Traffic Light Ladder Logic Diagram Using Sequence

This book provides a basic understanding of programmable logic controllers to people in all aspects of the industry. Covering the most popular PLC manufacturers, the book walks readers through a step-by-step introduction necessary to understanding ladder logic, peripheral devices, analog inputs and outputs, member systems and codes, and even programming languages. A useful guide for potential users of PLCs in any industry application.

A programmable logic controllers (PLC) is a real-time system optimized for use in severe conditions such as high/low temperatures or an environment with excessive electrical noise. This control technology is designed to have multiple interfaces (I/Os) to connect and control multiple mechatronic devices such as sensors and actuators. Programmable Logic Controllers, Fifth Edition, continues to be a straight forward, easy-to-read book that presents the principles of PLCs while not tying itself to one vendor or another. Extensive examples and chapter ending problems utilize several popular PLCs currently on the market highlighting understanding of fundamentals that can be used no matter the specific technology. Ladder programming is highlighted throughout with detailed coverage of design characteristics, development of functional blocks, instruction lists, and structured text. Methods for fault diagnosis, testing and debugging are also discussed. This edition has been enhanced with new material on I/Os, logic, and protocols and networking. For the UK audience only: This book is fully aligned with BTEC Higher National requirements. *New material on combinational logic, sequential logic, I/Os, and protocols and networking *More worked examples throughout with more chapter-ending problems *As always, the book is vendor agnostic allowing for general concepts and fundamentals to be taught and applied to several controllers

This handbook, which was developed in recognition of the need for the compilation and dissemination of information on advanced traffic control systems, presents the basic principles for the planning, design, and implementation of such systems for urban streets and freeways. The presentation concept and organization of this handbook is developed from the viewpoint of systems engineering. Traffic control studies are described, and traffic control and surveillance concepts are reviewed. Hardware components are outlined, and computer concepts, and communication concepts are stated. Local and central controllers are described, as well as display, television and driver information systems. Available systems technology and candidate system definition, evaluation and implementation are also covered. The management of traffic control systems is discussed.

This book constitutes the refereed post-conference proceedings of the 9th International Conference on Mobile Networks and Management, MONAMI 2017, held in Melbourne, Australia, in December 2017. The 30 revised full papers were carefully reviewed and selected from 43 submissions. The papers handle topics in the area of mobile computing, wireless networking and management.

IEC 61131–3: Programming Industrial Automation Systems

Applications and Programming

Hands On PLC Programming with RSLogix 500 and LogixPro

PLC Controls with Ladder Diagram (LD), Monochrome

Mitsubishi FX Programmable Logic Controllers

PLC Programming for Industrial Automation provides a basic, yet comprehensive, introduction to the subject of PLC programming for both mechanical and electrical engineering stu written, easy to follow and contains many programming examples to reinforce understanding of the programming theory. The student is led from the absolute basics of ladder logi the way through to complex sequences with parallel and selective branching. The programming is taught in a generic style which can readily be applied to any make and model of P uses the TriLogi PLC simulator which the student can download free of charge from the internet.

This book is an introduction to the programming language Ladder Diagram (LD) used in Programmable Logic Controllers (PLC). The book provides a general introduction to PLC cont be used for any PLC brands. With a focus on enabling readers without an electrical education to learn Ladder programming, the book is suitable for learners without prior knowledg The book contains numerous illustrations and program examples, based on real-world, practical problems in the field of automation. CONTENTS - Background, benefits and challenge programming - PLC hardware, sensors, and basic Ladder programming - Practical guides and tips to achieve good program structures - Theory and examples of flowcharts, block di sequence diagrams - Design guide to develop functions and function blocks - Examples of organizing code in program modules and functions - Sequencing using SELF-HOLD, SET / R MOVE / COMPARE - Complex code examples for a pump station, tank control and conveyor belt - Design, development, testing and simulation of PLC programs The book describes programming as described in the standard IEC 61131-3. PLC vendors understand this standard in different ways, and not all vendors follows the standard exactly. This will be clear material from the vendor. This means that some of the program examples in this book may not work as intended in the PLC type you are using. In addition, there is a difference in PLC type shows graphic symbols and instructions used in Ladder programming. Note: This is a book for beginners and therefore advanced techniques such as ARRAY, LOOPS, STRUC STRING, PID and FIFO are not included.

