时代教育·国外高校优秀教材精选

THOMSON

（英文版·原书第4版）

数字电子学教师手册

Instructor's Guide to Accompany Digital Electronics

（美）詹姆斯·比格内尔（James Bignell）
罗伯特·多诺万（Robert Donovan）著

机械工业出版社
CHINA MACHINE PRESS

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出 版 说 明

随着我国加入 WTO，国际间的竞争越来越激烈，而国际间的竞争实际上也就是人才的竞争、教育的竞争。为了加快培养具有国际竞争力的高水平技术人才，加快我国教育改革的步伐，国家教育部近来出台了一系列倡导高校开展双语教学、引进原版教材的政策。以此为契机，机械工业出版社陆续推出了一系列国外影印版教材，其内容涉及高等学校公共基础课，以及机、电、信息领域的专业基础课和专业课。

引进国外优秀原版教材，在有条件的学校推动开展英语授课或双语教学，自然也引进了先进的教学思想和教学方法，这对提高我国自编教材的水平，加强学生的英语实际应用能力，使我国的高等教育尽快与国际接轨，必将起到积极的推动作用。

为了做好教材的引进工作，机械工业出版社特别成立了由著名专家组成的国外高校优秀教材审定委员会。这些专家对实施双语教学做了深入细致的调查研究，对引进原版教材提出许多建设性意见，并慎重地对每一本将要引进的原版教材一审再审，精选再精选，确认教材本身的质量水平，以及权威性和先进性，以期所引进的原版教材能适应我国学生的外语水平和学习特点。在引进工作中，审定委员会还结合我国高校教学课程体系的设置和要求，对原版教材的教学思想和方法的先进性、科学性严格把关，同时尽量考虑原版教材的系统性和经济性。

这套教材出版后，我们将根据各高校的双语教学计划，举办原版教材的教师培训，及时地将其推荐给各高校选用。希望高校师生在使用教材后及时反馈意见和建议，使我们更好地为教学改革服务。

机械工业出版社

PREFACE

The textbook *Digital Electronics* was designed to be the primary textbook for a one-semester course of four to six semester hours in length. One chapter is to be covered each week, with the first day of the week used for testing and class lecture and the second day used for lab work.

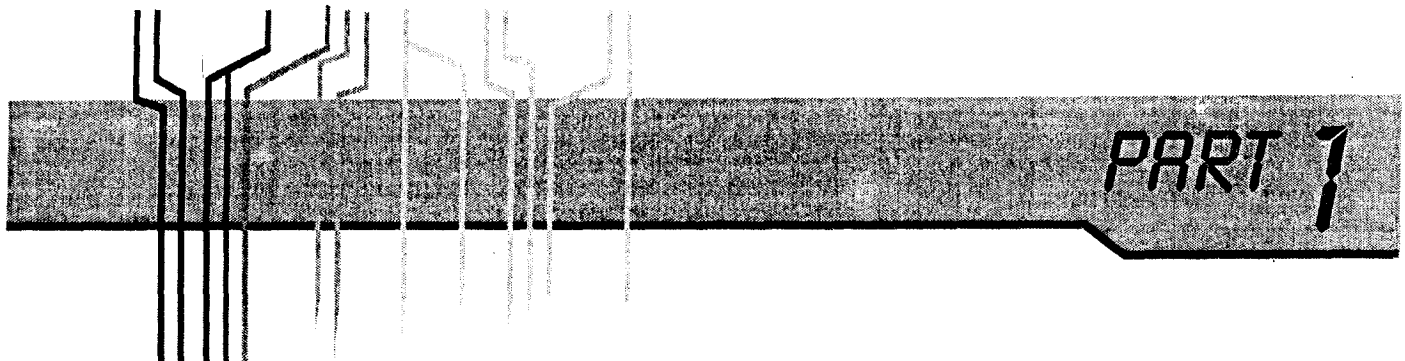
The practice of giving a short five- to ten-question test at the beginning of each lecture has many advantages in promoting the learning process. It gives the professor feedback as to how well students are doing and is also a good grading method. The work in digital electronics is cumulative, so students need to learn the material in a logical sequence. The short test at the beginning of each lecture class will keep the instructor from going on to new material if students have not yet mastered the prerequisite material. The short tests should be graded, handed back to students, and reviewed during the same class that they are taken. This can be done by the instructor if the class is not too large or by a lab assistant while the instructor is lecturing on the new material. If the class is too large for a lab assistant to complete grading the tests before the end of the class period, the tests can be reviewed and the graded tests handed back at the next lecture class. The use of fast feedback on tests is a very effective educational tool to inspire students and show them where they have made mistakes. It is hard to duplicate this with any other method. Also, students will be much more likely to study the material and read the chapters if they know that they will be tested on that material at the next class meeting.

