JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

Syllabi for Ph.D Credit Courses

Electrical & Electronics Engineering

Subject Code: 1423 **CUSTOM POWER DEVICES**

UNIT1: INTRODUCTION

Custom Power and Custom Power Devices - power quality variations in distribution circuits – Voltage Sags, Swells, and Interruptions - System Faults – Over voltages and Under voltages - Voltage Flicker - Harmonic Distortion - Voltage Notching - Transient Disturbances - Characteristics of Voltage Sags - Point of Initiation - Point of Recovery - Phase Shift - Impact of Phase Shift on Sizing of Static Voltage Compensator (SVC) - Missing Voltage.

UNIT2: OVERVIEW OF CUSTOM POWER DEVICES

Reactive Power and Harmonic Compensation Devices - Static Var Compensator - Static Shunt Compensation - Compensation Devices for Voltage Sags and Momentary Interruptions - Static Series Compensators - Backup Energy Supply Devices - Battery UPS – Super Conducting Magnetic Energy Storage systems - Flywheel – Voltage Source Converter - Muli-level Inverters – Diode clamped, Flying capacitor and Cascade type inverters.

UNIT3: REACTIVE POWER AND HARMONIC COMPENSATION DEVICES

Var control devices - Static Var Compensator – Topologies - Direct Connected Static Var Compensation for Distribution Systems – Static Series Compensator - Static Shunt Compensator (DSTATCOM) - Interaction with Distribution Equipment and System - Installation Considerations.

UNIT4: HIGH-SPEED SOURCE TRANSFER SWITCHES, SOLID STATE LIMITING, AND BREAKING DEVICES

Source Transfer Switch - Static Source Transfer Switch (SSTS),- Hybrid source transfer switch – High-speed mechanical source transfer switch - Solid state current limiter - Solid state breaker

UNIT5: APPLICATION OF CUSTOM POWER DEVICES IN POWER SYSTEMS

P-Q theory – Control of P and Q – Dynamic Voltage Restorer (DVR) – Operation and control – Interline Power Flow Controller (IPFC) – Operation and control – Unified Power Quality Conditioner (UPQC) – Operation and control.

UNIT6:Reference to research areas on Custom Power Devices

Control strategies of power converters - Custom power park – Status of application of custom power devices.

IEEE Transactions on Power Delivery, USA
IEEE Transactions on Power Electronics, USA
IEEE Transactions on Smart Grid, USA
Electric Power Systems Research, Elsevier, USA

1. The concept and operating principles of mini custom power park – Arindam Ghosh and Avinash Joshi, IEEE Transactions on Power Delivery, Vol. 19, No. 4, Oct 2004.

2. Power Quality Enhanced Operation and Control of a Microgrid based Custom Power Park - Arindam Ghosh et. al., 7th IEEE International Conference on Control & Automation (ICCA'09), December 9-11, 2009, New Zealand, Christchurch. (In Press)

3. Three-Level Converters based Generalized Unified Power Quality Conditioner - Bahr Eldin S. M, K. S. Rama Rao, and N. Perumal, World Academy of Science, Engineering and Technology 62 2012

Text Books

1. Guidebook on Custom Power Devices, Technical Report, Published by EPRI, Nov 2000

2. Power Quality Enhancement Using Custom Power Devices – Power Electronics and Power Systems, Gerard Ledwich, Arindam Ghosh, Kluwer Academic Publishers, 2002.

References

1. Power Quality, C. Shankaran, CRC Press, 2001
2. Instantaneous power theory and application to power conditioning, H. Akagi et.al., IEEE Press, 2007.
3. Custom Power Devices - An Introduction, Arindam Ghosh and Gerard Ledwich, Springer, 2002
4. A Review of Compensating Type Custom Power Devices for Power Quality Improvement, Yash Pal et.al., Joint International Conference on Power System Technology and IEEE Power India Conference, 2008. POWERCON 2008.

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JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

Syllabi for Ph.D Credit Courses

Electrical & Electronics Engineering

Subject Code: 1424 **ADVANCED CONTROL ENGINEERING**

UNIT-I: Modeling in Time Domain (State Space)

Introduction, some observations, the general state space representation, Applying the state space representation, Alternative representations, Similarity transformations, converting a transfer function to state space, converting from state space to transfer function, linearization, case-studies.

