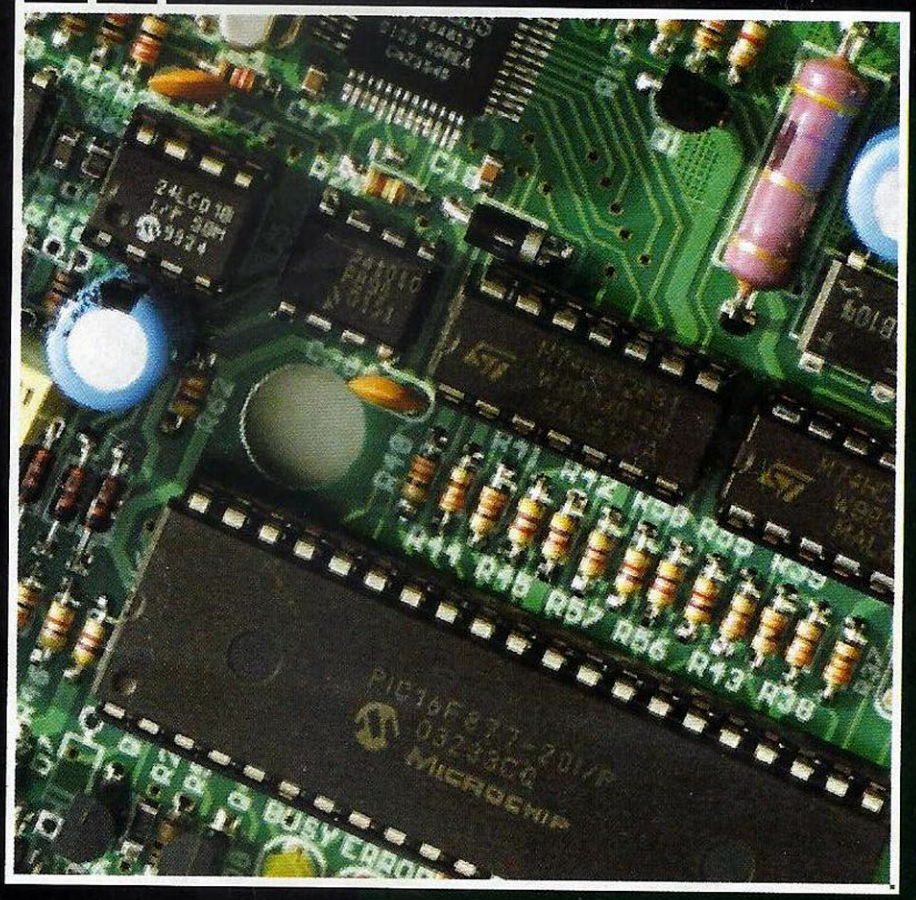
Microcontrollers and Embedded Systems



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MICROCONTROLLERS AND EMBEDDED SYSTEMS

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Dedicated to

My Parents

Sh. Bhavesh Arora

Smt. Harsh Arora

FOREWORD

Due credit goes to the author for his commendable work in writing this book on "Microcontrollers and Embedded systems".

The author has used his wide experience in preparing the manuscript to enable the reader understand the concepts of Microcontrollers and Embedded systems in the simplest manner. This book would really allow technocrats to use microcontroller for various applications in industry.

This book has covered 8051, PIC, 8096, Motorola microcontrollers, their architecture and peripheral support in detail. Numerous programs have been provided for the readers to build their own applications. The content of the book are well organized and written in a simple language.

I hope that all the readers i.e. hobbyists, undergraduate and PG students and professionals will have immense interest in acquiring knowledge through this book.

2012

Prof (Dr.) Sunil Kumar Garg
Jt. Director
Savera Group of Institutions
Faruknagar (Gurgaon)

FOREWORD

It is my pleasant privilege to write a foreword for this book "Microcontrollers and Embedded systems" authored by Anurag Arora.

Microcontrollers are a tool for computing and communication. Knowledge of Microcontrollers and Embedded systems are meaningful and very rewarding if it is applied to design a product that is useful in the industry or for the society in general.

There has been an increase in the demand for a suitable textbook on "Microcontrollers and Embedded systems". The level of presentation is suitable for self study. This book covers the complete new scheme syllabus of MDU,UPTech and KU.

I believe that this book will serve as a useful text for the subject "Microcontrollers and Embedded systems" in the undergraduate courses and as a ready reference for the course at postgraduate level.

2012

Prof (Dr.) N K Agarwal
Former Scientist/Engineer-H
Vikram Sarabhai Space Centre
Indian Space Research Organisation
Trivandrum

PREFACE

In this book, microcontrollers and their applications are mainly focused and targeted towards the automation of industrial machines and processes. For studying their use, normally a short classroom work followed by laboratory practice lasting for a semester is sufficient. At the beginning studying only one microcontroller is good enough. However as one progresses, practice on more than one microcontroller will be required. Considering these needs many practical examples with different microcontrollers are covered in this book. The text can serve as a source and learning module for the undergraduate students of instrumentation, electronics and computer engineering. Further, it will also be helpful for practicing engineers working in the field of microcontrollers and design applications using these.