The labs presented in the textbook are designed to reinforce the lecture material and are one of the best teaching methods available to the instructor. The labs should be graded and not just assigned to be done. Students can keep lab notebooks which can be graded by the instructor. The lab will be much more productive if the instructor okays each part of the lab and grades the performance of the students by grading the lab work. A completed lab for each chapter is shown in this manual for the instructor to use as a key in grading.

Organization of the lab will vary from site to site but it is suggested that a block of time of at least three hours be used for each lab. Two students can work together productively, but three or more should not be allowed because often the third person goes along for the ride and does not benefit from the lab work. The components for the labs can be organized into a small cabinet with drawers for each lab. Each column of drawers should contain all the components for a particular lab, with one drawer for each lab group in the class. If you have ten lab groups, you would have fourteen columns (one column per lab) of ten drawers per column. If you use this method of organization the small drawers can be checked out to the lab groups as they are needed and reused by the next class during the next lab period. Another method of component organization is to require the student to purchase all the components needed to do the labs in the textbook. This can be done by imposing a lab fee and having the institution purchase the necessary components, or by having students do the purchasing themselves. In any case students should supply themselves with simple hand tools such as wire strippers, needle-nose pliers, and a wireless breadboard.

This manual is intended to help the instructor in teaching the course of digital electronics and is not just an answer key to the end-of-chapter problems and questions, although these answers also are present in the manual. With each chapter lecture outline is a short section on administering the lab. This section discusses some of the problems and methods the authors have experienced while running the labs with a class. We both hope that the information presented in this manual will be of help to you.

CONTENTS



Solutions to Questions, Problems, and Labs in Textbook

CHAPTER 1 Number Systems

Answers to Questions and Problems

1. 100 101 110 111 1000

2. 1011 1100 1101 1110 1111 10000 10001 10010 10011 10100 10101

3. 66 67 70 71 72 73 74 75 76 77 100
101 102 103 104 105 106 107 110

4. 767 770 771 772 773 774 775 776 777 1000 1001
1002 1003 1004 1005 1006 1007 1010

5. DD DE DF E0 E1 E2 E3 E4 E5 E6 E7
E8 E9 EA EB EC ED EE EF F0 F1 F2
F3 F4 F5 F6 F7 F8 F9 FA FB FC FD
FE FF 100 101

6. EFD EFE EFF F00 F01 F02 F03 F04 F05 F06
F07 F08 F09 F0A F0B F0C F0D F0E F0F F10

7. 10001001 10010000 10010001 10010010 10010011
10010100 10010101 10010110 10010111 10011000
10011001 100000000 100000001

8. 1101000 1101001 1110000 1110001 1110010
1110011 1110100 1110101 1110110 1110111
1111000 1111001 10000000 10000001 10000010
10000011 10000100 10000101 10000110 10000111
10001000 10001001 10010000

9. **a.** $2 \cdot 2 \cdot 2 \cdot 2 - 1 = 15$ **b.** $2 \cdot 2 \cdot 2 \cdot 2 = 16$

A. **a.** $2^8 - 1 = 255$ **b.** $2^8 = 256$

B. **a.** $2^{16} - 1 = 65{,}535$ **b.** $2^{16} = 65{,}536$

C. **a.** eight, 0–7 **b.** sixteen, 0–9 and A–F **c.** two, 0 and 1

D.

Octal	Hexadecimal	Binary	Decimal	BCD
36	1E	11110	30	110000
251	A9	10101001	169	101101001
22	12	10010	18	11000
143	63	1100011	99	10011001
103	43	1000011	67	1100111

E.

