-Unit Commitment, Power system Stabilizer, Synchronous Machine, FACTS Devices, Stability studies, Renewable Energy Sources, Deregulation.

Lecture: 45, Tutorial: 00, Total: 45

REFERENCE BOOKS:

1. "Fuzzy sets, Uncertainty and Information", George Klir and Tina Folger. A, Prentice Hall of India, Pvt. Ltd, 1993.

2. "Neural Networks, Fuzzy Logic & Genetic Algorithms", S. Rajasekaran, G. A. VijayalakshmiPai - Prentice-Hall India, 2003.

3. "Genetic Algorithms", David. E. Goldberg –Pearson Education, 2003.

4. "Neuro-fuzzy and soft computing ", J. S. R. Jang, C. T. Sun, and E. Mizutani, Prentice-Hall of India, pvt .Ltd 1997. "

5. "Fundamentals of Neural Networks", Fausett Laurence-Pearson Education-New Delhi 2004.

6. "An Introduction to Fuzzy Control", Dirankov .D, Hellendoorn .H and Reinfrank. M, -Narosa Publishing House, New Delhi -2001.

7. "Artificial Neural Networks", B.Yegnanarayana, Prentice Hall of India Pvt.Ltd, 2001.

8. "Fuzzy Logic Engineering Applications", Timothy J.Ross, McGraw Hill, NewYork, 1997

9. "Practical Genetic Algorithm" , Randy L. Haupt, Sue Ellen Haupt ,John Wiley & sons ,2004

REFERENCE JOURNALS

1. IEEE Transactions on Fuzzy Systems.
2. IEEE Transactions on Neural Networks.
3. IEEE Transactions on Industrial Applications.
4. IEEE Transactions on Industrial Electronics.
5. IEEE Transactions on Power Systems.
6. IEEE Transactions on Power Delivery.

P15PSE 515 SOLAR AND ENERGY STORAGE SYSTEM 3 0 0 3

COURSE OUTCOMES:

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

1. Classify and explain PV cell and Interconnection.
2. Design stand-alone PV systems.
3. Design and analyze Grid connected PV systems.
4. Classify different Energy storage systems.
5. Describe the applications of solar energy.

UNIT I INTRODUCTION TO SOLAR SYSTEM 9

Characteristics of sunlight – semiconductors and P-N junctions – behavior of solar cells – cell properties – PV cell interconnection

UNIT II STAND ALONE PHOTOVOLTAIC SYSTEM 9

Solar modules – storage systems – power conditioning and regulation - protection – Stand-alone PV systems design – sizing of components

UNIT III GRID CONNECTED PHOTO VOLTAIC SYSTEMS 9

PV systems in buildings – design issues for central power stations – safety – Economicaspect – Efficiency and performance - International PV program

UNIT IV ENERGY STORAGE SYSTEMS 9

Impact of intermittent generation – Battery energy storage – solar thermal energystorage – pumped hydroelectric energy storage

UNIT V SOLAR SYSTEM APPLICATIONS 9

Applications in Water pumping – battery chargers – solar car – direct-drive applications –Space and Telecommunications.

Lecture: 45, Tutorial: 0, Total: 45

REFERENCE BOOKS:

1. S.N.Bhadra, D. Kastha, & S. Banerjee “Wind Electrical Systems”, Oxford University Press, 2009
2. Rashid .M. H “Power electronics Hand book”, Academic press, 2001.
3. Rai. G.D, “Non-conventional energy sources”, Khanna publishes, 1993.
4. Rai. G.D,” Solar energy utilization”, Khanna publishes, 1993.
5. Gray, L. Johnson, “Wind energy system”, Prentice Hall linc, 1995.
6. B.H. Khan,”Non-conventional Energy sources”, Tata McGraw-Hill PublishingCompany, New Delhi.

P15PSE205 POWER SYSTEM SIMULATION LABORATORY - II 0 0 4 2

COURSE OUTCOMESS:

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

1. Analyze the small signal stability of single machine and multi machine models.
2. Analyze the effect of FACTS controllers by performing steady state analysis.
3. Analyze the concepts in different wind energy conversion technologies.
4. Simulate various power electronic circuits using MATLAB and PSPICE

LIST OF EXPERIMENTS

1. Small-signal stability analysis of single machine-infinite bus system using classical
2. machine model
3. Small-signal stability analysis of multi-machine configuration with classical machine
4. model
5. Load flow analysis of two-bus system with STATCOM
6. Transient analysis of two-bus system with STATCOM
7. Available Transfer Capability calculation using an existing load flow program
8. Study of variable speed wind energy conversion system- DFIG
9. Study of variable speed wind energy conversion system- PMSG
10. Simulation of MOSFET, IGBT based Choppers using Matlab & PSpice
11. Simulation of IGBT based Single phase inverters using Matlab & PSpice
12. Simulation of Single phase AC voltage controller using Matlab & PSpice

