SONA COLLEGE OF TECHNOLOGY, SALEM-5

(An Autonomous Institution)

M.E-Electrical and Electronics Engineering

(Power Electronics and Drives)

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 Electronics and Drives

S. No	Course Code	Course Title	Lecture	Tutorial	Practical	Credit
		Theory				
1	P15PED101	Applied Mathematics	3	2	0	4
2	P15PED102	Advanced Power Semiconductor Devices	3	0	0	3
3	P15PED103	Analysis of Power Converters	3	2	0	4
4	P15PED104	Analysis of Inverters	3	0	0	3
5	P15PED105	Simulation of Power Electronic Circuits	3	0	0	3
6	P15PED501	**Elective**-High Voltage Direct Current Transmission	3	0	0	3
		Practical				
7	P15PED106	Power Electronics Simulation Laboratory-I	0	0	4	2
					Total Credits	**22**

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 PED 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 Electronics and Drives

S. No	Course Code	Course Title	Lecture	Tutorial	Practical	Credit
Theory						
1	P15PED201	Analysis of DC Drives	3	2	0	4
2	P15PED202	Analysis of AC Drives	3	2	0	4
3	P15PED203	Advances in Power Electronics	3	0	0	3
4	P15PED204	Modeling and Analysis of Electrical Machines	3	2	0	4
5	P15PED504	**Elective -** Flexible AC Transmission Systems	3	0	0	3
6	P15PED512	**Elective -** Pulse Width Modulation for Power Converters	3	0	0	3
Practical						
7	P15PED205	Power Electronics Simulation Lab - II	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, Second Semester ME PED Students and Staff, COE

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 Electronics and Drives

S. No	Course Code	Course Title	Lecture	Tutorial	Practical	Credit
Theory						
1	P15PED505	**Elective -** Special Electrical Machines and their Controllers	3	0	0	3
2	P15PED508	**Elective -** Power Electronics for Renewable Energy Systems	3	0	0	3
3	P15PED518	**Elective -** Advanced Controllers for Electric Drives	3	0	0	3
Practical						
4	P15PED301	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

Copy to:-
HOD/EEE, Third Semester ME PED Students and Staff, COE

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 Electronics and Drives

S. No	Course Code	Course Title	Lecture	Tutorial	Practical	Credit
Practical						
1	P15PED401	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

Copy to:-
HOD/EEE, Fourth Semester ME PED Students and Staff, COE

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 Electronics and Drives

S. No	Course Code	Course Title	Lecture	Tutorial	Practical	Credit
Theory						
1	P15PED101	Applied Mathematics	3	2	0	4
2	P15PED102	Advanced Power Semiconductor Devices	3	0	0	3
3	P15PED103	Analysis of Power Converters	3	2	0	4
4	P15PED104	Analysis of Inverters	3	0	0	3
5	P15PED105	Simulation of Power Electronic Circuits	3	0	0	3
6	P15PED501	**Elective**-High Voltage Direct Current Transmission	3	0	0	3
Practical						
7	P15PED106	Power Electronics Simulation Laboratory-I	0	0	4	2
					Total Credits	**22**

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 PED Students and Staff, COE

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.

P15PED103 ANALYSIS OF POWER CONVERTERS 3 2 0 4

COURSE OUTCOMES:

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

1. Analyze the switching circuits.
2. Analyze and study about the controlled rectifiers.
3. Discuss the various modes of operation of Dc- Dc switch mode converters.
4. Analyze the various types of Choppers.
5. 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 LABORATORY-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,

1. Discuss the general aspects of HVDC transmission and their power devices
2. Analyze the equivalent circuits and characteristics of thyristor converters
3. Explain the different modes of gate control of converters and discuss the reactive power control
4. Illustrate the protection, harmonics and filters of HVDC systems
5. 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.

