DOWNLOAD PDF POWER ELECTRONIC SYSTEMS THEORY AND DESIGN

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With numerous design examples, illustrations and problems, as well as clearly defined learning objectives for each chapter, this book presents an easy-to-understand development of theory and engineering design aspects of power electronic systems.

UWâ€"Madison and Wisconsin Electric Machines and Power Electronics Consortium WEMPEC faculty have established a comprehensive curriculum in the electrical machines and power electronics field that serves students at the university, as well as engineers already established in the industry. Many courses in the Master of Science: Courses in the power engineering curriculum offers students a chance to improve their skill set. The curriculum is designed to provide students with an engaging experience that is accessible anywhere, even when working full-time. Courses Introduction to Electric Drive Systems Learn the basic theory underlying the analysis and design of adjustable-speed drive systems employing power electronic converters and AC or DC machines. Learn the basic concepts of torque and speed control in both DC and AC machines, including variable-frequency operation of induction and synchronous machines, field-oriented control, and more. Power Electronic Circuits In this introduction to the basic power electronic devices, you will study and analyze fundamental power conditioning converters. Electric Power Systems Master computation, design, and analysis techniques appropriate to industrial and utility level-three phase electric power systems. Automatic Controls This course provides a comprehensive understanding of single input, single output SISO continuous closed-loop control system analysis and design. Discrete computer control also is introduced including analysis in the z domain. Computer Control of Machines and Processes Gain a comprehensive introduction to digital computer control theory and application, as well as sequential logic control. An increasing demand for engineers with automatic control background has been accelerated by the proliferation of computer control applications. The design of industrial processes and machines must be influenced by engineers with computer control background and experience to effectively apply computer control technology. Electric Machines and Drive Systems Laboratory This laboratory course consists of a series of experiments exploring the steady-state and dynamic performance of electric machines in combination with power electronic converters. Learn techniques for parameter measurement and performance evaluation of induction, PM synchronous, and switched reluctance machine drives, including exercises to compare predicted and measured performance characteristics. This is a three-week summer course offered in even years. Campus attendance is required. Theory and Control of Synchronous Machines Learn the basic theory for analyzing and applying synchronous machines in electric power systems and motors in electric drives. After reviewing electromagnetic theory and analysis for synchronous machine steady state behavior, you will apply the analysis and control of synchronous generators in the context of power systems applications like transient stability, sub-synchronous resonance, small disturbance stability, and inter-area oscillations and other applications including variable frequency drives and permanent magnet motors. Power Electronics Laboratory This laboratory introduces the measurement and simulation of important operating characteristics related to power electronic circuits and power semiconductor devices. Emphasis will be given to devices, circuits, gating methods, and power quality. This is a three-week summer course offered in odd years. Automatic Controls Laboratory Control theory is reduced to engineering practice through the analysis and design of actual systems in the laboratory. Experiments are conducted with modern servo systems using both analog and digital control. Systems identification and modern controls design are applied to motion and torque control.

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With numerous design examples, illustrations and problems, this book presents the development of theory and engineering design aspects of power electronic systems. It provides a conceptual foundation across several disciplines, including electronic devices and circuits, signals and systems, motor drives and control systems.

A Simple Voltage Converter. Systems View of Power Electronic Converters. Elements of the Converter Systems: Converter Operation and Desired Characteristics. Nonlinearities in Magnetic Components. Losses in Magnetic Components. Electrostatics and Dielectric Materials. Protection of Switching Devices. Parallel and Series Connection of Diodes. New Trends in Diodes. Level Triggered Switching Devices. Cathode-Shorted Structure of Thyristors. Series Operation of Thyristors. Parallel Operation of Thyristors. Forced Commutation of Thyristors. DC to Controlled DC. Uncontrolled and Controlled Conversion. DC to Controlled AC. Pruning of Harmonic Profile. Rectifier Mode of Operation of Inverters. Effect of Device Characteristics. AC to Controlled AC. Resonant Tank in Excitation. Control of Resonant Converters. Electric Utility Distribution System. Interface for Bidirectional Power Flow. DC Power Supply System. Protection of DC Power Supplies. Cross Regulation in Multiple Outputs. Temperature Control, Protection, and Packaging. Temperature Control in Semiconductor Devices. Review of Basic Principles.

Chapter 3 : Power Electronic Systems : Jai P. Agrawal :

1. Bird's Eye View of Power Electronics Systems. Introduction. A Simple Voltage Converter. Systems View of Power Electronic Converters. Elements of the Converter Systems: Modeling and Assumptions. Converter Topology. Converter Operation and Desired Characteristics. Converter Performance Measures.

