SRI VASAVI ENGINEERING COLLEGE

(AUTONOMOUS)

(Sponsored by Sri Vasavi Educational Society)

(Approved by AICTE, New Delhi &Recognized by UGC under section 2(f) & 12(B))

(Permanently affiliated to JNTUK, Kakinada, Accredited by NBA and NAAC with 'A' Grade)

Pedatadepalli, **TADEPALLIGUDEM–534 101.**W.G.Dist. **(A.P)**

Department of Electrical & Electronics Engineering

Date: 07-09-2021

The fifth meeting of Board of Studies in Department of Electrical and Electronics Engineering is held at 11.00 AM on 03-09-2021 though online mode using gotomeeting tool (Meeting ID: 954129285).

The following members are attended the meeting.

S.No.	Name	Designation	Role
1.	Dr. Sudha Rani Donepudi	Professor, Head, Dept. of EEE, SVEC, Pedatadepalli.	Chairperson
2.	Dr. R. SrinivasaRao	Professor, Dept. of EEE, UCEK, JNTUK, Kakinada	Subject Expert Nominated By V.C.
3.	Dr. M. Sydulu	Professor, Dept. of EE, NITW, Warangal	Subject Expert Nominated By A.C.
4.	Dr. Y.P. Obulesu	Professor, School of EE, VIT, Vellore	Subject Expert Nominated By A.C.
5.	Er. B.N.V.R.C. Suresh Kumar	Retired AGM, PGCI, Hyderabad	Industry Expert Nominated By A.C
6.	Er. Ch. Vinay Kumar	Assistant Engineer, EHT Lines, APTRANSCO, Eluru.	Alumni
7.	Dr. Ch. Rambabu	Professor	Member
8.	U. Chandra Rao	Sr. Asst. Professor	Member
9.	N. Sri Harish	Asst. Professor	Member
10.	K Ramesh Babu	Asst. Professor	Member
11.	M.T.V. L Ravi Kumar	Asst. Professor	Member
12.	V. Rama Narayana	Asst. Professor	Member
13.	G Madhu Sagar Babu	Asst. Professor	Member
14.	A Uma Siva Naga Prasad	Asst. Professor	Member
15.	K. Venkata Reddy	Asst. Professor	Member
16.	K Amarendra	Asst. Professor	Member
17.	Mr. V.S. Aditya	Asst. Professor	Member
18.	Pradeep Vejju	Asst. Professor	Member
19.	Ch Srinivas	Asst. Professor	Member

The following are the minutes of the meeting

Item No. 1: Welcome note by the Chairperson BOS

The HOD extended a formal welcome and introduced the members.

Item No. 2: Progress Report of the Department

Chairperson BOS had given the Brief on Progress Report of the Department.

Item No. 3: Review of course structure for VII & VIII semesters of B. Tech EEE under V18 Regulation.

Reviewed and approved the course structure of VII & VIII semesters of B.Tech-EEE Programme under V18 Regulation.

The details of the approved course structure for VII & VIII semesters of UG (B.Tech) Programme (EEE) under V18 Regulation are given in Annexure-I

Item No. 4: Approval of syllabi for the courses offered in VII & VIII semesters B. Tech EEE under V18 Regulation.

Approved the syllabi for the courses offered in VII & VIII semesters B. Tech EEE under V18 Regulation.

The approved syllabi for the courses offered in VII and VIII semesters of B.Tech EEE of under V18 Regulation is attached in Annexure-II.

Item No. 5: Approval of list of courses offering under Open Elective- II & III in VII & VIII semester B. Tech respectively under V18 Regulation for all other branches and the approval of their detailed syllabi.

Approved the list of courses and syllabi for the courses offered as Open Electives in VII and VIII semesters B. Tech for all other branches under V18 Regulation and the details are given in Annexure III.

Item No. 6: Approval of course structure for III & IV semesters of B. Tech EEE under V20 Regulation.

Approved the course structure of III & IV semesters of B.Tech-EEE Programme under V20 Regulation with the following modifications.

SEM	Suggestions	Inclusions / Modifications
III & IV Skill Oriented Courses (SOC)	Suggested to add Raspberry-pi, Arduino, and E-CAD	Included Arduino Board and E-CAD into pool of SOC at second year level and Raspberry-pi will be included at third year level

The details of the approved course structure for III & IV semesters of UG (B.Tech) Programme (EEE) under V20 Regulation are given in Annexure-IV

Item No. 7: Approval of syllabi for the courses offered in III & IV semesters of B. Tech EEE under V20 Regulation.

Approved the syllabi for the courses offered in III & IV semesters B. Tech EEE under V20 Regulation with the following suggestions/modifications.

SEM	Course Code	Course Title	Suggestions	Inclusions / Modifications
III	V20EET04	Electrical Circuit Analysis-II	Replace Network Synthesis Unit with Filters	Replaced Network Synthesis Unit with Filters
IV	V20EET10	Electrical Power Generation & Transmission	Add introduction level of Renewable Sources in Unit-I	Included Introduction to Renewable Energy Sources, Solar and wind Power plant Layouts.
IV	V20EEL06	Electrical Measurements Laboratory	Add demonstration of new electronic meters available for field electrical engineers	Included demonstration of electronic meters as an experiment

The approved syllabi for the courses offered in III and IV semesters of B. Tech EEE of under V20 Regulation is attached in Annexure-V.

Item No. 8: Approval of syllabi for the courses offered in III & IV semesters for other branches of B. Tech under V20 Regulation.

Approved the syllabus for the course offered in IV semesters B. Tech ECE under V20 Regulation and is given in Annexure – VI.

Item No. 9: Approval of course structure for I to IV semesters of M. Tech Power Electronics and Power Systems (PE&PS) under V21 Regulation.

Approved the proposed course structure from I to IV semesters M. Tech Power Electronics and Power Systems (PE&PS) under V21 Regulation with following suggestions/modifications.

SEM	Suggestions	Inclusions / Modifications
I	Advanced Digital Signal Processing Course (Course Code: V21PET04) in Elective –I can be replaced with Smart Grid	Advanced Digital Signal Processing Course (Course Code: V21PET04) is replaced with Smart Grid (Course Code: V21PET04)

II	DSP Controlled Drives course (Course code: V21PET12) in Elective-III can be changed as Control of Electric Drives	DSP Controlled Drives course (Course code: V21PET12) in Elective-III is modified as Control of Electric Drives (Course code: V21PET12)
III	In Elective-III, Optimization Techniques (Course code: V21PET18) and Artificial Intelligent Techniques (Course code: V21PET19) can combine together as a Soft Computing Techniques	Optimization Techniques (Course code: V21PET18) is merged with Artificial Intelligent Techniques (Course code: V21PET19) and renamed as Soft Computing Techniques in Electrical Engineering (Course code: V21PET18)

The approved course structure from I to IV semesters M. Tech Power Electronics and Power Systems (PE&PS) under V21 Regulation is given in Annexure VII.

Item No. 10: Approval of syllabi for the courses offered form I to IV semesters of M. Tech Power Electronics and Power Systems (PE&PS) under V21 Regulation.

Approved the syllabi for various courses offered from I to IV semesters of M. Tech Power Electronics and Power Systems (PE&PS) under V21 Regulation with the following modifications.

SEM	Course Code	Course Title	Suggestions	Inclusions / Modifications
I	V21PET02	Power System Operation & Control	Included Load Flow Analysis	Load Flow Analysis is added in the syllabus

The approved syllabi for various courses offered from I to IV semesters of M. Tech Power Electronics and Power Systems (PE&PS) under V21 Regulation is given in Annexure VIII.

Dr. Sudha Rani Donepudi

(BOS Chairperson)

Dr. Sudha Rani Donepudi, M.E., Ph.D
Head of the Department
Electrical & Electronics Engineering
SRI VASAVI ENGINEERING COLLEGE
(Autonomous)

Annexure I

Approved Course Structure of VII and VIII Semesters under V18 Regulation

VII Semester

S.No.	Course Code	Name of the Course	L	T	P	Credits
1.	V18EET26	Power System Operation and Control	3	-	-	3
2.	V18EET27	AI Techniques for Power Systems	3	-	-	3
3.		Professional Elective - III V18EET28 Power Quality V18EET29 High Voltage Engineering V18EET30 Modelling and Simulation of Power Electronics V18EET31 Flexible AC Transmission Systems	3		-	3
4.		Professional Elective – IV V18EET32 Modern Control Theory V18EET33 Smart Grid V18EET34 Electrical Machine Modelling Analysis V18EET35 Control of Grid Connected PV and Wind Energy Systems	3	-	-	3
5.		Open Elective – II	3	-	-	3
6.	V18EEL10	Power Systems Laboratory	-	-	2	1
7.	V18EEP01	Project Part - A	-	-	6	3
		Total Contact Hours(23)	**15**	**0**	**8**	**20**

VIII Semester

S.No.	Course Code	Name of the Course	L	T	P	Credits
1.		Professional Elective - V V18EET36 Electrical Distribution Systems V18EET37 Digital Signal Processing V18EET38 Digital Control Systems V18EET39 Electrical and Hybrid Vehicles	3	-	-	3
2.		Professional Elective – VI V18EET40 Power Systems Reforms V18EET41 Energy Storage and Management V18EET42 Switched Mode Power Converters V18EET43 Electrical Machine Design	3	-	-	3
3.		Open Elective – III	3	-	-	3
4.	V18EEP02	Project Part - B	-	-	18	9
		Total Contact Hours(27)	**9**	**0**	**18**	**18**

- **Internship/Industrial Training certificate must be submitted on or before last instruction day of VII Semester, otherwise his/her Semester End Examination results will not be declared.**
- **Certification Course certificate must be submitted on or before last instruction day of VII Semester, otherwise his/her Semester End Examination results will not be declared.**

Annexure II

Syllabi for the Courses offered in VII & VIII Semesters B. Tech EEE Under V18 Regulation

Semester	**VII SEM**	**L**	**T**	**P**	**C**	**Course Code**
Regulation	**V18**	**3**	**-**	**-**	**3**	**V18EET26**
Name of the Course	**Power System Operation and Control**					
Branches	**EEE**					

Course Outcomes:
After successful completion of this course, the students will be able to

CO No.	Course Outcome	Knowledge Level
CO1	Analyze the optimal scheduling of power generating thermal units	**K4**
CO2	Compute optimal hydro and thermal scheduling.	**K3**
CO3	Predict the optimal unit commitment problem	**K3**
CO4	Calculate the transfer function of single area and two area load frequency control.	**K4**
CO5	Evaluate the steady state response of single area load control with PI controller.	**K5**
CO6	Assess the reactive power control and compensation of transmission lines.	**K3**

UNIT–I: ECONOMIC OPERATION OF POWER SYSTEMS
Optimal operation of Generators in Thermal power stations, Heat rate curve, Cost Curve, Incremental fuel and Production costs, Input–output characteristics, Optimum generation allocation with line losses neglected, Optimum generation allocation including the effect of transmission line losses, Loss Coefficients, General transmission line loss formula.

UNIT–II: HYDROTHERMAL SCHEDULING
Optimal scheduling of Hydrothermal System: Hydroelectric power plant models, Scheduling problems, Short term hydrothermal scheduling problem.

UNIT–III: UNIT COMMITMENT
Optimal unit commitment problem, Need for unit commitment, Constraints in unit commitment, Cost function formulation, Solution methods, Priority ordering, Dynamic programming.

UNIT–IV: LOAD FREQUENCY CONTROL-I
Modeling of steam turbine, Generator, Mathematical modeling of speed governing system– Transfer function – Modeling of Hydro turbine –Necessity of keeping frequency constant–Definitions of Control area – Single area control system – Block diagram representation of an isolated power system – Steady state analysis – Dynamic response – Uncontrolled case. Proportional plus Integral control of single area and its block diagram representation – Steady state response.

UNIT–V: LOAD FREQUENCY CONTROL-II

Block diagram development of Load Frequency Control of two area system uncontrolled case and controlled case. Tie-line bias control. Load Frequency Control and Economic dispatch control.

UNIT–VI: REACTIVE POWER CONTROL

Overview of Reactive Power control – Reactive Power compensation in transmission systems– Advantages and disadvantages of different types of compensating equipment for transmission systems – Load compensation – Specifications of load compensator – Uncompensated and compensated transmission lines: Shunt and series compensation – Need for FACTS controllers.

TEXT BOOKS:

1. Electric Energy Systems Theory – by O. I. Elgerd, Tata Mc Graw–hill Publishing Company Ltd., Second edition. 2017
2. Power System stability & control, Prabha Kundur, TMH ,First Edition 2006.
3. Modern Power System Analysis – by I. J. Nagrath & D. P. Kothari Tata Mc Graw – Hill Publishing Company Ltd, 2nd edition Energy management by Paul o' Callaghan, Mc–Graw Hill Bookcompany–1st edition, 1998.

REFERENCE BOOKS:

1. Power System Analysis and Design by J. Duncan Glover and M.S. Sarma, THOMPSON, 6rd Edition2019.
2. Power System Analysis by Grainger and Stevenson, Tata McGraw Hill2017.
3. **https://nptel.ac.in/courses/108/101/108101040/**

Semester	**VII SEM**	**L**	**T**	**P**	**C**	**Course Code**
Regulation	**V18**	**3**	**-**	**-**	**3**	**V18EET27**
Name of the Course	**AI Techniques for Power Systems**					
Branches	**EEE**					

Course Outcomes:

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

CO No.	**Course Outcome**	**Knowledge Level**
CO1	Understand fundamentals concepts of artificial neural networks.	K2
CO2	Understand concepts of different algorithms ANN paradigms.	K2
CO3	Understand fundamentals of fuzzy set properties and membership functions.	K2
CO4	Understand the concept of evolutionary techniques operation.	K2
CO5	Understand fundamentals of optimization techniques.	K2
CO6	Apply optimization techniques to power system applications.	K4

UNIT-I: ARTIFICIAL INTELLIGENCE
Artificial Neural Networks (ANN) – definition and fundamental concepts – Biological neural networks – Artificial neuron – activation functions – setting of weights – typical architectures – biases and thresholds – learning/training laws and algorithms.

UNIT-II: ANN PARADIGMS
ADALINE – feed forward networks – Back Propagation algorithm-Radial Basis Function (RBF) network- Hopfield Neural Network.

UNIT- III: CLASSICAL AND FUZZY SETS
Introduction to classical sets- properties, Operations and relations; Fuzzy sets, Membership, Operations, Properties, Fuzzy relations, Membership functions.

UNIT-IV: EVOLUTIONARY TECHNIQUES
Introduction-concepts of genetic algorithms: Initialization-Selection-Genetic operators, Mutation- Evolutionary programming-Evolutionary techniques.

UNIT-V: FUNDMENTALS OF OPTIMIZATION
Classification of optimization problems-Unconstrained and Constrained optimization-Particle swarm optimization.

UNIT-VI: APPLICATIONS OF AI
PSO based Economic load dispatch without losses, Load flow, and Load frequency control: Single area system using ANN.

TEXT BOOKS:

1. Neural Networks, Fuzzy logic, Genetic algorithms: synthesis and applications by Rajasekharan and pai – PHI Publication, 2011.
2. Fuzzy logic with Fuzzy Applications – T.J Ross – Mc Graw Hill Inc, 1997.
3. NP Padhy, Artificial Intelligence and Intelligent Systems, Oxford University Press, 1st Edition, 2005.

REFERENCE BOOKS:

1. Goldberg D.E. "Genetic Algorithms in Search Optimization & Machine Learning", 13th Edition Addition Wesley Co., New York 1996.
2. D.P.Kothari and J.S.Dhillon, "Power System Optimization", 2ndEdition, PHI learning private limited, 2010
3. **https://nptel.ac.in/content/storage2/courses/109101003/downloads/Lecture-notes/Lecture-19-20-21.pdf**

Semester	**VII SEM**	**L**	**T**	**P**	**C**	**Course Code**
Regulation	**V18**	**3**	**-**	**-**	**3**	**V18EET28**
Name of the Course	**Power Quality (Professional Elective – III)**					
Branches	**EEE**					

Course Outcomes:

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

CO No.	**Course Outcome**	**Knowledge Level**
CO1	Explain different types of power quality phenomena	**K2**
CO2	Illustrate sources for voltage sag, voltage swell, interruption, transients, long duration over voltages & harmonics in a power system	**K3**
CO3	Describe power quality terms & study power quality standards	**K2**
CO4	Discuss principle of voltage regulation & power factor improvement methods	**K2**
CO5	Assess the relationship between distributed generation & power quality	**K3**
CO6	Discuss the power quality monitoring concepts & the usage of measuring instruments	**K2**

UNIT–I: INTRODUCTION

Overview of power quality – Concern about the power quality – General classes of power quality and voltage quality problems – Transients – Long–duration voltage variations – Short–duration voltage variations – Voltage unbalance – Waveform distortion – Voltage fluctuation – Power frequency variations.

UNIT–II: VOLTAGE IMPERFECTIONS IN POWER SYSTEMS

Power quality terms – Voltage sags – Voltage swells and interruptions – Sources of voltage sag, swell and interruptions – Nonlinear loads – IEEE and IEC standards. Source of transient over voltages – Principles of over voltage protection – Devices for over voltage protection – Utility capacitor switching transients.

UNIT–III: VOLTAGE REGULATION AND POWER FACTOR IMPROVEMENT

Principles of regulating the voltage – Device for voltage regulation – Utility voltage regulator application – Capacitor for voltage regulation – End–user capacitor application – Regulating utility voltage with distributed resources – Flicker – Power factor penalty – Static VAR compensations for power factor improvement.

UNIT– IV: HARMONIC DISTORTION AND SOLUTIONS

Voltage distortion vs. Current distortion – Harmonics vs. Transients – Harmonic indices – Sources of harmonics – Effect of harmonic distortion – Impact of capacitors, transformers, motors and meters – Point of common coupling – Passive and active

filtering – Numerical problems.

UNIT–V: DISTRIBUTED GENERATION AND POWER QUALITY

Resurgence of distributed generation – DG technologies – Interface to the utility system – Power quality issues and operating conflicts – DG on low voltage distribution networks.

UNIT–VI: MONITORING AND INSTRUMENTATION

Power quality monitoring and considerations – Historical perspective of PQ measuring instruments – PQ measurement equipment – Assessment of PQ measuring data – Application of intelligent systems – PQ monitoring standards.

TEXTBOOKS:

1. Electrical Power Systems Quality, Dugan R C, Mc Granaghan M F, Santoso S, and Beaty H W, Second Edition, McGraw–Hill, 2012, 3rdedition.
2. Electric power quality problems –M. H. J. Bollen IEEE series-Wiley Indiapublications,2011.

REFERENCE BOOKS:

1. Power Quality Primer, Kennedy B W, First Edition, McGraw–Hill,2000.
2. Understanding Power Quality Problems: Voltage Sags and Interruptions, Bollen M HJ, First Edition, IEEE Press;2000.
3. Power System Harmonics, Arrillaga J and Watson N R, Second Edition, John Wiley & Sons,2003.
4. Power Quality C. shankaran, CRC Press,2001
5. Power Quality in Power systems and Electrical Machines–Ewald F. fuchs, Mohammad A. S. Masoum–Elsevier.2nd edition 2015
6. **https://nptel.ac.in/courses/108/106/108106025/**

Semester	**VII SEM**	**L**	**T**	**P**	**C**	**Course Code**
Regulation	**V18**	**3**	**-**	**-**	**3**	**V18EET29**
Name of the Course	**High Voltage Engineering (Professional Elective – III)**					
Branches	**EEE**					

Course Outcomes:

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

CO No.	Course Outcome	Knowledge Level
CO1	Describe the electric field stress on different configuration of electrodes.	K2
CO2	Understand the breakdown phenomena in various dielectric materials.	K2
CO3	Illustrate the generation of high DC, AC and Impulse voltages and Currents.	K2
CO4	Explain various methods available for measurement of high DC, AC and Impulse voltages and currents.	K2
CO5	Describe different methods for measuring DC Resistivity, Dielectric Constant, Loss Factor & explain the phenomena of Partial Discharge.	K2
CO6	Illustrate the testing techniques for various equipment's used in High Voltage Engineering.	K2

UNIT–I: INTRODUCTION TO HIGH VOLTAGE TECHNOLOGY

Electric Field Stresses – Uniform and non–uniform field configuration of electrodes – Estimation and control of electric Stress – Numerical methods for electric field computation.

UNIT–II: BREAK DOWN PHENOMENON IN GASEOUS, LIQUID AND SOLID INSULATION

Gases as insulating media – Collision process – Ionization process – Townsend's criteria of breakdown in gases – Paschen's law – Liquid as Insulator – Pure and commercial liquids – Breakdown in pure and commercial liquid – Intrinsic breakdown – Electromechanical breakdown – Thermal breakdown –Breakdown of solid dielectrics, composite dielectrics used in practice.

UNIT–III: GENERATION OF HIGH VOLTAGES AND HIGH CURRENTS

Generation of High DC voltages – Generation of High Alternating Voltages – Generation of Impulse Voltages and Currents – Tripping and Control of Impulse Generators.

UNIT–IV: MEASUREMENT OF HIGH VOLTAGES AND HIGH CURRENTS

Measurement of High - Direct Current Voltages, AC and Impulse Voltages; Measurement of High – DC, AC and Impulse Currents.

UNIT–V: NON–DESTRUCTIVE TESTING OF MATERIAL AND ELECTRICAL APPARATUS

Measurement of DC Resistivity – Measurement of Dielectric Constant and Loss Factor – Partial Discharge Measurements.

UNIT–VI: High Voltage Testing of Electrical Apparatus

Testing of Insulators and Bushings – Testing of Isolators and Circuit Breakers – Testing of Cables – Testing of Transformers – Testing of Surge Diverters – Radio Interference Measurements.

TEXT BOOKS:

1. High Voltage Engineering: Fundamentals by E.Kuffel, W.S.Zaengl, J.Kuffel by Elsevier, 2nd Edition,2000.
2. High Voltage Engineering and Technology by Ryan, IET Publishers.3rd Edition,2013.

REFERENCE BOOKS:

1. High Voltage Engineering by M.S.Naidu and V. Kamaraju – TMH Publications, 4th Edition2009
2. High Voltage Engineering by C.L.Wadhwa, New Age Internationals (P) Limited, 1997.
3. High Voltage Insulation Engineering by Ravindra Arora, Wolfgang Mosch, New Age International (P)Limited, 1995.
4. **https://nptel.ac.in/courses/108/104/108104048/**

Semester	**VIISEM**	**L**	**T**	**P**	**C**	**Course Code**
Regulation	**V18**	**3**	**-**	**-**	**3**	**V18EET30**
Name of the Course	**Modelling and Simulation of Power Electronics (Professional Elective – III)**					
Branches	**EEE**					

Course Outcomes:

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

CO No.	**Course Outcome**	**Knowledge Level**
CO1	Understand the background activities i.e. numerical solution used in the simulation software.	**K3**
CO2	Describe the transient analysis in circuit simulation	**K2**
CO3	Explain the concepts of simulation of power electronic converters	**K2**
CO4	Compute properties of switching functions in single and parallel switch	**K3**
CO5	Express mathematical modelling of different converters	**K2**
CO6	Develop state space averaging technique and Hybrid Modelling for DC-DC converter	**K3**

UNIT-I: INTRODUCTION

Challenges in computer simulation – Simulation process–mechanics of simulation, Solution techniques for time domain analysis-Equation solvers, circuit-oriented simulators.

