DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

LIST OF COURSES OFFERED FOR HONOR PROGRAM (R20)

Course code	Course Title	Contact hours/week				Credits
		L	T	P	**Total**	
20EEH1	Energy storage systems	4	0	0	4	4
20EEH2	Analysis of Power Converters	4	0	0	4	4
20EEH3	Electrical Power Quality	4	0	0	4	4
20EEH4	Advanced Electric Drives	4	0	0	4	4

B.Tech.(IV Sem) (Honors)	20EEH1-ENERGY STORAGE SYSTEMS	L	T	P	Cr.
		4	0	0	4

Pre-requisites: Applied Chemistry, Electric and Magnetic Fields

Course Educational Objective: This course enables the student to understand the concept of and analyze the various types of energy storage and applications of energy storage systems.

Course Outcomes: At the end of the course, the student will be able to:

CO1: understand the necessity and usage of different energy storage schemes for different applications. (**Understand-L2)**

CO2: Analyze preliminary thermal and electrochemical storage systems. (**Understand-L2)**

CO3: Familiarize the operations of fuel cell and hybrid storage systems. (**Understand-L2)**

CO4: Specify appropriate energy storage technology for a particular context involving renewable energy resources. **(Apply-L3)**

UNIT I: NECESSITY OF ENERGY STORAGE

Need for energy storage, Types of energy storage-Thermal, electrical, magnetic, chemical and super conducting magnetic storage systems, comparison of energy storage technologies – Applications.

UNIT II: THERMAL STORAGE

Types - Modelling of thermal storage units - Simple water and rock bed storage pressurized water storage system–Modelling of phase change storage system–Simple units, packed bed storage units-Modelling using porous medium approach.

UNIT III: FUNDAMENTAL CONCEPTS OF BATTERIES

Measuring of battery performance - Charging and discharging of a battery - Storage density - Energy density - Safety issues - Types of batteries - Lead Acid, Nickel, Cadmium, Zinc Manganese dioxide and modern batteries - Zinc-Air, Nickel Hydride, Lithium ion Battery.

UNIT IV: HYBRID STORAGE DEVICES

Flywheel - Super capacitors - Principles & Methods – Applications - Compressed air Energy storage - Concept of Hybrid Storage - Applications. Super Conducting Magnetic Storage systems-system capabilities, Developments in Super Conducting Magnetic Storage systems .

UNIT V: FUEL CELL

Fuel Cell–History of Fuel cell, Principles of Electrochemical storage–Types–Hydrogen oxygen cells, Hydrogen air cell, Hydrocarbon air cell, alkaline fuel cell, detailed analysis–advantage and drawback of each type.

TEXT BOOKS:

1. Ibrahim Dincer and Mark A. Rosen, “Thermal Energy Storage Systems and Applications”, John Wiley & Sons 2011.
2. Ru-shiliu, Leizhang, Xueliang sun,”Electrochemical technologies for energy storage and conversion”, Wiley publications, 2012 .

REFERENCE:

1. Viswanathan B and M Aulice Scibioh, “Fuel Cells – Principles and Applications”,Universities Press 2007.
2. Rebecca L. and Busby, Penn Well Corporation, “Hydrogen and Fuel Cells: A Comprehensive Guide”, Oklahoma 2005.
3. Bent Sorensen, “Hydrogen and Fuel Cells: Emerging Technologies and Applications”, Elsevier, UK 2011.

B.Tech. (V Sem) (Honors)	20EEH2- ANALYSIS OF POWER CONVERTERS	L	T	P	Cr.
		4	0	0	4

Prerequisite: Electrical Circuit Analysis

Course Objective: This course deals with principles and basic topologies of non isolated and isolated converters. It also deals the switching losses, conduction losses taking place in switched mode converters and soft switching converter topologies.