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 Electronics and Drives

S. No	Course Code	Course Title	Lecture	Tutorial	Practical	Credit
Theory						
1	P15PED201	Analysis of DC Drives	3	2	0	4
2	P15PED202	Analysis of AC Drives	3	2	0	4
3	P15PED203	Advances in Power Electronics	3	0	0	3
4	P15PED204	Modeling and Analysis of Electrical Machines	3	2	0	4
5	P15PED504	**Elective -** Flexible AC Transmission Systems	3	0	0	3
6	P15PED512	**Elective -** Pulse Width Modulation for Power Converters	3	0	0	3
Practical						
7	P15PED205	Power Electronics Simulation Lab - II	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, Second Semester ME PED Students and Staff, COE

P15PED201 **ANALYSIS OF DC DRIVES** **3 2 0 4**

COURSE OUTCOMES

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

1. Analyze the operation of converter / chopper fed DC drive, both qualitatively and quantitatively.
2. Explain steady state operation and transient dynamics of a motor load system.
3. Analyze and design the current and speed controllers for a closed loop solid state DC motor drive.
4. Illustrate the implementation of control algorithms using microcontrollers and phase locked loop.
5. Describe the digital control of DC drives and its applications.

UNIT I DC MOTORS FUNDAMENTALS AND MECHANICAL SYSTEMS 15

DC motor- Types, induced emf, speed-torque relations; Speed control – Armature and field speed control; Ward Leonard control – Constant torque and constant horse power operation - Introduction to high speed drives and modern drives.

Characteristics of mechanical system – dynamic equations, components of torque, types of load; Requirements of drives characteristics – multi-quadrant operation; Drive elements, types of motor duty and selection of motor rating.

UNIT II CONVERTER CONTROL 15

Principle of phase control – Fundamental relations; Analysis of series and separately excited DC motor with single-phase and three-phase converters – waveforms, performance parameters, performance characteristics.

Continuous and discontinuous armature current operations; Operation with free wheeling diode; Implementation of braking schemes; Drive employing dual converter.

UNIT III CHOPPER CONTROL 15

Introduction to time ratio control and frequency modulation; Class A, B chopper controlled DC motor – performance analysis, multi-quadrant control - Chopper based implementation of braking schemes; Multi-phase chopper;

UNIT IV CLOSED LOOP CONTROL 15

Modeling of drive elements – Equivalent circuit, transfer function of self, separately excited DC motors; Linear Transfer function model of power converters; Sensing and feeds back elements - Closed loop speed control – current and speed loops, P, PI and PID controllers – response comparison.

UNIT V DIGITAL CONTROL OF D.C DRIVE AND APPLICATIONS 15

Phase Locked Loop and micro-computer control of DC drives; Applications -Rolling mills, Traction, Solar powered pump drives, Battery powered vehicles (Block diagram of subsystems).

Lecture: 45, Tutorial: 30, Total: 75

REFERENCES:

1. Gopal K Dubey, “Power Semiconductor controlled Drives”, Prentice Hall Inc., NewYersy, 1989.
2. R.Krishnan, “Electric Motor Drives – Modeling, Analysis and Control”, Prentice-Hall of India Pvt. Ltd., New Delhi, 2003.
3. GobalK.Dubey, “Fundamentals of Electrical Drives”, Narosal Publishing House, New Delhi.
4. VedamSubramanyam, “Electric Drives – Concepts and Applications”, Tata McGraw-Hill publishing company Ltd., New Delhi, 2002.
5. P.C Sen “Thyristor DC Drives”, John wiely and sons, New York, 1981.

P15PED202 **ANALYSIS OF AC DRIVES** **3 2 0 4**

COURSE OUTCOMES:

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

1. Explain the various operating regions of the induction motor drives.
2. Analyze the operation of VSI & CSI fed induction motor control.
3. Describe the speed control of induction motor drive from the rotor side.
4. Explain the field oriented control of induction machine.
5. Describe the control of synchronous motor drives.

