DOWNLOAD PDF ELECTRIC MOTORS AND CONTROL SYSTEMS

Chapter 1 : Electrical Motor Controls for Integrated Systems - ATP Learning

Electric Motors and Control Systems, 2nd Edition by Frank Petruzella () Preview the textbook, purchase or get a FREE instructor-only desk copy.

While the advantages are numerous, electronic D. Very complex and require highly skilled technicians to maintain. Control Methodology and Characteristics An electronic D. A converter is a complex electronic control that can precisely control a D. A full-wave, pulse bridge, B full-wave, 6-pulse bridge, or C half-wave, 3-pulse bridge. Both electronic controls produce a variable D. The time ratio of the chopper can be controlled to vary the average voltage. Voltage variation at the load can be obtained by either current limit or time ratio control. For instance, in current-limit control, when current reaches the upper limit, the chopper is turned off to disconnect the motor from supply. Load current freewheels through the freewheeling diode and decays. When it falls to the lower limit, the chopper is turned on and connected to supply, thus, an average current is maintained. The advantages 27 of a closed-loop system are: More accurate and reliable Effects due to non-linearity and distortion are reduced Preferred when disturbances and variations are unpredictable A closed-loop, speed-control system 28 consists of reference circuit the speed setpoint , a differential error amplifier, a firing pulse generator, an SCR bridge and a speed feedback signal from a tachometer or an encoder. The reference speed is set by adjusting the reference error differential amplifier to a voltage proportional to reference speed. An error signal the difference between speed setpoint and actual shaft speed is applied to the firing pulse generator which generates firing pulses which then set the firing angles of the thyristors of the SCR bridge. The output of the SCR bridge is a variable D. The speed of the D. The speed encoder or tachometer senses the actual speed of motor in rpm and converts it to a feedback signal proportional to shaft speed. This signal closes the speed-control loop. The feedback is compared with reference setpoint and fed to the differential error amplifier, ad infinitum. Motor speed will remain constant until the speed setpoint changes. Since the field flux is kept constant below base speed, the motor speed can be varied by increasing or decreasing the armature voltage. This is done by adjusting the variable voltage produced at the output of the SCR bridge drive phase controlled rectifier or the average variable voltage produced by that SCR bridge that controls the duty cycle of the D. When the maximum output voltage of the converter is reached, additional speed can be achieved by reducing the field flux. This is called field weakening. In field weakening, the speed range is usually limited to about 3: The motor has full torque over the normal speed range and even at standstill. In field weakening, torque falls in proportion to speed but the output power remains constant. C Drive Selection Selecting or sizing an electronic D. Ratings and capital cost.

Chapter 2 : Download Electric Motors And Control Systems

*Electric Motors and Control Systems [Frank Petruzella] on calendrierdelascience.com *FREE* shipping on qualifying offers. This manual contains quizzes, practical assignments, and computer-generated simulated circuit analysis assignments. Quizzes made up of multiple choice.*

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Chapter 3 : McGraw-Hill's "Electric Motors and Control Systems"

This book has been written for a course of study that will introduce the reader to a broad range of motor types and control systems. It provides an overview of electric motor operation, selection, installation, control and maintenance.