Total: 60 Hours

Sona College of Technology, Salem
(An Autonomous Institution)
Courses of Study for ME III Semester under Regulations 2015
Electrical and Electronics Engineering
Branch: M.E. Power System Engineering

S. No.	Course Code	Course Title	Lecture	Tutorial	Practical	Credit
Theory						
1	P15PSE521	**Elective -** Smart Grid Technology	3	0	0	3
2	P15PSE522	**Elective -** Energy Management and Auditing	3	0	0	3
3	P15PSE524	**Elective -** Power System Automation	3	0	0	3
Practical						
4	P15PSE301	Project Work Phase - I	0	0	16	8
					Total Credits	17

Approved by

Chairperson, Electrical and Electronics Engineering BOS
Dr.S.Padma

Member Secretary, Academic Council
Dr.R.Shivakumar

Chairperson, Academic Council & Principal
Dr.S.R.R.Senthil Kumar

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P15PSE521 SMART GRID TECHNOLOGY 3 0 0 3

COURSE OUTCOMES:

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

1. Understand the fundamental concepts associated with smart grids.
2. Assess the role of automation in transmission and distribution.
3. Understand the importance and application of AMI, PMUs and IEDs in smart grids.
4. Analyze the power quality and energy management issues in smart grid.
5. Identify the various communication networks for performance computation in smart grid.

UNIT I BASIC CONCEPTS IN SMART GRID 9

Evolution of Electric Grid, Concept, Definitions and Need for Smart Grid, Smart grid drivers, functions, opportunities, challenges and benefits, Difference between conventional & Smart Grid, Concept of Resilient & Self Healing Grid, Present development & International policies in Smart Grid, Diverse perspectives from experts and global Smart Grid initiatives.

UNIT II SMART GRID TECHNOLOGIES 9

Technology Drivers, Smart energy resources, Smart substations, Substation Automation, Feeder Automation, Transmission systems: EMS, FACTS and HVDC, Wide area monitoring, Protection and control, Distribution systems: DMS, Volt/VAR control, Fault Detection, Isolation and service restoration, Outage management, High-Efficiency Distribution Transformers, Phase Shifting Transformers, Plug in Hybrid Electric Vehicles (PHEV).

UNIT III SMART METERS AND ADVANCED METERING INFRASTRUCTURE 9

Introduction to Smart Meters, Advanced Metering infrastructure (AMI) drivers and benefits, AMI protocols, standards and initiatives, AMI needs in the smart grid, Phasor Measurement Unit(PMU), Intelligent Electronic Devices(IED) & their application for monitoring & protection.

UNIT IV POWER QUALITY MANAGEMENT IN SMART GRID 9

Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.

UNIT V HIGH PERFORMANCE COMPUTING FOR SMART GRID APPLICATIONS 9

Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broadband over Power line (BPL), IP based Protocols, Basics of Web Service and CLOUD Computing to make Smart Grids smarter, Cyber Security for Smart Grid.

Lecture: 45, Tutorial: 0, Total: 45Hrs

REFERENCES:

1. Stuart Borlase “Smart Grid: Infrastructure, Technology and Solutions”,CRC Press 2012.
2. Janaka Ekanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko
3. Yokoyama, “Smart Grid: Technology and Applications”, John Wiley and sons, 2012.
4. Vehbi C. Güngör, DilanSahin, TaskinKocak, Salih Ergüt, Concettina Buccella, Carlo Cecati, and Gerhard P. Hancke, Smart Grid Technologies: Communication Technologies and Standards IEEE Transactions On Industrial Informatics, Vol. 7, No. 4, November 2011.
5. Xi Fang, Satyajayant Misra, Guoliang Xue, and Dejun Yang “Smart Grid – The New and Improved Power Grid: A Survey” , IEEE Transaction on Smart grid.

P15PSE522 ENERGY MANAGEMENT AND AUDITING 3 0 0 3

COURSE OUTCOMES:

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

1. Describe the need for energy management and design energy accounting.
2. Explain the concepts behind economic analysis and load management.
3. Define necessity of energy management for motors, systems and electrical equipment.
4. Relate various meters, techniques for energy management.
5. Illustrate the concept of lighting systems and cogeneration.

UNIT I INTRODUCTION 9

Need for energy management - energy basics- designing and starting an energy management program – energy accounting -energy monitoring, targeting and reporting energy audit process.

UNIT II ENERGY COST AND LOAD MANAGEMENT 9

Important concepts in an economic analysis - Economic models-Time value of money- Utility rate structures - cost of electricity -Loss evaluation- Load management: Demand control techniques -Utility monitoring and control system - HVAC and energy management - Economic justification.

UNIT III ENERGY MANAGEMENT FOR MOTORS, SYSTEMS, AND ELECTRICAL EQUIPMENT 9

Systems and equipment- Electric motors-Transformers and reactors-Capacitors and Synchronous Machines.