Course Outcomes: At the end of the course, the student will be able to:

CO1: Identify the various types of non isolated power converter topologies.(**Understand-L2)**

CO2: Analyze the performance of isolated power converter topologies. **(Apply-L3)**

CO3: Understand soft switching techniques and its control techniques. (**Understand-L2)**

CO4: Understand the Power Factor Correction Circuits. (**Understand-L2)**

UNITI: NON ISOLATED SWICHMODE POWER CONVERSION

Analysis & Designing of Buck converters, Boost converters, Buck-Boost converters, Cuk converters-continuous and discontinuous modes, applications, problems

UNITII: ISOLATED SWICHMODE POWER CONVERSION

Requirement for isolation in the switch-mode converters, transformer connection, Forward and fly back converters, power circuit and steady state analysis-Applications. push-pull topologies- Applications, Half bridge and full bridge converters- Power circuit and steady state analysis

UNIT III: SOFT SWITCHING CONVERTERS

Classification of Resonant converters-Basic resonant circuits- Series resonant circuit-Parallel resonant circuits- Resonant switches, Concept of Zero voltage switching-Principle of operation, analysis of M-type and L-type Buck or boost Converters-Concept of Zero current switching-Principle of operation-Analysis of M-type and L-type Buck or boost Converters.

UNIT IV: CONTROL METHODS FOR SWITCHING POWER CONVERTERS

Control methods for buck, boost and forward dc-dc converters using State-space Modelling, Converter Transfer Functions, Pulse Width Modulator Transfer Functions

UNIT V: POWER FACTOR CORRECTION CIRCUITS

Introduction, Definition of PF and THD, Power Factor Correction, Energy Balance in PFC Circuits, Passive Power Factor Corrector, Basic Circuit Topologies of Active Power Factor Correctors, System Configurations of PFC Power Supply.

TEXT BOOKS:

1. Ned Mohan, Undeland and Robbin, 'Power Electronics: converters, Application and design', John Wiley and sons.Inc, Newyork, 2006.
2. Robert Erickson and Dragon Maksivimovic "Fundamentals of Power Electronics", Springer Publications.

REFERENCE:

1. Philip T.Krein “Elements of Power Electronics”, Oxford University Press
2. L. Umanand “Power Electronics Essentials & Applications”, Wiley India Private Limited.
3. Issa Batarseh “Power Electronics Circuits”, John Wiely, 2004.

B.Tech.(VI Sem) (Honors)

20EEH3- ELECTRICAL POWER QUALITY

L	T	P	Cr.
4	0	0	4

Pre-requisites: --- Power Systems-I, Power Systems-II

Course Educational Objective: This course enables the student to study the various issues affecting power quality and condition monitoring techniques used in electrical and industrial systems. It also introduces various power quality measurement devices.

Course Outcomes: At the end of the course, the student will be able to:

CO1: Classify power quality issues in a power system. (**Understand-L2)**

CO2: Understand the effects of various power quality phenomenon in various equipment and their impact on performance and economics. (**Understand-L2)**

CO3: Identify suitable device for power quality measurements. (**Understand-L2)**

CO4: Apply appropriate solution technique for power quality mitigation based on the type of problem. **(Apply-L3)**

UNIT – I: INTRODUCTION TO POWER QUALITY

Definitions of Power quality, Power Quality – Voltage and Current Quality, Importance of Power Quality, Power Quality Evaluation. Terms and Definitions: General Classes of Power Quality Problems, Transients, Long-Duration Voltage Variations, Short-Duration Voltage Variations, Voltage Imbalance, Waveform Distortion, Voltage fluctuation, Power Quality Terms and Ambiguous terms.

UNIT – II: VOLTAGE SAGS AND INTERRUPTIONS

Sources of sags and interruptions, estimating voltage sag performance, fundamental principles of protection, solutions at the end-user level, effects of voltage sags and interruptions on different loads, Motor –Starting Sags, Sources of transient over voltages - Capacitor switching, Lightning, Ferro resonance.

UNIT–III: HARMONICS

Definition of Harmonics, Harmonic Distortion - voltage vs current distortion, Harmonic indices, Harmonic sources from commercial and industrial loads, Locating harmonic sources, inter harmonics, Resonance, effects of harmonics on power system equipment.

UNIT – IV: POWER QUALITY MONITORING

Monitoring considerations, monitoring and diagnostic techniques for various power quality problems, Power Quality measurement equipment - Power line disturbance analyzer, Harmonic / Spectrum analyzer, Oscilloscopes, Smart Power Quality meters, Wiring and Grounding testers.