UNIT-II: Response and Stability (State Space) (with Case Studies)

Transient and steady response in State space (Various methods of evaluation of state transition Matrix), Stability in state space (Liapunov methods)

UNIT-III: Design criteria, Constraints and feed-back: Over-view

Introduction, Choice of a plant, Performance Criteria: (Steady-state performance – Accuracy, System Types – Unity feed-back configuration, Transient Performance –(Speed of Response, effects of non-linearities), Noise and Disturbances, Proper Compensators and Well-Posedness, Total Stability: (Imperfect Cancellations, Design Involving Pole-Zero Cancellations, Saturation: (Constraint on Actuating Signals), Open-loop and Closed-loop Configurations, Two Basic Approaches in Design

Design using classical approach (with case studies): Design of P-D Controller using root-locus, Design of P-I controller in frequency domain (Bode method)

UNIT-IV: Design using inward approach – Choice of Overall Transfer functions

Introduction, Implementable Transfer functions (Asymptotic Tracking and Permissible Pole-Zero Cancellations), various design criteria, Quadratic Performance indices: (Quadratic Optimal Systems, Computation of Spectral Factorization and selection of Weighting Factors)

State-space Design

Introduction, Controllability and Observability, Pole Placement, Quadratic Optimal Regulator, State Estimators, Connection of state feedback and state Estimators

Unit-VI: Strategies for Computer-Aided Process Control

Open loop control systems, closed loop (feedback) control system, feed forward control system, cascade control system, ratio control, controller design, controller tuning, tuning of P, PI and PID controllers, Ziegler-Nichols tuning method, selection of controllers.

Distributed Control Systems

Introduction, functional requirements of distributed control system, system architecture, distributed control systems configuration and applications of distributed control systems.

TEXT BOOKS:

1. Control Systems Engineering, Norman S. Nise, John Wiley
2. Analog & Digital Control System Design, Chi-Tsong Chen, Saunders College Publishing.
3. Computer based Industrial Control, Krishna Kant, Prentice-Hall India, 2003.

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JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

Syllabi for Ph.D Credit Courses

Electrical & Electronics Engineering

Subject Code: 1422 **VOLTAGE STABILITY**

Unit 1: Reactive Power flow and voltage stability in power systems

Physical relationship indicating dependency of voltage on reactive power flow - reactive power transient stability; Q-V curve; definition of voltage stability, voltage collapse and voltage security. Voltage collapse phenomenon, Factors of voltage collapse, effects of voltage collapse, voltage collapse analysis. Reasons for aggravation of the problem.

Unit 2: Power system loads

Load characteristics that influence voltage stability such as – Discharge lighting, Induction motor, Air conditioning and heat pumps, Electronic power supplies, Over Head lines and cables.

Unit 3: Reactive Power compensation

Generation and absorption of reactive power – Reactive power compensators & voltage controllers : - shunt capacitors, synchronous phase modifier – static VAR system – on load tap changing transformer, booster transformers.

Unit 4: Voltage stability static indices

Development of voltage collapse index – power flow studies – singular value decomposition – minimum singular value of voltage collapse – condition number as voltage collapse index.

Unit 5: voltage stability margins & Improvement of voltage stability

Stability margins, voltage stability margin of un compensated and compensated power system , Dynamic voltage stability – voltage security , Methods of improving voltage stability and its practical aspects.

Unit 6:

Classification of power system stability, derivation of voltage stability index for radial distribution networks, Derivation and Analysis of voltage stability using L-Index method and its extension to N-bus system, and also limitations, voltage stability enhancement using SVC and its optimal location selection.

References:

1. Performance operation and control of EHV power transmission SystemsA chakrabarti, D.P.Kothari, A.K. Mukhopadhyay, A.H. Wheeler publishing, 1995.
2. Power system Voltage stability - C.W. Taylor , Mc. Graw Hill, 1994

Reference Papers for Unit VI:

1. Definition and Classification of Power System Stability, IEEE/CIGRE Joint Task Force on Stability Terms and Definitions, IEEE TRANSACTIONS ON POWER SYSTEMS, VOL. 19, NO. 2, MAY 2004.
2. M.Chakravorthy, D.Das., "voltage stability analysis of radial distribution networks", Electrical power and energy systems, 23, (2001), 129-135, Elsevier.
3. http://www.eco-web.com/edi/110401.html
4. Jia Hongjie, Yu Xiaodan, etal., "An improved voltage stability index and its application", Electrical power and energy systems, 27, (2005), 567-574, Elsevier.
5. D.Thukaram, Abraham Lomi., "Selection of SVC location and size for system voltage stability improvement", Electrical power systems research, 54, (2000), 139-150, Elsevier.

