CONTENTS

vii

List of Abbreviations and Symbols	XV	
CHAPTER 1: Introduction		
 1.1 Terms Used in Microprocessor Literature 1.1 1.2 Evolution of Microprocessors 1.3 1.3 Basic Functional Blocks of a Microprocessor 1.5 1.4 Microprocessor-Based Systems (Organization of a Microcomputer) 1.6 1.4.1 Working of 8086 Microprocessor-Based System 1.8 1.4.2 Concept of Multiplexing in a Microprocessor 1.8 1.4.3 Demultiplexing of Address/Data Lines in an 8086 Processor 1.8 1.5 Short-Answer Questions 1.9 1.6 Exercises 1.11 		
CHAPTER 2: Intel 8086 Pins, Signals and Architecture	2.1-2.28	
 2.1 Introduction to INTEL 8086 2.1 2.2 Pins and Signals of INTEL 8086 2.2 2.2.1 Common Signals 2.4 2.2.2 Minimum Mode Signals 2.5 2.2.3 Maximum Mode Signals 2.6 2.3 Architecture of INTEL 8086 2.7 2.3.1 Instruction and Data Flow in 8086 2.10 2.3.2 Even and Odd Memory Banks 2.11 2.4 Bus Cycles and Timing Diagram 2.13 2.5 Short-Answer Questions 2.21 2.6 Exercises 2.24 		
CHAPTER 3: Instruction Set of 8086	3.1-3.86	
3.1 Introduction 3.13.2 Format of 8086 Instructions 3.1		

3.2.1 Addressing Modes of 8086 3.7

Preface

X				8086 Microprocessor and	Application
	3.3	Instruction	on Execution Time 3.12		
	3.4	3.4 Instructions Affecting Flags 3.27			
	3.5	Classific	ation of 8086 Instructions 3.29		
		3.5.1	Data Transfer Instructions 3.30		
		3.5.2	Arithmetic Instructions 3.35		
		3.5.3	Logical Instructions 3.45		
		3.5.4	String-Manipulation Instructions 3.53		
		3.5.5	Control-Transfer Instructions 3.57		
		3.5.6	Processor-Control Instructions 3.67		
	3.6	Example	es of 8086 Assembly Language Instructions 3.68		
	3.7	Short-Ar	nswer Questions 3.78		
	3.8	Exercise	es 3.82		
(CHA	PTER 4:	Memory and IO Interfacing		4.1-4.40
4.1 Introduction to Memory 4.1					
	4.2 Semiconductor Memory 4.1				
			ROM and PROM 4.3		
		4.2.2	EPROM 4.4		
		4.2.3	Static RAM 4.7		
		4.2.4	DRAM 4.11		
		4.2.5	NVRAM 4.12		
4.3 Interfacing Static RAM and EPROM 4.12					
		4.3.1	Typical EPROM and Static RAM 4.12		
		4.3.2	Memory Capacity 4.13		
		4.3.3	Choice of Memory ICIC and Address Allocation	4.14	
		4.3.4	Generation of Chip Select Signals 4.15		
		4.3.5	Decoder 4.16		
	4.4	Memory	Organization in 8086-Based System 4.17		
	4.5 IO Structure of a Typical Microcomputer 4.22				
		4.5.1	Interfacing IO and Peripheral Devices 4.22		
		4.5.2	INTEL IO Port Devices 4.23		
		4.5.3	INTEL Peripheral Devices 4.24		
			IO Interfacing in the 8086 Microprocessor-Based	d System 4.25	
		•	e of Memory and IO Interface in 8086 4.26		
	4.7	Short-Ar	nswer Questions 4.32		
	4.8	Exercise	es 4.36		

CHAPTER 5: Interrupts

5.1-5.26

- 5.1 Interrupt and its Need 5.1
 - 5.1.1 Interrupt Driven Data Transfer Scheme 5.1