Octal	Hexadecimal	Binary	Decimal	BCD
54	2C	101100	44	1000100
74	3C	111100	60	1100000
134	5C	1011100	92	10010010
144	64	1100100	100	100000000
121	51	1010001	81	10000001

F. **a.**
$$\begin{array}{r} 1001 \\ 1101 \\ \hline 10110 \end{array}$$

b.
$$\begin{array}{r} 1 \\ 1011 \\ 1001 \\ \hline 10101 \end{array}$$

c.
$$\begin{array}{r} 10010 \\ 1100 \\ 11101 \\ \hline 111011 \end{array}$$

10. **a.**
$$\begin{array}{r} 110 \\ +101 \\ \hline 1\ 011 \end{array}$$

b.
$$\begin{array}{r} 1110 \\ +110 \\ \hline 1\ 0100 \end{array}$$

c.
$$\begin{array}{r} 1 \\ 1101 \\ 1101 \\ \hline 1\ 1011 \end{array}$$

d.
$$\begin{array}{r} 1010 \\ 110 \\ 1011 \\ \hline 1\ 1011 \end{array}$$

11. **a.**
$$\begin{array}{r} 1001 \\ -110 \\ \hline 0011 \end{array}$$

b.
$$\begin{array}{r} 10101 \\ -1110 \\ \hline 00111 \end{array}$$

c.
$$\begin{array}{r} 1101 \\ -100100 \\ \hline \end{array} \qquad \begin{array}{r} 100100 \\ 1101 \\ \hline -010111 \end{array}$$

d.
$$\begin{array}{r} 10010100 \\ -1010010 \\ \hline 01000010 \end{array}$$

12. **a.**
$$\begin{array}{r} 1100 \\ -101 \\ \hline 0111 \end{array}$$

b.
$$\begin{array}{r} 11010 \\ -1011 \\ \hline 01111 \end{array}$$

c.
$$\begin{array}{r} 1101 \\ -100111 \\ \hline \end{array} \qquad \begin{array}{r} 100111 \\ 1101 \\ \hline -011010 \end{array}$$

d.
$$\begin{array}{r} 101 \\ -10010 \\ \hline \end{array} \qquad \begin{array}{r} 10010 \\ 101 \\ \hline -01101 \end{array}$$

13. Ones and zeros are easy to represent electronically.

14. Binary numbers are easy to represent electronically (on, off). Hexadecimal numbers are used to represent binary numbers.

Administering the Lab

Because this is the first lab, the instructor must cover a great deal of basic information, such as IC pinout configuration and the connection of simple circuits on the protoboard. This material is presented in the preparation section of the lab. Be sure to cover this material with students.

This lab uses a 7483 4-bit binary adder to reinforce the material in the chapter. Students often confuse the C_0 input with the carry-out and the C_4 output with the carry-in. This will cause the adder to produce unpredictable results.

Stress the use of short wires and the proper alignment of the inputs and outputs of the circuit. The inputs should be lined up MSB to LSB in a straight row, so that they can be made high or low easily.

Students like this lab because the IC performs according to the laws of the binary number system and they can predict the outputs.

Lab 1A 7483 4-Bit Full Adder

1. Correct operation of the 7483 adder.

3. $A = 10$ and $B = 6$ and $C_0 = 0$ 10000_2

5. $A = 7$ and $B = 4$ and $C_0 = 1$ 1100_2

7. Proper operation of two 7483 ICs.

The answers listed in problem 8 are the outputs of the 7483 adders.