UNIT IV METERING FOR ENERGY MANAGEMENT 9

Relationships between parameters-Units of measure-Typical cost factors- Utility meters - Timing of meter disc for kilowatt measurement - Demand meters - Paralleling of current Transformers - Instrument transformer burdens-Multitasking solid-state meters – Metering location vs. requirements- Metering Techniques and Practical examples.

UNIT V LIGHTING SYSTEMS & COGENERATION 9

Concept of lighting systems - The task and the working space -Light sources - Ballasts - Luminaries - Lighting controls-Optimizing lighting energy - Power factor and effect of harmonics on power quality - Cost analysis techniques - Lighting and energy standards Cogeneration: Forms of cogeneration - feasibility of cogeneration - Electrical interconnection.

Lecture: 45, Tutorial: 0, Total: 45Hrs

REFERENCE BOOKS:

1. Reay D.A, Industrial Energy Conservation, 1stedition, Pergamon Press, 1977.
2. IEEE Recommended Practice for Energy Management in Industrial and Commercial Facilities, IEEE, 196s
3. Amit K. Tyagi, Handbook on Energy Audits and Management, TERI, 2003.
4. Barney L. Capehart, Wayne C. Turner, and William J. Kennedy, Guide to Energy Management, Fifth Edition, The Fairmont Press, Inc., 2006.
5. Eastop T.D & Croft D.R, Energy Efficiency for Engineers and Technologists, Logman Scientific & Technical, ISBN-0-582-03184, 1990.

P15PSE524 POWER SYSTEM AUTOMATION 3 0 0 3

COURSE OUTCOMES:

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

1. Analyze the elements of SCADA, operation and control of SCADA.
2. Develop the Remote terminal unit and master terminal unit for automated systems.
3. Develop the communication standards and system components.
4. Analyze the structure of programmable logic controllers.
5. Analyze the substation and distribution automation schemes.

UNIT-I INTRODUCTION 9

Definition of SCADA – Applicable processes – Elements of SCADA systems – SCADA Architecture - operation and Control using SCADA - Development from telemetry – Dependence on communications & computers

UNIT-II COMPONENTS OF AUTOMATED SYSTEMS 9

Sensors, Transducers and Actuators: Forgotten cost - Special considerations - Standardization & Maintenance. Remote Terminal Unit: Communication interface – Protocol detailed – Discrete control – Analog control - Pulse control – Serial control – Monitor discrete & analog signals – Monitor pulse count & serial signals. Master Terminal Unit: Communication interface – Configuring a picture of the process – Data Storage – Applications

UNIT-III COMMUNICATIONS 9

Analog to digital conversion –Communication models and types – Communication Standards - Communications system components – Protocol – Modems – Field buses – Synchronous or asynchronous – Telephone cable or radio

UNIT-IV PROGRAMMABLE LOGIC CONTROLLERS 9

Structure of PLC - Control program – Programming: Simple Relay Layouts and Schematics - PLC Connections - Ladder Logic Inputs - Ladder Logic Outputs – Tutorial Problems - Case studies

UNIT-V SUBSTATIONS AND DISTRIBUTION AUTOMATION 9

Substation Automation-Structure of Subsystem Automation - Substation communications - Substation functions through SCADA- Distribution Automation- Functions of Distribution automation - Distribution Automation for improved Energy Management - Relative rating of communication media for DA-Automation in Process industries: SCADA systems in Industries - Requirements of Industrial Automation System - SCADA System in sugar Industries- Purification Systems - Evaporation – Crystallization - Centrifugation and Sugar Handling

Lecture: 45, Tutorial: 0, Total: 45

REFERENCE BOOKS:

1. Stuart A. Boyer, “SCADA: Supervisory Control and Data Acquisition”, 3rd Edition, ISA-The instrumentation systems and Automation Society
2. ISA’s Practical Guide Series, “Analytical Instrumentation (1996), Maintenance of Instrumentation and systems – 2nd Editions (2005), Fundamentals of Industrial Control – 2nd Editions (2006).
3. James Northcote-Green, Robert G. Wilson. “Control and Automation of Electrical Power Distribution Systems”, CRC Press, 2006.

Sona College of Technology, Salem
(An Autonomous Institution)
Courses of Study for ME IV Semester under Regulations 2015
Electrical and Electronics Engineering
Branch: M.E. Power System Engineering

S. No	Course Code	Course Title	Lecture	Tutorial	Practical	Credit
Practical						
1	P15PSE401	Project Work Phase – II	0	0	24	12
					Total Credits	**12**

Approved by

Chairperson, Electrical and Electronics Engineering BOS
Dr.S.Padma

Member Secretary, Academic Council
Dr.R.Shivakumar

Chairperson, Academic Council & Principal
Dr.S.R.R.Senthil Kumar

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