UNIT-II: SIMULATION OF POWER ELECTRONIC CONVERTERS-1

MNA and ST Approaches- Nodal Analysis, Modified Nodal Analysis, The Spare Tableau Approach, Nonlinear Circuits - The Newton Raphson Method, Computation Time, Convergence Issues, Nonlinear Circuit Equations, Introduction to Transient Simulation-Introduction, Discretization of Time, Transient Analysis, Accuracy and Stability, Explicit and Implicit Schemes, Methods for Transient Simulation - FE, BE and TRZ, Transient Analysis in Circuit Simulation, Equivalent Circuit Approach: RC Circuit,

UNIT- III: SIMULATION OF POWER ELECTRONIC CONVERTERS– II

Buck Converter; Some Practical Aspects: Undamped Oscillations, Ringing, Global Error in Switching Circuits, Round-off Error, Assessment of Accuracy,SingularMatrixProblem,Trapezoidalintegration,M&Nmethodforsimulatingpowerelectronicconverters(with buck converter as are presentative example).

UNIT-IV: SWITCHINGFUNCTION

Introduction, Application of the switching function technique, Properties of the switching function, Voltage-Current relations in switched circuits - Single Switch,

Parallel Switch, Pulse Width Modulation- Unipolar, PWM Signal of a composite function, bipolar square wave modulation.

UNIT-V: MATHEMATICAL MODELING OF CONVERTERS

Mathematical Modeling of Buck Converter, Modeling using switching function-buck converter, Rectifier,3-phase VSI inverter, matrix converter, m-phase rectifier. PWM rectifier topologies, modeling of power electronic converters-PWM rectifier in different frames-abc, alpha-beta and d-q.

UNIT-VI: MODELING, SIMULATION OF SWITCHING CONVERTERS WITH STATE SPACE AVERAGING, HYBRID MODEL

State space approach, averaging method, State Space Averaging Technique–Modeling AND linearization of converter transfer function-Hybrid Modeling for DC-DC converter.

TEXT BOOKS:

1. M. B. Patil, V. Ramnarayanan, V. T. Ranganathan: *Simulation of Power Electronic Converters*, 1st ed., Narosa Publishers, 2010

REFERENCE BOOKS:

1. Ned Mohan, Undeland and Robbins, "Power Electronics: Converters, Design and control"-3rd ed., John Wiley 2009.
2. https://nptel.ac.in/courses/108/106/108106023/

Semester	**VII SEM**	**L**	**T**	**P**	**C**	**Course Code**
Regulation	**V18**	**3**	**-**	**-**	**3**	**V18EET31**
Name of the Course	**Flexible AC Transmission Systems (Professional Elective – III)**					
Branches	**EEE**					

Course Outcomes:

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

CO No.	**Course Outcome**	**Knowledge Level**
CO1	Determine power flow control in transmission lines by using FACTS controllers.	**K3**
CO2	Explain operation and control of voltage source converter.	**K2**
CO3	Discuss compensation methods to improve stability and reduce power oscillations in the transmission lines.	**K2**
CO4	Explain the method of shunt compensation by using static VAR compensators.	**K2**
CO5	Appreciate the methods of compensations by using series compensators..	**K3**
CO6	Explain the operation of two modern power electronic controllers (Unified Power Quality Conditioner and Interline Power Flow Controller)	**K2**

UNIT-I: FACTS CONCEPTS

Introduction to FACTS: Transmission interconnections power flow in an AC system, loading capability limits, Dynamic stability considerations, importance of controllable parameters basic types of FACTS controllers, benefits from FACTS controllers.

UNIT-II: VOLTAGE SOURCE CONVERTERS

Single & three phase full wave bridge converters, Three level voltage source converter, pulse width modulation, basic concept of current source converters, and comparison of current source converters with voltage source converters

UNIT- III: STATIC SHUNT COMPENSATION

Objectives of shunt compensation: mid-point voltage regulation, voltage instability prevention, improvement of transient stability, Power oscillation damping, Methods of controllable VAR generation, variable impedance type static VAR generators switching converter type VAR generators, hybrid VAR generators.

UNIT-IV: STATICSHUNT COMPENSATION-2

Thyristor Switched Capacitor (TSC)– Thyristor Switched Capacitor – Thyristor Switched Reactor (TSC–TCR). Static VAR compensator (SVC) and Static Compensator (STATCOM): The regulation and slope transfer function and dynamic performance – Transient stability enhancement and power oscillation damping– Operating point control and summary of compensation control.

UNIT-V: SERIESCOMPENSATORS

Static series compensators: Concept of series capacitive compensation Improvement of transient stability – Power oscillation damping – Functional requirements. GTO thyristor controlled Series Capacitor (GSC) – Thyristor Switched Series Capacitor (TSSC) and Thyristor Controlled Series Capacitor (TCSC).

UNIT-VI: COMBINED CONTROLLERS

Schematic and basic operating principles of unified power flow controller (UPFC) and Interline power flow controller (IPFC) – Application of these controllers on transmission lines.

TEXT BOOKS:

1. Understanding FACTS" N. G. Hingorani and L. Guygi, IEEE Press. Indian Edition is available:––Standard Publications, 2001.
2. Thyristor-based FACTS Controllers for Electrical Transmission Systems, by R. Mohan Mathur and Rajiv K. Varma, Wiley, 2002.

REFERENCE BOOKS:

1. Zhang, Xiao-Ping, Rehtanz, Christian, Pal, Bikash "Flexible AC Transmission Systems: Modeling and Control", Springer, 2012.
2. Yong-Hua Song, Allan Johns, "Flexible AC Transmission Systems", IET, 1999.
3. **https://nptel.ac.in/courses/108/107/108107114/**

Semester	**VII SEM**	**L**	**T**	**P**	**C**	**Course Code**
Regulation	**V18**	**3**	**-**	**-**	**3**	**V18EET32**
Name of the Course	**Modern Control Theory (Professional Elective – IV)**					
Branches	**EEE**					

Course Outcomes:

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

CO No.	Course Outcome	Knowledge Level
CO1	Describe and analyse systems in state space model	K2
CO2	Model a system in various canonical forms	K3
CO3	Design a controller and observer using state feedback	K4
CO4	Analyse non-linear system using describing functions	K3
CO5	Analyse non-linear system using Phase plane analysis	K3
CO6	Analyse non-linear system using Lypanov method	K3

UNIT – I: STATE VARIABLE DESCRIPTION
Concept of State – State Equations for Linear Continuous time Models-Non uniqueness of state model – State diagrams for continuous time state models – Solution of state equations – State transmission matrix.

UNIT – II: CONTROLLABILITY AND OBSERVABILITY
Tests for controllability and observability for continuous time systems – Time varying case, minimum energy control, time invariant case, Principle of Duality, Controllability and observability of state models in Jordan canonical form and other canonical forms.

UNIT – III: MODAL CONTROL
Effect of state feedback on controllability and observability, Design of State Feedback Control through Pole placement. Full order observer and reduced order observer.

UNIT – IV: DESCRIBING FUNCTION ANALYSIS
Introduction to nonlinear systems, Types of nonlinearities, Concepts of describing functions, Derivation of describing functions for Dead zone, Saturation, backlash, relay with dead zone and Hysteresis – Jump Resonance.

UNIT-V: PHASE-PLANE ANALYSIS
Introduction to phase-plane analysis, Method of Isoclines for Constructing Trajectories, Singular points, Phase-plane analysis of nonlinear control systems.

UNIT-VI: STABILITY ANALYSIS
Stability in the sense of Lyapunov. Lyapunov‘s stability and Lypanov‘s instability theorems. Direct method of Lypanov for the Linear and Nonlinear continuous time autonomous systems.

TEXT BOOKS:

1. Modern Control System Theory – by M. Gopal, New Age International Publishers, 2nd edition, 1996.
2. Systems and Control by Stainslaw H. Zak , Oxford Press, 2003.

REFERENCE BOOKS:

1. Modern Control Engineering – by K. Ogata, Prentice Hall of India, 3rd edition, 1998.
2. Control Systems Engineering by I.J. Nagrath and M.Gopal, New Age International (P) Ltd. 2007.
3. Digital Control and State Variable Methods – by M. Gopal, Tata Mc Graw-Hill companies, 1997.
4. https://nptel.ac.in/courses/108/103/108103007/

Semester	VII SEM	L	T	P	C	Course Code
Regulation	V18	4	-	-	3	V18EET33
Name of the Course	Smart Grid (Professional Elective – IV)					
Branches	EEE					

Course Outcomes:

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

CO No.	Course Outcome	Knowledge Level
CO1	Understand concept of smart grid and its advantages over conventional grid.	K2
CO2	Explain the architecture of smart Grid	K2
CO3	Illustrate the concept of Micro Grid and its integration	K3
CO4	Understand smart metering techniques and measuring techniques	K2
CO5	Examine different communication technologies that can be used for smart grid	K3
CO6	Identify the power quality problems associated with smart grid	K2

UNIT –I: INTRODUCTION TO SMART GRID

Introduction to Smart Grid - Need of Smart Grid, Working definitions of Smart Grid and Associated Concepts – Smart Grid Functions – Traditional Power Grid and Smart Grid – New Technologies for Smart Grid – Advantages –– Key Challenges for Smart Grid.

UNIT—II: SMART GRID ARCHITECTURE

Components and Architecture of Smart Grid Design – Review of the proposed architectures for Smart Grid-Geographic Information System(GIS)-The fundamental components of Smart Grid designs – Transmission Automation – Sub-Station Automation -Distribution Automation – Feeder Automation, Renewable Integration

UNIT-III: DISTRIBUTION GENERATION

Introduction-necessity of DG– Concept of micro grid-Issues of interconnection-protection & control of micro grid – Storage Technologies – Smart Storages, Battery, SMES– Economic Issues.

UNIT-IV: SMART METERS

Introduction to smart Meters-Phasor Measurement Unit (PMU)-Wide Area Measurement Systems (WAMS). Intelligent Electronic Devices (IED) & their application for monitoring & protection

UNIT-V: INFORMATION AND COMMUNICATION TECHNOLOGY FOR SMART GRID

Advanced Metering infrastructure (AMI) drivers and benefits-AMI protocols-Standards and initiatives-AMI needs in the smart grid, Home Area Network (HAN), Wide Area Network (WAN)

UNIT – VI: POWER QUALITY MANAGEMENT IN SMART GRID

Introduction, Power Quality, Power Quality Issues of Grid Connected Renewable Energy Sources, Load Frequency Control (LFC) and Voltage Control in Micro Grid System – Reactive Power Control in Smart Grid- Web based Power Quality Monitoring-Permanent Power Quality Monitoring Equipment-Power Quality Audit.

TEXT BOOKS:

1. James Momoh, "Smart Grid :Fundamentals of Design and Analysis"-Wiley, IEEE Press,2012
2. Ali Keyhani, Mohammad N. Marwali, Min Dai ―Integration of Green and Renewable Energy in Electric Power Systems‖, Wiley2010.
3. JanakaEkanayake, KithsiriLiyanage, Jianzhong.Wu, AkihikoYokoyama, Nick Jenkins,"Smart Grid: Technology and Applications"- Wiley, 2012.
4. A.G. Phadke and J.S. Thorp, "Synchronized Phasor Measurements and their Applications", Springer Edition, 2010

REFERENCE BOOKS:

1. Yang Xiao, "Communication and Networking in Smart Grids", CRC Press 2012.
2. Wiley Blackwell 3.Peter S. Fox Penner, "Smart Power: Climate Changes, the Smart Grid, and the Future of Electric Utilities", Island Press; 1 edition 8 Jun 2010.
3. Stuart Borlase, "Smart Grids (Power Engineering)", CRC Press2015.
4. https://nptel.ac.in/courses/108/107/108107113/

Semester	**VII SEM**	**L**	**T**	**P**	**C**	**Course Code**
Regulation	**V18**	**3**	**-**	**-**	**3**	**V18EET34**
Name of the Course	**Electrical Machine Modelling & Analysis (Professional Elective – IV)**					
Branches	**EEE**					

Course Outcomes:

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

CO No.	Course Outcome	Knowledge Level
CO1	Analyze Kroon's Primitive Machine	K2
CO2	Develop modeling of dc machine	K3
CO3	Explain linear Transformation	K4
CO4	Apply mathematical modeling concepts to 3-phase Induction machines	K3
CO5	Design control strategies based on dynamic modeling of 3-ph Induction machines and3-phase Synchronous machine	K4
CO6	Analyze BLDC Machine and switched reluctance machine based on Mathematical modeling of BLDCM and SRM	K4

UNIT – I: BASIC CONCEPTS OF MODELING

Basic Two-pole Machine representation of Commutator machines, 3-phase synchronous machine with and without damper bars and 3-phase induction machine, Kron's primitive Machine-voltage, current and Torque equations.

UNIT – II: DC MACHINE MODELING

Mathematical model of separately excited D.C motor – Steady State analysis-Transient State analysis- Sudden application of Inertia Load-Transfer function of separately excited D.C Motor- Mathematical model of D.C Series motor, Shunt motor

UNIT- III: REFERENCE FRAME THEORY & MODELING OF SINGLE PHASE INDUCTION MACHINES

Linear transformation-Phase transformation - three phase to two phase transformation (abc to dq0) and two phase to three phase transformation dq0 to abc -Power equivalence- Mathematical modeling of single phase induction machines.

UNIT – IV: MODELING OF THREE PHASE INDUCTION MACHINE

Generalized model in arbitrary reference frame-Electromagnetic torque-Derivation of commonly used Induction machine models- Stator reference frame model-Rotor reference frame model-Synchronously rotating reference frame model-state space model with flux linkages as variables.

UNIT –V: MODELING OF SYNCHRONOUS MACHINE

Synchronous machine inductances–voltage equations in the rotor's dq0 reference frame electromagnetic torque- current in terms of flux linkages-three synchronous machine model.

UNIT –VI: MODELING OF SPECIAL MACHINES

Modeling of PM Synchronous motor, modeling of BLDC motor, modeling of Switched Reluctance motor.

TEXT BOOKS:

1. Generalized theory of Electrical Machinery–P. S. Bimbra - Khanna Publishers.-6th Edition 2017.
2. Electric Motor Drives-Modeling, Analysis & control- R. Krishnan-Pearson Publications-1st edition- 2002.

REFERENCE BOOKS:

1. Analysis of Electrical Machinery and Drive systems– P. C. Krause, Oleg Wasynczuk, Scott D. Sudhoff – Second Edition-IEEE Press2002.
2. Dynamic simulation of Electric machinery using Matlab / Simulink – Chee Mun Ong - PHI.1997.
3. Modern Power Electronics and AC Drives-B. K. Bose –PHI2001.
4. https://nptel.ac.in/courses/108/106/108106023/

Semester	**VII SEM**	**L**	**T**	**P**	**C**	**Course Code**
Regulation	**V18**	**3**	**-**	**-**	**3**	**V18EET35**
Name of the Course	**Control of Grid Connected Converters for PV and Wind Energy Systems (Professional Elective – IV)**					
Branches	**EEE**					

Course Outcomes:

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

CO No.	**Course Outcome**	**Knowledge Level**
CO1	Understand the basic requirements of grid for connecting PV and WT converters.	K2
CO2	Describe various grid synchronization techniques for single phase power converters.	K2
CO3	Describe various grid synchronization techniques for three phase power converters.	K2
CO4	Illustrate various filter topologies and control techniques for grid connected converters.	K2
CO5	Explain different MPPT Control Methods and limitations of standard MPPT.	K2
CO6	Illustrate the control of grid converter for renewable energy interface	K2

UNIT–I: GRID REQUIREMENT FOR PV AND WT SYSTEM

Introduction, International Regulations, Response to Abnormal Grid Conditions, Power Quality. Grid Code Evolution for WT system, Frequency and Voltage Deviation under Normal Operation, Active Power Control in Normal Operation, Reactive Power Control in Normal Operation.

UNIT–II: GRID SYNCHRONIZATION FOR SINGLE-PHASE POWER CONVERTERS

Grid Synchronization Techniques for Single-Phase Systems, Phase Detection Based on In-Quadrature Signals, Some PLLs Based on In-Quadrature Signal Generation.

UNIT–III: GRID SYNCHRONIZATION FOR THREE-PHASE POWER CONVERTERS

The Three-Phase Voltage Vector under Grid Faults, Synchronous Reference Frame PLL under Unbalanced and Distorted Grid Conditions, Decoupled Double Synchronous Reference Frame PLL (DDSRF-PLL), Double Second-Order Generalized Integrator FLL (DSOGI-FLL).

UNIT–IV: INTRODUCTION TO CONTROL STRATEGY OF CONVERTERS WITH DIFFERENT FILTER CONFIGURATIONS

Filter Topologies, Design Considerations, Practical Examples of LCL Filters and Grid Interactions, Resonance Problem and Damping Solutions, Nonlinear Behavior of the Filter. Converter configurations, Different current Control techniques– PI control, PR control, HCC, Model Predictive control.

UNIT–V: MPPT CONTROL FOR PV AND WT SYSTEM

The Dynamic Optimization Problem, Fractional Open-Circuit Voltage and Short-Circuit Current, MPPT Control Methods, The Perturb and Observe Approach, Improvements of the P&O Algorithm, The Incremental Conductance Method, MPPT Efficiency, Limitation of standard MPPT. Charge controller for off grid PV system.

UNIT–VI: GRID CONVERTER CONTROL FOR RENEWABLE ENERGY INTERFACE

Model of the Converter-Mathematical Model of the L-Filter Inverter; AC Voltage and DC Voltage Control-Management of the DC Link Voltage, Cascaded Control of the DC Voltage through the AC Current, Tuning Procedure of the PI Controller, PI-Based Voltage Control; Voltage Oriented Control (VOC) and Direct Power Control (DPC): Synchronous Frame VOC: PQ Open-Loop Control, PQ Closed-Loop Control, Direct Power Control, Stand-alone.

REFERENCES BOOKS:

1. Grid Converters for Photovoltaic and Wind Power systems, IEEE, A John Wiley and Sons, Ltd, Publication2010.
2. Power Electronics and Control Techniques for Maximum Energy Harvesting in Photovoltaic systems, CRC Press, Taylor and Francis Group2013.
3. Photovoltaic Power System: Modeling, Design, and Control by Weidong Xiao, Wiley Publication2017.
4. Modern MPPT Techniques for Photovoltaic Energy Systems by Ali M. Eltamaly, Almoataz Y. Abdelaziz, Springer International Publishing2020.
5. https://nptel.ac.in/courses/117/108/117108141/

Semester	**VII SEM**	**L**	**T**	**P**	**C**	**COURSE CODE**
Regulation	**V18**	**3**	**-**	**-**	**3**	**V18EEL10**
Name of the Course	**Power Systems Lab**					
Branches	**EEE**					

Course Outcomes:

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

CO No.	**Course Outcome**	**Knowledge Level**
CO1	Calculate the sequence impedances of 3 phase Transformer	**K4**
CO2	Determine the power Angle Characteristics of 3-phase Alternator with infinite bus bars	**K4**
CO3	Calculate the dielectric strength of Transformer oil	**K4**
CO4	Explain load flow studies using N-R method	**K5**
CO5	Assess load frequency control with &without controller	**K5**
CO6	Evaluate economic load dispatch with & without losses	**K5**

Any 10 of the Following experiments are to be conducted:

1. Sequence impedances of 3 phase Transformer.
2. Sequence impedances of 3 phase Alternator by Fault Analysis.
3. Sequence impedances of 3 phase Alternator by Direct method.
4. ABCD parameters of Transmission line.
5. Power Angle Characteristics of 3phase Alternator with infinite bus bars.
6. Dielectric strength of Transformer oil.
7. Calibration of Tong Tester.
8. Load flow studies using Gauss-Seidel method
9. Load flow studies using N-R method
10. Transient Stability Analysis
11. Load frequency control with & without control
12. Load frequency control with control
13. Economic load dispatch with & without losses
14. Economic load dispatch with losses.

Semester	**VIII SEM**	**L**	**T**	**P**	**C**	**Course Code**
Regulation	**V18**	**3**	**-**	**-**	**3**	**V18EET36**
Name of the Course	**Electrical Distribution Systems (Professional Elective – V)**					
Branches	**EEE**					

Course Outcomes:

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

CO No.	**Course Outcome**	**Knowledge Level**
CO1	Understand various factors of distribution system	**K2**
CO2	Construct the distribution substation and feeders	**K3**
CO3	Calculate the voltage drop and power loss calculations on Distribution System	**K3**
CO4	Understand the distribution system protection and its coordination.	**K2**
CO5	Understand the effect of compensation for power factor improvement.	**K2**
CO6	Understand the effect of voltage control on distribution system.	**K2**

UNIT I: GENERAL CONCEPTS

Introduction to distribution systems, Load modeling and characteristics, Coincidence factor, Contribution factor loss factor, Relationship between the load factor and loss factor, Classification of loads (Residential, commercial, Agricultural and Industrial).

UNIT II: SUBSTATIONS & DISTRIBUTION FEEDERS

Location of substations: Rating of distribution substation, Service area with 'n' primary feeders, Benefits and methods of optimal location of substations.

Design Considerations of distribution feeders: Radial and loop types of primary feeders, Voltage levels, Feeder loading, Basic design practice of the secondary distribution system.

UNIT III: SYSTEM ANALYSIS

Voltage drops and power–loss calculations: Derivation for voltage drop and power loss in lines, uniformly distributed loads and non-uniformly distributed loads, Numerical problems, three phase balanced primary lines.

UNIT IV: PROTECTION & CO-ORDINATION

Objectives of distribution system protection, Types of common faults and procedure for fault calculations for distribution system, Protective devices: Principle of operation of fuses, Circuit reclosures, Line sectionalizes and circuit breakers.

Co-ordination of protective devices: General coordination procedure, Various types of coordinated operation of protective devices, Residual Current Circuit Breaker.

UNIT V: COMPENSATION FOR POWER FACTOR IMPROVEMENT

Capacitive compensation for power factor control, Different types of power capacitors, shunt and series capacitors, Effect of shunt capacitors (Fixed and switched), Power factor correction, Capacitor allocation, Economic justification, Procedure to determine the best capacitor location, Numerical problems.

UNIT VI: VOLTAGE CONTROL

Equipment for voltage control, Effect of series capacitors, Effect of AVB/AVR, Line drop compensation

TEXT BOOK:

1. "Electric Power Distribution system, Engineering" – by Turan Gonen, CRC press, 2nd edition, 2007.
2. Electric Power Distribution – by A.S. Pabla, Tata McGraw–hill Publishing Company, 4th edition, 1997.

REFERENCE BOOKS:

1. Electrical Distribution Systems by Dale R. Patrick and Stephen W. Fardo, CRC press, 2nd edition, 2021.
2. Electrical Power Distribution Systems by V. Kamaraju, 8th edition, 2014, Right Publishers.
3. https://nptel.ac.in/courses/108/107/108107112/.