INTRODUCTION TO THE CONTROLLOGIX PROGRAMMABLE AUTOMATION CONTROLLER USING RSLOGIX 5OOO SOFTWARE: WITH LABS, 4E enables readers to master ControlLogix software with ease. Using its signature hands-on lab exercises that demonstrate Programmable Logic Controllers, this versatile guide walks readers step-by-step thro software from hardware configuration, to programming basic instructions and features, to RSLinx communications. Plus, this edition features manufacturer-specific illustrations an screenshots to teach key concepts. Important Notice: Media content referenced within the product description or the product text may not be available in the ebook version.

Learn how to master the Web through this advanced guide to the ins and outs of HTML, the lingua franca of the Internet. This knowledge-packed how-to reference will equip you ammunition necessary to create powerful Web pages through the latest HTML innovations such as Style Sheets and Document Types. In covering the entire HTML spectrum, this b beginners who are looking for a good grounding in HTML, experts who need a complete and in-depth reference, and those who are simply looking to stay on the cutting edge of W

Newnes Interfacing Companion

Concepts and Programming Languages, Requirements for Programming Systems, Aids to Decision-Making Tools

Automating Manufacturing Systems with Plcs

Model-Driven Approach and Practical Design Guidelines

Mechatronic Systems and Process Automation

John Ridley provides comprehensive information on usage, design and programming for the Mitsubishi FX range of programmable logic controllers, in this step-by-step, practical guide. Professional engineers working with Mitsubishi PLCs, as well as students following courses focusing on these devices, will find this book to be an essential resource for this popular PLC family. Numerous worked examples and assignments are included, to reinforce the practical application of these devices, widely used in industry. Fully updated throughout from coverage of the FX PLC to now cover the FxN PLC family from Mitsubishi, John Ridley also focuses on use of the Fx2N - the most powerful and diverse in function of this PLC group. The second edition contains advanced topics along with numerous ladder diagrams and illustrative examples. A hands-on approach to the programming, design and application of FX PLC based systems Programmed using GX Developer software - used worldwide for the whole range of the FX PLC family Covers Ladder Logic tester - the GX developer simulator that enables students and designers to test and debug their programs without a PLC

Simulation of Software Tools for Electrical Systems: Theory and Practice offers engineers and students what they need to update their understanding of software tools for electric systems, along with guidance on a variety of tools on which to model electrical systems—from device level to system level. The book uses MATLAB, PSIM, Pspice and PSCAD to discuss how to build simulation models of electrical systems that assist in the practice or implementation of simulation software tools in switches, circuits, controllers, instruments and automation system design. In addition, the book covers power electronic switches and FACTS controller device simulation model building with the use of Labview and PLC for industrial automation, process control, monitoring and measurement in electrical systems and hybrid optimization software HOMER is presented for researchers in renewable energy systems. Includes interactive content for numerical computation, visualization and programming for learning the software tools related to electrical sciences Identifies complex and difficult topics illustrated by useable examples Analyzes the simulation of electrical systems, hydraulic, and pneumatic systems using different software, including MATLAB, LABVIEW, MULTISIM, AUTOSIM and PSCAD

Development of Traffic Light Control System Using Programmable Logic Controller

IEC 61131-3 gives a comprehensive introduction to the concepts and languages of the new standard used to program industrial control systems. A summary of the special programming requirements and the corresponding features in the IEC 61131-3 standard make it suitable for students as well as PLC experts. The material is presented in an easy-to-understand form using numerous examples, illustrations, and summary tables. There is also a purchaser's guide and a CD-ROM containing two reduced but functional versions of programming systems.

Software Tools for the Simulation of Electrical Systems

Development of Traffic Light Control System Using Programmable Logic Controller

IEEE International Conference on Intelligent Transportation Systems Proceedings

Automation with Programmable Logic Controllers

Kempe's Engineers Year-book

★ Hacks To Crush PLC Programs From Beginning. Start Designing, Building, Simulating and Testing Programs in IEC Languange (This book guides only on LD (Ladder Diagram)★ This book will get you crushing PLC-HMI programming environment as well as familiarize you with (LD) ladder logic programming. You'll gain a deeper understanding of the LD programming and the editing interface, the practical methods used to build a PLC program, and how to . We also cover the basics of ladder logic programming that every beginner should know, and provide ample practical examples to help you gain a better understanding. By the end of this book you will be able to create a PLC-HMI program from start to finish, that can take on any real-world task. If you know how to write & test the PLC-HMI codes then you're on your way to work on any PLC environment.