8. **a.** $150 + 201 =$ 101011111_2
   b. $255 + 1 =$ 100000000_2

Lab 1B 4008 4-Bit Full Adder

- ***Part 1***

Circuit 1B-1.ewb:

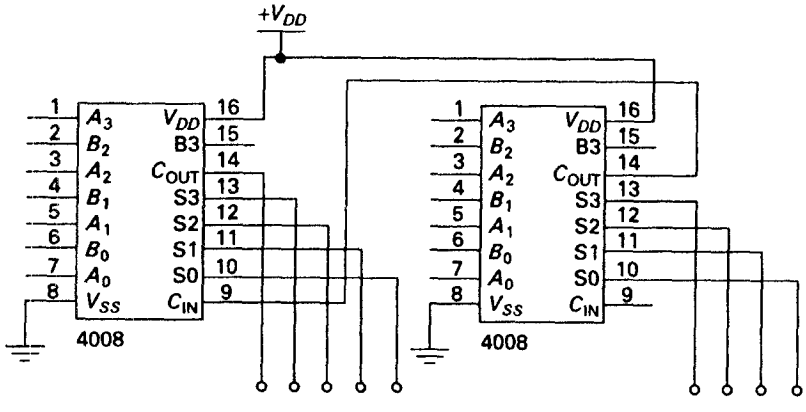
1. $1010 + 0011$

2. $C_{IN} = 1$

3. 1110 is correct.

4. The maximum output is 11111_2 or 31_{10}

- ***Part 2***



1. Result: 1 0010 0101

2. Result: 1011 1011

3. Result: 1 0110 0101

- ***Part 3***

Circuit 1B-2.ewb No power supplied to IC. Faulty connection.

Circuit 1B-3.ewb A_3 (pin 1) shorted to ground.

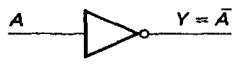
Circuit 1B-4.ewb C_{IN} (pin 9) shorted to ground (pin 8).

Circuit 1B-5.ewb S_2 (pin 12) open.

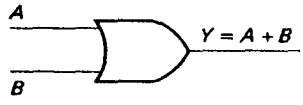
CHAPTER 2 Logic Gates

Answers to Questions and Problems

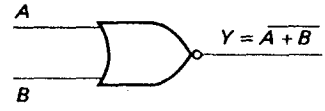
1. a.



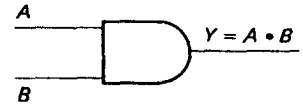
b.



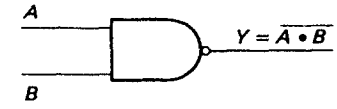
c.



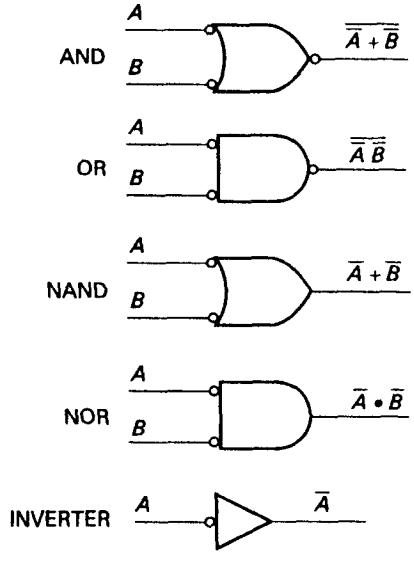
d.



e.



2.



3.

AND		
A	*B*	*X*
0	0	0
0	1	0
1	0	0
1	1	1

OR		
A	*B*	*X*
0	0	0
0	1	1
1	0	1
1	1	1

NAND		
A	*B*	*X*
0	0	1
0	1	1
1	0	1
1	1	0

NOR		
A	*B*	*X*
0	0	1
0	1	0
1	0	0
1	1	0

4.

AND			
A	*B*	*C*	*X*
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	1

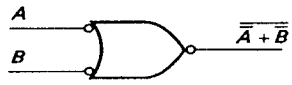
NAND			
A	*B*	*C*	*X*
0	0	0	1
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	0

OR			
A	*B*	*C*	*X*
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	1

NOR			
A	*B*	*C*	*X*
0	0	0	1
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	0

5. a.

b.



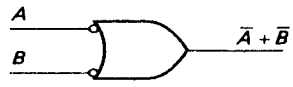
c.

A	B	X
0	0	0
0	1	0
1	0	0
1	1	1

Unique state

6. a.

b.

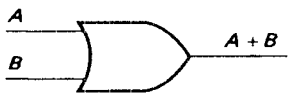


c.