Semester	**VIII SEM**	**L**	**T**	**P**	**C**	**Course Code**
Regulation	**V18**	**3**	**-**	**-**	**3**	**V18EET37**
Name of the Course	**Digital Signal Processing (Professional Elective – V)**					
Branches	**EEE**					

Course Outcomes:

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

CO No.	**Course Outcome**	**Knowledge Level**
CO1	Classify Discrete Time Signals, systems, estimate the response of various Systems	**K2**
CO2	Compute DFT for discrete time signals using FFT Algorithm.	**K3**
CO3	Describe the various implementations of digital filter structures.	**K2**
CO4	Analyze and design a Digital filter (FIR&IIR) from the given specifications.	**K4**
CO5	Use the Multi-rate Processing concepts in various applications.	**K2**
CO6	Describe the concepts of DSP Processor.	**K3**

UNIT I: INTRODUCTION

Review of Signals and systems, Digital Signal Processing: Discrete time signals & sequences, Classification of Discrete time Systems, stability of LTI systems. Response of LTI systems to arbitrary inputs. Solution of Linear constant coefficient difference equations. Frequency domain representation of discrete time signals and systems.

UNIT II: DISCRETE FOURIER TRANSFORMS

Introduction to DTFT, Discrete Fourier transforms, Properties of DFT, Introduction to Fast Fourier transforms (FFT) - Radix-2 decimation in time and decimation in frequency FFT Algorithms, Inverse FFT.

UNIT III: REALIZATION OF DIGITAL FILTER

Review of Z-transform, digital filters, Block diagram representation of linear constant coefficient difference equations, Basic structures of IIR systems, Transposed forms. Basic structures of FIR systems.

UNIT IV: DESIGN OF IIR and FIR DIGITAL FILTERS

Analog filter approximations – Butterworth and Chebyshev, Design of IIR Digital filters from Analog filters, Characteristics of FIR Digital Filters, frequency response. Design of FIR Digital Filters using Window Techniques and Frequency Sampling technique, Comparison of IIR & FIR filters.

UNIT V: MULTIRATE DIGITAL SIGNAL PROCESSING

Introduction, Decimation, Interpolation, Sampling rate conversion, Implementation of sampling rate converters, Applications – Sub-band Coding of Speech Signals.

UNIT VI: INTRODUCTION TO DSP PROCESSORS

Introduction to programmable DSPs, Multiplier and Multiplier Accumulator, Modified bus structures and memory access schemes in P-DSPs, Multiple Access Memory, Multiported memory, VLIW architecture, Pipelining, Special addressing modes, On-Chip Peripherals.

TEXT BOOKS:

1. Digital Signal Processing, Principles, Algorithms, and Applications by John G. Proakis, Dimitris G. Manolakis, Pearson Education / PHI, 4th edition, 2007.
2. Discrete Time Signal Processing by A. V. Oppenheim and R.W. Schaffer, 3rd edition, 2010, PHI.

REFERENCE BOOKS:

1. Digital Signal Processing by Andreas Antoniou, TATA McGraw Hill, 2nd edition, 2006
2. Digital Signal Processing by MH Hayes, Schaum's Outlines, TATA Mc-Graw Hill, 2nd edition, 2007.
3. Digital Signal Processing by Alan V. Oppenheim, Ronald W. Schafer, PHI Ed., 2nd edition, 2006
4. Digital Signal Processing by Ramesh babu, Sci Tech publications, 6th edition, 2011.
5. Digital Signal Processing by A. Nagoor Kani, RBA Publications, 2nd edition, 2017.
6. https://nptel.ac.in/courses/117/102/117102060/

Semester	**VIII SEM**	**L**	**T**	**P**	**C**	**Course Code**
Regulation	**V18**	**3**	**-**	**-**	**3**	**V18EET38**
Name of the Course	**Digital Control Systems (Professional Elective – V)**					
Branches	**EEE**					

Course Outcomes:

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

CO No.	Course Outcome	Knowledge Level
CO1	Understand the concepts of digital signal processing	**K2**
CO2	Solve difference equations and determine pulse transfer functions	**K3**
CO3	Analyze a discrete time system using state space model	**K3**
CO4	Determine the stability of a discrete time system	**K4**
CO5	Design a controller for discrete time system using conventional methods	**K4**
CO6	Design a controller for discrete time system using state feedback	**K4**

UNIT – I: INTRODUCTION AND SIGNAL PROCESSING

Introduction to analog and digital control systems – Advantages of digital systems – Typical examples – Signals and processing – Sample and hold devices – Sampling theorem and data reconstruction – Digital to Analog conversion and Analog to Digital conversion Frequency domain characteristics of zero order hold.

UNIT–II: Z-TRANSFORMS

Z-Transform and theorems, finding inverse and method for solving difference equations; Pulse transforms function, block diagram analysis of sampled – data systems.

UNIT–III: STATE SPACE ANALYSIS

State Space Representation of discrete time systems, Pulse Transfer Function Matrix solving discrete time state space equations, State transition matrix and it's Properties, Methods for Computation of State Transition Matrix, Discretization of continuous time state – space equations- Concepts of controllability and observability – Tests(without proof).

UNIT–IV: STABILITY ANALYSIS

Mapping between the S-Plane and the Z-Plane – Primary strips and Complementary Strips – Constant frequency loci, Constant damping ratio loci, Stability Analysis of closed loop systems in the Z-Plane. Jury stability test – Stability Analysis by use of the Bilinear Transformation and Routh Stability criterion.

UNIT – V: DESIGN OF DISCRETE TIME CONTROL SYSTEM BY CONVENTIONAL METHODS

Transient and steady – State response Analysis – Design based on the frequency response method – Bilinear Transformation and Design using frequency response in the w–plane for lag and led compensators and digital PID controllers.

UNIT – VI: STATE FEEDBACK CONTROLLERS AND OBSERVERS

Design of state feedback controller through pole placement – Necessary and sufficient conditions, Ackerman's formula.

TEXT BOOKS:

1. K. Ogata, "Discrete–Time Control systems", Pearson Education/PHI, 2nd Edition.
2. M. Gopal, "Digital Control and State Variable Methods", TMH, 4th Edition.

REFERENCE BOOKS:

1. Kuo, "Digital Control Systems", Oxford University Press, 2nd Edition, 2003.
2. https://nptel.ac.in/courses/108/103/108103008/

Semester	**VIII SEM**	**L**	**T**	**P**	**C**	**Course Code**
Regulation	**V18**	**3**	**-**	**-**	**3**	**V18EET39**
Name of the Course	**Electrical and Hybrid Vehicles (Professional Elective – V)**					
Branches	**EEE**					

Course Outcomes:

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

CO No.	**Course Outcome**	**Knowledge Level**
CO1	Differentiate between Electric vehicles and Hybrid Electric Vehicles	**K2**
CO2	Discriminate between various Drive-Train Topologies	**K2**
CO3	Identify different motors used for hybrid electric vehicles.	**K2**
CO4	Explain the Sizing of Drive Train	**K2**
CO5	Illustrate different batteries and other energy storage systems.	**K3**
CO6	Discuss Various issues of energy management strategies	**K2**

UNIT-I: INTRODUCTION TO ELECTRIC VEHICLES

Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics-Social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies.

UNIT-II: DRIVE TRAINS

Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train.

Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train.

UNIT-III: ELECTRIC PROPULSION UNIT

Introduction to electric components used in hybrid and electric vehicles, control of DC Motor drives, Control of Permanent Magnet Motor drives, control of Switch Reluctance Motor drives, drive system efficiency.

UNIT-IV: ENERGY STORAGE

Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage, Fuel Cell based energy storage - Super Capacitor based energy storage - Flywheel based energy storage

UNIT-V: SIZING THE DRIVE SYSTEM

Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems

UNIT-VI: ENERGY MANAGEMENT STRATEGIES

Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, implementation issues of energy management strategies.

TEXT BOOKS:

1. Ali Emadi, Advanced Electric Drive Vehicles, CRC Press, 1st edition, 2014.
2. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 1st edition, 2003.

REFERENCE BOOKS:

1. Mehrdad Ehsani, Yimin Gao, Ali Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: fundamentals, theory, and design, 2nd edition, 2009.
2. Sandeep Dhameja, "Electric Vehicle Battery Systems", Newnes, 1st edition, 2001.
3. http://nptel.ac.in/courses/108103009/

Semester	**VIII SEM**	**L**	**T**	**P**	**C**	**Course Code**
Regulation	**V18**	**4**	**-**	**-**	**3**	**V18EET40**
Name of the Course	**Power System Reforms (Professional Elective – VI)**					
Branches	**EEE**					

Course Outcomes:

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

CO No.	**Course Outcome**	**Knowledge Level**
CO1	Understand fundamentals of power system deregulation and restructuring.	**K2**
CO2	Compute Available Transfer Capability (ATC)	**K3**
CO3	Apply methods to reduce congestion	**K3**
CO4	Compute electricity pricing in deregulated environment	**K3**
CO5	Understand the power system operation in deregulated environment	**K2**
CO6	Understand importance of ancillary services	**K2**

UNIT-I: BASIC ISSUES IN ELECTRIC UTILITIES

Introduction – Restructuring models – Independent system operator (ISO) – Power Exchange – Market operations – Market Power – Stranded cost – Transmission Pricing – Congestion Pricing

UNIT-II: OVERVIEW OF OASIS

Structure of OASIS – Posting of Information – Transfer capability on OASIS –Definitions of Transfer capability – Transfer Capability Issues – ATC calculations – TTC calculations – TRM calculations – CBM calculations – Methods to calculate ATC.

UNIT-III: CONGESTION MANAGEMENT

Introduction to congestion management –Effects of congestion – Methods to relieve congestion – Non market methods –Market Based methods –Management of Inter zonal/Intra zonal Congestion

UNIT-IV: PRICING OF ELECTRICITY

Introduction – Electricity price volatility – Factors effecting volatility – Measuring Volatility – electricity price indexes– Construction of forward price curves – Short–time price forecasting – Factors impacting electricity prices – Forecasting Methods – Analysing forecasting errors – Impact of data pre-processing – Impact of training vectors.

UNIT-V: POWER SYSTEM OPERATION IN DEREGULATED ENVIRONMENT

Introduction – Operational planning activities of ISO – The ISO in pool markets – The ISO in bilateral markets – Operational planning activities of a GENCO– the GENCO in pool markets – The GENCO in bilateral markets.

UNIT-VI: ANCILLARY SERVICES

Introduction – Types of ancillary services – Reactive power as an ancillary service – Synchronous generators as ancillary service providers.

TEXT BOOKS

1. Mohammad Shahidehpour, and Muwaffaqalomoush, – "Restructured electrical Power systems" Marcel Dekker, Inc. 1st edition, 2001
2. Kankar Bhattacharya, Math H.J. Boller, Jaap E. Daalder, 'Operation of Restructured Power System' Kluver Academic Publisher, 2nd edition, 2001

REFERENCE BOOKS

1. Loi Lei Lai; "Power system Restructuring and Deregulation", Jhon Wiley & Sons Ltd., England, 1st edition, 2001.
2. Electrical Power Distribution Case studies from Distribution reform, upgrades and Management (DRUM) Program, by USAID/India, TMH, 1st edition, 2012.
3. https://nptel.ac.in/courses/108/101/108101005/.

Semester	**VIII SEM**	**L**	**T**	**P**	**C**	**Course Code**
Regulation	**V18**	**3**	**-**	**-**	**3**	**V18EET41**
Name of the Course	**Energy Storage and Battery Management (Professional Elective – VI)**					
Branches	**EEE**					

Course Outcomes:

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

CO No.	**Course Outcome**	**Knowledge Level**
CO1	Understand need of energy storage systems	**K3**
CO2	Determine various types of energy storage and various devices used for the purpose	**K3**
CO3	Examine various real time applications	**K3**
CO4	Interpret the role of battery management system	**K3**
CO5	Illustrate the requirements of Battery Management System	**K3**
CO6	Interpret the concept associated with battery charging / discharging process	**K3**

UNIT-I: INTRODUCTION TO ENERGY STORAGE

Necessity of energy storage, different types of energy storage, mechanical, chemical, electrical, electrochemical, biological, magnetic, electromagnetic, thermal, comparison of energy storage technologies.

UNIT-II: NEEDSFOR ELECTRICAL ENERGY STORAGE

Emerging needs for EES, More renewable energy, less fossil fuel, Smart Grid uses, the roles of electrical energy storage technologies, the roles from the viewpoint of a utility, the roles from the viewpoint of consumers, the roles from the viewpoint of generators of renewable energy.

UNIT- III: FEATURES OF ENERGY STORAGE SYSTEMS

Classification of EES systems , Mechanical storage systems, Pumped hydro storage (PHS), Compressed air energy storage (CAES), Flywheel energy storage (FES),Electrochemical storage systems, Secondary batteries, Flow batteries, Chemical energy storage, Hydrogen (H2),Synthetic natural gas (SNG).

UNIT- IV: INTRODUCTION TO BATTERY MANAGEMENT SYSTEM

Introduction to Battery Management System, Cells & Batteries, Nominal voltage and capacity, C rate, Energy and power, Cells connected in series, Cells connected in parallel, Electrochemical and lithium-ion cells, Rechargeable cell, Charging and Discharging Process, Overcharge and Undercharge, Modes of Charging.

UNIT- V: BATTERY MANAGEMENT SYSTEM REQUIREMENT

Introduction and BMS functionality, Battery pack topology, BMS Functionality, Voltage Sensing, Temperature Sensing, Current Sensing, BMS Functionality, High-voltage contactor control, Isolation sensing, Thermal control, Protection, Communication Interface, Range estimation, State-of charge estimation, Cell total energy and cell total power.

UNIT- VI: BATTERY STATE OF CHARGE AND STATE OF HEALTH ESTIMATION, CELL BALANCING

Battery state of charge estimation (SOC), voltage-based methods to estimate SOC, Model-based state estimation, Battery Health Estimation, Lithium-ion aging: Negative electrode, Lithium ion aging: Positive electrode, Cell Balancing, Causes of imbalance, Circuits for balancing

TEXT BOOKS:

1. "James M. Eyer, Joseph J. Iannucci and Garth P. Corey ", "Energy Storage Benefits and Market Analysis", Sandia National Laboratories, 1st edition, 2004.
2. The Electrical Energy Storage by IEC Market Strategy Board.

REFERENCE BOOK:

1. "Jim Eyer, Garth Corey", Energy Storage for the Electricity Grid: Benefits and Market Potential Assessment Guide, Report, Sandia National Laboratories, Feb 2010.
2. Plett, Gregory L. Battery management systems, Volume I: Battery modeling. Artech House, 1st edition, 2015.
3. Plett, Gregory L. Battery management systems, Volume II: Equivalent-circuit methods. Artech House, 1st edition, 2015.
4. Bergveld, H.J., Kruijt, W.S., Notten, P.H.L "Battery Management Systems -Design by Modelling" Philips Research Book Series 2002.
5. https://nptel.ac.in/content/storage2/courses/108103009/download/M9.pdf.

Semester	**VIII SEM**	**L**	**T**	**P**	**C**	**Course Code**
Regulation	**V18**	**3**	**-**	**-**	**3**	**V18EET42**
Name of the Course	**Switched Mode Power Converters (Professional Elective – VI)**					
Branches	**EEE**					

Course Outcomes:

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

CO No.	**Course Outcome**	**Knowledge Level**
CO1	Compute the operation and control of non-isolated switch mode converters	**K3**
CO2	Explain the operation and control of isolated switch mode converters	**K2**
CO3	Describe the concepts of resonant converters	**K2**
CO4	Compute control strategies of switching converters	**K3**
CO5	Develop modeling of DC-DC converters	**K3**
CO6	Illustrate controller design based on linearization	**K3**

UNIT-I: NON-ISOLATEDSWITCHMODECONVERTERS

Control of DC-DC converters: Buck converters, Boost converters, Buck-Boost converter, CUK Converter, continuous and discontinuous operation, Converter realization with non-ideal components.

UNIT-II: ISOLATED SWITCHED MODE CONVERTERS

Forwarded converter, fly back converter, push-pull converter, half-bridge converter, full bridge converter

UNIT- III: RESONANT CONVERTERS

Basic resonant circuit concepts, series resonant circuits, parallel resonant circuits, zero current switching quasi-resonant buck converter, zero current switching quasi-resonant boost converter, zero voltage switching quasi-resonant buck converter, zero voltage switching quasi-resonant boost converter.

UNIT-IV: CONTROL SCHEMES OF SWITCHING CONVERTERS

Voltage control, Current mode control, control scheme for resonant converters. Magnetic design consideration: Transformer design, inductor and capacitor design

UNIT-V: MODELING OF DC-DC CONVERTERS

Formulation of averaged models for buck and boost converters: state space analysis, average circuit models, linearization and small– signal analysis, small-signal models.

UNIT-VI: CONTROLLER DESIGN BASED ON LINEARIZATION

Control design based on linearization: Transfer function of converters, control design, large signal issues in voltage-mode and current-mode control.

TEXT BOOKS:

1. Fundamentals of Power Electronics-Erickson, Robert W.,Maksimovic, Dragan, Springer,2nd edition, 2011.
2. Power switching converters –SimonAng, Alejandro Oliva, CRCPress, 3rd edition, 2010.
3. Elements of Power Electronics–Philip T. Krein, Oxford University press, 2nd edition, 2014.
4. Design of Magnetic Components for Switched Mode Power Converters- Umanand, S.P. Bhat, John Wiley & Sons Australia, 1st edition, 1992.

REFERENCE BOOKS:

1. Power Electronics: Essentials and applications-L. Umanand, Wiley publications, 1st edition, 2009.
2. Switching Power Supply Design – Abraham I. Pressman, McGraw-Hill Ryerson, Limited, 3rd edition, 2009.
3. Power Electronics– Issa Batareseh, Jhon Wiley publications, 4th edition, 2004.
4. Power Electronics: converters Applications & Design–Mohan, Undeland, Robbins-Wiley publications 3rd edition, 2007.
5. https://nptel.ac.in/courses/108/108/108108036/.

Semester	**VIII SEM**	**L**	**T**	**P**	**C**	**Course Code**
Regulation	**V18**	**3**	**-**	**-**	**3**	**V18EET43**
Name of the Course	**Electrical Machine Design (Professional Elective – VI)**					
Branches	**EEE**					

Course Outcomes:

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

CO No.	**Course Outcome**	**Knowledge Level**
CO1	Study mmf calculation and thermal rating of various types of electrical machines.	**K2**
CO2	To design armature and field systems for D.C. machines.	**K3**
CO3	To design core, yoke, windings and cooling systems of transformers.	**K3**
CO4	To design stator and rotor of induction machines.	**K3**
CO5	To design stator and rotor of synchronous machines and study their thermal behavior	**K3**
CO6	The importance of computer aided design method.	**K3**

UNIT I: DESIGN OF FIELD SYSTEM AND ARMATURE

Major considerations in Electrical Machine Design – Electrical Engineering Materials – Space factor – Choice of Specific Electrical and Magnetic loadings – Thermal considerations – Heat flow – Temperature rise and Insulating Materials – Rating of machines – Standard specifications.

UNIT II: DESIGN OF DC MACHINES

Construction - Output Equations – Main Dimensions – Choice of specific loadings – Selection of number of poles – Design of Armature – Design of commutator and brushes – design of field Computer program: Design of Armature main dimensions.

UNIT III: DESIGN OF TRANSFORMERS

Construction - KVA output for single and three phase transformers – Overall dimensions – design of yoke, core and winding for core and shell type transformers – Estimation of No load current – Temperature rise in Transformers – Design of Tank and cooling tubes of Transformers. Computer program: Complete Design of single phase core transformer.

UNIT IV: DESIGN OF INDUCTION MOTORS

Construction - Output equation of Induction motor – Main dimensions – choice of specific loadings – Design of squirrel cage rotor and wound rotor –Magnetic leakage calculations – Operating characteristics : Magnetizing current - Short circuit current – Circle diagram - Computer program: Design of slip-ring rotor .

UNIT V: DESIGN OF SYNCHRONOUS MACHINES

Output equations – choice of specific loadings – Design of salient pole machines – Short circuit ratio – Armature design – Estimation of air gap length – Design of rotor –Design of damper

winding – Determination of full load field MMF – Design of field winding – Design of turbo alternators.

UNIT VI: DESIGN OF BLDC MACHINES

Computer program: Design of Stator main dimensions-Brushless DC Machines.

TEXT BOOKS:

1. Sawhney, A.K., 'A Course in Electrical Machine Design', Dhanpat Rai & Sons, New Delhi, 1st edition, 1984.
2. M. V. Deshpande "Design and Testing of Electrical Machine Design" Wheeler Publications, 1st edition, 2010.

REFERENCES BOOKS:

1. A. Shanmuga Sundaram, G. Gangadharan, R. Palani 'Electrical Machine Design Data Book', New Age International Pvt. Ltd., Reprint, 1st edition, 2007.
2. R. K. Agarwal "Principles of Electrical Machine Design" Esskay Publications, Delhi, 1st edition, 2002.
3. Sen, S.K., 'Principles of Electrical Machine Designs with Computer Programmes', Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, 1st edition, 1987.
4. https://nptel.ac.in/courses/108/106/108106023/.

Annexure III

List courses offered under Open Elective –II & III in VII & VII semesters respectively under V18 Regulation for all other branches:

Open Electives(Offered to the other Departments)						
S. No.	**Course Code**	**Name of the Course**	**L**	**T**	**P**	**Credits**
Open Elective-I: (Approved by BOS)						
1.	V18EEOE1	Energy Audit & Conservation	3	-	-	3
2.	V18EEOE2	Electrical Measuring Instruments	3	-	-	3
3.	V18EEOE3	Industrial Safety	3	-	-	3
Open Elective-II: (For the Approval from BOS)						
1.	V18EEOE4	Non-Conventional Energy Sources	3	-	-	3
2.	V18EEOE5	Electrical Engineering Materials	3	-	-	3
3.	V18EEOE6	Servicing of Electrical Appliances	3	-	-	3
Open Elective-III: (For the Approval from BOS)						
1.	V18EEOE7	Energy Storage Systems	3	-	-	3
2.	V18EEOE8	Basics of Electrical Power Generation	3	-	-	3
3.	V18EEOE9	Industrial Automation	3	-	-	3

Semester	No. of Credits
I	16.5
II	19.5
III	22
IV	21
V	24
VI	20
VII	19
VII	18
Total	160

Syllabi for the Courses offering under Open Elective – II & III

Semester	**VII SEM**	**L**	**T**	**P**	**C**	**Course Code**
Regulation	**V18**	**3**	**-**	**-**	**3**	**V18EETOE4**
Name of the Course	**Non Conventional Energy Sources (Open Elective-II)**					
Branches	**EEE**					

Course Outcomes:

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

CO No.	**Course Outcome**	**Knowledge Level**
CO1	Understand the solar radiation and calculate geometric angle	**K3**
CO2	Understand the working of solar thermal collectors	**K2**
CO3	Understand the working of solar photo voltaic systems and develop the maximum power point techniques	**K3**
CO4	Understand the wind energy conversion systems, Betz coefficient and tip speed ratio.	**K2**
CO5	Understand the basic principle and working of hydro and tidal systems.	**K2**
CO6	Understand the basic principle and working of, biomass, fuel cell and geothermal systems.	**K2**

UNIT–I: FUNDAMENTALS OF SOLAR ENERGY AND ENERGY CONSERVATION PRINCIPLE

Energy scenario (world and India) – various forms of renewable energy - Solar radiation: Outside earth's atmosphere –Earth surface– Analysis of solar radiation data –Geometry– Radiation on tilted surfaces– Numerical problems.