PRINCIPLES OF ENGINEERING will help your students better understand the engineering concepts, mathematics, and scientific principles that form the foundation of the Project Lead the Way (PLTW) Principles Of Engineering course. Important concepts and processes are explained throughout using full-color photographs and illustrations. Appropriate for high school students, the mathematics covered includes algebra and trigonometry. The strong pedagogical features to aid comprehension include: Case Studies, boxed articles such as Fun Facts and Points of Interest, Your Turn activities, suggestions for Off-Road Exploration, connections to STEM concepts, Career Profiles, Design Briefs, and example pages from Engineers' Notebooks. Each chapter concludes with questions designed to test your students' knowledge of information presented in the chapter, along with a hands-on challenge or exercise that compliments the content and lends itself to exploration in the classroom. Key vocabulary terms that align with those contained in the PLTW POE course are highlighted throughout the book and emphasized in margin definitions. Important Notice: Media content referenced within the product description or the product text may not be available in the ebook version.

How this Book can Help You This book is aimed at students, electricians, technicians and engineers who want to learn PLC programming from scratch. It covers the

fundamental knowledge they need to start writing their very first ladder logic program on RSLogix 500. It also covers some advanced knowledge of PLCs they need to become experts in programming PLCs. After reading this book, you should have a clear understanding of the structure of ladder logic programming and be able to apply it to real world industrial applications. The best way to master PLC programming is to use real world situations to practice. The real-world scenarios and industrial applications taught in this book will help you to learn better and faster many of the functions and features of the RSLogix 500 using programmable logic controllers. The methods presented in this book are those that are usually employed in the real world of industrial automation, and they may be all that you will ever need to learn. The information in this book is very valuable, not only to those who are just starting out, but also to anybody looking for a way to improve their skills in PLC programming. Merely having a PLC user manual or referring to its help contents is far from sufficient in becoming a skillful PLC programmer. Therefore this book is extremely useful for building PLC programming skills. First, it will give you a big head start if you have never programmed a PLC before. Then it will teach you more advanced techniques you need to learn, design and build anything from simple to complex programs on the RSLogix 500 platform. One of the questions I get quite often is, where can I get a free download of RSLogix 500 to practice? I provide in this book links to a free version of RSLogix 500 and a free version of RSLogix Emulate 500 for simulating real PLCs. So you don't even need to buy a PLC to learn, run and test your ladder logic programs. I do not only show you how to get these important Rockwell Automation software for free and without hassle, I also show with crystal-clear screenshots how to install, configure, navigate and use them to write ladder logic programs.

Master the art of PLC programming and troubleshooting Program, debug, and maintain high-performance PLC-based control systems using the detailed information contained in this comprehensive guide. Written by a pair of process automation experts, Hands-On PLC Programming with RSLogixTM 500 and LogixPro® lays out cutting-edge programming methods with a strong focus on practical industrial applications. Homework questions and laboratory projects illustrate important points throughout. A start-to-finish capstone design project at the end of the book illustrates real-world uses for the concepts covered. Inside: • Introduction to PLC control systems and automation • Fundamentals of PLC logic programming • Timer and counter programming • Math, move, comparison, and program control instructions • HMI design and hardware configuration • Process control design and troubleshooting • Instrumentation and process control • Analog programming and advanced control • Comprehensive case studies

Programming Methods and Applications

Electrical Concepts and Applications

13th International Conference on Transport Systems Telematics, TST 2013, Katowice-Ustron, Poland, October 23--26, 2013. Proceedings

Learn ladder logic step by step with real-world applications

PLC Programming for Industrial Automation

Facilitates a thorough understanding of the fundamental principles and elements of automated machine control systems. Describes mechatronic concepts, but highlights PLC machine control and interfacing with the machine's actuators and peripheral equipment. Explains methodical design of PLC control circuits and programming, and presents solved, typical industrial case problems, shows how a modern PLC control system is designed, structured, compiled and commissioned. Distributed by ISBS. Annotation copyrighted by Book News, Inc., Portland, OR