Conte	nts		xi
5.2	2 Classification of Interrupts 5.2		
5.3	Sources of Interrupts in 8086 5.3		
5.4	4 Interrupts of 8086 5.3		
	5.4.1	INTEL Predefined (or Dedicated) Interrupts 5.3	
	5.4.2	Software Interrupts of 8086 5.5	
	5.4.3	Hardware interrupts of 8086 5.5	
	5.4.4	Priorities of interrupts of 8086 5.5	
5.5	Impleme	enting Interrrupt Scheme in 8086 5.6	
	5.5.1	Interrupt Vector Table 5.6	
	5.5.2	Servicing an Interrupt by 8086 5.6	
5.6	INTR ar	nd its Expansion 5.8	
5.7	Program	nmable Interrupt Controller-INTEL 8259 5.9	
	5.7.1	Interfacing 8259 with 8086 Microprocessor 5.10	
	5.7.2	Functional Block Diagram of 8259 5.10	
	5.7.3	Processing of Interrupts by 8259 5.14	
	5.7.4	Programming (or initializing) 8259 5.14	
	5.7.5	Initialization Common Words (ICWs) 5.15	
	5.7.6	Operation Common Words (OCWs) 5.17	
5.8	Short-A	nswer Questions 5.19	
5.9	Exercise	es 5.23	
CHA	APTER 6:	Assembly Language Programming	6.1-6.124
6.1	Introduc	tion to Assembly Language Programming 6.1	
	6.1.1	Machine-Level Programming 6.1	
	6.1.2	Assembly-Level Programming 6.1	
	6.1.3	Hgh-Level Programming 6.2	
		Flowchart 6.2	
		Variables and Constants Used in Assemblers 6.3	
	6.1.6	Assembler Directives 6.5	
6.2	Assemb	ly Language Program Development Tools 6.9	
		Editor (Text Editor) 6.9	
		Assembler 6.9	
		Library Builder 6.10	
	6.2.4		
		Debugger 6.11	
	6.2.6		
	6.2.7	Emulator 6.12	

6.3 Modular Programming 6.14

6.3.1 Linking and Relocations 6.14

7.1-7.108

ii			808
	6.3.2	Stacks 6.15	
	6.3.3	Stack in 8086 Microprocessor 6.15	
	6.3.4	Procedures 6.16	
	6.3.5	Macros 6.17	
6.4	Interrupt	ts of Personal Computers 6.18	
6.5	Byte and	d String Manipulation in 8086 6.24	
	6.5.1	Byte Manipulation in 8086 6.24	
	6.5.2	String Manipulation in 8086 6.24	
6.6	Hand Co	oding of Assembly Language Programs 6.25	
6.7	Example	es of 8086 Assembly Language Programs 6.29	
6.8	Short-A	nswer Questions 6.118	
6.9	Exercise	es 6.121	
CHA	APTER 7:	Peripheral Devices and Interfacing	
7.1	Program	nmable Peripheral Devices 7.1	
7.2	Parallel	Data Communication Interface 7.1	
	7.2.1	Parallel Data Transfer Schemes 7.2	
	7.2.2	Programmable Peripheral Interface-INTEL 825	5 7.4
		DMA Data Transfer Scheme 7.12	
	7.2.4	DMA Controller-INTEL 8237 7.14	
	7.2.5	DMA Controller-INTEL 8257 7.27	

7.3 Serial Data Communication Interface 7.33

7.3.3 USART-INTEL 8251A 7.38

7.4 Keyboard and Display Interface 7.43

7.6 Programmable Timer-INTEL 8254 7.62

7.6.3 Programming 8254 7.657.6.4 Operating Modes of 8254 7.67

7.7 DAC Interface 7.73

7.7.1 DAC0800 7.75

7.3.1 Serial Data Communication 7.337.3.2 RS-232C Serial Data Standard 7.35

7.4.1 Keyboard Interface Using Ports 7.43
7.4.2 Display Interface Using Ports 7.49
7.5 Keyboard/Display Controller-INTEL 8279 7.55