UNIT–II: SOLAR THERMAL SYSTEMS

Liquid flat plate collectors: Performance analysis –Transmissivity– Absorptivity product collector efficiency factor –Collector heat removal factor – Numerical problems. Introduction to solar air heaters – Concentrating collectors, solar pond and solar still–solar thermal plants.

UNIT–III: SOLAR PHOTOVOLTAIC SYSTEMS

Solar photovoltaic cell, module, array – construction – Efficiency of solar cells – Developing technologies – Cell I-V characteristics – Equivalent circuit of solar cell – Series resistance – Shunt resistance – Applications and systems –Balance of system components - System design: storage sizing – PV system sizing – Maximum power point techniques: Perturb and observe(P&O)technique–Hill climbing technique.

UNIT–IV: WIND ENERGY

Sources of wind energy - Wind patterns – Types of turbines –Horizontal axis and vertical axis machines - Kinetic energyofwind–Betzcoefficient–Tip–speedratio–Efficiency–Poweroutputofwindturbine–Selection of generator(synchronous,induction) –Maximum power point tracking –wind farms–Power generation for utility grids.

UNIT–V: HYDRO AND TIDAL POWER SYSTEMS

Basic working principle – Classification of hydro systems: Large, small, micro–measurement of head and flow–Energy equation – Types of turbines – Numerical problems. Tidal power – Basics – Kinetic energy equation – Turbines for tidal power - Numerical problems – Wave power – Basics – Kinetic energy equation – Wave power devices – Linear generators.

UNIT–VI: BIOMASS AND GEOTHERMALSYSTEMS

Fuel classification – Pyrolysis – Direct combustion of heat– Different digesters and sizing. Geothermal: Classification – Dry rock and hot aquifer–Energy analysis–Geothermal based electric power generation

TEXT BOOKS:

1. Solar Energy: Principles of Thermal Collection and Storage, S.P. Sukhatme and J.K. Nayak, TMH, New Delhi, 3rd edition , 2013.
2. Renewable Energy Resources, John Twidell and Tony Weir, Taylor and Francis-2nd edition, 2013.

REFERENCE BOOKS:

1. Energy Science: Principles, Technologies and Impacts, John Andrews and Nick Jelly, Oxford University Press, 2nd edition, 2013.
2. Renewable Energy-Edited by Godfrey Boyle- oxford University. Press, 3rd edition, 2013.
3. Hand book of renewable technology Ahmed and Zobaa, Ramesh C Bansal, World scientific, Singapore, 1st edition, 2011.
4. Renewable Energy Technologies, Ramesh & Kumar, Narosa, 1st edition, 1997.
5. Renewable energy technologies– A practical guide for beginners –Chetong Singh Solanki, PHI, 1st edition, 2008.
6. Non-conventionalenergysource–B.H.khan-TMH-2nd edition, 2017.
7. https://nptel.ac.in/courses/121/106/121106014/.

Semester	**VII SEM**	**L**	**T**	**P**	**C**	**Course Code**
Regulation	**V18**	**3**	**-**	**-**	**3**	**V18EEOE5**
Name of the Course	**Electrical Engineering Materials (Open Elective-II)**					
Branches	**EEE**					

Course Outcomes:

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

CO No.	**Course Outcome**	**Knowledge Level**
CO1	Familiarise the properties of different conducting materials and their applications	**K2**
CO2	Analyse the properties of Insulating materials	**K2**
CO3	Understand semi conducting and dielectric materials and their properties	**K2**
CO4	Understand Magnetic materials and their properties	**K2**
CO5	Comprehend the working function of Special purpose materials	**K2**
CO6	Understand and analyse the working of Various Batteries	**K3**

UNIT-I: CONDUCTING MATERIALS

Conducting Materials – Properties -Hardening, Annealing – Its effects- Low Resistive Materials –Requirements – Properties and applications of Copper and Aluminum - Comparison between Copper and Aluminum - ACSR Conductors, AAAC, - High Resistive Materials – Requirements-Properties and applications of Manganin, Eureka, Constantan, Nichrome, Tungsten, Mercury and Carbon-colour coding of resistor.

UNIT-II: INSULATING MATERIALS

Properties -Insulation resistance - Factors effecting Insulation resistance - Classification of Insulating materials - Properties & Applications i) Impregnated paper ii) Wood iii) Cardboard iv) Asbestos v)Mica vi)Ceramics and vii) Glass- Thermo Plastics, Thermo Setting resins – PVC- Effects on PVC- Properties and Applications of Insulating Gases(Air, Nitrogen, Hydrogen and Sulphur Hexa Fluoride).

UNIT- III: SEMICONDUCTING & DIELECTRIC MATERIALS

Semiconductors - Intrinsic and Extrinsic semiconductors- `P' and `N' type materials- Distinguish between P-type and N- type Semi-Conductors. Permittivity of different Di-electric materials-Polarization-Dielectric Loss– Applications of Dielectrics- Colour coding of capacitors.

UNIT-IV: MAGNETIC MATERIALS

Classification of magnetic materials - Soft & Hard magnetic materials- B-H Curves – Hysteresis loop - Hysteresis loss - Steinmetz constant - Eddy Current Loss -- Curie Point – Magneto striction.

UNIT-V: SPECIAL PURPOSE MATERIALS

Need of Protective materials – List of Special Purpose Materials (Lead, Paints, Steel Tapes) - Thermocouple - Bi-metals- Fabrication -Soldering- Fuses -Galvanizing and Impregnating- Importance of Nano Materials.

UNIT-VI: BATTERIES

Primary cell and Secondary cells-Lead-Acid, Nickel iron and Nickel - cadmium -Chemical reactions during charging and discharging– Charging of Batteries- Constant Current method and Constant Voltage method-Trickle charging- Capacity of Battery - Ampere-Hour efficiency and Watt-Hour efficiency-Numerical problems on Ampere-Hour efficiency and Watt-Hour efficiency - Maintenance free batteries

TEXT BOOKS:

1. Electrical Engineering Materials – N.I.T.T.T.R Publications, 1st edition, 1959.
2. Introduction to Engineering materials – B. K. Agarwal, 1st edition, 2006.
3. Electrical Engineering Materials by PL Kapoor, Khanna Publishers, New Delhi, 1st edition, 1988.
4. Electrical & Electronics Engineering Materials BR Sharma and Others, Satya Parkashan, New Delhi, 1st edition, 2013.

REFERENCE BOOKS

1. Electronic Components -Dr. K. Padmanabham, laxmi publications (p) Ltd, 1st edition, 2016.
2. Electronic Components -D. V. Prasad
3. Material science for Electrical and Electronic Engineers – Ian P. Jones, Oxford Publications, 1st edition, 2000.
4. Electrical and Electronic Engineering Materials by SK Bhattacharya, Khanna Publishers, New Delhi Electronic Components and Materials by Grover and Jamwal, Dhanpat Rai and Co., New Delhi, 1st edition, 1996.
5. Electrical Engineering Materials by Sahdev, Unique International Publications
6. Electronic Components and Materials by SM Dhir, Tata McGraw Hill, New Delhi, 1st edition, 2006.
7. Electronic Engineering Materials by ML Gupta, Dhanpat Rai & Sons, New Delhi

Semester	**VII SEM**	**L**	**T**	**P**	**C**	**Course Code**
Regulation	**V18**	**3**	**-**	**-**	**3**	**V18EEOE6**
Name of the Course	**Servicing of Electrical Appliances (Open Elective-II)**					
Branches	**EEE**					

Course Outcomes:

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

CO No.	Course Outcome	Knowledge Level
CO1	Understand Testing of Electrical Domestic Appliances	**K2**
CO2	Understand maintenance of U.P.S and SMPS	**K2**
CO3	Understand Maintenance of Electrical Power devices	**K2**
CO4	Understand Safety procedure	**K2**
CO5	Understand Departmental Tests	**K2**
CO6	Understand Rural electrification and Indian Electricity Act	**K2**

UNIT-I: TESTING OF ELECTRICAL DOMESTIC APPLIANCES

Tools & meters required for testing and repair of Domestic appliances-Principle, construction & working with fault finding, dismantling, assembling and testing after repair of the Domestic appliances.

Note: Suitable tests to be conducted on the above Electrical Domestic appliances are Open circuit, Short circuit, Earth fault and Leakage tests.

UNIT-II: U.P.S AND SMPS

Commercial power supply-Disturbances and Spikes in voltages-UPS-SMPS

UNIT- III: MAINTENANCE OF ELECTRICAL POWER DEVICES

Preventive and periodical maintenance schedule of the following electrical power devices. i.e Batteries (Dry / Wet), UPS / Inverters, DC & AC Motors, Motor starters (AC & DC), Air conditioners, Power transformers, Pole mounted & Plinth mounted transformer yards, Circuit breakers.

UNIT-IV: SAFETY

Need of safety - Equipment used in Electrical and general safety - Different types of Electrical hazards / accidents - Causes of different Electrical hazards / accidents - Methods to avoid Electrical hazards / accidents - First-Aid methods followed to rescue a person met with Electric shock - Do's & Don't's of Electrical supervisor at Electrical substations - Different fire extinguishers- operation and application of different fire extinguishers.

UNIT-V: DEPARTMENTAL TESTS

Electrical installation testing - departmental procedure for testing before giving service connection – departmental procedure for obtaining service connection - desirable insulation resistance for domestic and power circuits – Tests for measuring insulation resistance - procedure for conducting insulation resistance test and continuity tests, earth continuity test

UNIT-VI: RURAL ELECTRIFICATION AND INDIAN ELECTRICITY ACTS.

Design of rural electrification scheme - Load survey-determination of capacity of transformer - estimation of quantity of materials required for the erection of distribution lines and 11 kV feeder from a nearby 11 kV feeder - determining the economic feasibility of the scheme as per the procedure laid out in NEC, - Indian Electricity Act-2003 rules related to domestic and Industrial lighting- power, agricultural and earthing installations, erection of 11 kV, 400 Volt

TEXT BOOKS:

1. Operation & Maintenance of Electrical Machines Vol – I by B.V.S. Rao - Media Promoters & Publisher, 1963.
2. Operation & Maintenance of Electrical Machines Vol – II by B.V.S. Rao - Media Promoters & Publisher, 1967.
3. Study of Electrical Appliances and devices by K. B. Bhatia, Khanna Publishers, New Delhi, 1st edition, 1988.

REFERENCE BOOKS:

1. Preventive Maintenance by C.J. Hubert, zs
2. Testing, Commissioning Operation & Maintenance of Electrical equipment by S. Rao
3. Indian Electricity Act-2003
4. APERC regulation Act (www.aperc.gov.in)
5. Electrical Installation design and drawing by CR Dargar -New Asian publishers

Semester	**VIII SEM**	**L**	**T**	**P**	**C**	**Course Code**
Regulation	**V18**	**3**	**-**	**-**	**3**	**V18EEOE7**
Name of the Course	**Energy Storage Systems (Open Elective-III)**					
Branches	**EEE**					

Course Outcomes:

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

CO No.	**Course Outcome**	**Knowledge Level**
CO1	Identify the Factors for the Need of Energy Storage	**K2**
CO2	Classify various types of energy Storages	**K2**
CO3	Describe the performance factors of Energy Storage Systems.	**K2**
CO4	Describe charging patterns in Battery Storage Systems	**K2**
CO5	Identify Various Types of Fuel Cells	**K2**
CO6	Identify various applications of Electrical Storage	**K2**

UNIT – I: NEED FOR ENERGY STORAGE

Electricity and the roles of EES, High generation cost during peak-demand periods, Long distance between generation and consumption-Variations in Energy Demand Variations in Energy Supply - Interruptions in Energy Supply - Transmission Congestion - Demand for Portable Energy

UNIT-II: TYPES OF ENERGY STORAGE SYSTEMS

Potential energy -pumped hydro, compressed air, springs - Kinetic energy -mechanical flywheels - Thermal energy with phase change-ice, molten salts, steam - Chemical energy-hydrogen, methane, gasoline, coal, oil - Electrochemical energy-batteries, fuel cells, Electrostatic energy -capacitors, Electromagnetic energy-superconducting magnets.

UNIT-III: PERFORMANCE FACTORS OF ENERGY STORAGE SYSTEMS

Energy capture rate and efficiency - Discharge rate and efficiency - Dispatch ability and load flowing characteristics, scale flexibility, durability – Cycle lifetime, mass and safety – Risks of fire, explosion, toxicity - Ease of materials, recycling and recovery - Environmental consideration and recycling

UNIT-IV: BATTERY STORAGE SYSTEM

Introduction with focus on Lead Acid and Lithium - Chemistry of Battery Operation, Power storage calculations, Reversible reactions, Charging patterns, Battery Management system.

UNIT-V: FUEL CELL

Fuel Cell-Construction-Working Principle-Types of Fuel Cells-Polymer electrolyte membrane Fuel Cell-Alkaline Fuel Cell-Solid oxide Fuel Cell-Merits and Demerits

UNIT – VI: APPLICATIONS OF ELECTRICAL ENERGY STORAGE

Waste heat recovery-Solar energy storage- Power plant applications-Energy storage in automotive applications

TEXT BOOKS:

1. Doughty Liaw, Narayan and Srinivasan, “Batteries for Renewable Energy Storage".
2. The Electroc Jiujun Zhang, Lei Zhang, Hansan Liu, Andy Sun, Ru-Shi Liu, “Electrochemical Technologies for Energy Storage and Conversion", John Wiley and Sons, 2012.hemical Society, New Jersy, 2010.
3. Detlef Stolten, "Hydrogen and Fuel Cells: Fundamentals, Technologies and Applications ", Wiley, 2010.

REFERENCE BOOKS:

1. The Electrical Energy Storage by IEC Market Strategy Board.
2. “James M. Eyer, Joseph J. Iannucci and Garth P. Corey “, “Energy Storage Benefits and Market Analysis”, Sandia National Laboratories, 2004.
3. https://nptel.ac.in/content/storage2/courses/108103009/download/M9.pdf

Semester	**VIII SEM**	**L**	**T**	**P**	**C**	**Course Code**
Regulation	**V18**	**3**	**-**	**-**	**3**	**V18EETOE8**
Name of the Course	**Basics of Electrical Power Generation (Open Elective-III)**					
Branches	**EEE**					

Course Outcomes:

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

CO No.	**Course Outcome**	**Knowledge Level**
CO1	Understand the various energy sources, substations and switchgear devices.	**K2**
CO2	Understand the principle of operation of different components of thermal power stations.	**K2**
CO3	Understand the principle of different components of a Nuclear power stations.	**K2**
CO4	Understand the principle of operation of different components of hydro power stations.	**K2**
CO5	Understand the working of solar photo voltaic systems and applications.	**K3**
CO6	Understand the wind energy conversion systems, efficiency and power generation.	**K2**

UNIT–I: FUNDAMENTALS OF ELECTRICAL POWER SYSTEM

Energy scenario (world and India) – various Conventional and non-conventional energy sources–structure of electric power system: generation, transmission, distribution-classification of substations-switchgear devices: switches, fuses, relay, MCB.

UNIT–II: THERMAL POWER STATIONS

Schematic arrangement- Selection of site- general layout of a thermal power plant showing paths of coal, steam, water, air, ash handling system: generation, transmission, distribution and flue gasses, ash handling system- Brief description of components: Boilers, Super heaters, Economizers, electrostatic precipitators Condensers, feed water circuit, Cooling towers and Chimney.

UNIT–III: NUCLEAR POWER STATIONS

Location of nuclear power plant, Working principle, Nuclear fission, Nuclear fuels, Nuclear chain reaction, nuclear reactor Components: Moderators, Control rods, Reflectors and Coolants. Types of Nuclear reactors, Radiation: Radiation hazards and Shielding, nuclear waste disposal.

UNIT–IV: HYDRO POWER STATIONS

Schematic arrangement, advantages and disadvantages, choice of site constituents of

hydro power plant, Hydro turbine. Environmental aspects for selecting the sites and locations of hydro power stations.

UNIT–V: SOLAR POWER PLANT

Solar photovoltaic cell, module, array – construction of power plant– Efficiency of solar cells – Cell I-V characteristics – Equivalent circuit of solar cell – Series resistance – Shunt resistance – Applications and systems - System design: storage sizing – PV system sizing.

UNIT–VI: WIND POWER PLANT

Sources of wind energy - Wind patterns – Types of turbines –Horizontal axis and vertical axis machines - construction of power plant –Efficiency–Poweroutputofwindturbine– Selectionofgenerator(synchronous,induction) –Power generation for utility grids.

TEXT BOOKS:

1. A Text Book on Power System Engineering by M. L. Soni, P. V. Gupta, U. S. Bhatnagar and A. Chakrabarti, Dhanpat Rai & Co. Pvt. Ltd.- 2nd edition, 2013.
2. Renewable Energy Resources, John Twidell andTonyWeir,TaylorandFrancis-2nd edition, 2013.

REFERENCE BOOKS:

1. Elements of Electrical Power Station Design by – M V Deshpande, PHI, NewDelhi-3rdedition,2010.
2. Renewable Energy – Edited by Godfrey Boyle – oxford university Press, 3rdedition, 2013.
3. Electrical Power Systems by C. L. Wadhwa, 6th Edition, New Age International Publishers, 2018.
4. Non-conventionalenergysource–B.H.khan-TMH-2ndedition,2017.
5. https://nptel.ac.in/content/storage2/courses/108105053/pdf/L-02(TB)(ET)%20((EE)NPTEL).pdf

Semester	**VIII SEM**	**L**	**T**	**P**	**C**	**Course Code**
Regulation	**V18**	**3**	**-**	**-**	**3**	**V18EEOE9**
Name of the Course	**Industrial Automation (Open Elective-III)**					
Branches	**EEE**					

Course Outcomes:

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

CO No.	**Course Outcome**	**Knowledge Level**
CO1	Understand the basic concepts of control systems.	**K3**
CO2	Understand the concepts of industrial automation and components of control system.	**K3**
CO3	Illustrate the concepts of electrical actuators and controllers.	**K3**
CO4	Analyse the Control Procedures in Control systems	**K4**
CO5	Analyse the Process control	**K4**
CO6	Understand the concept of PLC and its application	**K3**

UNIT-I: BASIC CONCEPTS OF CONTROL SYSTEMS

Basic concepts-Definition of open loop and closed loop system, examples with block diagrams. Terms used in the control systems-Types of feedback-Transfer function Definition &derivation control systems- Equivalence of physical system components

UNIT-II: INTRODUCTION TO INDUSTRIAL AUTOMATION

Need of Automation and its requirements, Structure & components Industrial Automation systems, Architectural levels of Industrial controls. Components of control systems-Contact types-Normally open & Normally closed, Solenoids-AC/DC, Input devices Push button, Selector switch, Photo electric, Level Control, Pressure sensing device, Output devices- contactors, valves, Pilot lamps, Relays-Electromagnetic and Reed Relay

UNIT- III: ELECTRICAL ACTUATORS AND CONTROLLERS

Potentiometers –working principle, AC & DC Servomotors-working principle, working of Synchro's - transmitter, control transformer, concept and purpose of a Tacho –generator

UNIT-IV: CONTROL PROCEDURES IN CONTROL SYSTEMS

Types of control systems-Time Variant/ Invariant systems, Continuous data and sampled data system, Linear and Non-Linear control system, Digital Control system Concept of controllers- P Controller, I Controller, PI Controller, PD Controller, PID Controller

UNIT-V: PROCESS CONTROL

Introduction to process control, PID control, controller tuning, implementation of PID controllers, speed control structures- feed forward and ratio control, predictive control, cascade, override and split range control.

UNIT-VI: PLC AND ITS APPLICATIONS

PLC Definition-advantages-Block diagram-Ladder diagrams for AND, OR, NOT, NAND, NOR-Instruction set-Ladder diagram for DOL starter, Star-Delta Starter, Stair case lighting, Traffic light control, Temperature controller-Special control systems DCS, SCADA.

TEXT BOOKS:

1. I J Nagarath & Gopal- Control Systems Engineering, New Age International Publishers, 6th edition, 2017.
2. Webb J.W-Programmable controllers: Principle and Applications, PHI publishers, 5th edition, 2002.
3. B.C. Kuo – Automatic Control Systems –John Wiley and Sons, 9th edition, 2014.

REFERENCE BOOKS:

1. Gary Dunning- Introduction to PLC - Delmar Cengage learning publisher, 3rd edition, 2005.
2. Jon Sterenson-Industrial automation and process control, Pearson publisher, 1st edition, 2002.
3. Ogata-Modern Control Engineering, Pearson publisher, 5th edition,2009.
4. https://nptel.ac.in/noc/courses/noc16/SEM1/noc16-ee02/

Annexure- IV

APPROVED COURSE STRUCTURE B. TECH (EEE) UNDER V20 REGULATION

III-Semester

S.No.	Course Code	Course Title	Hours per Week			Credits
			L	T	P	
1	V20MAT03	Transform Calculus	3	0	0	3
2	V20EET04	Electrical Circuit Analysis-II	3	0	0	3
3	V20EET05	Electro Magnetic Fields	3	0	0	3
4	V20EET06	Electrical Machines-I	3	0	0	3
5	V20ECT06	Analog Electronics	3	0	0	3
6	V20EEL04	Electrical Circuits Lab	0	0	3	1.5
7	V20ECL03	Analog Electronics Laboratory	0	0	3	1.5
8	V20CSL31	Data Structures & Algorithms Lab	0	1	3	1.5
9		Skill Oriented Course	1	0	2	2
10	V20ENT02	Professional Communication Skills-I	2	0	0	0
					Total Credits	21.5

Total Contact Hours: 29 Total Credits : 21.5

IV-Semester

S.No.	Course Code	Course Title	Hours per Week			Credits
			L	T	P	
1	V20EET07	Signals and Systems	3	0	0	3
2	V20EET08	Electrical Machines - II	3	0	0	3
3	V20EET09	Electrical and Electronic Measurements	3	0	0	3
4	V20EET10	Electrical Power Generation and Transmission	3	0	0	3
5	V20MBT51	Managerial Economics and Financial Analysis	3	0	0	3
6	V20CSL32	Python Programming Lab	0	1	3	1.5
7	V20EEL05	Electrical Machines-I Lab	0	0	3	1.5
8	V20EEL06	Electrical Measurements Lab	0	0	3	1.5
9		Skill Oriented Course	1	0	2	2
10	V20ENT03	Professional Communication Skills-II	2	0	0	0
					Total Credits	21.5

Total Contact Hours: 29 Total Credits : 21.5

Internship two months (Mandatory) during summer vacation.