The book discusses the concept of process automation and mechatronic system design, while offering a unified approach and methodology for the modeling, analysis, automation and control, networking, monitoring, and sensing of various machines and processes from single electrical-driven machines to large-scale industrial process operations. This step-by-step guide covers design applications from various engineering disciplines (mechanical, chemical, electrical, computer, biomedical) through real-life mechatronics problems and industrial automation case studies with topics such as manufacturing, power grid, cement production, wind generator, oil refining, incubator, etc. Provides step-by-step procedures for the modeling, analysis, control and automation, networking, monitoring, and sensing of single electrical-driven machines to large-scale industrial process operations. Presents model-based theory and practice guidelines for mechatronics system and process automation design. Includes worked examples in every chapter and numerous end-of-chapter real-life exercises, problems, and case studies.

This outstanding book for programmable logic controllers focuses on the theory and operation of PLC systems with an emphasis on program analysis and development. The book is written in easy-to-read and understandable language with many crisp illustrations and many practical examples. It describes the PLC instructions for the Allen-Bradley PLC 5, SLC 500, and Logix processors with an emphasis on the SLC 500 system using numerous figures, tables, and example problems. New to this edition are two column and four-color interior design that improves readability and figure placement and all the chapter questions and problems are listed in one convenient location in Appendix D with page locations for all chapter references in the questions and problems. This book describes the technology so that readers can learn PLCs with no previous experience in PLCs or discrete and analog system control.

Tony Fischer-Cripps is a Project Leader in the Division of Telecommunications and Industrial Physics of the CSIRO (Commonwealth Scientific &

*Industrial Research Organisation), Australia. He was previously lecturer, University of Technology, Sydney (UTS), Australia, and has also worked for the National Institute of Standards and Technology, USA (NIST, formerly National Bureau of Standards – NBS). *The essential pocket reference for engineers and students *Interfacing in action: PCs, PLCs, transducers and instrumentation in one book *Develop systems and applications that work with Newnes Interfacing Companion*

Internet of Things in Smart Technologies for Sustainable Urban Development

Automation in Textile Machinery

Introduction to the ControlLogix Programmable Automation Controller with Labs

Programmable Logic Controllers

PLC Controls with Ladder Diagram (LD)

An in depth examination of manufacturing control systems using structured design methods. Topics include ladder logic and other IEC 61131 standards, wiring, communication, analog IO, structured programming, and communications.Allen Bradley PLCs are used extensively through the book, but the formal design methods are applicable to most other PLC brands.A full version of the book and other materials are available on-line at http://engineeronadisk.com

Learning programmable logic controllers (PLCs) can be fun when users are able to make connections with familiar control systems like conveyer belts and traffic lights! This innovative Lab Manual uses projects and examples that are based on everyday automated control systems to provide readers with a clear understanding of the "hows" and "whys" involved in the use of latches, timers, counters, sensors, relays, and more. A comprehensive introduction to ladder logic diagrams and PLCs sets the stage for more than 50 project-based lab exercises that effectively expose users to a number of control situations for active, "hands-on" learning.

In this book I provide the foundation you will need to begin writing your first ladder logic program, using RSLogix 500. I also provide advanced and practical hands-on training you need to a program Programmable Logic Controllers (PLC) with confidence. It is simply not enough to have a PLC user guide/manual, or refer to the help content in order become a skilled PLC programmer. This book is a great resource for learning PLC programming skills. It will give you a head start if this is your first time programming a PLC. It will also teach you advanced techniques that you can use to design, build and program anything on the RSLogix 500 platform. After reading the book, you will have a good understanding and broad knowledge of PLCs and ladder logic programming. You will also be able to apply it to numerous real-world situations and industrial applications, such as: Paper Mill Coal Kiln Shaft Kiln Glass Industry Cement Industry Automated Drill Press Control SCADA Robot Cell with Trapped-key Access and so much more. Using real-world situations and industrial applications is the best way to learn PLC programming. This book contains real-world examples and industrial applications that will help you to quickly learn many functions and features of RSLogix 500. The methods I present in this book are the ones that are most commonly used in industrial automation. They may be all you ever need. This book is a valuable resource for anyone who is just starting out in PLC programming, as well as any other skilled programmer of PLCs, regardless of their level. One of the most frequent questions I get from beginners is, "Where can I download RSLogix 500 for free?" Later in this book, I provide links to free versions of RSLogix 500 and RSLogix Emulate 500. So, to learn, run and test your ladder logic programs, you don't need a PLC. You will not only learn how to obtain these Rockwell Automation software without any hassle. I also demonstrate with clear screenshots how to configure, navigate, and use them to create ladder logic programs.