7.5.1 Pins, Signals and Functional Block Diagram of 8279 7.55

7.6.1 Pins, Signal and Functional Block Diagram of 8254 7.62

7.5.2 Keyboard and Display Interface Using 8279 7.59

7.6.2 Interfacing 8254 with the 8086 Processor 7.64

7.7.2 Interfacing DAC0800 with 8086 7.76

Contents xiii

7.8	8 ADC Interface 7.77		
	7.8.1	ADC0809 7.79	
	7.8.2	Interfacing ADC0809 with 8086 7.82	
7.9	Liquid C	rystal Display (LCD) 7.83	
7.10	Short-Ar	nswer Questions 7.97	
7.11	Exercise	es 7.103	
		Intel 80x86 Family of Processors	8.1–8.60
	8.1 Introduction 8.1		
8.2	INTEL 8	0186 Microprocessor 8.2	
		Pins and Signals of 80186 8.3	
		Architecture of 80186 8.7	
8.3	INTEL 8	0286 Microprocessor 8.10	
		Pins and Signals of 80286 8.10	
	0.0	Architecture of 80286 8.13	
		Real Address Mode of 80286 8.16	
		Protected Virtual Address Mode of 80286 8.16	
8.4 INTEL 80386 Microprocessor 8.20		·	
		Pins and Signals of 80386 8.21	
		Architecture of 80386 8.25	
		Registers of 80386 Microprocessor 8.27	
		Operating Modes of 80386 Microprocessor 8.30	
8.5		0486 Microprocessor 8.34	
		Pins and Signals of 80486 8.34	
		Architecture of 80486 8.38	
8.6	Pentium	Microprocessor 8.40	
	8.6.1	Pins and Signals of Pentium Microprocessor 8.40	
		Architecture of Pentium Processor 8.47	
8.7	,	ed Pentium Processors 8.49	
	• • • • • • • • • • • • • • • • • • • •	Pentium Pro 8.49	
		Pentium II 8.50	
	8.7.3	Pentium III 8.50	
		Pentium 4 8.51	
	8.8 Short-Answer Questions 8.52		
8.9	Exercise	es 8.55	
СПУ	DTED O	9094 Microprocessor-Based System	9.1-9.48
		8086 Microprocessor-Based System	7.1-7.40
9.1	Designir	ng a Microprocessor-Based System 9.1	

9.1.1 Clock Generator-INTEL 8284A 9.3

I.1-I.7

1.8-1.9

INDEX

CHIP INDEX

9.1.2 Bus Controller-INTEL 8288 9.69.1.3 Coprocessor-INTEL 8087 9.7

2 Basic Configuration 9.11		
9.2.1	Minimum Mode 8086 Microprocessor System 9.11	
9.2.2	Maximum Mode 8086 Microprocessor System 9.12	
Multiprod	cessor Configurations 9.14	
9.3.1	Closely Coupled Configuration 9.15	
9.3.2	Loosely Coupled Configuration 9.15	
9.4 Application to Automation Systems 9.17		
9.4.1	Sensor Interface in 8086 for Automation System 9.17	
9.4.2	Temperature Control System 9.20	
9.4.3	Motor Speed Control System 9.22	
9.4.4	Traffic Light Control System 9.24	
9.4.5	Stepper Motor Control System 9.28	
9.4.6	Alarm Controller 9.32	
9.4.7	Servo Motor 9.36	
9.5 Short-Answer Questions 9.44		
Exercise	es 9.46	
APPENDICES A.1		A.1-A.16
ENDIX I	Templates for 8086 Instructions A.1	
ENDIX II	DOS and BIOS Interrupts A.11	
ENDIX III	List of Microprocessors released by INTEL A.15	
	9.2.1 9.2.2 Multiproc 9.3.1 9.3.2 Applicati 9.4.1 9.4.2 9.4.3 9.4.4 9.4.5 9.4.6 9.4.7 Short-Ar Exercise ENDICES	9.2.1 Minimum Mode 8086 Microprocessor System 9.11 9.2.2 Maximum Mode 8086 Microprocessor System 9.12 Multiprocessor Configurations 9.14 9.3.1 Closely Coupled Configuration 9.15 9.3.2 Loosely Coupled Configuration 9.15 Application to Automation Systems 9.17 9.4.1 Sensor Interface in 8086 for Automation System 9.17 9.4.2 Temperature Control System 9.20 9.4.3 Motor Speed Control System 9.22 9.4.4 Traffic Light Control System 9.24 9.4.5 Stepper Motor Control System 9.28 9.4.6 Alarm Controller 9.32 9.4.7 Servo Motor 9.36 Short-Answer Questions 9.44 Exercises 9.46