The potential applications of microcontrollers in the industry attracted the author towards the subject. Microcontroller must be treated as a tool for computing and communication; knowledge of microcontrollers is meaningful and very rewarding if it is applied to design a product that is useful in the industry or for the society in general. This is a subject which has direct relevance to industrial product development and automation. This inspired the author to write this book.

As we start journey into the world of Embedded System, lets consider number of embedded system we are surrounded with in our daily life like mobile phone, microwave oven, set top box, smart cards, digital camera, watches. Air conditioner and so on. Many of us do not know that these devices contain a processor with a lot of software embedded. These embedded systems are focused to do a specific job.

With the advent of industrial automation embedded systems have been around in fields like telecommunications, banking, health care, automobile semiconductor electronics, defence etc. in embedded system. Recently breath taking development were seen, For example in microelectronics, processor speeds are increasing tremendously and memory costs are dropping rapidly. Now we can make Embedded System Network enabled and connect them to the Internet or corporate Intranet. This feature enhances utility of Embedded System.

Revolutionary developments are also taking place in area of mobile devices. No longer its just a voice communication device. It is also now used for accessing data, voice and video services using 3G (Third Generation) Wireless Networks. Anytime anywhere communication for data, voice and video applications is now a reality thanks to the power of Embedded software in mobile devices.

With the availability of tools operating system that occupy very small memory which facilitate fast development and easy debugging. Tools are useful for testing the software before putting it in Embedded system.

Last but not least still we have the challenges for Embedded software programmer to develop cost effective, reliable embedded software and minimal development time. In addition the product should be delivered in the market just in time.

2012

—ANURAG ARORA

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ABOUT THE BOOK

This book has been written in a very different fashion with specific objectives. Firstly, it covers both CISC and RISC processors. Secondly, it will be useful for both students and practicing engineers. Further, it will be useful for the beginners as well as experts or designers who are using microcontrollers. For the beginners it serves as a learning module whereas for the practitioners it serves as a practical guide. Coverage of more than one microcontroller is another unique feature of this book. This text considers MCS-51 as a starting point. It also covers the popular PIC microcontrollers from Microchip which use the RISC architecture. Interfacing and several industrial applications of microcontrollers is another salient feature of the book

The book is organized into 9 chapters:

Chapter 1: It covers the complete introduction to microcontrollers, their potential in industrial applications and the history of microcontrollers. Concepts such as the CISC and RISC processors, embedded and external memory devices are covered. A brief idea about the available microcontrollers from Intel and Microchip and is given for the purpose of comparison.

Chapter 2: Is mainly targeted towards learning MCS-51 products. Their architectural features along with registers, Pin diagram, basic connections and memory organization are covered in this chapter. I/O port structure is also discussed in this chapter. Emphasis is laid on the hardware aspect of the 8051 microcontroller.

This chapter also covers the addressing modes supported by MCS-51.

Chapter 3: The MCS-51 instruction set prepares for using the MCS-51 instructions of writing simple programs. Operations with registers, stack memory, etc. are discussed initiating programming the 8051 microcontroller.

Chapter 4: The programming aspects of 8051 microcontrollers are covered in this chapter 4 is also devoted to the interrupt, timer counting and serial communication facilities supported by 8051. Hardware aspects and several programming examples are the major highlights of this chapter.

Chapter 5: Interfacing and design applications are covered. This is to penetrate the design issues in general. Therefore, interfacing data input and presentation devices are the issues discussed in this chapter and LCD, keyboard, ADC appliations are focused. The whole idea is to emphasise the hardware interfacing and programming issues of all MCS-51 microcontrollers.

Chapter 6: Describe the programmable interface controller and its family in detail with SPI and I2C mode.

Chapter 7: Presents the basic concepts of embedded systems and reviews trends in embedded software development and the issues in developing embedded software.

It also provides the introduction of operating system types of embedded operating systems.

It also discuss the issue involved in embedded software development. The focus is on the process of embedded software development, comparing and contrasting the application software development with embedded software development.

It also presents the case study of embedded system. It's also described the hardware and software languages used for embedded system.

Chapte 8: Discuss about PPI and its interfacing with microprocessor.

Chapter 9: Discuss about Intel 8096 and MC68HC11 microcontroller.

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I deeply express my heartful thanks to Chief executive officer **Dr. Harsh Vardhan,** Registrar **Dr. Neelima,** Executive director **Dr. S.S. Agrawal, Principal Dr. V.K. Syal, (HOD) Dr. NK Agarwal, (HOD) Dr. Vikram Singh** of KIIT college of Engineering and **Prof(Dr) Sunil Kumar Garg (Jt. Director)** of Savera group of institutions for their valuable technical suggestions and constant encouragement, without which this book would not have come into existence.