List of Skill Oriented Courses:

S. No.	Course Code	Course Title
1.	V20EES01	PCB Design
2.	V20EES02	Scilab
3.	V20EES03	Electrical CAD
4.	V20EES04	Arduino Board
5.	V20EES05	Fundamentals of Drone Technology
6.	V20EES06	Industrial Automation with PLC

Annexure- V

Syllabi for the course offered in III & IV Semesters of B. Tech by Department of EEE under V20 Regulation

Semester	**III SEM**	**L**	**T**	**P**	**C**	**Course Code**
Regulation	**V20**	**3**	**-**	**-**	**3**	**V20EET04**
Name of the Course	**Electrical Circuit Analysis –II**					
Branches	**EEE**					

Course Outcomes:
After successful completion of this course, the students will be able to

CO No.	**Course Outcome**	**Knowledge Level**
CO1	Determine electrical parameters for 3-phase unbalanced systems	**K3**
CO2	Apply the network theorems for solving electrical circuits.	**K3**
CO3	Analyze circuit parameters under transient conditions	**K3**
CO4	Calculate two-port network parameters for any type of electrical networks	**K3**
CO5	Understand the concept of filters	**K2**

Unit-I: Unbalanced Three phase circuits
Unbalanced star connected load supplied from: Balanced 3-ϕ, 4-wire system and balanced 3-ϕ, 3-wire system using Millman's, Mesh/Loop and Star-Delta transformation methods; Unbalanced delta connected load supplied from: Balanced 3-ϕ, 3-wire system; Measurement of 3-ϕ active power using two wattmeter method; Measurement of 3-ϕ reactive power using one wattmeter method; Numerical Problems.

Unit-II: Network Theorems (DC & AC Excitations)
Superposition, Thevenin's, Norton's, Milliman's, Reciprocity, Compensation, Maximum Power Transfer, Tellegen's theorems; Problem solving for the network consisting of independent and dependent sources; Concept of Duality and Dual networks.

Unit-III: Transient analysis in DC and AC Circuits
Initial Conditions; Analysis of R-L, R-C and R-L-C circuits with DC and AC excitations using differential equations and Laplace transforms; Numerical Problems.

Unit-IV: Two-Port Networks
Basic Definitions; Z-parameters; Y-parameters; Transmission line (ABCD) parameters; h-parameters; Relationship between parameter sets; Series, Parallel and Cascade connections of two port networks; Problem solving for the network consisting of independent and dependent sources.

Unit-V: Passive Filters

Classification of filters; Analysis and Design of low pass, high pass, band pass and band stop filters (Constant-k & m-derived); Low Pass and High Pass Filters with RC and RL Circuits; Band Pass and Band Stop Filters with RLC Circuit.

Text Books:

1. Engineering Circuit Analysis by William Hayt and Jack E. Kemmerley, McGraw Hill Company,6th edition,Jan 2005
2. Network Analysis by Van Valkenburg, Prentice-Hall of India Private Ltd, revised 3rd edition, 15 April 2019
3. Circuit Theory (Analysis and Synthesis) by A.Chakrabarthi, DhanpatRai& Co.,7th revised edition,1 Jan 2018
4. Network Analysis and Synthesis by Ravish R Singh, Mc Graw Hill Education (I) Pvt. Ltd., 2nd edition, 1 may 2019

Reference Books:

1. Network Theory-Analysis and Synthesis by Smarajit Ghosh, PHI Publishers, 9th edition, Aug 2015
2. Network Theory by N.C. Jagan, C. Lakshminarayana, Anshan Publications, 2nd edition September 30, 2005
3. Fundamentals of Electrical Circuits by Charles K. Alexander and Mathew N.O. Sadiku, McGraw Hill Education (India), 5th edition, 1st july 2013
4. Network Analysis by C.L.Wadhwa, New Age International Publishers., 3rd edition, 1 Aug 2018
5. Electrical Circuit Analysis by Sudhakar A. & Shyammohan S. Palli, McGraw Hill Publication, 5th edition 1 july 2017
6. Introductory Circuit Analysis by Robert L Boylestad, Pearson Publications,12th edition,1st Jan 2013
7. https://nptel.ac.in/courses/108/105/108105159/

Semester	**III SEM**	**L**	**T**	**P**	**C**	**Course Code**
Regulation	**V20**	**3**	**-**	**-**	**3**	**V20EET05**
Name of the Course	**Electro Magnetic Fields**					
Branches	**EEE**					

Course Outcomes:

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

CO No.	Course Outcome	Knowledge Level
CO1	Compute the electric field and potential due to different configurations of static charges and electric dipole.	**K3**
CO2	Calculate the capacitance of various configurations and understand the concept of conduction and convection current densities.	**K3**
CO3	Apply the Biot-Savart's law and Amperes Circuital Law for finding MFI for different cables and develop the Maxwell equations.	**K3**
CO4	Determine the magnetic forces, torque produced by currents in magnetic fields, self-inductance of solenoid and toroid.	**K3**
CO5	Calculate the induced E.M.F's and understand the concept of fields varying with time.	**K3**

Unit-I: Electrostatics

Electrostatic Fields; Coulomb's Law; Electric Field Intensity (EFI) - EFI due to a line and a surface charges; Work done in moving a point charge in an electrostatic field; Electric Potential - Properties of potential function, Potential gradient; Guass's law; Maxwell's first law, div(D)=ρv; Laplace's and Poison's equations; Electric dipole - Potential and EFI due to an electric dipole, Torque on an Electric dipole placed in an electric field.

Unit-II: Conductors, Dielectrics and Capacitance Conductors & Dielectrics

Conductors - Behavior of conductors in an electric field; Dielectrics - Polarization; Electric boundary conditions.

Capacitance: Capacitance of parallel plates, spherical and coaxial cables with composite dielectrics; Energy density in a static electric field; Current density - Conduction and Convection current densities; Ohm's law in point form, Equation of continuity.

Unit-II: Magneto Statics

Introduction; Biot-Savart's law; Magnetic Field Intensity (MFI) - MFI due to a straight current carrying filament, circular, square and solenoidal current carrying wires; Maxwell's second Equation i.e, div(B)=0.

Ampere's circuital law - MFI due to an infinite sheet of current, long filament current carrying conductor, Pointform of Ampere's circuital law; Maxwell's third equation i.e, Curl (H)=J.

Unit-IV: Forces in Magnetic fields and Inductance

Magnetic force; Behavior of charges moving in magnetic field; Lorentz force equation; Force on a current carrying element placed in a magnetic field; Force on a straight and a long current carrying conductor placed in a magnetic field; Force between two straight long and parallel current carrying conductors; Magnetic dipole - a differential current loop as a magnetic dipole, Torque on a current loop placed in a magnetic field; Inductance: Basic expressions for self and mutual inductances, self-inductance of a solenoid and toroid.

Unit-V: Time Varying Fields

Introduction; Integral and point forms of faraday's laws of electromagnetic induction; statically and dynamically induced EMFs; Maxwell's fourth equation, Curl (E) = $-\partial B/\partial t$; Modification of Maxwell's equations for time varying fields; Simple problems.

Text Books:

1. Engineering Electromagnetics by William H. Hayt& John. A. Buck Mc. Graw-Hill Companies, 7th Editon.2006.
2. Electromagnetic Fields by R MeenaKumari, R Subhasri, New Age International, 2nd edition, Jan 2007.
3. Elements of Electromagnetics by Matthew N.O. Sadiku, Oxford University Press, 4th edition, 1 Jan 2006

Reference Books:

1. Introduction to Electro Dynamics by D J Griffiths, Prentice-Hall of India Pvt. Ltd, 4th edition, 1st Jan 2015
2. Electromagnetic Field Theory by Yaduvir Singh, Pearson., 1st edition 23 April 2011
3. Fundamentals of Engineering Electromagnetics by Sunil Bhooshan, Oxford higher education., 1st edition 30 june 2012
4. https://nptel.ac.in/courses/108/106/108106073/

Semester	**III SEM**	**L**	**T**	**P**	**C**	**Course Code**
Regulation	**V20**	**3**	**-**	**-**	**3**	**V20EET06**
Name of the Course	**Electrical Machines – I**					
Branches	**EEE**					

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

CO No.	Course Outcome	Knowledge Level
CO1	Asses the performance of a DC Machines	**K3**
CO2	Understand the torque production mechanism and control the speed of DC Machines	**K2**
CO3	Asses the performance of single phase transformers	**K3**
CO4	Calculate the regulation, losses and efficiency of single phase transformers	**K3**
CO5	Understand the parallel transforms, control voltages with tap changing methods and achieve three phase to two phase transformation	**K2**

Unit-I: Introduction and Performance of DC machines
Construction and principle of operation of DC machine; EMF equation of DC generator; Classification of DC machines based on excitation; Magnetization Characteristics of DC shunt generator, DC machine acts as a motor - back-emf and Torque, Armature Reaction and Commutation; Characteristics of separately-excited, shunt, series and compound motors; losses and efficiency of a DC machine; Applications of DC motors

Unit-II: Starting, Speed Control and Testing of D.C. Machines
Necessity of Starter - Working of 3-Point and 4-Point Starters; Speed Control of DC shunt motor by armature voltage and field flux control; Testing of DC machines - Brake Test, Swinburne‘s method, Hopkinson‘s Test, Retardation Test; Simple Numerical Problems.

Unit-III: Single-phase Transformers
Types, Constructional details, Principle of operation, EMF Equation of a 1-Φ Transformer; Transformer operation on No-Load and On-Load for lagging, leading and unity power factors loads and their phasor diagrams; Transformer equivalent circuit; Transformer Regulation, Losses and efficiency; effect of variation of supply frequency and voltage on losses; All day efficiency.

Unit-IV: Testing of Single-phase Transformers
O.C. and S.C. tests; Sumpner‘s test; Separation of losses of a 1-Φ transformer; Parallel operation with equal voltage ratios; Auto Transformer - equivalent circuit, comparison with two winding transformers.

Unit-V:-3-Phase Transformers

Poly-phase connections, Y/Y, Y/Δ, Δ/Y, Δ/Δ and open-Δ; Scott Connection; Three winding Transformer: Determination of Zp, Zs and Zt; Off-load and On-load tap changers.

Text Books:

1. Electrical Machines by P.S. Bhimbra, Khanna Publishers.7th edition 1st Jan 1977

2. Theory & Performance of Electrical Machines by J. B. Guptha. S. K. Kataria& Sons. 15th edition 2015

Reference Books:

1. Electrical Machines by D. P.Kothari, I .J .Nagarth, Mc Graw Hill Publications, 5thedition 23 june 2017

2. Electrical Machines by R. K. Rajput, Lakshmi publications, 5th edition, 1st Jan 2016

3. Electrical Machinery by Abijith Chakrabarthi and Sudhipta Debnath, McGraw Hill Education 1st edition 9th Feb 2015

4. Electrical Machinery Fundamentals by Stephen J Chapman, McGraw Hill education 4th edition 1st july 2017

5. Electric Machines by Mulukutla S. Sarma & Mukeshk. Pathak, CENGAGE Learning., 1st edition 1st November 2009

6. Electric Machinery by A. E. Fitzgerald, Charles kingsley, Stephen D. Umans, TMH 6th edition 16th Aug 2002

7.https://nptel.ac.in/courses/108/105/108105155/

Semester	**III SEM**	**L**	**T**	**P**	**C**	**Course Code**
Regulation	**V20**	**0**	**0**	**3**	**1.5**	**V20EEL04**
Name of the Course	**Electrical Circuits Laboratory**					
Branches	**EEE**					

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

CO No.	Course Outcome	Knowledge Level
CO1	Compute response in the electrical circuits using various Network theorems	**K3**
CO2	Sketch Locus Diagrams of RL and RC Series Circuits	**K2**
CO3	Find parameters of the circuit under resonance conditions	**K3**
CO4	Determine two port network parameters	**K3**
CO5	Calculate 3phase power and choke coil parameters	**K3**

Any 10 experiments are to be conducted

1. Verification of KVL and KCL
2. Verification of Thevenin‘s and Norton‘s Theorems
3. Verification of Superposition and Reciprocity Theorem
4. Verification of Compensation and Millmann‘s Theorems.
5. Verification of Maximum Power Transfer Theorem.
6. Locus Diagrams of RL and RC Series Circuits.
7. Time Response of first order RC and second order RLC Networks.
8. Series and Parallel Resonance
9. Determination of Z and Y parameters.
10. Determination of Transmission and hybrid parameters.
11. Determine the Parameters of a choke coil
12. Measurement of 3-phase Power by two Wattmeter Method for unbalanced loads

Semester	**IV SEM**	**L**	**T**	**P**	**C**	**Course Code**
Regulation	**V20**	**3**	**-**	**-**	**3**	**V20EET07**
Name of the Course	**Signals and Systems**					
Branches	**EEE**					

Course Outcomes

After Successful completion of this course, students will be able to

CO No.	Course Outcome	Knowledge Level
CO1	Understand and estimate various types of signals and systems.	(K2)
CO2	Understand the basic principles of Sampling Theorem.	(K2)
CO3	Understand the characteristics of LTI Systems	(K2)
CO4	Understand the concepts of Cross-Correlation and Auto-Correlation of Functions	(K2)
CO5	Apply the concept of ROC for Laplace Transform and Z transform, Inverse Z transforms.	(K3)

Unit-I:Introduction

Definition of Signals and Systems, Classification of Signals, Classification of Systems, Operations on signals: time-shifting, time-scaling, amplitude-shifting, amplitude-scaling. Problems on classification and characteristics of Signals and Systems. Complex exponential and sinusoidal signals, Singularity functions and related functions: impulse function, step function signum function and ramp function. Analogy between vectors and signals, orthogonal signal space, Signal approximation using orthogonal functions, mean square error, closed or complete set of orthogonal functions, Orthogonality in complex functions.

Unit–II: Sampling theorem

Graphical and analytical proof for Band Limited Signals, impulse sampling, Natural and Flat top Sampling, Reconstruction of signal from its samples, effect of under sampling – Aliasing, Introduction to Band Pass sampling.

Unit-III: Linear Time Invariant (LTI) System

Linear- nonlinear, Time variant-invariant, casual - non-casual, static-dynamic, stable-unstable, invertible. Convolution sum and convolution integral using graphical methods for different signals (Time domain).

Unit-IV: Cross-Correlation And Auto-Correlation of Functions

Properties of correlation function, Energy density spectrum, Parseval's theorem, Power density spectrum, Relation between auto correlation function and energy/power spectral density function. Relation between convolution and correlation, Detection of periodic signals in the presence of noise by correlation, Extraction of signal from noise by filtering.

Unit –V: Transforms

Concept of region of convergence (ROC) for Laplace transforms, constraints on ROC for various classes of signals, Distinction between Laplace, Fourier and Z transforms. Region of convergence in Z-Transform, constraints on ROC for various classes of signals, Inverse Z-transform, properties of Z-transforms.

Text Books:

1. Signals, Systems & Communications - B.P. Lathi, BS Publications, 2008.
2. Signals and Systems - A.V. Oppenheim, A.S. Willsky and S.H. Nawab, PHI, 2nd Edn, 1996.
3. Signals & Systems- Narayan Iyer and K Satya Prasad, Cenage Publications, 1st Edition 2011.

Reference Books:

1. Signals & Systems - Simon Haykin and Van Veen, Wiley, 2nd Edition, 2017.
2. Principles of Linear Systems and Signals – BP Lathi, Oxford University Press, 2015
3. Signals and Systems – K Raja Rajeswari, B Visweswara Rao, PHI, 2nd Edition 2014
4. Fundamentals of Signals and Systems- Michel J. Robert, MGH International Edition,2008.
5. Signals and Systems – T K Rawat , Oxford University press, 2011

NPTEL Link : https://nptel.ac.in/courses/117/101/117101055/

Semester	**IV SEM**	**L**	**T**	**P**	**C**	**Course Code**
Regulation	**V20**	**3**	**-**	**-**	**3**	**V20EET08**
Name of the Course	**Electrical Machines – II**					
Branches	**EEE**					

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

CO No.	Course Outcome	Knowledge Level
CO1	Explain the operation and performance of three phase induction motor	**K2**
CO2	Assess the torque-speed relation, performance of induction motor and induction generator	**K3**
CO3	Explain the torque production mechanism and starting of single phase induction motors	**K2**
CO4	Asses the performance of synchronous generators by determining its voltage regulation	**K3**
CO5	Explain the operation and performance of Synchronous Motors	**K2**

Unit-I: 3-Phase Induction Motors
Construction details of cage and wound rotor machines; Production of rotating magnetic field; Principle of operation; Rotor EMF, Rotor frequency, Rotor Current and p.f. at standstill and during running conditions; Rotor power input; rotor copper losses; Mechanical power developed and their interrelationship; Equivalent circuit; Phasor diagram.

Unit-II: Characteristics, starting and testing methods of Induction Motors
Torque equation; expressions for maximum torque and starting torque; torque-slip characteristics; double cage and deep bar rotors construction; crawling and cogging; speed control of induction motor with V/f method; no-load and blocked rotor tests (construction of circle diagram for predetermination of performance parameters); methods of starting, soft starters; induction generator operation (Qualitative treatment only).

Unit-III: Single Phase Motors
Constructional features and its equivalent circuit; Problem of starting – Double revolving field theory; Starting methods; shaded pole motors; AC Series motor.

Unit-IV: Alternators
Constructional features of non–salient and salient pole type alternator; Armature windings – Distributed and concentrated windings; Distribution, Pitch and Winding factors; E.M.F equation; Improvements of waveform and armature reaction; Voltage regulation by synchronous impedance method, MMF method and Potier triangle method; Phasor

diagrams; Two reaction analysis of salient pole machine and phasor diagram; Parallel operation of alternators, Numerical problems.

Unit-VI: Synchronous Motors

Principle and theory of operation of Synchronous Motor; Phasor diagram; Starting torque; Variation of current and power factor with excitation; Synchronous condenser; Mathematical Analysis for power developed; Hunting and its suppression; Methods of starting.

Text Books:

1. Electrical Machines by P.S. Bhimbra, Khanna Publishers , Edition-2,2021
2. Theory & Performance of Electrical Machines by J. B. Guptha. S. K. Kataria & Sons , Edition-2,2013
3. Electrical Machinery Fundamentals by Stephen J Chapman McGraw Hill education 5th edition 2011

Reference Books:

1. Electrical Machines by D. P. Kothari, I .J .Nagarth, McGrawHill Publications, 5th edition,2017
2. Electrical Machines by R. K .Rajput, Lakshmi publications, 5th edition, 2016
3. Electrical Machinery by Abijith Chakrabarthi and Sudhipta Debnath, McGraw Hill education 2015
4. Electric Machines by Mulukutla S. Sarma & Mukeshk .Pathak, CENGAGE Learning.
5. Electric Machinery by A.E.Fitzgerald, Charles kingsley, Stephen D.Umans, TMH

NPTEL Link : https://nptel.ac.in/courses/108/105/108105131/

Semester	**IV SEM**	**L**	**T**	**P**	**C**	**Course Code**
Regulation	**V20**	**3**	**-**	**-**	**3**	**V20EET09**
Name of the Course	**Electrical and Electronic Measurements**					
Branches	**EEE**					

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

CO No.	Course Outcome	Knowledge Level
CO1	Identify the proper instrument for measurement of AC or DC voltages and currents	**K2**
CO2	Choose the suitable instrument for the measurement of power and energy.	**K3**
CO3	Compute the electrical parameters by using appropriate bridge.	**K3**
CO4	Calculate different magnetic parameters by using magnetic instruments and Understand the operation of potentiometer.	**K3**
CO5	Understand the operation of various digital instruments.	**K2**

Unit-I: Electromechanical Indicating Instruments
Classification of measuring instruments; Construction and principle of operation of PMMC, MI instruments; Extension of instrument ranges using shunts, multipliers; Numerical Problems.
Instrument Transformers: Ratio and Phase angle errors (Derivation & Phasor Diagram) and their applications in the extension of instrument ranges, Numerical Problems.
Unit-II: Power and Energy Measurement
Single phase dynamometer wattmeter (LPF and UPF), expression for deflecting and control torques; Type of P.F. Meters; Single phase induction type energy meter, Driving and braking torques, errors and compensations, testing by phantom loading using R.S.S. meter; Numerical Problems.

Unit-III: Measurement of Parameters
Measurement of Resistance: wheat stone‘s bridge and its Sensitivity; Ohm meter; Kelvin‘s double bridge; Loss of charge method; Earth resistance measurement by fall of potential method and megger.

Measurement of inductance & Q-Factor: Maxwell‘s bridge; Hay‘s bridge; Anderson‘s bridge.

Measurement of capacitance and loss angle: Desauty‘s Bridge; Schering Bridge.

Unit-IV: Magnetic Measurements & Potentiometers
Magnetic Measurements: Constructional details of Flux meter; Determination of B–H Loop: Methods of reversals and Step-by-Step method; Core loss measurements by Maxwell‘s and Campbell‘s Bridges, D.C. & A.C. Crompton‘s potentiometer and their applications.

Unit-V: Electronic Instruments

Introduction; Digital Voltmeters (DVM); Ramp type DVM; Integrating type DVM; Successive-approximation DVM; Q- Meter, Digital frequency meter, Digital Tachometer; Measurement of phase difference & Frequency by using lissajous patterns in CRO; Electronic Multi meter.

Text Books:

1. A course in Electrical& Electronic Measurement and Instrumentation by A. K. Sawhney, Dhapat Rai& Co. 2015
2. Electronic Instruments by H.S. Kalsi, Tata Mc-Graw hill. 7th edition 2017

Reference Books:

1. Electrical and Electronic Measurements and instrumentation by R. K. Rajput, S.Chand. 2016
2. Digital Instrumentation by A.J. Bouwens, Tata Mc-Graw hill.
3. Modern Electronic instrumentation & Measuring instruments by A.D. Heltric & W.C. Copper, Wheeler Publication. 2015
4. Instrument transducers by H.K.P. Neubert, Oxford University press.
5. Electrical Measurements by Forest K. Harris, John Wiley and Sons.
6. **NPTEL Link** : https://nptel.ac.in/courses/108/105/108105153/

Semester	**IV SEM**	**L**	**T**	**P**	**C**	**Course Code**
Regulation	**V20**	**3**	**-**	**-**	**3**	**V20EET10**
Name of the Course	**Electrical Power Generation & Transmission**					
Branches	**EEE**					

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

CO No.	Course Outcome	Knowledge Level
CO1	Understand the working of conventional power generating stations	K2
CO2	Calculate various factors of load, insulation resistance and power factor of the cables.	K3
CO3	Compute the resistance, inductance and capacitance of transmission lines	K3
CO4	Determine the various transmission line parameters	K3
CO5	Calculate the corona loss, sag and tension in transmission lines	K3

Unit-I: Power Generating Stations
Introduction to renewable and non-renewable energy sources - general layout of a thermal power plant and its Components-General layout of Nuclear power plant -Nuclear fission and Chain Reaction –General Layout of Hydel power plant and Description of its main components- General Layout of Solar and wind Power plants.

Unit-II: Economic Aspects of Power Generation, Tariffs and Cables
Load curve- load duration and integrated load duration curves- discussion on economic aspects: connected load, maximum demand, and demand factor. Different Tariff methods. Construction of cables, Types of Cables, Calculation of insulation resistance and power factor of the cable.

Unit-III: Transmission Line Parameters
Conductor materials: Types of conductors – Calculation of resistance for solid conductors – Calculation of inductance for single phase– Single and double circuit lines–Concept of GMR and GMD–Symmetrical and asymmetrical conductor configuration with and without transposition–Bundled conductors-Numerical Problems–Calculation of capacitance for 2 wire– Effect of ground on capacitance – Capacitance calculations for symmetrical and asymmetrical for single phase–Numerical Problems.