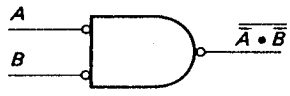
A	B	X
0	0	1
0	1	1
1	0	1
1	1	0

Unique state

7. a.



b.

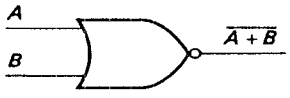


c.

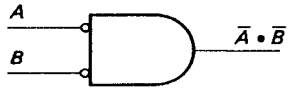
A	B	X
0	0	0
0	1	1
1	0	1
1	1	1

Unique state

8. a.



b.



c.

A	B	X
0	0	1
0	1	0
1	0	0
1	1	0

Unique state

9. 1; 0; 0; 0

10. 1; 0; 1; 1

11. 0; 1; 1; 0

12. 1; 0; 0; 0

13. 0; 1; 0; 0

14. 0; 1; 1; 0

15. enables

16. inverted

17. Put a 1 on the control input.

18. Put a 1 on the control input.

19. 0

20. 0

21. inverted

22. Put a 1 on the control input.

23. Put a 1 on the control input.

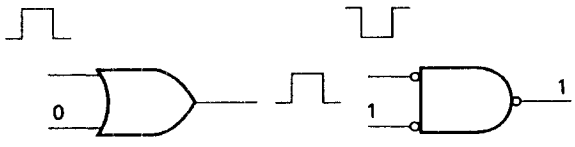
24. 1

25. 1

26. unaltered

27. unaltered

28.



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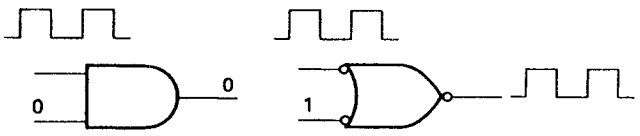

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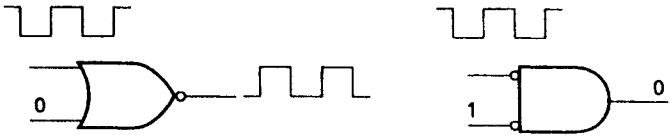

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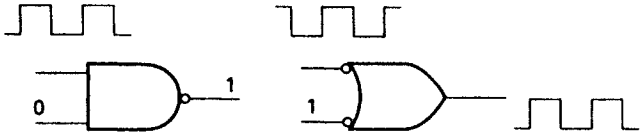

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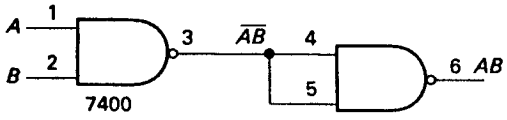

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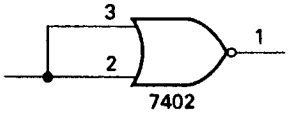
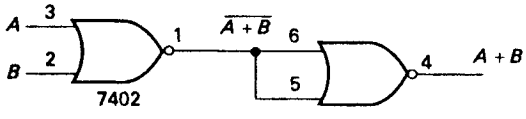
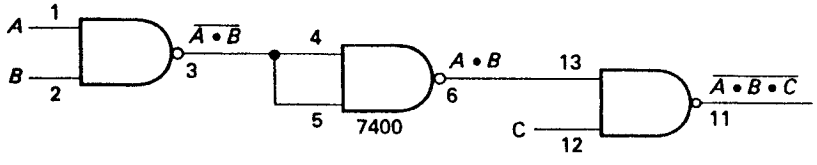


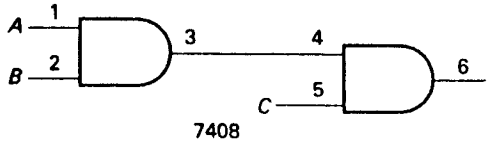
34.



35.



36.



37. **a.** 7427 Triple 3-input NOR (TTL)
b. 4025 Triple 3-input NOR (CMOS)
c. 74C20 Dual 4-input NAND (CMOS)
d. 7410 Triple 3-input NAND (TTL)
e. 4081 Quad 2-input AND (CMOS)
f. 4069 Hex Inverter (CMOS)