UNIT 1 FUNDAMENTALS OF**AC MOTORS** **15**

Steady state performance equations- Rotating Magnetic Field- Torque production, Equivalent circuit-Performance of the machine with Variable Voltage-Variable frequency operation, constant Volt/Hz operation, Slip power recovery – Static Kramer Drive - Synchronous Drives.

UNIT II VSI AND CSI FED INDUCTION MOTOR CONTROL **15**

AC voltage control circuit- six step inverter voltage control- closed loop variable frequency PWM inverter with dynamic braking- CSI fed IM variable frequency drives- comparison.

UNIT III FIELD ORIENTED CONTROL **15**

Field oriented control of induction machines- Theory-DC analogy- Direct or feedback vector control- Indirect or feed forward vector control- Flux vector estimation- Space vector modulation control.

UNIT IV DIRECT TORQUE CONTROL **15**

Direct torque control of induction machines- Torque expression with stator and rotor fluxes, DTC control strategy- Optimum switching vector selection- reduction or torque ripple methods.

UNIT V SYNCHRONOUS MOTOR DRIVES **15**

Wound field cylindrical rotor motor- Equivalent circuit –Performance equations of operation from a voltage source- Power factor control and V curves- Starting and braking, self control – Load commutated Synchronous motor drives – Brush and Brushless excitation.

Lecture: 45, Tutorial: 30, Total: 75

REFERENCES:

1. Bimal K Bose, ‘Modern Power Electronics and AC Drives’, Pearson Education Asia 2002.
2. Gopal K Dubey, ‘Power Semiconductor Controlled Drives’, Prentice Hall Inc., New Jersey, 1999.
3. R.Krishnan, ‘Electric Motor Drives- Modeling, Analysis and Control’, Prentice- Hall of India Pvt. Ltd., New Delhi, 2003.
4. P.Vas, ‘ Sensorless Vector and Direct Torque Control’, Oxford University Press, New York 1998.

P15PED203 ADVANCES IN POWER ELECTRONICS 3 0 0 3

COURSE OUTCOMES:

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

1. Design and analysis the different types of resonant converters.
2. Explain the harmonics and need for improved utility interface.
3. Describe about the electric utility applications.
4. Discuss about the power line disturbances and applications.
5. Explain the new semiconductor materials for power devices.

UNIT I RESONANT CONVERTERS 9

Basic resonant circuit concepts – Classifications of resonant converters – Resonant switch dc to dc converters – Zero current switching converters and Zero voltage switching converters –Zero voltage switching, clamped voltage converters- ZVS-CV dc to dc converters, ZVS-CV dc to ac converters, ZVS-CV dc to dc converter with zero voltage cancellation. -Resonant DC link Inverters and Zero voltage switching.

UNIT II IMPROVED UTILITY INTERFACE 9

Generation of current harmonics – Current harmonics and power factor – Harmonic Standards and recommended practices - Need for improved utility interface - Improved single phase utility interface - Improved three phase utility interface - Electromagnetic interference.

UNIT III ELECTRIC UTILITY APPLICATIONS 9

Introduction- Residential applications - Industrial applications - High voltage dc transmission - Static var compensators - Interconnection of renewable energy sources and energy storage systems to the utility grid.

UNIT IV POWER CONDITIONERS AND APPLICATIONS 9

Over view of switching power supplies - Control of switch mode dc power supplies - Power supply protection - Power line disturbances - Power conditioners - Uninterruptable power supplies.

UNIT V EMERGING DEVICES AND CIRCUITS 9

Power Junction Field Effect Transistors - Field Controlled Thyristors - JFET based devices Vs other power devices - MOS controlled thyristors - Power integrated circuits - New semiconductor materials for power devices.