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JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA
Syllabi for Ph.D Credit Courses
Electrical & Electronics Engineering

Subject Code: 1425

ADVANCED POWER SEMICONDUCTOR DEVICES AND PROTECTION

Unit I Power Transistors & Power MOSFETs
Basic structures, I-V characteristics, Switching characteristics, Operation limitations design of drive circuits for BJTs and MOSFETs - snubber circuits for BJTs and MOSFETs

Unit II GTOs and IGBTs
Basic structures - I-V characteristics, physics of device operation, GTO switching Characteristics of GTOs and IGBTs-snubber circuits-over protection of GTOs

Introduction - basic structures - I-V characteristics - physics of device operation - Latch in IGBTs switching characteristics-Device limits and safe operating areas-drive and snubber circuits.

Unit III Emerging Devices and Circuits
Introduction - Power junction field effect transistors-field controlled Thyristor-JFET based devices versus other power devices-MOS controlled Thyristors-high voltage integrated circuits-new semiconductor materials

Unit IV Passive Components and Electromagnetic compatibility
Introduction-design of inductor-transformer design-selection of capacitors-resistors current measurements-heat sinking circuit lay out –Electromagnetic Interference (EMI)-Sources of EMI-Electromagnetic Interference in Power Electronic Equipment

UNIT-V Noise, Protection of Devices & Circuits
Common noises sources in SMPS - Noises Due to High frequency transformer - measuring of noise - minimizing EMI - EMI shielding - EMI standards Cooling & Heat sinks – Thermal modeling of power switching devices- snubber circuits – Reverse recovery transients – Supply and load side transients – voltage protections – current protections.

UNIT-VI Injection Enhanced Gate Transistor (IEGT)
Introduction - IGBT Vs IEGT- Structure-circuit model-Turn off and Turn ON mechanisms - Equivalent circuit of two parallel IEGTs - V-I transfer Characteristics-Applications of Ultra high power IEGT

Reference books:

1. Power Electronics Circuits, Devices and Applications – M.H.Rashid-PHI-
2. Power Electronics –Converters, Applications and Design – Mohan and Undeland-John Wiley&Sons
3. Power Electronics Circuits-Vithayathil
4. Power Electronics Circuits-W.C. Lander

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JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

Syllabi for Ph.D Credit Courses

Electrical & Electronics Engineering

Subject Code: 1421 **ELECTRIC ENERGY UTILISATION AND CONVERSATION**

UNIT1:Energy Auditing: Level of responsibility, Internal control questionnaire, energy conservation schemes, Industrial energy use, energy conversion, energy index, energy costs, cost index, representation of energy consumption, energy auditing.

UNIT 2: Space heating, ventilation, air-conditioning (HVAC) and water heating

Introduction, heating of buildings, transfer of heat, space heating methods, ventilation and air conditioning, insulation, cooling load, electric water heating systems electric energy conservation methods.

UNIT 3: Electric lighting

Introduction, definition of terms and units, luminous efficiency, polar curve, calculation of illumination level, Illumination of inclined surface to beam, luminance or brightness, types of lamps, types of lighting, electric lighting fittings(luminary),flood lighting, energy conservation measures.

UNIT 4: Industrial heating, welding and electro-chemical process

Introduction, heating by indirect resistance, direct resistance heating(salt bath furnace),heat treatment by induction heating, melting of metals in induction furnace, dielectric heating, arc furnace, compensation of furnace loads for power factor improvement, energy conservation in the electric arc Industry, welding, electro-chemical process.

UNIT 5: Energy-Efficient Motors

Standard motor efficiency- energy-efficient motor-constructional features-efficiency determination, motor efficiency labeling. Varying duty applications, effects of voltage variation and voltage unbalance. Over motoring.

Energy efficient electric drives

Introduction, running characteristics, starting characteristics and speed fluctuation, speed control of traction motors, braking.

UNIT 6: Energy conservation in electric utility and industry

Introduction, energy costs and two-part tariff, energy conservation in utility by improving load factor, energy conservation in industries.

Power Factor

Power factor improvement, power factor motor controllers- single phase motors, three phase motors

References:

1. Energy-Efficient Electric Motors selection and application by-John C. Andreas, Marcel Dekker Inc, New York, NY
2. Electric Energy Utilisation And Conservation by S C Tripathy,Tata Mc Grawhill publishing company Ltd.
3. Energy Management –by W.R.Murphy& G,McKay, Butterworh Heinemann New Delhi.
4. Efficiency of electric motors under practical conditions, Power engineering journal,volume:15,issue:3 June 2001 PP 163-167.
5. The potential for energy efficiency in end use technologies, IEEE transactions on power systems August 1993.
6. Hand Book on energy audits and Management ,TERI(Tata energy research institute),2001.
7. Budeget constrained energy conservation an experience with a textile industry, Power engineering society, winter meeting, Jan 2002 IEEE,
8. Energy management for motors, systems, and electrical equipment, Industry Applications, EEE Transactions on March-April2000.

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