As the number of Internet of Things (IoT) elements grows exponentially, their interactions can generate a massive amount of raw and multi-structured data. The challenge with this data explosion is to transform any raw data into information and knowledge, which can be used by people and systems to make intelligent decisions. Industrial IoT Application Architectures and Use Cases explores how artificial intelligence (AI), data analytics, and IoT technology combine to promote intelligent decision-making and automation in a range of industries. With faster, more stable AI algorithms and approaches, knowledge discovery and dissemination from IoT-device data can be simplified and streamlined. An era of powerful cognitive technology is beginning due to cloud-based cognitive systems that are forming the foundation of game-changing intelligent applications. This book presents next-generation use cases of IoT and IoT data analytics for a variety of industrial verticals as given below: An Intelligent IoT framework for smart water management An IoT-enabled smart traffic control system for congestion control and smart traffic management An

intelligent airport system for airport management and security surveillance An IoT framework for healthcare to integrate and report patient information Fuzzy scheduling with IoT for tracking and monitoring hotel assets An IoT system for designing drainage systems and monitoring drainage pipes Predictive maintenance of plant equipment to decide the actual mean time to malfunction Integrated neural networks and IoT systems for predictive equipment maintenance IoT integration in blockchain for smart waste management This book also includes a chapter on the IoT paradigm and an overview of uses cases for personal, social, and industrial applications.

Applied Programmable Logic Controllers Laboratory Manual

Mobile Networks and Management

PLC Controls with Ladder Diagram (LD), Wire-O

PLC Programming Using RSLogix 500 & Real World Applications

Advanced Circuit Simulation Using Multisim Workbench

This book is an introduction to the programming language Ladder Diagram (LD) used in Programmable Logic Controllers (PLC). The book provides a general introduction to PLC cont can be used for any PLC brands. With a focus on enabling readers without an electrical education to learn Ladder programming, the book is suitable for learners without prior know Ladder. The book contains numerous illustrations and program examples, based on real-world, practical problems in the field of automation. CONTENTS - Background, benefits and challenges of Ladder programming - PLC hardware, sensors, and basic Ladder programming - Practical guides and tips to achieve good program structures - Theory and examples o flowcharts, block diagrams and sequence diagrams - Design guide to develop functions and function blocks - Examples of organizing code in program modules and functions - Seque using SELF-HOLD, SET/RESET and MOVE/ COMPARE - Complex code examples for a pump station, tank control and conveyor belt - Design, development, testing and simulation of PL programs The book describes Ladder programming as described in the standard IEC 61131-3. PLC vendors understand this standard in different ways, and not all vendors follows t standard exactly. This will be clear through material from the vendor. This means that some of the program examples in this book may not work as intended in the PLC type you ar addition, there is a difference in how the individual PLC type shows graphic symbols and instructions used in Ladder programming. Note: This is a book for beginners and therefore techniques such as ARRAY, LOOPS, STRUCT, ENUM, STRING, PID and FIFO are not included.

Automation is the use of various control systems for operating equipment such as machinery and processes. In line, this book deals with comprehensive analysis of the trends and technologies in automation and control systems used in textile engineering. The control systems descript in all chapters is to dissect the important components of an integrated c in spinning, weaving, knitting, chemical processing and garment industries, and then to determine if and how the components are converging to provide manageable and reliable sys throughout the chain from fiber to the ultimate customer. Key Features: • Describes the design features of machinery for operating various textile machineries in product manufac Covers the fundamentals of the instrumentation and control engineering used in textile machineries • Illustrates sensors and basic elements for textile automation • Highlights the robotics in textile engineering • Reviews the overall idea and scope of research in designing textile machineries

This book provides solution for challenges facing engineers in urban environments looking towards smart development and IoT. The authors address the challenges faced in developi applications along with the solutions. Topics addressed include reliability, security and financial issues in relation to all the smart and sustainable development solutions discussed. T solutions they provide are affordable, resistive to threats, and provide high reliability. The book pertains to researchers, academics, professionals, and students. Provides solutions t sustainable development problems facing engineers in developing and developed countries Discusses results with industrial problems and current issues in smart city development I solutions that are reliable, secure and financially sound

This book constitutes the proceedings of the 13th International Conference on Transport Systems Telematics, TST 2013, held in Katowice-Ustron, Poland, in October 2013. The 58 included in this volume were carefully reviewed and selected for inclusion in this book. They provide an overview of solutions being developed in the field of intelligent transportatio and include theoretical and case studies in the countries of conference participants.