Lecture: 45, Tutorial: 00, Total: 45

REFERENCES

1. Ned Mohan., Undeland and Robbins, " Power Electronics: Converters, Applications and Design ", John Wiley and Sons (Asia) Pte Ltd, Singapore, 2003.
2. Rashid, M.H., “Power Electronics – Circuits, Devices and Applications”, Pearson Education (Singapore) Pte. Ltd, New Delhi, 2004./ Prentice Hall of India, New Delhi.
3. Joseph Vithayathil., ”Power Electronics”, Mc-Graw Hill series in Electrical and Computer Engineering, USA, 1995.
4. Mohan Mathur P, Rajiv K Varma, “Thyristor – Based Facts Controllers for Electrical Transmission Systems”, John Wiley and Sons Inc., IEEE Press,USA,2002.
5. Bimal K Bose, “Modern Power Electronics – Evolution, Technology and application”, Jaico Publishing House, Mumbai, 2006.

P15PED204 MODELING AND ANALYSIS OF ELECTRICAL MACHINES 3 2 0 4

COURSE OUTCOMES

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

1. Explain the importance of DC motors and Induction motors
2. Describe the basic mathematical equations to model the electrical motors.
3. Illustrate dynamic modeling and phase, frequency
4. Explain the vector control of induction motors.
5. Describe different types of special electrical machines.

UNIT I MODELING OF DC MACHINES 15

Induced EMF-Equivalent circuit and Electromagnetic torque-Field excitation: separate, shunt, series and compound excitation-Commutator action. Effect of armature mmf-Analytical fundamentals: Compensating winding -Inter poles.

UNIT II DYNAMIC MODELING OF INDUCTION MACHINES 15

Equivalent circuits- Steady state performance equations-Dynamic modeling of induction machines: Real time model of a two phase induction machines, Three phase to two phase transformation-Electromagnetic torque-generalized model in arbitrary reference frames-stator reference frames model-rotor reference frames model-synchronously rotating reference frame model.

UNIT III PHASE CONTROLLED AND FREQUENCY CONTROLLED INDUCTION MACHINES 15

Stator voltage control-Steady state analysis-approximate analysis-Slip energy recovery scheme: principle of operation-steady state analysis range of slip - equivalent circuit and performance characteristics - Static Scherbius drive. Constant Volts/Hz controls implementation-steady state performance-dynamic simulation. Constant slip speed control-Constant air-gap flux control.

UNIT IV VECTOR CONTROLLED INDUCTION MACHINES 15

Principle of vector control-Direct vector control: flux and torque processor-DVC in stator reference frames with space vector modulation. Indirect vector control scheme: Derivation and implementation. Flux weakening operation: principle-flux weakening in stator flux linkage and rotor flux linkage.

UNIT V SPECIAL MACHINES 15

Permanent magnet – Airgap line- Demagnetizing characteristics –Energy density -synchronous machines with PMs: Machine configuration-flux density distribution - types of PMSM - Vector control of PMSM - Variable Reluctance Machines: Basics-analysis-practical configuration-circuit wave forms for torque production - stepping motors.

Lecture : 45, Tutorial :30, Total : 75

REFERENCE BOOKS

1. R.Krishnan.”Electric motor & Drives: Modeling, Analysis and Control”, Prentice Hall of India, 2001.
2. Charles kingsley, Jr., A.E.Fityzgerald, Stephen D.Umans “Electric Machinery”, Tata McGraw Hill, Sixth Edition, 2002.
3. Miller, T.J.E.”Brushless permanent magnet and reluctance motor drives”, Oxford, 2005.
4. C.V.Jones, ”The Unified Theory of ElectricalMachines:,Butterworth,London,1967.
5. P.S.Bhimbra, ”Generalised theory of electrical machines”, Khanna Publishers.
6. P.S.Bhimbra,”Generalised theory of electrical machines”, Khanna Publishers, 4th Edition, 1993.

P15PED504 FLEXIBLE AC TRANSMISSION SYSTEMS 3 0 0 3

COURSE OUTCOMES

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

1. Explain the basic FACTS controllers and their needs.
2. Describe the principle and control methods of various types of compensator.
3. Explain the basic principle of series compensators
4. Design the UPFC and IPFC controllers
5. 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

REFERENCES

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.