UNIT-V: MITIGATION OF POWER QUALITY ISSUES: Mitigation of voltage sags at consumer level - active series compensators, Harmonic distortion evaluation, Devices for controlling harmonic distortion – passive and active filters. Mitigation of over-voltages - Surge Arresters, Low pass filters, Power conditioners. Lightning protection - Shielding, Line arresters, Effects of over-voltages in power system and protection of equipment from transients.

TEXT BOOKS:

1. Roger C Dugan, Surya Santoso, Mark F. Mc Granaghan, H. Wayne Beaty, "Electrical power systems quality", Tata McGraw-Hill Education, 3rd Edition.2017.
2. C. Sankaran, "Power Quality" CRC Press,1st Edition, 2017.

REFERENCE:

1. Math H J Bollen, "Understanding Power Quality Problems: voltage sags and interruptions", Wiley-IEEE Press, 2011

2. Angelo Baggini, “Hand book of power quality”, John Wiley & Sons, 2008.
3. J. Arrillaga, N.R Watson, S.Chen, “Power System Quality Assessment”, John Wiley & Sons, 20011
4. TuranGonen, “Electric Power Distribution Engineering”, CRC Press, 3rd Editio,2014

B.Tech.(VII Sem) (Honors)

20EEH4-ADVANCED ELECTRIC DRIVES

L	T	P	Cr.
4	0	0	4

Pre-requisites **:** Power Electronics, Solid State Drives

Course Educational Objective: This course enables the student to provide knowledge on various motor drives and also design and analysis of different advanced power converters to control AC motor drives.

Course Outcomes: At the end of the course, student will be able to:

CO1: Understand the vector control principle of Induction motors (**Understand-L2)**

CO2: Analyze the Sensor less vector control operation of Induction Motor. **(Apply-L3)**

CO3: Understand the control mechanism for synchronous motor drive. (**Understand-L2)**

CO4: Analyze the control mechanisms for switched reluctance and BLDC motor drives. **(Apply-L3)**

UNIT – I: VECTOR CONTROL OF INDUCTION MOTOR

Principles of vector control, Direct vector control, derivation of indirect vector control, implementation – block diagram; estimation of flux, flux weakening operation.

UNIT – II SENSORLESS VECTOR CONTROL OF INDUCTION MOTOR

Slip and Speed Estimation at low performance, Rotor Angle and Flux linkage Estimation at high performance -rotor Speed Estimation Scheme- estimators using rotor slot harmonics, Model Reference adaptive systems, Extended Kaman Filter

UNIT – III :CONTROL OF SYNCHRONOUS MOTOR DRIVES

Synchronous motor and its characteristics- Control strategies-Constant torque angle control power factor control, constant flux control, flux weakening operation, Load commutated inverter fed synchronous motor drive, motoring and regeneration, phasor diagrams

UNIT – IV: CONTROL OF SWITCHED RELUCTANCE MOTOR DRIVES

SRM-principle of operation, Design aspects of stator and rotor pole arcs, torque equation, torque-speed characteristics-Stator Excitation-techniques of sensor less operation-convertor topologies- SRM Waveforms-SRM drive design factors

UNIT – V: CONTROL OF BLDC MOTOR DRIVES

Principle of operation of BLDC Machine, Sensing and logic switching scheme, BLDM as Variable Speed Synchronous motor-methods of reducing Torque pulsations -Three-phase full wave Brushless dc motor -Sinusoidal type of Brushless dc motor - current controlled Brushless dc motor Servo drive.

TEXT BOOKS:

1. R. Krishnan “Electric Motor Drives Modelling, Analysis & control”, Pearson Education, 2015

2. Bimal K. Bose “Modern Power Electronics and AC Drives”, Prentice Hall,2002.

REFERENCE :

1. MD Murphy & FG Turn Bull “Power Electronics control of AC motors”, Pergman Press, 1st edition-1998

2. G.K. Dubey “Fundamentals of Electrical Drives”, CRC Press, 2002

3. Peter Vas “Sensor less Vector Direct Torque control”, Oxford University Press, 1998.

4. Venkataratnam “Special electrical Machines”, University press,2008.