Learners gain understanding of the operation, installation, design, and troubleshooting of AC electric motor control circuits for many common applications. Interactive screens paired with instructive graphics teach an array of electric motor control topics from control transformers to reversing motor control. With the optional hardware, learners can then apply this theoretical knowledge to immediate hands-on skills. For example, learners study the operation and application of a two-wire motor control circuit and then connect and operate this circuit for themselves. Braking is essential to motor control when motors must be stopped and restarted multiple times. Common applications include rolling mills, conveyors, and power fans. Learners study industry-relevant skills for three of the most common braking methods: Troubleshooting braking problems under realistic conditions allows learners to experience the challenge and reward that result from applied problem solving. This system uses industrial quality components that stand up to frequent use and enable learners to better prepare for what they will encounter on the job. Practice Real-World Skills on Heavy-Duty Components Plugging, stopping an electric motor by reversing its magnetic field, is a relatively simple concept with complex and dramatic results. This low cost, quick method has emergency application but does create significant stress and frequently does not bring the motor to a perfect stands still. Learners will study about the inner-workings of electromagnetic brakes, how to operate them, how the output from a DC braking station can be used to control them, and the advantages and disadvantages of using them. Learners then apply this knowledge by connecting and operating a motor braking circuit using an electromagnetic brake and a three phase induction motor. They will then connect and operate a motor braking circuit using DC injection braking. The included components are heavy-duty and industrial quality ready for repeated use. The DC braking station includes a DC power source, control relay, and step-down transformer. Practice Motor Braking Troubleshooting The MT5-A also covers motor braking troubleshooting by allowing learners to practice troubleshooting faults in an electrical motor control plugging circuit and a DC injection braking control circuit. Other major topic areas covered in the curriculum include drum switch plugging, electromagnetic braking, DC injection dynamic braking, and much more! The MT5-A also offers optional multimedia curriculum that brings this vital industrial skill to life by utilizing audio, text, 3D graphics, and strong interaction to fully engage learners. If you would like to inquire about purchasing additional Student Reference Guides for your program, contact your local Amatrol Representative for more information. Reduced voltage starting is ideal for applications where full motor torque could tear or damage a product, such as paper or delicate fabric. Learners will study Wye-Delta power distribution, types of voltage circuits, and the operation of an autotransformer reduced voltage starter. This system uses industrial quality components that stand up to frequent use and enables learners to practice with real-world components that they will encounter on the job. Each of these panels is made of gauge steel for durability and easily integrates with the Electric Motor Control Learning System MT5. Learners use these panels to study the operation, installation, performance analysis, and design of components used for reduced voltage motor starting. The power resistor station includes three 3 25 ohm, watt power resistors. The dual transformer station features two 2 control transformers VA minimum , multiple tap primary , , VAC , and a single tap secondary VAC. Build Troubleshooting Skills for Reduced Voltage Motor Starting Troubleshooting is a vital industry skill that will help learners understand malfunctions in normal operation and give them the skills to correct faults as they arise. The MT5-B allows learners to practice troubleshooting skills for reduced voltage motor starting, such as primary resistor motor starter faults, autotransformer reduced voltage motor starter faults, and part winding motor starter faults. Major topic areas include different types of motor starters, AC power generation, and transformers in power distribution. The MT5-B also offers optional multimedia curriculum that brings this vital industrial skill to life by utilizing audio, text, 3D graphics, and strong interaction to fully engage learners. Students will learn industry-relevant skills related to these new topics including operation, installation, performance analysis, troubleshooting, and design. This system uses industrial quality components to help students become better prepared for what they will encounter on the job and to withstand frequent student use. This thorough, exceptionally detailed curriculum is built to begin with the basics and steadily advance to more complex concepts and skills. Through partnerships with key industry leaders and leading edge educators, Amatrol developed the right balance of knowledge and applied skills needed to train learners to work in their chosen field. This learning system is comprised of heavy-duty, real-world industrial components such as capacitive, inductive, and infrared sensors that are built to stand up to heavy use. Learners can connect and operate these sensors, study their design, and analyze their performance in order to build skills that can be applied to real-world job opportunities. Industry-Relevant Hands-On Skills This learning system offers industry-standard components so that learners can get direct, hands-on practice with the installation, operation, performance analysis, and design of various electronic sensors. Specific industrial-relevant skills include designing a level sensing control circuit that uses a capacitive proximity sensor, designing a drill motor control circuit that uses an inductive proximity sensor, troubleshooting a motor control circuit with an electronic sensor, and designing a motor control circuit that will sense product jams on a conveyor system. This learning system consists of an gauge steel slide-in panel that features capacitive, inductive, and infrared sensors. These components are pre-wired and terminated to banana jacks to allow quick connection of control circuits. The MT5-D also includes wood, plastic, aluminum, and steel targets for testing sensors. Electrical counters are used in a wide variety of applications including production counting, reject counting, sorting, and flow timing. The MT5-E features a digital 3-digit electronic counter set within a heavy-duty, gauge steel slide in panel built to stand up to frequent use. This learning system also features world-class curriculum that covers counter and timer operation, designing circuits, and troubleshooting. Learners can then directly apply this theoretical knowledge to practice hands-on skills such as designing a timed one-shot motor control circuit, a timed repeat cycle motor control circuit, and a motor control circuit using the counter to tally operations. Learners can also practice troubleshooting a timed one-shot motor control circuit and a timed repeat cycle motor control circuit. Amatrol uses heavy-duty, industry-standard components to help learners better prepare for what they will encounter on the job and to withstand frequent, repeated use. Once learners grasp the theory of electronic counter operation, Amatrol allows them to put that knowledge into direct action through hands-on skill building. This depth of understanding enhances the comprehension of component operation and troubleshooting because learners walk through entire circuits. Specifically, the MT5-E covers the operation and application of one-shot timers, repeat cycle timers, and counters; the function of two types of counters and applications of each, and the operation of an up counter and a down counter and the ladder diagram symbol for each. This multimedia is loaded with 3D graphics, audio, and interactions to fully engage the learner and increase their comprehension of electronic counter topics by using multiple learning styles. SCRs convert AC voltage into a DC voltage in order to provide efficient variable speed control of DC motors and are widely used within industrial applications such as cranes and machine tool spindles. The MT5-F features heavy-duty components like an SCR speed control unit, DC shunt wound motor, and fuse block to give learners real-world practice on SCR speed control skills such as connecting and operating a motor with SCR half-wave speed control, measuring the performance of SCR half-wave speed control, and troubleshooting an SCR speed control circuit. As an example, learners will connect and operate a DC shunt wound motor with both SCR half-wave and full-wave speed control and measure their performances. This multimedia combines text, audio, 3D graphics, and interactions to fully engage learners and support all learning styles. The FTS-1 is unique because it can insert faults into electrical lines that carry full power to electric motors as well as control-level signals. This gives it the ability to create a more realistic troubleshooting environment for students. The Motor Control Troubleshooting Module also avoids damage to the equipment that is normally associated with manual fault insertion because it inserts the faults electronically. Training equipment last longer and troubleshooting is safer for both the student and the teacher. Troubleshooting is one of the most important skills a student can learn. The FTS-1 module gives teachers the ability to accomplish this in an effective manner because it can automatically insert a wide array of faults throughout the training system and record student responses in a computer database. The FTS-1 Motor Control Troubleshooting Module consists of