P15PED512 PULSE WIDTH MODULATION FOR POWER CONVERTERS 3 0 0 3

COURSE OUTCOMES

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

1. Describe the Pulse width modulation of power electronic converters.
2. Analyze the different types of PWM techniques.
3. Analyze the PWM phenomena in single and three phase voltage source inverters.
4. Analyze the harmonic losses in switching PWM.
5. Explain the zero space vector control techniques in power electronic systems.

UNIT I INTRODUCTION TO POWER ELECTRONICS CONVERTERS 9

Basic Converter Topologies - Voltage Source/Stiff Inverters - Switching function representation of three phase converters - Output Voltage control - current source/stiff inverters - concept of a space vector – three level inverters - Multilevel Inverters Topologies

UNIT II MODULATION OF ONE INVERTER PHASE LEG 9

Fundamental Concepts of PWM - Evolution of PWM schemes - Double Fourier Integral Analysis of Two–level Pulse Width Modulated Waveform - Naturally Sampled pulse Width Modulation - PWM Analysis by Duty Cycle variation - Regular Sampled Pulse width modulation-Direct Modulation - Integer versus Non-integer frequency ratios - Review of PWM variations.

UNIT III MODULATION OF SINGLE-PHASE VOLTAGE SOURCE INVERTERS 9

Topology of a Single-Phase Inverter - Three-level Modulation of a Single Phase inverters - analytic calculation of harmonic losses – Side band Modulation - Switched Pulse position - switched pulse sequence

UNIT IV MODULATION OF THREE –PHASE VOLTAGE SOURCE INVERTERS 9

Topology of a three phase inverter (VSI) - three–phase modulation with sinusoidal Reference -Third–Harmonic Reference Injection - Analytic calculation of harmonic losses - Triplen carrier rations and Sub harmonics.

UNIT V ZERO SPACE VECTOR PLACEMENT MODULATION STRATEGIES 9

Space Vector Modulation – Phase leg references of space vector modulation - Naturally Sampled SVM - Analytical solution of SVM-harmonic losses for SVM – placement of the zero space vector - Discontinues modulation - phase leg reference for discontinuous PWM - Analytical solutions for Discontinuous PWM - comparison of harmonic performance-harmonic losses for discontinuous PWM-single edge SVM - switched pulse sequence.

Lecture : 45, Tutorial : 0, TOTAL : 45

REFERENCES:

1. Mohammed H.Rashid, “Power Electronics – Circuits, Devices and Applications”, Eastern Economy Edition, Third Edition 2004.
2. Bimal K Bose, “Modern Power Electronics and AC Drives”, Pearson Education Asia, 2003.
3. Grahame Holmes .D, Thomas A.Lipo, “Pulse Width Modulation for Power Converters, Principles and Practice” – IEEE Press – 2003.
4. F.Blaabjerg, J.K. Pedersen and P.Thoegersen, “Improved Modulation Techniques for PWM-VSI drive", IEEE Trans. On Industrial Electronics, Vol.44, No.1, Feb 1997, pp.87-95.

P15PED205 POWER ELECTRONICS SIMULATION LABORATORY – II 0 0 4 2

COURSE OUTCOMES:

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

1. Explain the requisite knowledge necessary to appreciate the dynamical equations involved in the analysis of different Power electronics circuits.
2. Analyze, design and simulate different power Electronic Drives of AC and DC Machines.

LIST OF EXPERIMENTS

HARDWARE:

1. Speed Control Converter fed DC drive.
2. Speed control of Chopper Fed DC Drive
3. V/f Control of Induction motor drive using DSP.
4. FPGA controlled induction motor drive.
5. Micro controller based speed control of Stepper motor.
6. DSPIC based speed control of BLDC motor.
7. DSP based speed control of SRM motor.
8. Power quality analysis of three phase induction motor drive.

