Microprocessors and Microcontrollers
8085, 8086 and 8051

Amar K. Ganguly
Anuva Ganguly

Alpha Science International Ltd.
Oxford, U.K.
Acknowledgements vii-viii
Preface ix-xi

1. Fundamentals of Microprocessor 1.1
   1.1 Introduction 1.1
   1.2 Codes 1.1
   1.3 Representation of Binary Numbers 1.3
   1.4 Binary Arithmetic 1.4
   1.5 Digital Circuits 1.6
   1.6 Arithmetic Circuits 1.9
   1.7 Tristate-Logic 1.12
   1.8 Encoder 1.15
   1.9 Decoder 1.18
   1.10 Display Systems 1.19
   1.11 Comparator 1.26
   1.12 Multiplexer 1.28
   1.13 Demultiplexer/Decoder 1.28

2. Overview of Microprocessors and Microcontrollers 2.1
   2.1 Introduction 2.1
   2.2 Microprocessor AGE 2.2
   2.3 Microcontrollers 2.3
   2.4 Embedded Microprocessor 2.5
   2.5 Bit Slice Processor 2.7
   2.6 Vector Processor 2.10
   2.7 Transputers 2.11
   2.8 Advanced Microprocessor 2.12
   2.9 Microprocessor with Multimedia Extension Technology 2.15
2.10 Pentium Processor MMX Technology 2.15
2.11 Von Neumann Architecture of Computer 2.17

3. Architecture of 8085 Microprocessor 3.1
   3.1 Introduction 3.1
   3.2 Architecture of 8085 Microprocessor 3.1
   3.3 Functions of Registers of 8085 Microprocessor 3.3
   3.4 Internal Buses 3.4
   3.5 Control System Unit 3.5
   3.6 Arithmetic and Logic Unit 3.6
   3.7 Instruction Register and Decoder 3.8
   3.8 Interrupt 3.8
   3.9 Serial Input Output Control 3.8
   3.10 PIN Function of 8085 Microprocessor 3.8
   3.11 Electrical Characteristics of Intel 8085 Microprocessor 3.10
   3.12 Demultiplexing Address/Data BUS 3.11
   3.13 Machine Cycles and BUS Timings 3.11
   3.14 Opcode Fetch Machine Cycle 3.13

4. Programming the Intel 8085 Microprocessor 4.1
   4.1 Introduction 4.1
   4.2 Addressing Modes of Intel 8085 Microprocessor 4.3
   4.3 Instruction Sets for Intel 8085 Programming 4.4
   4.4 Programs 4.9
   4.5 Looping, Counting and Indexing 4.13
   4.5 Counters and Time Delays 4.28

5. Interrupts 5.1
   5.1 Introduction 5.1
   5.2 Interrupts of Intel 8085 Microprocessor 5.1
   5.3 Priority, Call Locations and Triggering Levels of Interrupts 5.3
   5.4 RST (Restart), SIM and RIM Instructions 5.3
   5.5 Programmable Interrupt Controller 8259A 5.6
   5.6 Functional Description of 8259A 5.8

6. Memory Interfacing 6.1
   6.1 Introduction 6.1
   6.2 Classification of Memory 6.1
   6.3 Memory Interfacing Requirements 6.9
   6.4 Dynamic RAM Structure 6.14
   6.5 Interfacing Memory 6.15
   6.6 Timing Diagram of Memory Write Cycle 6.19

7. Programmable Timer/Counter 8254 7.1
   7.1 Introduction 7.1
   7.2 Programmable Timer/Counter Intel 8254 7.2
Contents

7.3 Pin Functions 7.3
7.4 Control Word for 8254 7.4
7.5 Read Back Control Word 7.6
7.6 Modes of Operation 7.7
7.7 Interfacing 8254 7.9
7.8 Interfacing of 8254 to Microprocessor 7.10