I am specially thankful to **Prof. A.K.Dubey (J B Knowledge Park)** for first proof reading of the manuscript. I would like to express my sincere thanks to **Mr.Om Prakash Singh (WIT college of Engineering), Mr. Pawan (J B Knowledge Park)** for their time to time, much needed valuable guidance.

Special thanks to all the students I have taught and interacted, whose probing and incisive questions have only bettered my own understanding of my subject matter I also thank the entire editorial team of **UDH publishers & Distributors** for the help and support they have provided during the preparation of this book. Special thanks to **Mr. K.K. Thukral** who took a responsibility of publishing this book.

I would also like to express my deep gratitude to my parents who are always an encouragement for me. I own a lot to them. **My father Sh. Bavesh Arora and My Mother Smt. Harsh Arora** are always an inspiration for me who supported a lot to write this book. I would also like to thank my loved ones **Girish Saluja, Shweta Arora Saluja, Shipra, Shikha and Shivani** who played a vital role in the preparation of manuscript. Finally I would like to convey my special thanks to **my uncle Mr. Chander prakash Valecha, and my aunt Mrs. Asha Valecha** who always kept me motivated enough to be able to make this book a reality. Last but not the least I would also like to thank **my grand Mother Late Smt. Shanti devi** who played a vital role in shaping my future.

—ANURAG ARORA

SYLLABUS FOR MDU

EE-312-F (MICROCONTROLLERS & EMBEDDED SYSTEMS)

SECTION A

INTRODUCTION OF MICROCONTROLLER: Different types of microcontrollers: Embedded microcontrollers, External memory microcontrollers; Processor Architectures: Harvard V/S Princeton , CISC V/S RISC; microcontrollers memory types; microcontrollers features: clocking, i/o pins, interrupts, timers, peripherals.

SECTION B

MICROCONTROLLER ARCHITECTURE: Introduction to PIC microcontrollers, Architecture and pipelining, program memory considerations, Addressing modes, CPU registers, Instruction set, simple operations.

SECTION C

Microcontrollers - Microcontroller 8051- Architecture, Pin Diagram, I/O Ports, Internal RAM and Registers, Interrupts, Addressing Modes, Memory Organization and External Addressing, Instruction Set, Assembly Language Programming, Real Time Applications of MicrocontrollerInterfacing with LCD, ADC, DAC, Stepper Motor, Key Board and Sensors.

SECTION D

Embedded Systems- Introduction, Classification, Processors, Hardware Units, Software Embedded into System, Applications and Products of Embedded Systems, Structural Units in Processor, Memory Devices, I/O Devices, Buses, Interfacing of Processor Memory and I/O Devices, Case Study of an Embedded System for a Smart Card.

SYLLABUS FOR UPTECH

EIC-601 (MICROCONTROLLERS)

I. Introduction Microcontrollers and Embedded processors, Overview of the 8051, Inside the 8051, Addressing modes,

II. Introduction to 8051 assembly programming, Assembling and running an 8051 program, The program counter and ROM space in the 8051, 8051 data types and directives, 8051 flag bits and the PSW register, 8051 register banks and stack, 8051 I/O programming, I/O bit manipulation programming.

III. Programming the 8051 timers, Counter programming, Basics of serial communications, 8051 connection to RS-232, 8051 serial port programming assembly, 8051 interrupts, Programming timer interrupts, programming external hardware interrupts, programming the Serial communication interrupts, Interrupts priority in the 8051,

IV. Interfacing with 8051: Memory address decoding 8031/ 51 interfacing with external ROM, 8051 data memory space, LCD, Keyboard, Parallel and Serial ADC, DAC interfacing, Sensor interfacing and Signal Conditioning, Stepper motor and DC motor,

V. Programming the 8255 and Interfacing, Introduction to Intel 8096 and MC68HC11 microcontroller*.

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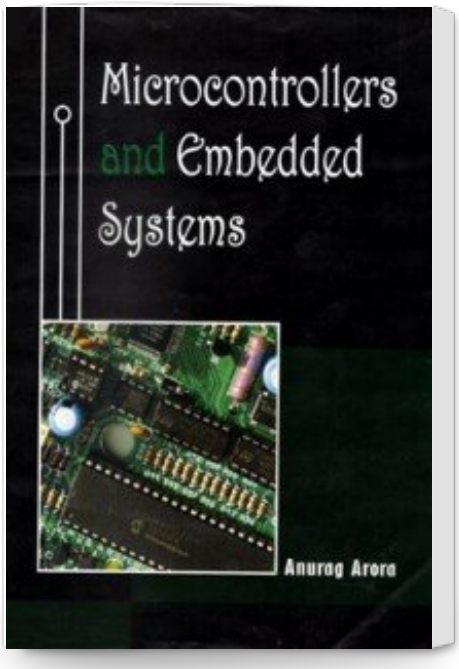

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