Single-Phase Half-Bridge Voltage Source Inverter The single-phase voltage source half-bridge inverters, are meant for lower voltage applications and are commonly used in power supplies. Low-order current harmonics get injected back to the source voltage by the operation of the inverter. This means that two large capacitors are needed for filtering purposes in this design. If both switches in a leg were on at the same time, the DC source will be shorted out. Inverters can use several modulation techniques to control their switching schemes. If the over-modulation region, ma, exceeds one, a higher fundamental AC output voltage will be observed, but at the cost of saturation. For SPWM, the harmonics of the output waveform are at well-defined frequencies and amplitudes. This simplifies the design of the filtering components needed for the low-order current harmonic injection from the operation of the inverter. The maximum output amplitude in this mode of operation is half of the source voltage. If the maximum output amplitude, ma, exceeds 3. Therefore, the AC output voltage is not controlled by the inverter, but rather by the magnitude of the DC input voltage of the inverter. The fundamental component of the AC output voltage can also be adjusted within a desirable range. Since the AC output voltage obtained from this modulation technique has odd half and odd quarter wave symmetry, even harmonics do not exist. Carrier and Modulating Signals for the Bipolar Pulsewidth Modulation Technique The full-bridge inverter is similar to the half bridge-inverter, but it has an additional leg to connect the neutral point to the load. Any modulating technique used for the full-bridge configuration should have either the top or the bottom switch of each leg on at any given time. Due to the extra leg, the maximum amplitude of the output waveform is Vi, and is twice as large as the maximum achievable output amplitude for the half-bridge configuration. The AC output voltage can take on only two values, either Vi or â€”Vi. To generate these same states using a half-bridge configuration, a carrier based technique can be used. Unlike the bipolar PWM technique, the unipolar approach uses states 1, 2, 3 and 4 from Table 2 to generate its AC output voltage. Therefore, the AC output voltage can take on the values Vi, 0 or â€”V [1]i. To generate these states, two sinusoidal modulating signals, Vc and â€”Vc, are needed, as seen in Figure 4. The phase voltages VaN and VbN are identical, but degrees out of phase with each other. The output voltage is equal to the difference of the two phase voltages, and do not contain any even harmonics. Therefore, if mf is taken, even the AC output voltage harmonics will appear at normalized odd frequencies, fh. These frequencies are centered on double the value of the normalized carrier frequency. This particular feature allows for smaller filtering components when trying to obtain a higher quality output waveform. States 7 and 8 produce zero AC line voltages, which result in AC line currents freewheeling through either the upper or the lower components. However, the line voltages for states 1 through 6 produce an AC line voltage consisting of the discrete values of Vi, 0 or â€”Vi. In order to preserve the PWM features with a single carrier signal, the normalized carrier frequency, mf, needs to be a multiple of three. This keeps the magnitude of the phase voltages identical, but out of phase with each other by degrees. In applications requiring sinusoidal AC waveforms, magnitude, frequency, and phase should all be controlled. CSIs have high changes in current over time, so capacitors are commonly employed on the AC side, while inductors are commonly employed on the DC side. In its most generalized form, a three-phase CSI employs the same conduction sequence as a six-pulse rectifier. At any time, only one common-cathode switch and one common-anode switch are on. States are chosen such that a desired waveform is output and only valid states are used. This selection is based on modulating techniques, which include carrier-based PWM, selective harmonic elimination, and space-vector techniques. The digital circuit utilized for modulating signals contains a switching pulse generator, a shorting pulse generator, a shorting pulse distributor, and a switching and shorting pulse combiner. A gating signal is produced based on a carrier current and three modulating signals. The same methods are utilized for each phase, however, switching variables are degrees out of phase relative to one another, and the current pulses are shifted by a half-cycle with respect to output currents. If a triangular carrier is used with sinusoidal modulating signals, the CSI is said to be utilizing synchronized-pulse-width-modulation SPWM. If full over-modulation is used in conjunction with SPWM the inverter is said to be in square-wave operation. Utilizing the gating signals developed for a VSI and a set of synchronizing sinusoidal current signals, results in symmetrically distributed shorting pulses and, therefore, symmetrical gating patterns. This allows any arbitrary number of harmonics to be eliminated. Optimal switching patterns must have quarter-wave and half-wave symmetry, as well as symmetry about 30 degrees and degrees. Switching patterns are never allowed between 60 degrees and degrees. The current ripple can be further reduced with the use of larger output capacitors, or by increasing the number of switching pulses. Valid switching states and time selections are made digitally based on space vector transformation. Modulating signals are represented as a complex vector using a transformation equation. These space vectors are then used to approximate the modulating signal. If the signal is between arbitrary vectors, the vectors are combined with the zero vectors I7, I8, or I9. Three-Level Neutral-Clamped Inverter A relatively new class called multilevel inverters has gained widespread interest. Normal operation of CSIs and VSIs can be classified as two-level inverters because the power switches connect to either the positive or the negative DC bus. Control methods for a three-level inverter only allow two switches of the four switches in each leg to simultaneously change conduction states. This allows smooth commutation and avoids shoot through by only selecting valid states. Carrier-based and space-vector modulation techniques are used for multilevel topologies. The methods for these techniques follow those of classic inverters, but with added complexity. Space-vector modulation offers a greater number of fixed voltage vectors to be used in approximating the modulation signal, and therefore allows more effective space vector PWM strategies to be accomplished at the cost of more elaborate algorithms. Due to added complexity and number of semiconductor devices, multilevel inverters are currently more suitable for high-power high-voltage applications. AC converters that allow the user to change the frequency are simply referred to as frequency converters for AC to AC conversion. Under frequency converters there are three different types of converters that are typically used: Typically used for heating loads or speed control of motors, this control method involves turning the switch on for n integral cycles and turning the switch off for m integral cycles. Because turning the switches on and off causes undesirable harmonics to be created, the switches are turned on and off during zero-voltage and zero-current conditions zero-crossing , effectively reducing the distortion. Various circuits exist to implement a phase-angle control on different waveforms, such as half-wave or full-wave voltage control. The power electronic components that are typically used are diodes, SCRs, and Triacs. With the use of these components, the user can delay the firing angle in a wave which will only cause part of the wave to be in output. The other two control methods often have poor harmonics, output current quality, and input power factor. In order to improve these values PWM can be used instead of the other methods. What PWM AC Chopper does is have switches that turn on and off several times within alternate half-cycles of input voltage. Cycloconverters are widely used in industry for ac to ac conversion, because they are able to be used in high-power applications. They are commutated direct frequency converters that are synchronised by a supply line. The cycloconverters output voltage waveforms have complex harmonics with the higher order harmonics being filtered by the machine inductance. Causing the machine current to have fewer harmonics, while the remaining harmonics causes losses and torque pulsations. Note that in a cycloconverter, unlike other converters, there are no inductors or capacitors, i. For this reason, the instantaneous input power and the output power are equal. Single-Phase to Single-Phase Cycloconverters started drawing more interest recently[when? The single-phase high frequency ac voltage can be either sinusoidal or trapezoidal. These might be zero voltage intervals for control purpose or zero voltage commutation. Three-Phase to Single-Phase Cycloconverters: There are two kinds of three-phase to single-phase cycloconverters: Both positive and negative converters can generate voltage at either polarity, resulting in the positive converter only supplying positive current, and the negative converter only supplying negative current. With recent device advances, newer forms of cycloconverters are being developed, such as matrix converters. The first change that is first noticed is that matrix converters utilize bi-directional, bipolar switches. A single phase to a single phase matrix converter consists of a matrix of 9 switches connecting the three input phases to the tree output phase.