Industrial IoT Application Architectures and Use Cases

Theory and Practice

Activities of Transport Telematics

Traffic Control Systems Handbook

Robotics And Industrial Automation

Development of a traffic light control system using PLC (Programmable Logic Controller) is the title of this project. This project is divided into two parts which are hardware and software. The hardware part for this project is a model of four way junction of a traffic light. Each lane has two limits switch (input) function as a sensor. Three indicator lamps with different colours (Red, Yellow and Green) are installed at each lane for represents as traffic light signal. This limit switches and indicator lamps are connected to Omron PLC CQM1H-CPU51. The PLC controls every signal which is coming from the inputs (Limit switch) to software and display to the outputs (Indicator lamps). The software part operates with Omron PLC is CX-Programmer. With using this software,

the ladder logic diagram is programmed to control the traffic light base on the flow chart. At the end of this project, the traffic light successfully control by PLC. -Author.

Multisim is now the de facto standard for circuit simulation. It is a SPICE-based circuit simulator which combines analog, discrete-time, and mixed-mode circuits. In addition, it is the only simulator which incorporates microcontroller simulation in the same environment. It also includes a tool for printed circuit board design. Advanced Circuit Simulation Using Multisim Workbench is a companion book to Circuit Analysis Using Multisim, published by Morgan & Claypool in 2011. This new book covers advanced analyses and the creation of models and subcircuits. It also includes coverage of transmission lines, the special elements which are used to connect components in PCBs and integrated circuits. Finally, it includes a description of Ultiboard, the tool for PCB creation from a circuit description in Multisim. Both books completely cover most of the important features available for a successful circuit simulation with Multisim. Table of Contents: Models and Subcircuits / Transmission Lines / Other Types of Analyses / Simulating Microcontrollers / PCB Design With Ultiboard

*This is the introduction to PLCs for which baffled students, technicians and managers have been waiting. In this straightforward, easy-to-read guide, Bill Bolton has kept the maths to a minimum, avoided detailed programming instructions and presented the subject in a way that is not device specific - increasing its applicability to courses in electronics and control systems. Having read this book, you should be able to: * Identify the main design characteristics and internal architecture of PLCs. * Describe and identify the characteristics of commonly used input and output devices. * Explain the processing of inputs and outputs of PLCs. * Describe communication links involved with control systems. * Develop ladder programs for the logic functions AND, OR, NOR, NAND, NOT and XOR. * Demonstrate use of internal relays, timers, counters, shift registers, sequencers and data handling. * Identify fail/safe methods. * Identify methods used for fault diagnosis, testing and debugging programs. The third edition has been expanded to contain new material on fail / safe operating conditions, Sequential Function Charts, floating point numbers and dummy rungs, with discussion of commercial PLCs. There is also extended coverage on the programming of PLCs for fault diagnosis, as well as distributed systems and program documentation. Each chapter is followed with a Problems section, for students to put the theory they have learnt into practice. Appendices contain further problems, and answers to all questions from each chapter are included at the back of the book. * New edition expanded to cover safety - a key aspect of PLC use * Further problems included at the end of each chapter, with a complete set of answers given at the back of the book * Presentation is not device-specific, maximising applicability to a range of courses in electronics and control systems*

"Programmable Logic Controllers" provides the student with a general working knowledge of the various PLC brands and models. Programming concepts applicable to virtually all controllers are discussed, and practical programming problems are presented throughout the text. A basic understanding of AC/DC circuits, electronic devices (including thyristors), basic logic gates, flip-flops, Boolean algebra, and college algebra and trigonometry is a prerequisite. The PLC simulation CD that accompanies the text provides hands-on programming experience.

Instrumentation and Control System Design Principles

PLC And SCADA

IEC 61131-3 and introduction to Ladder programming

Learn Ladder Logic Concepts Step by Step with Real Industrial Applications