Unit-IV: Modeling of Transmission Lines
Classification of Transmission Lines: Short, medium and their model representations – Nominal-T–Nominal-Pie and A, B, C, D Constants for symmetrical and Asymmetrical Networks–– Evaluation of A,B,C,D Constants– regulation and efficiency-Numerical

problems-Surge Impedance –Surge Impedance loading-Wavelengths and Velocity of Propagation.

Unit-V: Sag and Tension Calculations and Overhead Line Insulators

Skin and Proximity effects – Ferranti effect – Charging Current –Shunt Compensation – Corona – Description of the phenomenon–Factors affecting corona- Sag and Tension calculations with equal and unequal heights of towers–Effect of Wind and Ice on weight of Conductor–Numerical Problems

Text Books:

1. Generation, Distribution and Utilization of Electric Energy by C.L.Wadhawa, New age International (P) Limited, Publishers
2. Thermal Engineering by Rajput, Lakshmi publications
3. Electrical Power Systems by C.L.Wadhwa, 6th Edition, New Age International Publishers.

Reference Books:

1. Text Book on Power System Engineering by M.L.Soni, P.V.Gupta, U.S.Bhatnagar and Chakrabarti, DhanpatRai& Co. Pvt. Ltd
2. A Course in Power Systems by J. B. Gupta, S K Kataria& Sons Publishers. 2013
3. Principles of Power Systems by V.K Mehta and Rohit Mehta, S. Chand Publishers. 2nd Edition 2005
4. Electrical Power Systems by P.S.R. Murthy, B.S.Publications, 2017
5. **NPTEL Link :** https://nptel.ac.in/courses/108/102/108102047/

Semester	**IV SEM**	**L**	**T**	**P**	**C**	**Course Code**
Regulation	**V20**	**0**	**0**	**3**	**1.5**	**V20EEL05**
Name of the Course	**Electrical Machines-I Lab**					
Branches	**EEE**					

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

CO No.	Course Outcome	Knowledge Level
CO1	Sketch the magnetizing characteristics of DC shunt generator	**K3**
CO2	Determine and predetermine the performance of DC machines	**K3**
CO3	Apply different methods to control the speed of the DC motors	**K3**
CO4	Assess the performance of transformers	**K3**
CO5	Convert three phase supply to two phase	**K2**

Any 10 of the following experiments are to be conducted

1. Magnetization characteristics of DC shunt generator: Determination of critical field resistance and critical speed.
2. Brake test on DC shunt motor. Determination of performance curves.
3. Hopkinson‘s test on DC shunt machines. Predetermination of efficiency.
4. Swinburne‘s test and Predetermination of efficiencies as Generator and Motor.
5. Speed control of DC shunt motor by Field and armature Control.
6. Retardation test on DC shunt motor. Determination of losses at rated speed.
7. Separation of losses in DC shunts motor.
8. OC & SC test on single phase transformer.
9. Sumner‘s test on single phase transformers.
10. Scott connection of transformers.
11. Parallel operation of Single phase Transformers.
12. Separation of core losses of a single phase transformer.
13. Heat run test on a bank of 3 Nos. of single phase Delta connected transformers.

Semester	**IV SEM**	**L**	**T**	**P**	**C**	**Course Code**
Regulation	**V20**	**0**	**0**	**3**	**1.5**	**V20EEL06**
Name of the Course	**Electrical Measurements Laboratory**					
Branches	**EEE**					

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

CO No.	Course Outcome	Knowledge Level
CO1	Calibrate voltmeters, ammeters, single phase energy meter	**K3**
CO2	Measure the electrical parameters using Anderson, Schering& Kelvin's double Bridges.	**K5**
CO3	Apply various methods to calculate powers and choke coil parameters	**K3**
CO4	Calibrate dynamometer and LPF Wattmeters	**K3**
CO5	Measure the Dielectric Strength of transformer oil	**K3**

Any 10 experiments are to be conducted

1. Calibration and Testing of single phase energy Meter
2. Calibration of PMMC ammeter and voltmeter using Crompton D.C. Potentiometer
3. Calibration of AC voltmeter and measurement of choke parameters using AC Potentiometer in polar form.
4. Calibration of dynamometer wattmeter by using phantom loading.
5. Calibration of LPF wattmeter by using direct loading.
6. Capacitance Measurement using Schering Bridge
7. Inductance Measurement using Anderson Bridge.
8. Measurement of 3 phase power with single wattmeter and using two C.Ts
9. Measurement of single phase Power by using 3 Voltmeter and 3 Ammeter method.
10. Measurement of resistance using Kelvin's double Bridge.
11. Dielectric oil testing using H.T test Kit.
12. Measurement of 3 phase reactive power with single wattmeter for balanced loading.
13. Demonstration of Electronic Meters used by electrical field engineers

Annexure VI

Semester	**IV SEM (ECE & ECT); V SEM (EEE)**	**L**	**T**	**P**	**C**	**Course Code**
Regulation	**V20**	**3**	**-**	**-**	**3**	**V20EET11**
Name of the Course	**Control Systems**					
Branches	**EEE, ECE & ECT**					

Course Outcomes

After successful completion of this course, students will be able to

CO No.	**Course Outcome**	**Knowledge Level**
CO1	Determine the mathematical modelling of physical systems	(K3)
CO2	Calculation of Time Domain Specification of first and second order systems and understand the effect of Controllers	(K3)
CO3	Investigate the stability of closed loop systems using Routh's stability criterion and root locus method.	(K3)
CO4	Find the stability of control systems using frequency response approaches.	(K3)
CO5	Analyze physical systems using state space approach.	(K4)

Unit – I: Mathematical Modeling of Control Systems

Classification of control systems, Open Loop and closed loop control systems and their differences, Feed-Back Characteristics, transfer function of linear system, Differential equations of electrical networks, Translational and Rotational mechanical systems, Transfer Function of DC Servo motor - AC Servo motor- Synchro, transmitter and receiver - Block diagram algebra – Representation by Signal flow graph - Reduction using Mason's gain formula.

Unit-II: Time Response Analysis

Standard test signals - Time response of first and second order systems - Time domain specifications - Steady state errors and error constants – Effects of various controllers

Unit –III: Stability And Root Locus Technique

The concept of stability – Routh's stability criterion –limitations of Routh's stability –Root locus concept - construction of root loci

Unit–IV: Frequency Response Analysis

Introduction to Frequency domain specifications-Bode diagrams- transfer function from the Bode Diagram-Phase margin and Gain margin-Stability Analysis from Bode Plots, Polar Plots, Nyquist Stability criterion. Effects of various controllers.

Unit–V: State Space Analysis of LTI Systems

Concepts of state, state variables and state model, state space representation of transfer function, Diagonalization- Solving the time invariant state equations- State Transition Matrix and it's Properties – Concepts of Controllability and Observability.

Text Books:

1. Control Systems principles and design, M. Gopal, Tata McGraw Hill education Pvt Ltd., 4th Edition, 2014.
2. Automatic control systems, Benjamin C. Kuo, Prentice Hall of India,2nd Edition, 2014.

Reference Books:

1. Modern Control Engineering, Kotsuhiko Ogata, Prentice Hall of India, 2002.
2. Control Systems, ManikDhanesh N, Cengage Publications, 2012.
3. Control Systems Engineering, I.J.Nagarath and M.Gopal, Newage International Publications, 5th Edition, 2007.
4. Control Systems Engineering, S.Palani, Tata McGraw Hill Publications, 2009.
5. https://nptel.ac.in/courses/107/106/107106081/

Annexure VII

Approved Course Structure of M. Tech EEE for Power Electronics & Power Systems (PE&PS) under V21 Regulation

M. Tech - I Semester							
S.No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**Credits**	**Marks**
1.	V21PET01	Analysis of Power Electronic Converters	3	0	0	3	100
2.	V21PET02	Power System Operation & Control	3	0	0	3	100
3.	V21PET03 V21PET04 V21PET05	Elective – I: 1. Control & Integration of Renewable Energy systems 2. Smart Grid 3. Power Quality	3	0	0	3	100
4.	V21PET06 V21PET07 V21PET08	Elective – II: 1. Electrical Distribution Automation 2. HVDC Transmission 3. Advanced Power System Protection	3	0	0	3	100
5.	V21MBT55	Research Methodology and IPR	2	0	0	2	100
6.	V21PEL01	Power Electronics Simulation Lab	0	0	4	2	100
7.	V21PEL02	Power Systems Lab	0	0	4	2	100
8.		Audit Course – I	2	0	0	0	100
			16	0	8	18	800

M. Tech – II Semester							
S.No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**Credits**	**Marks**
1.	V21PET09	Switched Mode Power Conversion	3	0	0	3	100
2.	V21PET10	Real Time Control of Power Systems	3	0	0	3	100
3.	V21PET11 V21PET12 V21PET13	Elective – III: 1. Electrical Machine Modeling & Analysis 2. Control of Electric Drives 3. Application of Power Converters	3	0	0	3	100
4.	V21PET14 V21PET15 V21PET16	Elective – IV: 1. EHVAC Transmission 2. Flexible AC Transmission Systems 3. Power System Dynamics & Stability	3	0	0	3	100
5.	V21PEP01	Mini Project with Seminar	0	0	4	2	100
6.	V21PEL03	Power Converters Lab	0	0	4	2	100
7.	V21PEL04	Power Systems Simulation Lab	0	0	4	2	100
8.		Audit Course – II	2	0	0	0	100
			14	0	12	18	800

Audit course 1 & 2

1. English for Research Paper Writing
2. Disaster Management
3. Value Education
4. Constitution of India
5. Pedagogy Studies
6. Stress Management by Yoga
7. Personality Development through Life Enlightenment Skills.

M. Tech – III Semester							
S.No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**Credits**	**Marks**
1.	V21PET17 V21PET18 V21PET19	Elective – V: 1. Hybrid Electric Vehicles 2. Soft Computing Techniques in Electrical Engineering 3. MOOCS-1 through NPTEL/ SWAYAM- 12 Week Program related to the programme which is not listed in the course structure	3	0	0	3	100
2.	V21OET01 V21MBT56 V21OET03	Open Elective : 1. Operations Research 2. Cost Management of Engineering Projects 3. MOOCs-2 Through NPTEL /SWAYAM - Any 12 week course on Engineering/ Management/ Mathematics offered by other than parent department	3	0	0	3	100
3.	V21PEP02	Dissertation Phase - I	0	0	20	10	50
			6	0	20	16	250

M. Tech – IV Semester							
S.No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**Credits**	**Marks**
1.	V21PEP03	Dissertation Phase – II	0	0	32	16	100
			0	0	32	16	100

Annexure VIII

Syllabi for the Courses offered in I to IV semesters of M. Tech EEE for Power Electronics & Power Systems (PE&PS) under V21 Regulation

Semester	**I SEM**	**L**	**T**	**P**	**C**	**COURSE CODE**
Regulation	V21	3	0	0	3	V21PET01
Name of the Course	Analysis of Power Electronic Converters					
Specialization	Power Electronics & Power systems					

Course Outcomes:

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

CO No.	**Course Outcome**	**Knowledge Level**
CO1	Explain the Static and Dynamic Characteristics of power switching devices.	K2
CO2	Analyze the parameters of AC-DC converters	K4
CO3	Explain the operation of power factor correction converters	K2
CO4	Analyze the operation of three phase inverters with PWM control.	K4
CO5	Understand the principles of operation of multi- level inverters and their applications	K2

UNIT– I : Overview of Switching Devices:

Power MOSFET, IGBT, GTO, GaN devices-static and dynamic characteristics, gate drive circuits for switching devices.

UNIT– II: AC-DC converters:

Single phase fully controlled converters with RL load–Evaluation of input power factor and harmonic factor- Continuous and Discontinuous load current, Power factor improvements, Extinction angle control, symmetrical angle control, PWM control. Three Phase AC-DC Converters, fully controlled converters feeding RL load with continuous and discontinuous load current, Evaluation of input power factor and harmonic factor-three phase dual converters

UNIT– III: Power Factor Correction Converters:

Single-phase single stage boost power factor corrected rectifier, power circuit principle of operation and steady state- analysis, three phase boost PFC converter.

UNIT– IV : PWM Inverters:

Principle of operation - Voltage control of single phase inverters - sinusoidal PWM– modified PWM – phase displacement Control – Trapezoidal, staircase, stepped, harmonic injection and delta modulation. Voltage Control of Three-Phase Inverters- Sinusoidal PWM- 60^0 PWM- Third Harmonic PWM- Space Vector Modulation- Comparison of PWM Techniques- Three phase current source inverters-Variable dc link inverter.

UNIT– V : Multi level inverters:

Introduction, Multilevel Concept, Types of Multilevel Inverters- Diode-Clamped Multilevel Inverter, Principle of Operation, Features of Diode-Clamped Inverter, Improved Diode-Clamped Inverter- Flying-Capacitors Multilevel Inverter- Principle of Operation, Features of Flying-Capacitors Inverter- Cascaded Multilevel Inverter- Principle of Operation-Features of Cascaded Inverter-Switching Device Currents-DC-Link Capacitor Voltage Balancing- Features of Multilevel Inverters-Comparisons of Multilevel Converters.

Text Books

1. Ned Mohan, Tore M. Undeland, William P. Robbins, "Power Electronics: Converters, Applications, and Design", John Wiley& Sons, 2nd Edition, 2003.
2. Md. H. Rashid, "Power Electronics" –Pearson Education, 3rd Edition- First Indian Reprint-2008.

Reference Books:

1. Philip T. Krein, "Elements of Power Electronics", Oxford University press, 2nd Edition, 2015.
2. William Shepherd & Li Zhang-Yes Dee, "Power Converter Circuits", CRC Press, 1st Edition 2004.
3. https://nptel.ac.in/courses/108/108/108108035/

Semester	**I SEM**	**L**	**T**	**P**	**C**	**COURSE CODE**
Regulation	V21	3	0	0	3	V21PET02
Name of the Course	Power System Operation & Control					
Specialization	Power Electronics & Power systems					

Course Outcomes:

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

CO No.	**Course Outcome**	**Knowledge Level**
CO1	Apply various load flow methods to analyse the system	K3
CO2	Apply various methods to solve unit commitment problem and understand Optimal power flow	K3
CO3	Determine the transfer function of single area load frequency control	K3
CO4	Calculate the frequency deviation for two area load frequency control	K3
CO5	Explain the effect of generation with limited energy supply.	K2

UNIT– I: Load Flow Analysis

Newton Raphson method, Fast Decoupled method, AC-DC load flow – Single and three phase methods

UNIT– II: Unit commitment & Optimal power flow

Unit commitment problem and optimal power flow solution: Unit commitment: Constraints in UCP, UC solution methods. Priority list method, introduction to Dynamic programming Approach.

Optimal power flow: OPF without inequality constraints, inequality constraints on control variables and dependent variables.

UNIT– III: Single area Load Frequency Control:

Necessity of keeping frequency constant. Definition of control area, single area control, Block diagram representation of an isolated Power System, Steady State analysis, Dynamic response-Uncontrolled case. Proportional plus Integral control of single area and its block diagram representation, steady state response.

UNIT– IV : Two area Load Frequency Control:

Load frequency control of two-area system, uncontrolled case and controlled case, tie-line bias control, steady state representation. Optimal two-area LF control- performance Index and optimal parameter adjustment. Load frequency control and Economic dispatch control.

UNIT– V: Generation with limited Energy supply:

Take-of-pay fuel supply contract, composite generation production cost function. Solution by gradient search techniques, hard limits and slack variables, Fuel scheduling by linear programming.

Text Books:

1. A. J. Wood and F. Wollenberg, "Power Generation, Operation and Control", John Wiley & sons Inc., 3rd Edition, 2013.
2. I. J. Nagrath & D. P. Kothari, "Modern Power System Analysis", Tata McGraw Hill Publishing Company ltd, 3rd edition 2007.

Reference Books:

1 P.S.R.Murthy, "Power System operation and Control", 1st Edition, Tata McGraw Hill Publishers, 2008
2 O.I. Elgerd, "Electrical Energy Systems Theory", Tata McGraw-Hill Publishing Company Ltd, 2nd edition, 2007.
3 T. J. E Miller, "Reactive Power Control in Electric Systems", John Wiley & sons, 1982.
4 https://nptel.ac.in/courses/108/101/108101040/

Semester	**I SEM**	**L**	**T**	**P**	**C**	**COURSE CODE**
Regulation	V21	3	0	0	3	V21PET03
Name of the Course	Control & Integration of Renewable Energy Systems (Elective -I)					
Specialization	Power Electronics & Power systems					

Course Outcomes:

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

CO No.	**Course Outcome**	**Knowledge Level**
CO1	Understand the fundamental requirements of Grid Integration	K2
CO2	Explain different conventional & non-conventional dynamic energy conversion technologies	K2
CO3	Describe different renewable energy sources and storage devices	K2
CO4	Understand the real & reactive power control techniques with renewable generators	K2
CO5	Develop a model of complete system for standalone/grid connected system	K4

UNIT– I: Introduction:

Electric grid introduction, Supply guarantee and power quality, Stability, Effects of renewable energy penetration into the grid, Boundaries of the actual grid configuration, Consumption models and patterns, static and dynamic energy conversion technologies, interfacing requirements .

UNIT– II: Dynamic Energy Conversion Technologies:

Introduction to different conventional and non-conventional dynamic generation technologies, principle of operation and analysis of reciprocating engines, gas and micro turbines, hydro and wind based generation technologies, control and integrated operation of different dynamic energy conversion devices.

UNIT– III: Static Energy Conversion Technologies:

Introduction to different conventional and non conventional static generation technologies, principle of operation and analysis of fuel cell, photovoltaic based generators, and wind based generation technologies, different storage technologies such as batteries, fly wheels and ultra-capacitors, plug-in-hybrid vehicles, control and integrated operation of different static energy conversion devices.

UNIT– IV: Real and reactive power control:

Control issues and challenges in Diesel, PV, wind and fuel cell based generators, PLL, Modulation Techniques, Dimensioning of filters, Linear and nonlinear controllers, predictive controllers and adaptive controllers, Fault-ride through Capabilities, Load frequency and Voltage Control.

UNIT– V: Integration of different Energy Conversion Technologies:
Resources evaluation and needs, Dimensioning integration systems, Optimized integrated systems, Interfacing requirements, integrated Control of different resources, Distributed versus Centralized Control, Synchro Converters, Grid connected and Islanding Operations, stability and protection issues, load sharing, Cases studies.

Text books:

1. Ali Keyhani Mohammad N. Marwali and Min Dai,"Integration and Control of Renewable Energy in Electric Power System", John Wiley publishing company, 2010.
2. S. Chowdhury, S. P. Chowdhury, P. Crossley, "Microgrids and Active Distribution Networks", IET Power Electronics Series, 2012.
3. G.M. Masters, "Renewable and Efficient Electric Power Systems", IEEE-Wiley Publishers, 2nd edition2013.

References:

1. Quing-Chang Zhong, "Control of Power Inverters in Renewable Energy and Smart Grid Integration", Wiley-IEEE Press, 1st edition, 2012.
2. BinWu, Yongqiang Lang, Navid Zargari, "Power Conversion and Control of Wind Energy Systems", Wiley, 1st edition, 2011.

Semester	**I SEM**	**L**	**T**	**P**	**C**	**COURSE CODE**
Regulation	V21	3	0	0	3	V21PET04
Name of the Course	Smart Grid (Elective-I)					
Specialization	Power Electronics & Power systems					

Course Outcomes:

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

CO No.	**Course Outcome**	**Knowledge Level**
CO1	Understand concept of smart grid and its advantages over conventional grid.	K2
CO2	Understand smart metering techniques and measuring techniques	K2
CO3	Understand monitoring, protection techniques and storage systems for smart grids	K2
CO4	Illustrate the concept of Micro Grid and its integration	K2
CO5	Examine different communication technologies that can be used for smart grid	K2

UNIT-I: Introduction to Smart Grid

Evolution of Electric Grid, Concept of Smart Grid, Definitions, Need of Smart Grid, Functions of Smart Grid, Opportunities & Barriers of Smart Grid, Difference between conventional & smart grid. Case study of Smart Grid.

UNIT-II : Smart Grid Technologies: Part 1

Introduction to Smart Meters, Real Time Prizing, Smart Appliances, Automatic Meter Reading (AMR), Outage Management System (OMS), Plug in Hybrid Electric Vehicles (PHEV), Vehicle to Grid, Smart Sensors, Home & Building Automation.

UNIT-III :Smart Grid Technologies: Part 2

Smart Substations, Substation Automation, Feeder Automation. Geographic Information System (GIS), Intelligent Electronic Devices (IED) & their application for monitoring & protection, Smart storage like Battery, SMES, Pumped Hydro, Compressed Air Energy Storage, Wide Area Measurement System (WAMS), Phasor Measurement Unit (PMU).

UNIT-IV : Microgrids and Distributed Energy Resources

Concept of micro grid, need & applications of micro grid, formation of microgrid, Issues of interconnection, protection & control of microgrid. Plastic & Organic solar cells, Thin film solar cells, Variable speed wind generators, fuelcells, microturbines, Captive power plants, Integration of renewable energy sources.

UNIT-V: Information and Communication Technology for Smart Grid

Advanced Metering Infrastructure (AMI), Home Area Network (HAN), Neighborhood Area Network (NAN), Wide Area Network (WAN).

Text Books:

1. Ali Keyhani, Mohammad N. Marwali, Min Dai "Integration of Green and Renewable Energy in Electric Power Systems", Wiley
2. Clark W. Gellings, "The Smart Grid: Enabling Energy Efficiency and Demand Response",CRC Press
3. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama,"Smart Grid: Technology and Applications", Wiley
4. Jean Claude Sabonnadière, NouredineHadjsaïd, "Smart Grids", Wiley Blackwell 19
5. Peter S. Fox Penner, "Smart Power: Climate Changes, the Smart Grid, and the Futureof Electric Utilities", Island Press; 1 edition 8 Jun 2010
6. S. Chowdhury, S. P. Chowdhury, P. Crossley, "Microgrids and Active Distribution Networks." Institution of Engineering and Technology, 30 Jun 2009
7. Stuart Borlase, "Smart Grids (Power Engineering)", CRC Press

Reference Books:

1. Andres Carvallo, John Cooper, "The Advanced Smart Grid: Edge Power Driving Sustainability: 1", Artech House Publishers July 2011
2. James Northcote, Green, Robert G. Wilson "Control and Automation of Electric Power Distribution Systems (Power Engineering)", CRC Press
3. MladenKezunovic, Mark G. Adamiak, Alexander P. Apostolov, Jeffrey George Gilbert "Substation Automation (Power Electronics and Power Systems)", Springer
4. R. C. Dugan, Mark F. McGranghan, Surya Santoso, H. Wayne Beaty, "Electrical Power System Quality", 2nd Edition, McGraw Hill Publication
5. Yang Xiao, "Communication and Networking in Smart Grids", CRC Press

Semester	**I SEM**	**L**	**T**	**P**	**C**	**COURSE CODE**
Regulation	V21	3	0	0	3	V21PET05
Name of the Course	Power Quality (Elective-I)					
Specialization	Power Electronics & Power systems					

Course Outcomes:

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

CO No.	**Course Outcome**	**Knowledge Level**
CO1	Identify the issues related to power quality in power systems	K2
CO2	Describe the problems of transient and long duration voltage variations in power systems	K2
CO3	Analyze the effects of harmonics and understand different mitigation techniques.	K4
CO4	Identify the importance of custom power devices and their applications	K2
CO5	Choose suitable custom power device to mitigate power quality problem	K2

UNIT– I: Introduction to power quality:

Overview of Power Quality, Concern about the Power Quality, General Classes of Power Quality Problems, Voltage Unbalance, Waveform Distortion, Voltage fluctuation, Power Frequency Variations, Power Quality Terms, Voltage Sags, swells, flicker and Interruptions - Sources of voltage and current interruptions, Nonlinear loads.

