BOARD OF STUDIES
NEW SOUTH WALES

STUDENT NUMBER

CENTRE NUMBER

HIGHER SCHOOL CERTIFICATE EXAMINATION

1997

INDUSTRIAL TECHNOLOGY

2 UNIT

SECTION III—ELECTRONICS

Total time allowed for Sections I, II, and III—One hour and a half
(Plus 5 minutes reading time)

DIRECTIONS TO CANDIDATES

- Write your Student Number and Centre Number at the top right-hand corner of this page.
- Where appropriate, show working for solutions neatly and clearly.
- You may use Board-approved drawing instruments and calculators.

Section III—Electronics

- Attempt ALL questions.
- Answer questions in the spaces provided in this paper.

EXAMINER'S USE ONLY

Question			
13			
14			
15			

SECTION III—ELECTRONICS

DATA SHEET

Circuit Laws

$E = RI$

$P = EI$

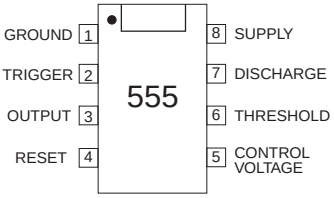
$R_r = R_1 + R_2 + R_3 + ...$

$\frac{1}{R_r} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + ...$

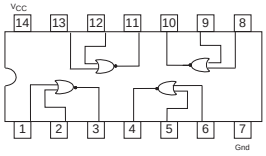
$C_r = C_1 + C_2 + C_3 + ...$

$\frac{1}{C_r} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + ...$

$T = RC$

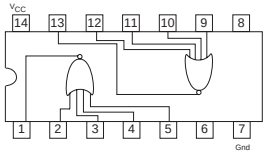


CD4001



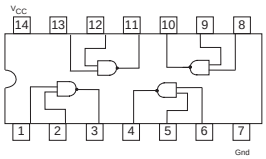
QUAD 2-INPUT NOR GATE

CD 4002



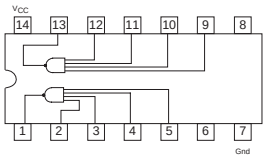
DUAL 4-INPUT NOR GATE

CD 4011



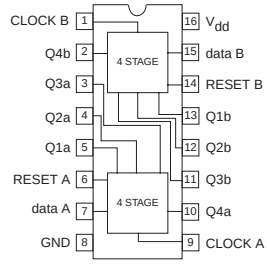
QUAD 2-INPUT NAND GATE

CD 4012



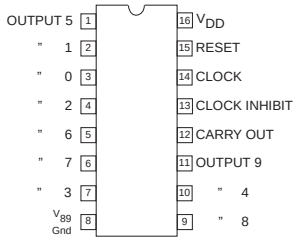
DUAL 4-INPUT NAND GATE

CD 4015



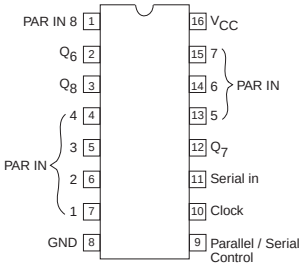
DUAL 4-BIT STATIC SHIFT REGISTER

CD4017 B



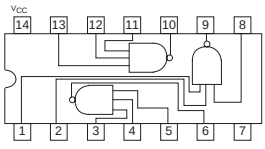
DECADE COUNTER/DIVIDER

CD 4021 CN



8-BIT STATIC SHIFT REGISTER

CD4023 B



TRIPLE 3-INPUT NAND GATE

Resistors

Black	0	Blue	6	Red	2%
Brown	1	Violet	7	Gold	5%
Red	2	Grey	8	Silver	10%
Orange	3	White	9	No band	20%
Yellow	4	Gold	× 0·1		
Green	5	Silver	× 0·01		

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QUESTION 13. (5 marks)

EXAMINER'S USE ONLY

(a) The circuit in Figure 1 is for a short-wave radio receiver.

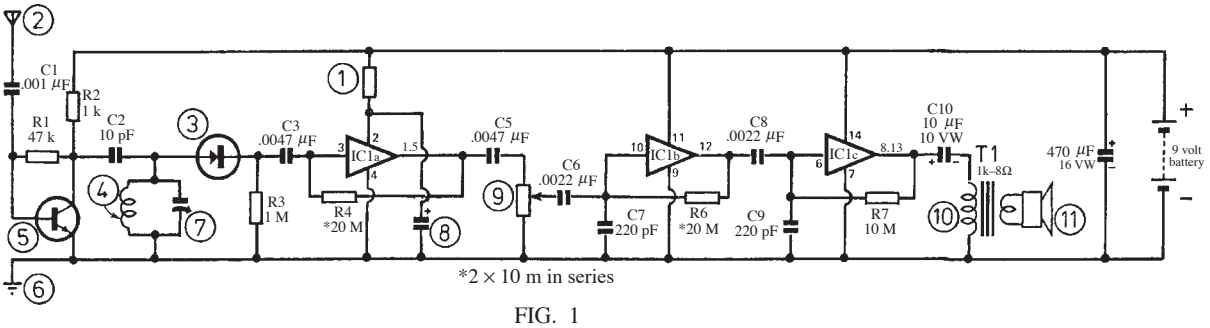

FIG. 1

Courtesy Dick Smith Electronics.