FaultPro software, PC-based fault control card, fault module with a wide array of faults and individual plug-in connection cables, power supplies, and operation manual. FaultPro software is a Windows-based software package that provides an online interface for student troubleshooting and a database for recordkeeping of student responses. Real World Faults The FTS-1 can insert faults into electrical lines that carry full power to electric motors as well as control level signals, providing students with a more realistic troubleshooting experience. It contains heavy-duty industrial relays that are optically-isolated from the PC running the Fault-Pro software. Online Student Control FaultPro software features online student control of troubleshooting activities through menu-driven screens, making it easy for students to perform their own troubleshooting exercises. Students get immediate feedback about their responses so they know if they are learning. An online help screen provides step-by-step instructions during the troubleshooting process. The data recorded includes: Class statistics can also be generated so teachers can analyze exercises and students. Custom Templates FaultPro software gives the teacher the ability to create custom templates for each troubleshooting exercise so students are presented with an appropriate troubleshooting experience for each lab activity. Faults can be added or deleted to each exercise as needed. Templates can be created for entire classes so setup for new classes is only a few clicks away.

DOWNLOAD PDF ELECTRIC MOTORS AND CONTROL SYSTEMS

Chapter 4 : Electric Motors and Control Systems

Electric Motors and Control Systems - Kindle edition by Frank Petruzella. Download it once and read it on your Kindle device, PC, phones or tablets. Use features like bookmarks, note taking and highlighting while reading Electric Motors and Control Systems.

It provides an overview of electric motor operation, selection, installation, control, and maintenance. Every effort has been made in this first edition text to present the most up-to-date information, reflecting the current needs of the industry. The broad-based approach taken makes this text viable for a variety of motor and control system courses. Electrical apprentices and journeymen will find this book to be invaluable because of National Electrical Code references as well as information on maintenance and troubleshooting techniques. Personnel involved in motor maintenance and repair will find the book to be a useful reference text. The text is comprehensive! It includes coverage of how motors operate in conjunction with their associated control circuitry. Both older and newer motor technologies are examined. Topics covered range from motor types and controls to installing and maintaining conventional controllers, electronic motor drives, and programmable logic controllers. Features you will find unique to this motors and controls text include: Each chapter constitutes a complete and independent unit of study. All chapters are divided into parts designed to serve as individual lessons. Instructors can easily pick and choose chapters or parts of chapters that meet their particular curriculum needs. When understanding the operation of a circuit is called for, a bulleted list is used to summarize its operation. The lists are used in place of paragraphs and are especially helpful for explaining the sequenced steps of a motor control operation. Integration of Diagrams and Photos. When the operation of a piece of equipment is illustrated by means of a diagram, a photo of the device is included. This feature is designed to increase the level of recognition of devices associated with motor and control systems. Troubleshooting is an important element of any motors and controls course. The chapter troubleshooting scenarios are designed to help students with the aid of the instructor to develop a systematic approach to troubleshooting. Discussion and Critical Thinking Questions. These open-ended questions are designed to give students an opportunity to reflect on the material covered in the chapter. In most cases, they allow for a wide range of responses and provide an opportunity for the student to share more than just facts. This manual contains quizzes, practical assignments, and computer-generated simulated circuit analysis assignments. These serve as an excellent review of the material presented. Practical assignments are designed to give the student an opportunity to apply the information covered in the text in a hands-on motor installation. The Constructor motor control simulation software CD is included as part of the manual. This special edition of the program contains some 45 preconstructed simulated motor control circuits. The Constructor analysis assignments provide students with the opportunity to test and troubleshoot the motor control circuits discussed in the text. The Constructor simulation engine visually displays power flow to each component and using animation and sound effects, each component will react accordingly once power is supplied. Answers to the textbook review questions and the Activities Manual quizzes and assignments. PowerPoint presentations that feature enhanced graphics along with explanatory text and objective type questions. EZ Test testing software with text-coordinated question banks. ExamView text coordinated question banks.