SOFTWARE USING MATLAB:

1. Simulation of Converter Fed Closed Loop Control of a DC motor
2. Simulation of Dual Converter Fed DC Motor Drive
3. Simulation of Chopper Fed Closed Loop control of a AC motor
4. Simulation of Four Quadrant operation of three –phase Induction Motor
5. Simulation of VSI and CSI Fed Induction Motor Drive
6. Simulation of Vector Controlled Induction Motor Drive
7. Simulation of Self Controlled Synchronous Motor Drive

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 Electronics and Drives

S. No	Course Code	Course Title	Lecture	Tutorial	Practical	Credit
Theory						
1	P15PED505	**Elective -** Special Electrical Machines and their Controllers	3	0	0	3
2	P15PED508	**Elective -** Power Electronics for Renewable Energy Systems	3	0	0	3
3	P15PED518	**Elective -** Advanced Controllers for Electric Drives	3	0	0	3
Practical						
4	P15PED301	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

Copy to:-
HOD/EEE, Third Semester ME PED Students and Staff, COE

P15PED505 SPECIAL ELECTRICAL MACHINES AND THEIR CONTROLLERS 3 0 0 3

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

1. Explain the importance of advanced electrical motors.
2. Discuss the working principle and performance of advanced electrical motors such as stepper motors, Brushless dc motors and Switched Reluctance motors.
3. Design control techniques of electrical motors.
4. Discuss operation and characteristics of permanent magnet synchronous motors.
5. Design the controllers for Special machines.

UNIT I STEPPING MOTORS 9
Principle of operation – Classification – Construction and operation: VR motor, permanent magnet stepping motor, hybrid stepping motor. Monofilar and bifilar windings, Static characteristics – Dynamic characteristics – Modes of excitation- Micro stepping – Applications.

UNIT II SWITCHED RELUCTANCE MOTOR 9
Construction – Principle of operation – SRM Vs stepper motor, poles, phase and windings – Static torque production – Energy conversion loop – Partition of energy and effect of saturation – Converter circuits, Controls: current regulation, commutation, Torque-speed characteristics.

UNIT III BRUSHLESS DC MOTORS 9
Fundamentals of permanent magnets – demagnetization curve – comparison of conventional and brushless dc machine – Position detection using hall element – Basic three phase bipolar driven motor – Multi phase brushless motor – Square wave permanent magnet brushless motor – Torque and emf equations – Torque speed characteristics – Control methods.

UNIT IV PERMANENT MAGNET SYNCHRONOUS MOTORS 9
Principle of operation, EMF, power input and torque expressions, Phasor diagram, Power controllers, Torque speed characteristics, Self control, Vector control, Current control schemes.

UNIT V CONTROLLER FOR SPECIAL MACHINES 9
Stepper motor: drive systems and circuit for open loop control – closed loop operation system using microprocessor, SRM: microcontroller based control, BLDC: six step commutations for PM Brushless dc motor and sinusoidal commutation drive.

Lecture: 45, Tutorial: 00, Total:45Hrs

REFERENCES
1. Miller. T.J.E. “Brushless permanent magnet and reluctance motor drives ", Clarendon Press, Oxford, 1989.
2. Kenjo. T, “Stepping motors and their microprocessor control ", Clarendon Press, Oxford, 1989.
3. Kenjo. T and Naganori, S “Permanent Magnet and brushless DC motors ", Clarendon Press, Oxford, 1989.
4. B.K. Bose, “Modern Power Electronics & AC drives” Prentice-Hall of India Pvt. Ltd., New Delhi, 2003.

P15PED508 POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS 3 0 0 3

COURSE OUTCOMES:

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

1. Discuss about the stand alone and grid connected renewable energy systems.
2. Relate equip with required skills to derive the criteria for the design of power converters for renewable energy applications.
3. Analyze and comprehend the various operating modes of wind electrical generators and solar energy systems.
4. Design different power converters namely AC to DC, DC to DC and AC to AC converters for renewable energy systems.
5. Develop maximum power point tracking algorithms.

UNIT I INTRODUCTION 9

Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment (cost-GHG Emission) - Qualitative study of different renewable energy resources ocean, Biomass, Hydrogen energy systems : operating principles and characteristics of: Solar PV, Fuel cells, wind electrical systems-control strategy, operating area.