8. Input Output Interface 8.1
  8.1 Introduction 8.1
  8.2 Adding Input/Output Devices to Microprocessor 8.2
  8.3 Input Interface 8.3
  8.4 Output Interface 8.4
  8.5 Handshaking 8.4
  8.6 Address Decoding for I/O 8.6
  8.7 Interfacing Input Output Controllers (8255) 8.9
  8.8 Internal Block Diagram and System Connections to 8255A 8.9
  8.9 Programmable Keyboard/Display Interface 8279 8.15
  8.10 Programmable Direct Memory Access (DMA) Controller 8237A 8.21
  8.11 Key Matrix Interface with 8085 Microprocessor Using 8255 PPI 8.31
  8.12 Led Display Interface with 8088 Microprocessor Using 8255 PPI 8.32

9. Microprocessor Based Systems 9.1
  9.1 Introduction 9.1
  9.2 Operational Amplifier Circuits 9.2
  9.3 Sensors and Transducers 9.4
  9.4 Signal Conditioning and Multiplexing 9.13
  9.5 Signal Linearization and Scaling 9.15
  9.6 Interfacing Analog to Digital Converter to Microprocessor 9.17
  9.7 Interfacing Digital to Analog Converter to Microprocessor 9.19
  9.8 Microprocessor based Temperature Measurement and Control 9.20
  9.9 Stepper Motor Control using 8086 Microprocessor 9.21

10. Programmable Communication Interface 10.1
  10.1 Introduction 10.1
  10.2 Serial Data Transmission 10.2
  10.3 Serial Data Transmission Methods and Standards 10.3
  10.4 Universal Asynchronous Receiver Transmitter (Uart - 8250) 10.9

11. Intel 8086/8088 Microprocessor 11.1
  11.1 Introduction 11.1
  11.2 Architecture of Intel 8086 Microprocessor 11.2
  11.3 BUS Interface Unit 11.3
  11.4 Execution Unit 11.5
  11.5 Pin Functions of Intel 8086 and 8088 Microprocessor 11.9
12. Programming the Intel 8086 Microprocessor 12.1
12.1 Introduction 12.1
12.2 Instruction Sets for Intel 8086 Programming 12.2
12.3 Addressing Modes of Intel 8086 Microprocessor 12.3
12.4 Instructions for Intel 8086 Microprocessor 12.5
12.5 Construction of Hexadecimal Code for Instructions of 8086 12.9
12.6 Programs 12.11
12.7 Instruction Codes 12.24

13. The Arithmetic Coprocessor 8087 13.1
13.1 Introduction 13.1
13.2 Math Coprocessor 8087 Data Formats 13.2
13.3 Architecture of Math Coprocessor 8087 13.4
13.4 8087 PIN Connections and Cooperation 13.10
13.5 Instruction Set of Math Coprocessor 8087 13.11
13.6 Instruction Format of Math Coprocessor 8087 13.18
13.7 Programming Arithmetic Coprocessor 8087 13.19

14. Microcontrollers 14.1
14.1 Introduction 14.1
14.2 Classification of Microcontrollers 14.2
14.3 Additional Functions of Microcontrollers 14.3
14.4 Uses of Microcontrollers 14.4
14.5 Architecture of 8051 Microcontroller 14.4
14.6 PIN Diagram of 8051 14.12
14.7 Interrupts 14.15
14.8 Data Communication 14.18
14.9 Programming 8051 Microcontroller 14.24

Appendix-I Instructions of 8085 AI.1-AI.6
Appendix-II Hex Code of 8085 Instructions AII.1-AII.3
Appendix-III Instructions of 8086/8088 AIII.1-AIII.14
Appendix-IV Instructions Set of 8051 AIV.1-AIV.4
Appendix-V Hexadecimal Codes of 8051 Instructions AV.1-AV.3
Appendix-VI Specification of Intel Microprocessors and Microcontrollers AVI.1-AVI.12

References R.1-R.2

Index I.1-I.6