Chapter 5 : Motor Controls Basic Theory Quiz | Electrician Exams Practice Tests

This book has been written for a course of study that will introduce the reader to a broad range of motor types and control systems. It provides an overview of electric motor operation, selection, installation, control, and maintenance.

Applications[edit] Every electric motor has to have some sort of controller. The motor controller will have differing features and complexity depending on the task that the motor will be performing. The simplest case is a switch to connect a motor to a power source, such as in small appliances or power tools. The switch may be manually operated or may be a relay or contactor connected to some form of sensor to automatically start and stop the motor. The switch may have several positions to select different connections of the motor. This may allow reduced-voltage starting of the motor, reversing control or selection of multiple speeds. Overload and over current protection may be omitted in very small motor controllers, which rely on the supplying circuit to have over current protection. Small motors may have built-in overload devices to automatically open the circuit on overload. Larger motors have a protective overload relay or temperature sensing relay included in the controller and fuses or circuit breakers for over current protection. An automatic motor controller may also include limit switches or other devices to protect the driven machinery. More complex motor controllers may be used to accurately control the speed and torque of the connected motor or motors and may be part of closed loop control systems for precise positioning of a driven machine. For example, a numerically controlled lathe will accurately position the cutting tool according to a preprogrammed profile and compensate for varying load conditions and perturbing forces to maintain tool position. Types of motor controller[edit] Motor controllers can be manually, remotely or automatically operated. They may include only the means for starting and stopping the motor or they may include other functions. A motor controller is connected to a power source such as a battery pack or power supply, and control circuitry in the form of analog or digital input signals. Motor soft starter A small motor can be started by simply plugging it into an electrical receptacle or by using a switch or circuit breaker. A larger motor requires a specialized switching unit called a motor starter or motor contactor. When energized, a direct on line DOL starter immediately connects the motor terminals directly to the power supply. Reduced-voltage, star-delta or soft starters connect the motor to the power supply through a voltage reduction device and increases the applied voltage gradually or in steps. Very large motors running on medium voltage power supplies thousands of volts may use power circuit breakers as switching elements. A direct on line DOL or across the line starter applies the full line voltage to the motor terminals, the starters or cubicle locations, can usually be found on an ELO drawing. This is the simplest type of motor starter. A DOL motor starter also contains protection devices, and in some cases, condition monitoring. Smaller sizes of direct on-line starters are manually operated; larger sizes use an electromechanical contactor relay to switch the motor circuit. Solid-state direct on line starters also exist. A direct on line starter can be used if the high inrush current of the motor does not cause excessive voltage drop in the supply circuit. The maximum size of a motor allowed on a direct on line starter may be limited by the supply utility for this reason. In the case of an asynchronous motor, such as the 3-phase squirrel-cage motor , the motor will draw a high starting current until it has run up to full speed. This starting current is typically times greater than the full load current. To reduce the inrush current, larger motors will have reduced-voltage starters or variable speed drives in order to minimise voltage dips to the power supply. A reversing starter can connect the motor for rotation in either direction. Such a starter contains two DOL circuitsâ€"one for clockwise operation and the other for counter-clockwise operation, with mechanical and electrical interlocks to prevent simultaneous closure. Single phase AC motors and direct-current motors require additional devices for reversing rotation. Reduced voltage starters[edit] Two or more contactors may be used to provide reduced voltage starting of a motor. By using an autotransformer or a series inductance , a lower voltage is present at the motor terminals, reducing starting torque and inrush current. Once the motor has come up to some fraction of its full-load speed, the starter switches to full voltage at the motor terminals. Since the autotransformer or series reactor only carries the heavy motor starting current for a few seconds, the devices can be much smaller compared to continuously rated equipment. The transition between reduced and full voltage may be based on elapsed time, or triggered when a current sensor shows the motor current has begun to reduce. An autotransformer starter was patented in Adjustable-speed drive An adjustable-speed drive ASD or variable-speed drive VSD is an interconnected combination of equipment that provides a means of driving and adjusting the operating speed of a mechanical load. An electrical adjustable-speed drive consists of an electric motor