ADVANCED POWER ELECTRONICS: TECHNOLOGY AND APPLICATIONS

INTRODUCTION

Power Electronics is the technology that links the two major traditional divisions of Electrical Engineering, namely, Electric Power and Electronics. It has shown rapid development in recent years, primarily because of the development of power semiconductor switches that can efficiently switch large currents at high voltages and frequencies. Power Electronics control techniques are progressively replacing traditional methods of power conversion and control, causing what may be described as a technological revolution in certain power areas such as regulated power supplies and UPS systems, variable-speed drives, high voltage DC transmission HVDCT, energy savings etc. The generation of harmonics and the reduction in the input power factor are considered as the major drawbacks of power electronics in a world where 'Power Quality' becomes an environmental issue of great concern.

OBJECTIVES

This workshop is designed to introduce the subject of "Power Electronics: Technology & Applications" with concentration on the

- Latest technological advances, developments and availability of power semiconductor switches.
- Proper selection of both type and ratings of power semiconductor switches to match the requirements of a certain application.
- Basic merits of power electronics converters over the conventional counterparts
- Power quality issues of power electronics converters:
  Understanding the term "power factor" in power electronics applications
  Load and line harmonics: generation, evaluation, reduction and-or elimination
- Investigation of DC and AC power conditioning techniques and converters, including Rectifiers, AC Regulators, Choppers and Inverters. This includes power circuits configuration, control topologies, conduction patterns, analysis, and performance evaluation.

PRESENTER

Prof. Sadeq Abdullah Hamed

Professor Hamed received the B.Sc. degree in Electrical Power Engineering from Damascus University, Syria, in 1980. From 1980 to 1982, he was with the Department of Electrical Engineering at Jordan University, Amman, Jordan. He received the M.Sc. and Ph.D. degrees in Power Electronics and Systems from the University of Manchester Institute of Science and Technology (UMIST), Manchester, U. K., in 1983 and 1986 respectively. In 1986, he joined the Department of Electrical Engineering, Jordan University, as an Assistant Professor. In 1991, he became an Associate Professor at the same department. From 1993 to 1995, he was the Chairman of Department of Electrical Engineering, Jordan University. In 1997, he became a Full Professor. From 1997 to 1999, Professor Hamed was the Vice Dean, Faculty of Engineering and Technology, Jordan University. From 1999 to 2001, he was the Dean, Faculty of Engineering Technology, Al-Balqa' Applied University. Since September 2005, Prof. Hamed is the Chairman of Department of Electrical Engineering, Jordan University. Prof. Hamed is a member of the IEE, IEEE and the Jordanian Engineers Association.

PROGRAM

DAY ONE

POWER ELECTRONICS: REVIEW AND GENERAL INTRODUCTION

- The identity of power electronics
- Elements of power electronics systems
- Merits and drawbacks of power electronics
- Classification and comparison criterion of the main power electronics switches:
  - Major thyristor devices: SCRs, GTOs and MCTs
  - Major power transistor devices: BJTs, MOSFETs and IGBTs.
- Commutation process and classification
- PE switch selection: types and ratings
- Protection of PE switches: snubber circuits
- Classification of PE converters and applications

DAY TWO

PERFORMANCE PARAMETERS OF PE SYSTEMS

- The Ripple Factor RF, The Distortion Factor DTF
- The Displacement Factor DPF, The Power Factor PF
- The Harmonic Factor HF and the Total Harmonic Distortion Factor THDF

RECTIFICATION PROCESS AND RECTIFIERS

- Rectification process and rectifier classifications.
- The concept of 'Phase Angle Control', and the 'Firing Angle'
- Practical design & implementation of SCR Triggering (or Firing) circuits
- Which Power Semiconductor Switch to use and why ?
- Operation, waveforms construction of Rectifier circuits
- Basic relationships and SCR ratings
- Load & Line Harmonics generation: Nature & Drawbacks
- Load & Line Performance parameters: RF, PF & THDF
- Applications: Battery Chargers, DC Motor Drives and DC Links.

DAY THREE

AC VOLTAGE REGULATORS

- AC Voltage Regulation, Types of AC Switches
- Power Circuit Configurations & Control Topologies
- Basic relationships and Performance Parameters
- Applications: ON-OFF Control, Static Switches, Static Tap Changers, Static VAr Compensation, Soft Motor Starters, … etc.
- Cycloconverters: Power Circuit Configurations, Control Topology & Applications

DC-TO-DC CONVERSION: DC CHOPPERS

- The Chopping Process: Principles, Classifications & Applications.
- DC-to-DC Control Topologies: PWM and FM
- Which Power Semiconductor Device to Use and Why ?
- Waveforms construction, modes identification and basic relationships
- Performance evaluation: Harmonics generation and Ripple Factor

DAY FOUR

INVERTERS: VARIABLE-VOLTAGE VARIABLE-FREQUENCY (VVVF) CONVERTERS

- The Needs for Variable Frequency
- The Inversion process (DC-to-AC Conversion)
- Classification and relative merits of the different control topologies
- Voltage/Frequency (VVVF) control profile
- Operation & waveforms construction of basic Inverter circuits: Square-Wave, Quasi Square-Wave , PWM (Uniform & Sinusoidal), Multi-Level VSI
- Harmonics & performance parameters of the different types of Inverters
- Three-phase Inverters: configuration & conduction patterns
- Inverter applications

DAY FIVE

SELECTED SYSTEM APPLICATIONS OF POWER ELECTRONICS

- Uninterruptible power supplies (UPS) systems
  - Critical loads
  - Classification and Constructional Features of UPS systems
  - Ratings & Specifications of UPS Systems
- Speed control of DC/AC Electric Motors Drive
- HVDC Transmission