(i) Complete the table below by naming the type of components indicated by EACH of the numbers 1–11 in Figure 1.

Number	*Component*
1	Fixed value resistor
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	

(ii) Component 7 is variable. Explain its role in the circuit.

……

……

QUESTION 13. (Continued)

EXAMINER'S USE ONLY

(iii) Using the 4 band code, complete the table below. Assume that ALL resistors have a tolerance of five per cent.

Resistor	*Value*	*Colour*			
		Band 1	Band 2	Band 3	Band 4
R1	47 k				
R7	10 M				

(iv) Capacitance values can be marked on the outside of the capacitor.

How would the values of C2 and C7 be indicated if BOTH had a tolerance of 5 per cent?

C2 10 pF ……

C7 220 pF ……

(v) Briefly explain the role of T1, component 10, in the circuit.

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(vi) A power switch has to be included in the circuit. What type could be used, and where could it be placed in the circuit?

Type ……

Position ……

(vii) What is the function of the THREE integrated circuits?

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Question 13 continues on page 6

QUESTION 13. (Continued)

EXAMINER'S USE ONLY

(viii) Calculate the total manufacturing cost of EACH radio, based on the prices listed below.

• Electronic components and circuit board per radio	\$7·60
• Assembly of electronics	4 minutes at \$50 per hour
• Enclosure materials per radio	\$1·20
• Enclosure manufacturing	2 minutes at \$30 per hour
• Radio assembly and testing	4 minutes at \$40 per hour

Total cost per radio \$ .....

(b) Calculate the total resistance of the arrangement in Figure 2.

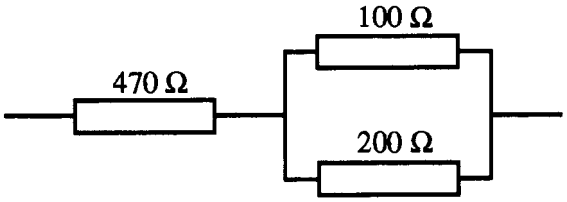

FIG. 2

Total resistance .....

(c) Calculate the total capacitance of the arrangement in Figure 3.

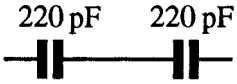

FIG. 3

Total capacitance .....

QUESTION 14. (5 marks)

EXAMINER'S USE ONLY

(a) Compare the simplest construction of a printed circuit board (PCB), in a school workshop to that of a complex PCB mass produced in an industrial setting.

Creating the artwork

School workshop ……

Industry ……

……

Transferring the image to the PCB

School workshop ……

Industry ……

……

Etching

School workshop ……

Industry ……

……

(b) Various soldering techniques are used, BOTH in industry and by hobbyists.

(i) Briefly describe the process of wave soldering.

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……

(ii) Explain the role of flux in the soldering process.

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……

Question 14 continues on page 8

QUESTION 14. (Continued)

EXAMINER'S USE ONLY

(iii) Sketch and describe ONE common soldering fault that may occur in the school workshop. Suggest a remedy for the fault.

Fault

Description ……

……

Remedy ……

……

……

(c) Coal, water (hydro), and nuclear power are used in mains electricity generating facilities.

(i) Give ONE disadvantage to the environment of the use of EACH power source.

Coal ……

……

Water ……

……

Nuclear ……

……

(ii) What is the role of coal or nuclear power in the generating process?

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QUESTION 14. (Continued)

EXAMINER'S USE ONLY

(d) Fuses are used to protect circuits.

(i) For a 240 V supply, calculate the current rating of the fuse suitable for protecting a 2·4 kW appliance.

Current rating …… amps

(ii) How does a circuit breaker differ from a fuse?

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(iii) Briefly explain how a residual current device works.

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(e) Identify the following CMOS integrated circuits.

Description	*Code*
Quad NAND gate	
	CD4001
Decade counter/divider	
	CD4015

(f) What gate, when connected with an AND gate, will produce a NAND gate?

Gate ……

(g) How can a NAND gate be used as a NOT gate?

……

Question 14 continues on page 10

QUESTION 14. (Continued)

EXAMINER'S USE ONLY

(h) Complete the truth table for the circuit shown in Figure 4 below.