UNIT– II: Transient and Long Duration Voltage Variations:

Source of Transient Over Voltages - Principles of Over Voltage Protection, Devices for Over Voltage Protection, Utility Capacitor Switching Transients, Utility Lightning Protection, Load Switching Transient Problems.

Principles of Regulating the Voltage, Device for Voltage Regulation, Utility Voltage Regulator Application, Capacitor for Voltage Regulation, End-user Capacitor Application, Regulating Utility Voltage with Distributed generation

UNIT– III : Harmonic Distortion and solutions:

Voltage vs. Current Distortion, Harmonics vs. Transients – Power System Quantities under Non-sinusoidal Conditions, Harmonic Indices, Sources of harmonics, Locating Sources of Harmonics, System Response Characteristics, Effects of Harmonic Distortion,

Inter harmonics, Harmonic Solutions - Harmonic Distortion Evaluation, Devices for Controlling Harmonic Distortion, Harmonic Filter Design, Standards on Harmonics

UNIT– IV: Custom Power Devices:
Custom power and custom power devices, voltage source inverters, reactive power and harmonic compensation devices, compensation of voltage interruptions and current interruptions, static series and shunt compensators, compensation in distribution systems, interaction with distribution equipment, installation considerations.

UNIT– V: Application of custom power devices in power systems:
Static and hybrid Source Transfer Switches, Solid state current limiter - Solid state breaker. P-Q theory – Control of P and Q, Dynamic Voltage Restorer (DVR): Operation and control – Interline Power Flow Controller (IPFC): Operation and control of Unified Power Quality Conditioner (UPQC); Generalized power quality conditioner

Text Books:

1. Dugan R C, McGranaghan M F, Santoso S, and Beaty H W, "Electrical Power Systems Quality",2nd Edition, McGraw-Hill, 2002.
2. Bollen M H J, "Understanding Power Quality Problems: Voltage Sags and Interruptions", 1st Edition, IEEE Press; 2000.
3. Guidebook on Custom Power Devices, Technical Report, Published by EPRI, Nov 2000.
4. Gerard Ledwich, Arindam Ghosh, "Power Quality Enhancement Using Custom Power Devices – Power Electronics and Power Systems", Springer US, 1st edition, 2002.

Reference Books:

1. Kennedy B W, "Power Quality Primer", 1st Edition, McGraw-Hill, 2000.
2. Arrillaga J and Watson N R, "Power System Harmonics", John Wiley & Sons, 2nd edition, 2003.
3. W. E. Kazibwe and M. H. Sendaula, "Electric Power Quality control Techniques", Van Nostrad Reinhold Inc, New York, 1993 ed., 1993.
4. C. Shankaran, "Power Quality", CRC Press, The electric power engineering series, 2002
5. Franciso C.DE LA Rosa, "Harmonics and Power Systems", CRC Press (Taylor & Francis), 1st edition, 2006.
6. EwaldF.fuchs, Mohammad A.S. Masoum, "Power Quality in Power systems and Electrical Machines", Elsevier, 1st edition, 2008.
7. H. Akagiet.al., "Instantaneous Power Theory and Application to Power Conditioning", IEEE Press series, 2007.

8. Arindam Ghosh and Gerard Ledwich, "Custom Power Devices - An Introduction", Springer, 1st edition, 2002
9. Yash Pal et.al., "A Review of Compensating Type Custom Power Devices for Power Quality Improvement", Joint International Conference on Power System Technology and IEEE Power India Conference, 2008. POWERCON 2008.
10. https://nptel.ac.in/courses/108/107/108107157/

Semester	**I SEM**	**L**	**T**	**P**	**C**	**COURSE CODE**
Regulation	V21	3	0	0	3	V21PET06
Name of the Course	Electrical Distribution Automation (Elective-II)					
Specialization	Power Electronics & Power systems					

Course Outcomes:

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

CO No.	**Course Outcome**	**Knowledge Level**
CO1	Understand various factors of distribution system	**K2**
CO2	Construct the distribution substation and feeders	**K3**
CO3	Understand the distribution system protection and its coordination.	**K2**
CO4	Understand the effect of compensation for power factor improvement.	**K2**
CO5	Explain the distribution automation functions	**K2**

UNIT– I: Introduction to Distribution systems:

Introduction, an overview of the role of computers in distribution system planning-Load modeling and characteristics - definition of basic terms like demand factor, utilization factor, load factor, plant factor, diversity factor, coincidence factor, contribution factor and loss factor-Relationship between the load factor and loss factor - Classification of loads (Residential, Commercial, Agricultural and Industrial) and their characteristics.

UNIT– II: Distribution Feeders and Substations:

Design consideration of Distribution feeders: Radial and loop types of primary feeders, voltage levels, and feeder-loading. Design practice of the secondary distribution system. Location of Substations: Rating of a Distribution Substation, service area with ”n‟ primary feeders. Benefits derived through optimal location of substations.

UNIT– III: **Protective devices and coordination:**

Objectives of distribution system protection, types of common faults and procedure for fault calculation. Protective Devices: Principle of operation of fuses, circuit reclosers, line sectionalizer and circuit breakers. Coordination of protective devices: General coordination procedure; types of coordination.

UNIT– IV: Capacitive compensation for power factor control:

Different types of power capacitors, shunt and series capacitors, effect of shunt capacitors (Fixed and switched), power factor correction, capacitor location. Economic justification.

Procedure to determine the best capacitor location. Voltage control: Equipment for voltage control, effect of series capacitors, effect of AVB/AVR, line drop compensation.

UNIT– V: Distribution automation functions:

Electrical system automation, EMS functional scope, DMS functional scope functionality of DMS- Steady state and dynamic performance improvement; Geographic information systems-AM/FM functions and Database management; communication options, supervisory control and data acquisition: SCADA functions and system architecture; Synchro phasors and its application in power systems.

Text Books:

1. Turan Gonen, "Electric Power Distribution System Engineering ", CRC Press, 2nd edition, 2008.
2. Juan M. Gers, "Distribution System Analysis and Automation", The Institution of Engineering and Technology, UK, Power and energy series 68, 2014.

Reference Books:

1. A.S. Pabla, "Electric Power Distribution", Tata McGraw-Hill Publishing Company, 4thedition, 1997.
2. V. Kamaraju, "Electrical Distribution", Tata McGraw Hill-8th Edition, 2009.
3. Gorti Ramamurthy "Handbook of Electrical Power Distribution", Universities press, 2009.
4. https://nptel.ac.in/courses/108/107/108107112/

Semester	**I SEM**	**L**	**T**	**P**	**C**	**COURSE CODE**
Regulation	V21	3	0	0	3	V21PET07
Name of the Course	HVDC Transmission (Elective-II)					
Specialization	Power Electronics & Power systems					

Course Outcomes:

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

CO No.	**Course Outcome**	**Knowledge Level**
CO1	Understand the various schemes of HVDC transmission	K2
CO2	Explain the operation of static power converters for HVDC transmission	K2
CO3	Describe various control techniques of power converters	K2
CO4	Understand the interaction between HVAC and HVDC system.	K2
CO5	Understand the various protection schemes of HVDC transmission	K2

UNIT– I: Limitation of EHV AC Transmission, Advantages of HVDC:

Technical economical and reliability aspects. HVDC Transmission: General considerations, Power Handling Capabilities of HVDC Lines, Basic Conversion principles, static converter configuration. Types of HVDC links-Apparatus and its purpose

UNIT– II: Static Power Converters:

6-pulse bridge circuit and 12-pulse converters, converter station and Terminal equipment, commutation process, Rectifier and inverter operation, equivalent circuit for converter – special features of converter transformers. Comparison of the performance of diametrical connection with 6-pulse bridge circuit

UNIT– III: Control of HVDC Converters and systems:

Constant current, constant extinction angle and constant Ignition angle control. Individual phase control and equidistant firing angle control, DC power flow control. Factors responsible for generation of Harmonics voltage and current, harmonics effect of variation of α and μ. Filters, Harmonic elimination.

UNIT– IV: Interaction between HV AC and DC systems:

Voltage interaction, Harmonic instability problems and DC power modulation. Development of DC circuit Breakers, Multi-terminal DC links and systems; series, parallel and series parallel systems, their operation and control.

UNIT– V: Transient over voltages in HV DC systems:

Over voltages due to disturbances on DC side, over voltages due to DC and AC side line faults. Converter faults and protection in HVDC Systems: Converter faults, over current protection - valve group, and DC line protection, circuit breakers. Over voltage protection of converters, surge arresters.

Text Books:

1. S Kamakshaih and V Kamaraju "HVDC Transmission", Tata Mc Graw hill, 2011.
2. K.R.Padiyar, "High Voltage Direct current Transmission", Wiley Eastern Ltd., New Delhi – 1992.

Reference Books:

1. E.W. Kimbark, "Direct current Transmission", Wiley Inter Science – New York, 1st edition, 1971.
2. J.Arillaga, "H.V.D.C.Transmission", Peter Peregrinus ltd., London UK, 1983.
3. Vijay K Sood, "HVDC and FACTS controllers:Applications of static converters in power systems", Springer US, 1st edition, 2004.
4. https://nptel.ac.in/courses/108/104/108104013/

Semester	**I SEM**	**L**	**T**	**P**	**C**	**COURSE CODE**
Regulation	V21	3	0	0	3	V21PET08
Name of the Course	Advanced Power Systems Protection (Elective-II)					
Specialization	Power Electronics & Power systems					

Course Outcomes:

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

CO No.	**Course Outcome**	**Knowledge Level**
CO1	Classify different types of static relays and tools.	K2
CO2	Explain various Amplitude and Phase Comparators	K2
CO3	Describe different types of static over current relays.	K2
CO4	Understand the PILOT Relaying schemes	K2
CO5	Identify suitable Microprocessor based and Numerical relays for power system protection	K2

UNIT– I: Static Relays classification and Tools :
Comparison of Static with Electromagnetic Relays, Basic classification, Level detectors and Amplitude and phase Comparators – Duality – Basic Tools – Schmitt Trigger Circuit, Multi-vibrators, Square wave Generation – Polarity detector – Zero crossing detector – Thyristor and UJT Triggering Circuits. Phase sequence Filters – Speed and reliability of static relays.

UNIT– II: Amplitude and Phase Comparators (2 Input) :
Generalized equations for Amplitude and Phase comparison – Derivation of different characteristics of relays – Rectifier Bridge circulating and opposed voltage type amplitude comparators – Averaging & phase splitting type amplitude comparators – Principle of sampling comparators.

Phase Comparison : Block Spike and phase Splitting Techniques – Transistor Integrating type, phase comparison, Rectifier Bridge Type Comparison – Vector product devices.

UNIT– III: Static over current (OC) relays:
Instantaneous, Definite time, Inverse time OC Relays, static distance relays, static directional relays, static differential relays, measurement of sequence impedances in distance relays, multi input comparators, elliptic & hyperbolic characteristics, switched distance schemes, Impedance characteristics during Faults and Power Swings,

UNIT– IV: PILOT Relaying schemes:

Wire pilot protection: circulating current scheme – balanced voltage scheme – translay scheme – half wave comparison scheme - carrier current protection: phase comparison type – carrier aided distance protection – operational comparison of transfer trip and blocking schemes – optical fibre channels.

UNIT– V: Microprocessor based relays and Numerical Protection:

Introduction – over current relays – impedance relay – directional relay – reactance relay. Numerical Protection: Introduction - numerical relay - numerical relaying algorithms - mann-morrison technique - Differential equation technique and discrete fourier transform technique - numerical over current protection - numerical distance protection.

Text Books:

1. TS MadhavaRao, "Power System Protection with Static Relays", TMH, 2nd edition, 2017.
2. Badri Ram & D N vishwakarma, "Power system protection & switchgear", TMH, 22nd reprint, 2007.

Reference Books:

1. A.R. van C.Warrington, "Protective Relays their Theory and Practice, Vol-II", Springer, 3rd edition, 1978.
2. C R Mason, "The Art & Science of Protective Relaying", Willey-Blackwell,1966.
3. Kimbark, "Power System Stability", Vol-II, student edition, Wiley, 2007.
4. C.Christopoulos and A.Wright, "Electrical Power System Protection", Springer US, 2nd Edition, 1999.
5. BhaveshBhalaja, R.PMaheshwari, NileshG.Chothani "Protection & Switchgear", Oxford university press, 2nd edition, 2018.
6. https://nptel.ac.in/courses/108/101/108101039/

Semester	**I SEM**	**L**	**T**	**P**	**C**	**COURSE CODE**
Regulation	V21	0	0	4	2	V21PEL01
Name of the Course	Power Electronics Simulation Laboratory					
Specialization	Power Electronics & Power systems					

Course Outcomes:

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

CO No.	**Course Outcome**	**Knowledge Level**
CO1	Analyze the DC-DC converters using small signal model	K4
CO2	Analyze the operation of Multi-level inverters	K4
CO3	Analyze the different PWM techniques for inverters	K4
CO4	Analyze the operation of AC Voltage regulators	K4
CO5	Analyze the operation of AC-DC converters	K4

List of Experiments:

1. Simulation of Buck converter using small signal model.
2. Simulation of Boost converter using small signal model.
3. Simulation of single phase half bridge inverter.
4. Simulation of full bridge inverter using Uni-polar & Bi-polar PWM techniques.
5. Simulation of three phase inverter using sine-triangle PWM.
6. Simulation of three phase inverter using space vector PWM.
7. Simulation of three level three phase NPC inverter.
8. Study of neutral point voltage floating in NPC three level inverter
9. Simulation of 3-level flying capacitor inverter & evaluation of capacitor voltage balanced methods.
10. Simulation of single phase AC voltage regulator.
11. Simulation of three phase AC voltage regulator.
12. Comparison of harmonic profile of two level& three level inverter (FFT analysis).
13. Simulation of 5-level inverter using carrier based PWM methods.
14. Simulation of three phase full converter with RL & RLE loads.
15. Simulation of three-phase dual converter.

Semester	**I SEM**	**L**	**T**	**P**	**C**	**COURSE CODE**
Regulation	V21	0	0	4	2	V21PEL02
Name of the Course	Power Systems Laboratory					
Specialization	Power Electronics & Power systems					

Course Outcomes:

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

CO No.	**Course Outcome**	**Knowledge Level**
CO1	Calculate the sequence impedances of 3 phase Transformer and Alternator	K3
CO2	Determine the power Angle Characteristics of 3-phase Alternator with infinite bus bars	K4
CO3	Estimate the performance of long transmission lines	K4
CO4	Determine the ABCD parameters of a transmission line model	K4
CO5	Analyse the Ferranti effect in long transmission line	K4

List of Experiments:

1. Determination of Sequence Impendence of an Alternator by direct method.
2. Determination of Sequence impedance of an Alternator by fault Analysis.
3. Measurement of sequence impedance of a three phase transformer
   (a) application of sequence voltage. (b). using fault analysis.
4. Power angle characteristics of a salient pole Synchronous Machine.
5. Poly-phase connection on three single phase transformers and measurement of phase displacement.
   a. Determination of equivalent circuit of 3-winding Transformer.
6. Measurement of ABCD parameters on transmission line model.
7. Performance of long transmission line without compensation.
8. Study of Ferranti effect in long transmission line.
9. Performance of long transmission line with shunt compensation.

Semester	**II SEM**	**L**	**T**	**P**	**C**	**COURSE CODE**
Regulation	V21	3	0	0	3	V21PET09
Name of the Course	Switched Mode Power Conversion					
Specialization	Power Electronics & Power systems					

Course Outcomes:

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

CO No.	**Course Outcome**	**Knowledge Level**
CO1	Explain operation and control of non-isolated switch mode converters.	K2
CO2	Describe operation and control of isolated switch mode converters.	K2
CO3	Understand the operation and control of resonant converters	K2
CO4	Compute control strategies of switching converters	K3
CO5	Explain the operation of switch mode converters based on linearization and small-signal analysis.	K3

UNIT– I: Non-isolated switch mode converters:

Control of DC-DC converters: Buck converters, Boost converters, Buck-Boost converter, CUK Converter, continuous and discontinuous operation, Converter realization with non-ideal components.

UNIT– II: Isolated switched mode converters:

Forwarded converter, flyback converter, push-pull converter, half-bridge converter, full bridge converter.

UNIT– III: Resonant converters:

Basic resonant circuit concepts, series resonant circuits, parallel resonant circuits, zero current switching quasi-resonant buck converter, zero current switching quasi-resonant boost converter, zero voltage switching quasi-resonant buck converter, zero voltage switching quasi-resonant boost converter.

UNIT– IV: Control schemes of switching converters:

Voltage control, Current mode control, control scheme for resonant converters.
Magnetic design consideration: Transformer design, inductor and capacitor design.

UNIT– V: Modeling and Controller design based on linearization:

Formulation of averaged models for buck and boost converters: state space analysis, average circuit models, linearization and small – signal analysis, small-signal models.

Control design based on linearization: Transfer function of converters, control design, large signal issues in voltage-mode and current-mode control.

Text Books:

1. Fundamentals of Power Electronics Third Edition-Erickson, Robert W., Maksimovic, Dragan, Springer, 2011.
2. Power switching converters Third Edition-Simon Ang, Alejandro Oliva, CRC Press, 2010.
3. Elements of Power Electronics Second Edition– Philip T. Krein, Oxford University press, 2014.
4. Design of Magnetic Components for Switched Mode Power Converters First Edition-Umanand, S.P. Bhat, John Wiley & Sons Australia, 1992.

Reference Books:

1. Switching Power Supply Design Third Edition-Abraham I. Pressman, McGraw-Hill Ryerson, Limited, 1991.
2. Power Electronics Second Edition– Issa Batareseh, Jhon Wiley publications, 2004.
3. Power Electronics: converters Applications & Design Third Edition- – Mohan, Undeland, Robbins-Wiley publications,2002.
4. https://nptel.ac.in/courses/108/108/108108036/

Semester	**II SEM**	**L**	**T**	**P**	**C**	**COURSE CODE**
Regulation	V21	3	0	0	3	V21PET10
Name of the Course	Real Time Control of Power Systems					
Specialization	Power Electronics & Power systems					

Course Outcomes:

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

CO No.	**Course Outcome**	**Knowledge Level**
CO1	Classify the state estimation methods and understand the concepts of bad data observability, detection, identification and elimination	K2
CO2	Identify and Recognize the security, contingency and line outages in power system	K2
CO3	Illustrate the need of computer control and SCADA in real time power system	K2
CO4	Understand the concept of voltage stability in real time power systems	K2
CO5	Understand the basic concepts of Synchrophasor Measurement units	K2

UNIT– I: State Estimation:

Different types of State Estimations, Theory of WLS state estimation, sequential and non-sequential methods to process measurements. Bad data Observability, Bad data detection, identification and elimination.

UNIT– II: Security and Contingency Evaluation:

Security concept, Security Analysis and monitoring, Contingency Analysis for Generator and line outages by iterative linear power flow method, Fast Decoupled model, and network sensitivity methods.

UNIT– III: Computer Control of Power Systems:

Need for real time and computer control of power systems, operating states of a power system, SCADA - Supervisory control and Data Acquisition systems implementation considerations, energy control centers, software requirements for implementing the above functions.

UNIT– IV: Voltage Stability:

Voltage collapse, and voltage security, relation of voltage stability to rotor angle stability. Voltage stability analysis Introduction to voltage stability analysis `P-V"curves and `Q-V" curves, voltage stability in mature power systems, long-term voltage stability, power flow analysis for voltage stability, voltage stability static indices.

UNIT– V: Synchrophasor Measurement units:

Introduction, Phasor representation of sinusoids, a generic PMU, GPS, Phasor measurement systems, Communication options for PMUs, Functional requirements of PMUs and PDCs, Phasors for nominal frequency signals, types of frequency excursions in power systems, DFT estimation at off nominal frequency with a nominal frequency clock.

Text Books:

1. John J.Grainger and William D.Stevenson, Jr. First Edition: Power System Analysis, McGraw-Hill, 1994, International Edition
2. Allen J.Wood and Bruce F.Wollenberg Third Edition: Power Generation operation and control, John Wiley & Sons, 2013.
3. A.G.PhadkaandJ.S.Thorp,"SynchronizedPhasorMeasurementsandTheir Applications" First Edition,Springer,2008

Reference Books:

1. R.N.Dhar : Computer Aided Power Systems Operation and Analysis First Edition, Tata McGraw Hill, 1982
2. L.P.Singh : Advanced Power System Analysis and Dynamics Fourth Edition, Wiley Eastern Ltd. 2008
3. PrabhaKundur : Power System Stability and Control First Edition, McGraw Hill, 2006
4. P.D.Wasserman : `Neural Computing:Theory and Practice‟Van Nostrand First Edition - Feinhold, New York.

Semester	**II SEM**	**L**	**T**	**P**	**C**	**COURSE CODE**
Regulation	V21	3	0	0	3	V21PET11
Name of the Course	Electrical Machine Modeling and Analysis (Elective –III)					
Specialization	Power Electronics & Power systems					

Course Outcomes:

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

CO No.	**Course Outcome**	**Knowledge Level**
CO1	Analyze Kroon's Primitive Machine	K2
CO2	Develop modeling of dc machine	K3
CO3	Explain linear Transformation	K4
CO4	Apply mathematical modeling concepts to 3-phase Induction machines	K3
CO5	Design control strategies based on dynamic modeling of 3-ph Induction machines and3-phase Synchronous machine	K4

UNIT– I: Basic concepts of Modeling:

Basic two-pole machine representation of Commutator machines, representations of 3-phase synchronous machine with and without damper bars and 3-phase induction machine, Kron‟s primitive Machine voltage, current and torque equations.

UNIT– II: DC Machine Modeling:

Mathematical model of separately excited D.C motor – Steady state analysis-transient State analysis-sudden application of inertia load-transfer function of separately excited D.C motor- Mathematical model of D.C Series motor, Shunt motor-Linearization techniques for small perturbations

UNIT– III: Reference frame theory & Modeling of single phase Induction Machines:

Linear transformation-Phase transformation - three phase to two phase transformation (abc to αβ0) and vice-versa, transformation to rotating reference frame, (αβ0 to dqo) and vice versa -Power equivalence-Mathematical modeling of single phase induction machines.