and a speed controller or power converter plus auxiliary devices and equipment. IMCs monitor the load on a motor and accordingly match motor torque to motor load. This is accomplished by reducing the voltage to the AC terminals and at the same time lowering current and kvar. This can provide a measure of energy efficiency improvement for motors that run under light load for a large part of the time, resulting in less heat, noise, and vibrations generated by the motor. Overload relays[edit] A starter will contain protective devices for the motor. At a minimum this would include a thermal overload relay. The thermal overload is designed to open the starting circuit and thus cut the power to the motor in the event of the motor drawing too much current from the supply for an extended time. The overload relay has a normally closed contact which opens due to heat generated by excessive current flowing through the circuit. Thermal overloads have a small heating device that increases in temperature as the motor running current increases. There are two types of thermal overload relay. In one type, a bi-metallic strip located close to a heater deflects as the heater temperature rises until it mechanically causes the device to trip and open the circuit, cutting power to the motor should it become overloaded. A thermal overload will accommodate the brief high starting current of a motor while accurately protecting it from a running current overload. The heater coil and the action of the bi-metallic strip introduce a time delay that affords the motor time to start and settle into normal running current without the thermal overload tripping. Thermal overloads can be manually or automatically resettable depending on their application and have an adjuster that allows them to be accurately set to the motor run current. A second type of thermal overload relay uses a eutectic alloy , like a solder , to retain a spring-loaded contact. When too much current passes through the heating element for too long a time, the alloy melts and the spring releases the contact, opening the control circuit and shutting down the motor. Since eutectic alloy elements are not adjustable, they are resistant to casual tampering but require changing the heater coil element to match the motor rated current. These devices model the heating of the motor windings by monitoring the motor current. They can also include metering and communication functions. Loss of voltage protection[edit] Starters using magnetic contactors usually derive the power supply for the contactor coil from the same source as the motor supply. An auxiliary contact from the contactor is used to maintain the contactor coil energized after the start command for the motor has been released. If a momentary loss of supply voltage occurs, the contactor will open and not close again until a new start command is given. This connection also provides a small degree of protection against low power supply voltage and loss of a phase. Servo drive and Servomechanism Servo controllers are a wide category of motor control. Other position feedback methods measure the back EMF in the undriven coils to infer the rotor position, or detect the Kick-Back voltage transient spike that is generated whenever the power to a coil is instantaneously switched off. These are therefore often called "sensorless" control methods. A servo may be controlled using pulse-width modulation PWM. How long the pulse remains high typically between 1 and 2 milliseconds determines where the motor will try to position itself. Another control method is pulse and direction. Stepper motor controllers[edit] Main article: Rohm BDKV A stepper, or stepping, motor is a synchronous, brushless, high pole count, polyphase motor. Control is usually, but not exclusively, done open loop, i. Because of this, precise positioning with steppers is simpler and cheaper than closed loop controls. Modern stepper controllers drive the motor with much higher voltages than the motor nameplate rated voltage, and limit current through chopping. The usual setup is to have a positioning controller, known as an indexer, sending step and direction pulses to a separate higher voltage drive circuit which is responsible for commutation and current limiting. Check date values in:

Chapter 6 : A Guide to Electric Drives and DC Motor Control - Ohio Electric Motors

Electric Motors and Control Systems has been written for a course of study that will introduce the reader to a broad range of motor types and control systems. It provides an overview of electric motor operation, selection, installation, *control and maintenance.*

Chapter 7 : Electric Motors and Control Systems - Frank Petruzella - Google Books

Electric Drives - Motor Controllers and Control Systems (Description and Applications) Purpose. For many years the motor controller was a box which provided the motor speed control and enabled the motor to adapt to variations in the load.

Chapter 8 : AC Electric Motor Control Systems Training | Amatrol

Electric motors consume almost 50% of the world's electricity. With the cost of energy rising steadily, industry is focused on replacing inefficient constant-speed motors and drives with microprocessor-based, variable-speed drives.

Chapter 9 : Motor controller - Wikipedia

State Motor and Control Solutions has been designing and fabricating Industrial and Commercial Electrical Control Panels and Automation Systems for a multitude of industries/applications for over 25 years.