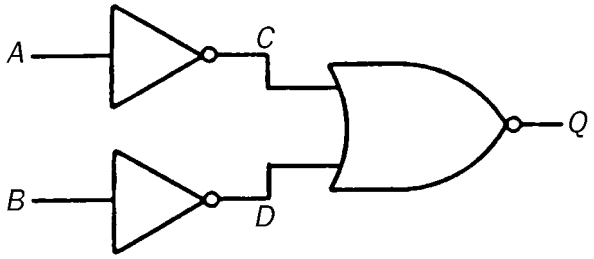

FIG. 4

A	*B*	*C*	*D*	*Q*
0	0			
1	0			
0	1			
1	1			

(i) When using CMOS integrated circuits in circuit design, what must be done with unused inputs?

……

……

(j) Complete the table below that compares the properties of TTL and CMOS integrated circuits.

Property	*TTL*	*CMOS*
Input impedance		Very high
Switching speed	Fast	
Fan-out	Ten	

QUESTION 15. (5 marks)

EXAMINER'S USE ONLY

(a) The circuit shown in Figure 5 allows the lamp L_1 to flash.

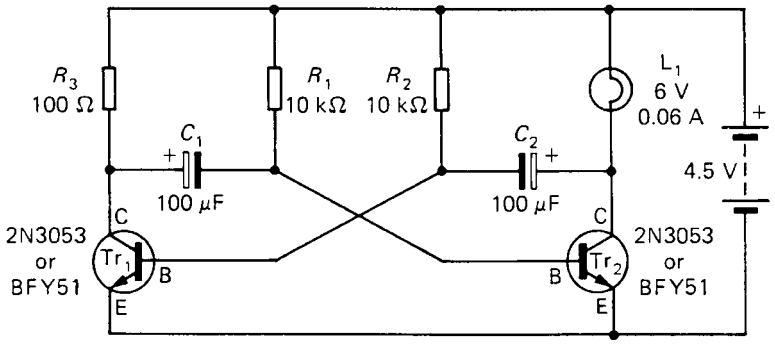

FIG. 5

'Introducing Electronic Systems', MW Brimicombe, Thomas Nelson & Sons 1987 p34.

(i) Briefly explain how the circuit functions.

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(ii) What is the basic circuit called?

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(iii) If C_1 and C_2 were not of equal value, how would this affect the operation of L_1?

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Question 15 continues on page 12

QUESTION 15. (Continued)

EXAMINER'S USE ONLY

(b) Students wish to adapt the circuit in part (a) to run a flashing rear bicycle light. To do this, the lamp, 4·5 V battery pack, and one resistor will be removed and then two high intensity LEDs, a 9 V battery, toggle switch, and two extra resistors will be added.

(i) Complete the circuit diagram for the rear bicycle light which is commenced in Figure 6. Use correct circuit symbols and component values.

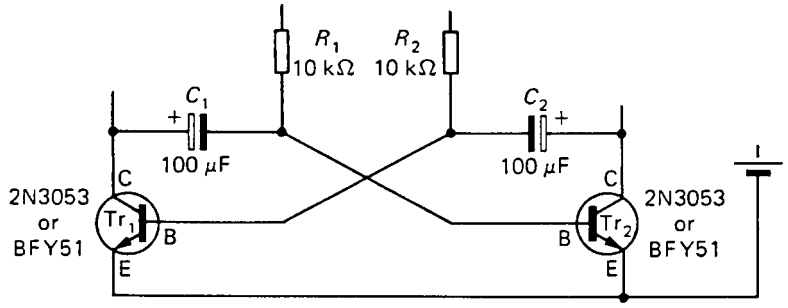

FIG. 6

(ii) What is the function of the two new resistors in the circuit?

……

(iii) Name FOUR different components in the completed Figure 6 that are polarised.

1. ……

2. ……

3. ……

4. ……

(iv) When mounting the project in an enclosure, it was deemed necessary to remove the LEDs from the PCB and mount them on leads.

Describe ONE method of preventing the legs of the LEDs from 'shorting out'.

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QUESTION 15. (Continued)

EXAMINER'S USE ONLY

(v) Students have a number of materials available to them for the construction of an enclosure that may be mounted on the rear of a bicycle. These include:

- sheet aluminium
- ∅40 mm plastic conduit and end caps
- small nuts and bolts.

The enclosure must house:

- a 9 V battery — 50 mm long × 25 mm wide × 16 mm thick
- a circuit board — 60 mm long × 25 mm wide × 15 mm thick
- two high-intensity LEDs — ∅5 mm
- a toggle switch — ∅8 mm.

1. Sketch an enclosure that could be used. Include overall dimensions on the sketch.

2. Indicate how it can be mounted on the rear of a bicycle.

Question 15 continues on page 14

QUESTION 15. (Continued)

EXAMINER'S USE ONLY

(c) A faulty transistor must be replaced in a circuit.

(i) Outline the steps in removing the faulty component.

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(ii) What precaution must be taken when installing the new transistor?

……

……

(d) Outline how a multimeter can be used to check if a transistor is an NPN type.

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