Any input phase and output phase can be connected together at any time without connecting any two switches from the same phase at the same time; otherwise this will cause a short circuit of the input phases. Matrix converters are lighter, more compact and versatile than other converter solutions. As a result, they are able to achieve higher levels of integration, higher temperature operation, broad output frequency and natural bi-directional power flow suitable to regenerate energy back to the utility. The matrix converters are subdivided into two types: A direct matrix converter with three-phase input and three-phase output, the switches in a matrix converter must be bi-directional, that is, they must be able to block voltages of either polarity and to conduct current in either direction. This switching strategy permits the highest possible output voltage and reduces the reactive line-side current. Therefore, the power flow through the converter is reversible. Because of its commutation problem and complex control keep it from being broadly utilized in industry. Unlike the direct matrix converters, the indirect matrix converters has the same functionality, but uses separate input and output sections that are connected through a dc link without storage elements. The design includes a four-quadrant current source rectifier and a voltage source inverter. The input section consists of bi-directional bipolar switches. The commutation strategy can be applied by changing the switching state of the input section while the output section is in a freewheeling mode. This commutation algorithm is significantly less complexity and higher reliability as compared to a conventional direct matrix converter. Meaning that the power in the converter is converted to DC from AC with the use of a rectifier, and then it is converted back to AC from DC with the use of an inverter. The end result is an output with a lower voltage and variable higher or lower frequency. Multiple types of hybrid converters have been developed in this new category, an example being a converter that uses uni-directional switches and two converter stages without the dc-link; without the capacitors or inductors needed for a dc-link, the weight and size of the converter is reduced.

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INTRODUCTION. 1. Bird's Eye View of Power Electronics Systems. Introduction. A Simple Voltage Converter. Systems View of Power Electronic Converters. Elements of the Converter Systems: Modeling and Assumptions.

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Chapter 6 : Electrical Engineering: Power Engineering

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Chapter 8 : Power electronics - Wikipedia

Power Electronic Systems: Theory and Design / Edition 1 Divided into four parts, the book presents an array of design examples and problems to keep up with current trends, and satisfies a portion of the ABET design requirements for accreditation.

Chapter 9 : - Power Electronic Systems Theory and Design by Jai P. Agrawal

Iranian - Toofan (Storm) 5 Missile, Anti Tank/Aircraft with counter electronic warfare systems.