UNIT– IV: Modeling of three phase Induction Machine:

Generalized model in arbitrary reference frame-Derivation of commonly used induction machine models-Synchronously rotating reference frame model, Stator reference frame model-Rotor reference frame model--power equation, electromagnetic torque equation, state space model in induction motor with flux linkages as variables

UNIT– V: Modeling of Synchronous Machine:

Synchronous machine inductances –derivation of voltage equations in the rotor‟s dq0 reference frame electromagnetic torque-current in terms of flux linkages-three phase synchronous motor. State space models with flux linkages as variables.

Text Books

1. Analysis of Electric Machinery and Drive Systems, 3rd Edition-Wiley-IEEE Press- Paul Krause, Oleg Wasynczuk, Scott D. Sudhoff, Steven Pekarek, Junr 2013.
2. Electric Motor Drives First Edition- Modeling, Analysis & control -R. Krishnan- Pearson Publications.

Reference Books:

1. Generalized theory of Electrical Machines First edition- Khanna Publishers P. S. Bimbhra, 1985.
2. Dynamic simulation of Electric machinery using MATLAB / Simulink Second Edition– CheeMunOng- Prentice Hall, 2003.
3. Magneto electric devices transducers, transformers and machines-G. R. Slemon First Edition - Wiley in New York, London, 1966
4. https://nptel.ac.in/courses/108/106/108106023/

Semester	**II SEM**	**L**	**T**	**P**	**C**	**COURSE CODE**
Regulation	V21	3	0	0	3	V21PET12
Name of the Course	Control of Electric Drives (Elective –III)					
Specialization	Power Electronics & Power systems					

Course Outcomes:

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

CO No.	**Course Outcome**	**Knowledge Level**
CO1	Understand fundamentals of electric drives	K2
CO2	Understand various DC motor drives and control	K2
CO3	Analyze control techniques of synchronous motor drives	K4
CO4	Analyze control techniques for Switched Reluctance Motor	K4
CO5	Understand operation and various control schemes of BLDC motor	K2

Unit I: Fundamentals of Electric Drive:

Electric Drives and its parts, advantages of electric drives Classification of electric drives Speed-torque conventions and multi-quadrant operations, Constant torque and constant power operation, Types of load torque: components, nature and classification

Unit II: DC Motor Drives:

Starting, Braking and Speed Control, Transient analysis of separately excited motor with armature and field control, Energy losses during transient operation, Phase controlled converter fed DC drives, Chopper Control DC drives.

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 Structure-Stator Excitation-techniques of sensor less operation-convertor topologies-RM Waveforms-SRM drive design factors-Torque controlled SRM-Torque Ripple-Instantaneous Torque control -using current controllers-flux controllers.

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. Fundamentals of Electrical Drives – G.K. Dubey – Narosa Publications -1995
2. Power Electronics control of AC motors – MD Murphy & FG Turn Bull Pergman Press -1st edition-1998.
3. Electric Motor Drives Modeling, Analysis & control -R. Krishnan- Pearson Education-4th edition – 2015
4. Brushless permanent magnet and reluctance motor drives- T J E Miller- Oxford university press- 1989

Reference Books:

1. Ned Mohan, T.M. Undeland and William P. Robbins: Power Electronics: Converters, Applications, 3rd Edition, John Wiley & Sons, 2009
2. Modelling, Simulation and control of Electric Drives- M.F Rahman, Sanjeet K. Dwivedi- IET Publiers-1st edition-Oct 2019
3. Power Semiconductor drives- G.K. Dubey-Prentice hall-1989

Semester	**II SEM**	**L**	**T**	**P**	**C**	**COURSE CODE**
Regulation	V21	3	0	0	3	V21PET13
Name of the Course	Applications of Power Converters (Elective –III)					
Specialization	Power Electronics & Power systems					

Course Outcomes:

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

CO No.	**Course Outcome**	**Knowledge Level**
CO1	understand the inverters for induction heating applications	K2
CO2	understand the power converters for different industrial applications	K2
CO3	understand modeling of high voltage power supplies using the power converters for radar and space applications	K2
CO4	understand modeling of low voltage and high current power supplies using the power converters for microprocessors and computer loads	K2
CO5	understand the applications of DC-DC converters	K2

UNIT– I: Inverters for Induction Heating:

For induction cooking, induction hardening, melting, and welding applications.

UNIT– II: Power Converters for Lighting, pumping and refrigeration Systems:

Electronic ballast, LED power drivers for indoor and outdoor applications. PFC based grid fed LED drivers, PV / battery fed LED drivers. PV fed power supplies for pumping/refrigeration applications.

UNIT– III: **High Voltage Power Supplies:**

Power supplies for X-ray applications - power supplies for radar applications - power supplies for space applications.

UNIT– IV: Low voltage high current power supplies:

Power converters for modern microprocessor and computer loads

UNIT– V: Bi-directional DC-DC (BDC) converters:

Electric traction, automotive Electronics and charge/discharge applications, Line Conditioners and Solar Charge Controllers

Text Books:

1. Ali Emadi, A. Nasiri, and S. B. Bekiarov: Uninterruptible Power Supplies and Active Filters First Edition, CRC Press, 2004.
2. M. Ehsani, Y. Gao, E. G. Sebastien and A. Emadi: Modern Electric, Hybrid Electric and Fuel Cell Vehicles, 1st Edition,CRC Press, 2004.

References Books:

1. William Ribbens: Understanding Automotive Electronics Eight Edition, Newnes, 2017.
2. https://nptel.ac.in/courses/108/107/108107128/

Semester	**II SEM**	**L**	**T**	**P**	**C**	**COURSE CODE**
Regulation	V21	3	0	0	3	V21PET14
Name of the Course	EHVAC Transmission (Elective –IV)					
Specialization	Power Electronics & Power systems					

Course Outcomes:

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

CO No.	**Course Outcome**	**Knowledge Level**
CO1	Determine the transmission line parameters	K3
CO2	Calculate the field effects on EHV and UHV AC lines.	K3
CO3	Determine the corona, RI and audible noise in EHV and UHV lines	K3
CO4	Analyze voltage control and compensation problems in EHV and UHV transmission systems	K4
CO5	Understand reactive power compensation using SVC and TCR	K2

UNIT– I: E.H.V. A.C. Transmission, line trends and preliminary aspects, standard transmission voltages – power handling capacities and line losses – mechanical aspects. Calculation of line resistance and inductance: resistance of conductors, temperature rise of conductor and current carrying capacity. Properties of bundled conductors and geometric mean radius of bundle, inductance of two conductor lines and multi conductor lines, Maxwell‟s coefficient matrix. Line capacitance calculation. Capacitance of two conductor line, and capacitance of multi conductor lines, potential coefficients for bundled conductor lines, sequence inductances and capacitances and diagonalization.

UNIT– II: Calculation of electro static field of AC lines:

Effect of high electrostatic field on biological organisms and human beings. Surface voltage Gradient on conductors, surface gradient on two conductor bundle and cosine law, maximum surface voltage gradient of bundle with more than 3 sub conductors, Mangolt formula.

UNIT– III: Corona:

Corona in EHV lines – corona loss formulae – attenuation of traveling waves due to corona – Audio noise due to corona, its generation, characteristics and limits, measurement of audio noise.

UNIT– IV: Power Frequency voltage control:

Problems at power frequency, generalized constants, No load voltage conditions and charging currents, voltage control using synchronous condenser, cascade connection of components : Shunt and series compensation, sub synchronous resonance in series – capacitor compensated lines

UNIT– V: Reactive power compensating systems:

Introduction, SVC schemes, Harmonics injected into network by TCR, design of filters for suppressing harmonics injected into the system.

Text Books :

1. Extra High Voltage AC Transmission Engineering Fourth Edition– Rakesh Das Begamudre, Wiley Eastern ltd., New Delhi – 2011.
2. EHV Transmission line reference book – Edison Electric Institute (GEC) 1986.
3. https://nptel.ac.in/courses/108/108/108108099/

Semester	**II SEM**	**L**	**T**	**P**	**C**	**COURSE CODE**
Regulation	V21	3	0	0	3	V21PET15
Name of the Course	Flexible AC Transmission System (Elective –IV)					
Specialization	Power Electronics & Power systems					

Course Outcomes:

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

CO No.	**Course Outcome**	**Knowledge Level**
CO1	Explain the improvements of transmission system with FACTS	K2
CO2	Illustrate different Types of Static VAr generation systems	K3
CO3	Estimate the effect of static shunt compensation.	K2
CO4	Estimate the effect of static series compensation.	K2
CO5	Explain the principle of operation and various controls of UPFC	K2

UNIT– I: Introduction

FACTS concepts, Transmission interconnections, power flow in an AC System, loading capability limits, Dynamic stability considerations, importance of controllable parameters, basic types of FACTS controllers, benefits from FACTS controllers.

UNIT– II: Static shunt compensation

Basic concept of voltage and current source converters, comparison of current source converters with voltage source converters.

Static shunt compensation : Objectives of shunt compensation, midpoint voltage regulation, voltage instability prevention, improvement of transient stability, Power oscillation damping, methods of controllable VAr generation, variable impedance type static VAr generation, switching converter type VAr generation, hybrid VAr generation.

UNIT– III: SVC and STATCOM

The regulation slope, transfer function and dynamic performance, transient stability enhancement and power oscillation damping, operating point control and summary of compensation control.

UNIT– IV: Static Series compensators

Concept of series capacitive compensation, improvement of transient stability, power oscillation damping, functional requirements. GTO Thyristor controlled series capacitor (GSC), Thyristor switched series capacitor (TSSC), and Thyristor controlled series capacitor (TCSC), control schemes for GSC, TSSC and TCSC.

UNIT– V: Unified Power Flow Controller

Basic operating principle, conventional transmission control capabilities, independent real and reactive power flow control, comparison of the UPFC to series compensators and phase angle regulators. Introduction to Inter line Power Flow Controller (IPFC)

Text Books:

1. Understanding FACTS Devices by N. G. Hingorani and L. Guygi, IEEE Press, 2001

Reference Books:

1. Flexible AC Transmission systems bySang. Y. Hand John. A.T, IEEE Press, 2006
2. HVDC & FACTS Controllers: applications of static converters in power systems by Vijay K. Sood, First Edition- - Springer publishers, 2004.
3. https://nptel.ac.in/courses/108/107/108107114/

Semester	**II SEM**	**L**	**T**	**P**	**C**	**COURSE CODE**
Regulation	V21	3	0	0	3	V21PET16
Name of the Course	Power System Dynamics and Stability (Elective –IV)					
Specialization	Power Electronics & Power systems					

Course Outcomes:

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

CO No.	**Course Outcome**	**Knowledge Level**
CO1	Develop the State space Model of Synchronous Machine	K3
CO2	Analyse the Steady State Stability and Dynamic Stability of Synchronous machine	K4
CO3	Solve the Swing Equation using different methods to obtain the Transient Stability	K3
CO4	Illustrate the Effect of Governing and Excitation systems on Stability	K3
CO5	Discuss Different types of Excitation Systems	K2

UNIT– I: System Dynamics

Synchronous machine model in state space from computer representation for excitation and governor system –modeling of loads and induction machines.

UNIT– II: Steady state stability

steady state stability - steady state stability limit – Dynamics Stability limit – Dynamic stability analysis – State space representation of synchronous machine connected to infinite bus-time response – Stability by eigen value approach.

UNIT– III: Digital Simulation of Transient Stability

Swing equation machine equations – Representation of loads – Alternate cycle solution method – Direct method of solution – Solution Techniques : Modified Euler method – Runge Kutta method – Concept of multi machine stability.

UNIT– IV

Effect of governor action and excite on power system stability effect of saturation, saliency & automatic voltage regulators on stability.

UNIT– V: Excitation Systems

Rotating Self-excited Exciter with direct acting Rheostatic type voltage regulator – Rotating main and Pilot Exciters with Indirect Acting Rheostatic Type Voltage Regulator – Rotating Main Exciter, Rotating Amplifier and Static Voltage Regulator – Static excitation scheme – Brushless excitation system.

Text Books:

1. Power System Stability by Kimbark Vol. I&II, III, Willey.
2. Power System control and stability Third Edition by Anderson and Fund, IEEE Press, 2019.

Reference Books:

1. Power systems stability and control First Edition by PRABHA KUNDUR, TMH, 2006.
2. Computer Applications to Power Systems Twelth Edition–Glenn. W. Stagg& Ahmed. H. El. Abiad, TMH 1987.
3. Computer Applications to Power Systems Third Edition– M.A.Pai, TMH, 2014.
4. Power Systems Analysis & Stability First Edition– S.S.Vadhera, Khanna Publishers, 2005.
5. https://nptel.ac.in/courses/108/101/108101004/

Semester	**II SEM**	**L**	**T**	**P**	**C**	**COURSE CODE**
Regulation	V21	0	0	4	2	V21PEL03
Name of the Course	Power Converters Laboratory					
Specialization	Power Electronics & Power systems					

Course Outcomes:

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

CO No.	**Course Outcome**	**Knowledge Level**
CO1	Find the duty ratio of DC-DC Converters	K3
CO2	Analyze the performance of 1- ϕ AC-DC Controlled rectifiers	K4
CO3	Sketch the characteristics of power semiconductor devices	K3
CO4	Find the modulation index of square wave &SPWM inverters	K3
CO5	Calculate input power factor of 3-ϕ full converter	K3

Any 10 of the following experiments are to be conducted.

List of experiments

1. Study of DC-DC non-isolated converters such as Buck & Boost converter.
2. Study of DC-DC Buck - Boost and Cuk converters.
3. Study of 1-ϕ dual converter.
4. Determination of input p.f. and harmonic factor for 1-ϕ semi- converter and 1-ϕ full-converter (Inductive load)
5. Study of p.f. improvement in 1-ϕ full-converter with symmetric and extinction angle control.
6. Study of 1-ϕ square wave and sinusoidal PWM inverter.
7. Study of 3-ϕ inverter with 120^o and 180^o mode of operation.
8. Study of 3-ϕ sinusoidal PWM inverter.
9. Study of 3-level NPC inverter.
10. Study of 5-level cascaded H-bridge inverter.
11. Determination of input p.f. and harmonic factor for 3-ϕ full converter (Inductive load).
12. Determination of input p.f. and harmonic factor for 3-ϕ semi converter (Inductive load).
13. Study the characteristics of IGBT, MOSFET & GTO‟s.
14. Design of gate drive circuits for IGBT & MOSFET‟s.

Semester	**II SEM**	**L**	**T**	**P**	**C**	**COURSE CODE**
Regulation	V21	0	0	4	2	V21PEL04
Name of the Course	Power Systems Simulation Laboratory					
Specialization	Power Electronics & Power systems					

Course Outcomes:

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

CO No.	**Course Outcome**	**Knowledge Level**
CO1	Analyze the performance of the various transmission lines at different loading conditions	K4
CO2	Examine the load flow study on distribution systems	K4
CO3	Inspect the Z- and Y-bus matrices for the given power transmission system	K4
CO4	Determine the load flow solution obtained using GS and NR methods	K4
CO5	Analyze the transient stability & load frequency control problem of a power system	K4

Any 10 of the following experiments are to be conducted.

List of Experiments:

1. Performance analysis of short, medium and long transmission lines
2. Distribution load flow analysis
3. Economic Load Dispatch with & without transmission losses
4. Formation of Y-bus by direct inspection method
5. Formations of Z-bus by building algorithm
6. Load Flow Solution Using Gauss Siedel Method
7. Load Flow Solution Using Newton Raphson Method
8. Symmetrical and Unsymmetrical Fault analysis using Z-bus
9. Transient Stability Analysis using modified Euler‟s method.
10. Transient Stability Analysis using modified R-K method
11. Transient Stability Analysis Using Point By Point Method
12. Load Frequency Control of Single Area Control & Two Area Control system with and without controllers.

Semester	**II SEM**	**L**	**T**	**P**	**C**	**COURSE CODE**
Regulation	V21	0	0	4	2	V21PEP01
Name of the Course	Mini Project with Seminar					
Specialization	Power Electronics & Power systems					

Syllabus content:

A Student has to select one paper published in any of the IEEE Transactions and simulate the same. The student has to present the progress of the work at the middle of the semester. At the end of the semester, the student has to present the results by explaining the idea of the topic, methodology, finding of the simulations. A Student should also submit a report of the entire work carried out under this course. The end semester presentation must be video recorded and preserved.

Semester	**III SEM**	**L**	**T**	**P**	**C**	**COURSE CODE**
Regulation	V21	3	0	0	3	V21PET17
Name of the Course	Hybrid Electric Vehicles (Elective–V)					
Specialization	Power Electronics & Power systems					

Course Outcomes:

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

CO No.	**Course Outcome**	**Knowledge Level**
CO1	Explain various configurations and basics of HEVs	K2
CO2	Distinguish the concepts and components of various hybrid technologies	K2
CO3	Review the architectures, range extension mechanisms and grid support of PHEVs	K2
CO4	Discuss the PE converters for battery charging and speed control of HEVs	K2
CO5	Illustrate various Energy Storage Technologies	K2

UNIT– I: Introduction

History of hybrid vehicles, architectures of HEVs, series and parallel HEVs, complex HEVs.

UNIT– II: Hybridization of Automobile

Fundamentals of vehicle, components of conventional vehicle and propulsion load; Drive cycles and drive terrain; Concept of electric vehicle and hybrid electric vehicle; Plug-in hybrid vehicle, constituents of PHEV, comparison of HEV and PHEV; Fuel Cell vehicles and its constituents.

UNIT– III: Plug-in Hybrid Electric Vehicle

PHEVs and EREVs blended PHEVs, PHEV Architectures, equivalent electric range of blended PHEVs; Fuel economy of PHEVs, power management of PHEVs, end-of-life battery for electric power grid support, vehicle to grid technology, PHEV battery charging.

UNIT– IV: Power Electronics in HEVs

Rectifiers used in HEVs, voltage ripples; Buck converter used in HEVs, non-isolated bidirectional DC-DC converter, regenerative braking, voltage source inverter, current source inverter, isolated bidirectional DC-DC converter, PWM rectifier in HEVs, EV and PHEV battery chargers.

UNIT– V: Battery and Storage Systems

Energy Storage Parameters; Lead–Acid Batteries; Ultra capacitors; Flywheels - Superconducting Magnetic Storage System; Pumped Hydroelectric Energy Storage; Compressed Air Energy Storage - Storage Heat; Energy Storage as an Economic Resource

Text Books

1. Ali Emadi, Advanced Electric Drive Vehicles, CRC Press, 2014.
2. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.

Reference Books:

1. Mehrdad Ehsani, YimiGao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
2. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.
3. H. Partab: Modern Electric Traction – Dhanpat Rai & Co, 2007.
4. Pistooa G.,"Power Sources, Models, Sustanability, Infrstructure and the market", Elsevier2008
5. Mi Chris, MasrurA., and GaoD.W., "Hybrid Electric Vehicle: Principles and Applications with Practical Perspectives" 1995.

Semester	**III SEM**	**L**	**T**	**P**	**C**	**COURSE CODE**
Regulation	V21	3	0	0	3	V21PET18
Name of the Course	Soft Computing Techniques in Electrical Engineering (Elective–V)					
Specialization	Power Electronics & Power systems					

Course Outcomes:

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

CO No.	**Course Outcome**	**Knowledge Level**
CO1	Understand the basic of Soft Computing Techniques.	K2
CO2	Recognize an appropriate soft computing methodology for an engineering problem.	K3
CO3	Apply fuzzy logic and reasoning to handle uncertainty while solving engineering problems.	K3
CO4	Analysis of neural network and genetic algorithms to combinatorial optimization problems.	K4
CO5	Design of different problems of optimization in power systems	K5

UNIT– I: Introduction to Soft Computing

Introduction, Definition of Soft Computing Techniques, Importance of Soft Computing, Main Components of Soft Computing: Fuzzy Logic, Artificial Neural Networks, Introduction to Evolutionary Algorithms, Hybrid Intelligent Systems, Single and multi-objective optimization.

UNIT– II: Artificial Neural Network and Applications

Introduction, Artificial Neuron Structure, ANN Learning; Back-Propagation Learning, Properties of Neural Networks, Unsupervised learnings, Hopfield networks, Application of GN Models to Electrical Machine Modeling, Short Term Electrical Load Forecasting Using Generalized Neuron Model, Aircraft Landing Control System Using GN Model.

UNIT– III: Introduction to Fuzzy Logic and Genetic Algorithm

Introduction, Uncertainty and Information, Types of Uncertainty, Introduction of Fuzzy Logic, Fuzzy Set, Operations on Fuzzy Sets, Fuzzy Intersection, Fuzzy Union, Fuzzy Complement, Fuzzy Concentration, Fuzzy Dilation, Fuzzy Intensification, α-Cuts, Characteristics of Fuzzy Sets, Demorgan‟s Law, Fuzzy Cartesian Product, Various Shapes of Fuzzy Membership Functions, Methods of Defining of Membership Functions, Fuzzy Relation, Defuzzification Methods. Introduction to Genetic Algorithm, Crossover, Mutation, Survival of Fittest, Population Size, Evaluation of Fitness Function.

UNIT– IV: Applications of Fuzzy Rule Based System

Introduction, System‟s Modeling and Simulation Using Fuzzy Logic Approach, Selection of Variables, Normalization Range and Number of Linguistic Values, Selection of Shape of Membership Functions for Each Linguistic Value, Selection of Fuzzy Union and intersection Operators, Selection of Defuzzification Method, Power System Stabilizer Using Fuzzy Logic.

UNIT– V: Applications of Soft Computing Techniques to Electrical Engineering

Applications of Artificial Neural Network, Genetic Algorithms, Fuzzy and Hybrid Systems for Power System Applications: voltage stability, Economic load dispatch, Unit commitment, Condition monitoring.

Text Books:

1. Neural Networks: A Comprehensive Foundation – Siman Haykin, IEEE, Press, MacMillan, N.Y. 1994.
2. S. Rajasekaran, G. A. Vijayalakshmi, Neural Networks, Fuzzy logic and Genetic algorithms, PHI publication.
3. Fuzzy logic with Engineering Applications - Timothy J. Ross, McGraw-Hill International Editions.
4. Chaturvedi, Devendra K, Soft Computing Techniques and its Applications in Electrical Engineering, Hardcover ISBN:- 978-3-540-77480-8, Springer.
5. Kalyanmoy Deb, Multi-objective Optimization using Evolutionary Algorithms, Willey Publication.

Reference Books:

1. Soft Computing with Matlab Programming by N.P.Padhy & S.P.Simson, Oxford University Press – 2015
2. Kalyanmoy Deb, Optimization for Engineering Design, PHI publication
3. Kevin Warwick, Arthur Ekwue, Rag Agarwal, Artificial intelligence techniques in power systems. IEE Power Engineering Series-22.
4. Fuzzy Sets and Fuzzy logic: Theory and Applications - George J. Klir and Bo. Yuan, Prentice- Hall of India Private Limited.

Semester	**III SEM**	**L**	**T**	**P**	**C**	**COURSE CODE**
Regulation	V21	0	0	20	10	V21PEP02
Name of the Course	DISSERTATION PHASE-I					
Specialization	Power Electronics & Power systems					

Semester	**IV SEM**	**L**	**T**	**P**	**C**	**COURSE CODE**
Regulation	V21	0	0	32	16	V21PEP03
Name of the Course	DISSERTATION PHASE-II					
Specialization	Power Electronics & Power systems					