UNIT II ELECTRICAL MACHINES FOR RENEWABLE ENERGY CONVERSION 9

Review of reference theory fundamentals-principle of operation and analysis: IG, PMSG, SCIG and DFIG.

UNIT III POWER CONVERTERS 9

Solar: Block diagram of solar photo voltaic system : line commutated converters (inversion mode) - Boost and buck-boost converters- selection of inverter, battery sizing, array sizing.

Wind: three phase AC voltage controllers- AC-DC-AC converters: uncontrolled rectifiers, PWM Inverters, Grid Interactive Inverters-matrix converters.

UNIT IV ANALYSIS OF WIND AND PV SYSTEMS 9

Stand alone operation of fixed and variable speed wind energy conversion systems and solar system-Grid connection Issues -Grid integrated PMSG and SCIG Based WECS-Grid Integrated solar system.

UNIT V HYBRID RENEWABLE ENERGY SYSTEMS 9

Need for Hybrid Systems- Range and type of Hybrid systems- Case studies of Wind-PV Maximum Power Point Tracking (MPPT).

Lecture : 45, Tutorial : 00, Total: 45Hrs

REFERENCES:

1. S.N.Bhadra, D. Kastha, & S. Banerjee “Wind Electricaal 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. Non-conventional Energy sources B.H.Khan Tata McGraw-hill Publishing Company,New Delhi.

P15PED518 ADVANCED CONTROLLERS FOR ELECTRIC DRIVES 3 0 0 3

COURSE OUTCOMES:

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

1. Explain the microprocessor based control of drives.
2. Explain the microcomputer based control of drives.
3. Discuss on application and implementation of DSP based motor control on drives.
4. Design and implementation of ASIC for control drives.
5. Explain programmable logic control for AC and DC drives.

UNIT I MICROPROCESSOR CONTROL OF DRIVES 9

Introduction- Closed loop control of DC Drives- A Microprocessor based Induction Motor Drives- Pulse Width Modulation- Protection including Fault Monitoring and Control- Microprocessor based implementation of Field Oriented Control for a VSI.

UNIT II MICROCOMPUTER CONTROL OF DRIVES 9

Digital Versus Analog control- Processor selection- Controlling Power Electronic Systems- Microcomputer control of Power Electronic systems- Advantages and Limitations of Micro computer based control.

UNIT III DSP MOTOR CONTROL APPLICATIONS 9

DSP Controller- DSP based implementation of DC- DC Boost converter- DSP based control of permanent magnet brushless DC motor using LF 2407.

UNIT IV ASICS FOR CONTROL OF DRIVES 9

ASIC Terminology - ASIC Design - Field Programmable Gate Arrays and Programmable Logic Devices- Implementation of ASICs for control of AC Drives.

UNIT V PROGRAMMABLE LOGIC CONTROL FOR DRIVES 9

PLC-Architecture of PLC-Advantages- Types of PLC- PLC arithmetic functions- PLC control for AC and DC Drives.

Lecture: 45, Tutorial :0, TOTAL : 45 Hrs

REFERENCES:

1. V.R.Moorthi, “Power Electronics- Devices, Circuits and Industrial Applications”, Oxford University Press,2006.
2. Bimal K, Bose, “Power Electronics and Variable Frequency Drives- Technology and Applications", IEEE Press, Standard Publishers Distributors, Delhi, 2000.
3. Hamid A. Toliyat, “DSP Based Electro Mechanical Motton Control”,CRC-Press, 2004.
4. Frank D. Petruzella, “ Programable Logic Controllers”, Tata MC Graw Hill, Pvt Ltd New Delhi, 2010.

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 Electronics and Drives

S. No	Course Code	Course Title	Lecture	Tutorial	Practical	Credit
Practical						
1	P15PED401	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

Copy to:-
HOD/EEE, Fourth Semester ME PED Students and Staff, COE