Candidate forename		Candidate surname	

Centre number						Candidate number				

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

ADVANCED GCE

F614

ELECTRONICS

Control Systems

WEDNESDAY 8 JUNE 2011: Morning
DURATION: 1 hour 40 minutes

SUITABLE FOR VISUALLY IMPAIRED CANDIDATES

Candidates answer on the question paper.

OCR SUPPLIED MATERIALS:

Loose sheets containing Microcontroller Instructions and the Datasheet
Loose sheet for Q4

OTHER MATERIALS REQUIRED:

Scientific calculator

READ INSTRUCTIONS OVERLEAF

DC (KN/KN) 11MEP06425 49168

INSTRUCTIONS TO CANDIDATES

- **Write your name, centre number and candidate number in the boxes on the first page. Please write clearly and in capital letters.**
- **Use black ink. Pencil may be used for graphs and diagrams only.**
- **Read each question carefully. Make sure you know what you have to do before starting your answer.**
- **Write your answer to each question in the space provided. Additional paper may be used if necessary but you must clearly show your candidate number, centre number and question number(s).**
- **Answer ALL the questions.**

INFORMATION FOR CANDIDATES

- **The number of marks is given in brackets [ ] at the end of each question or part question.**
- **The total number of marks for this paper is 110.**
- **You will be awarded marks for the quality of your written communication where this is indicated in the question.**
- **You are advised to show all the steps in any calculations.**

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Answer ALL questions.

1 Fig. 1.1 shows a memory cell.

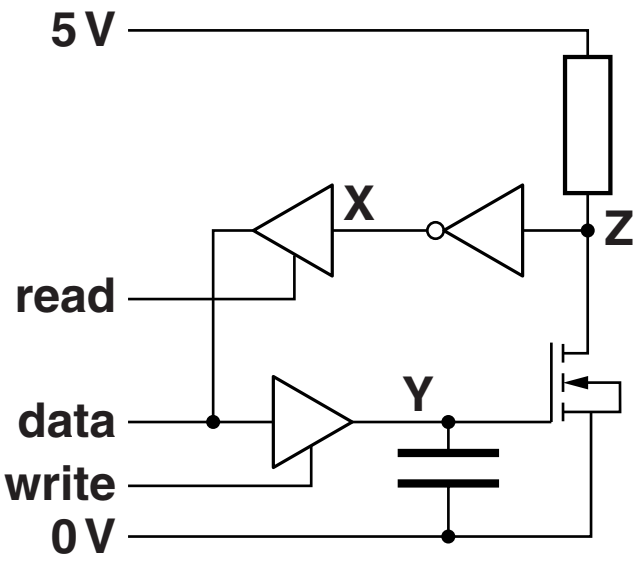
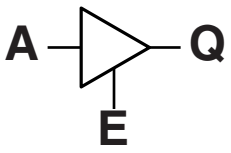


Fig. 1.1

(a) The memory cell uses tri-states. Complete the truth table for one of the tri-states.



A	E	Q
0	0	High impedance

[4]

(b) State why a tri-state is used in Fig. 1.1 to connect X to the data-bus.

_____ **[1]**

(c) Explain how the components in the memory cell can be used to store a 1. Your answer should include the sequence of signals at read, data and write.

_____

_____

_____

_____ **[5]**

(d) Explain how the components in Fig. 1.1 allow the 1 to be read at a later time.

_____

_____

_____

_____ **[3]**

[Total: 13]

2 Fig. 2.1 shows an op-amp circuit to control the brightness of a bulb.

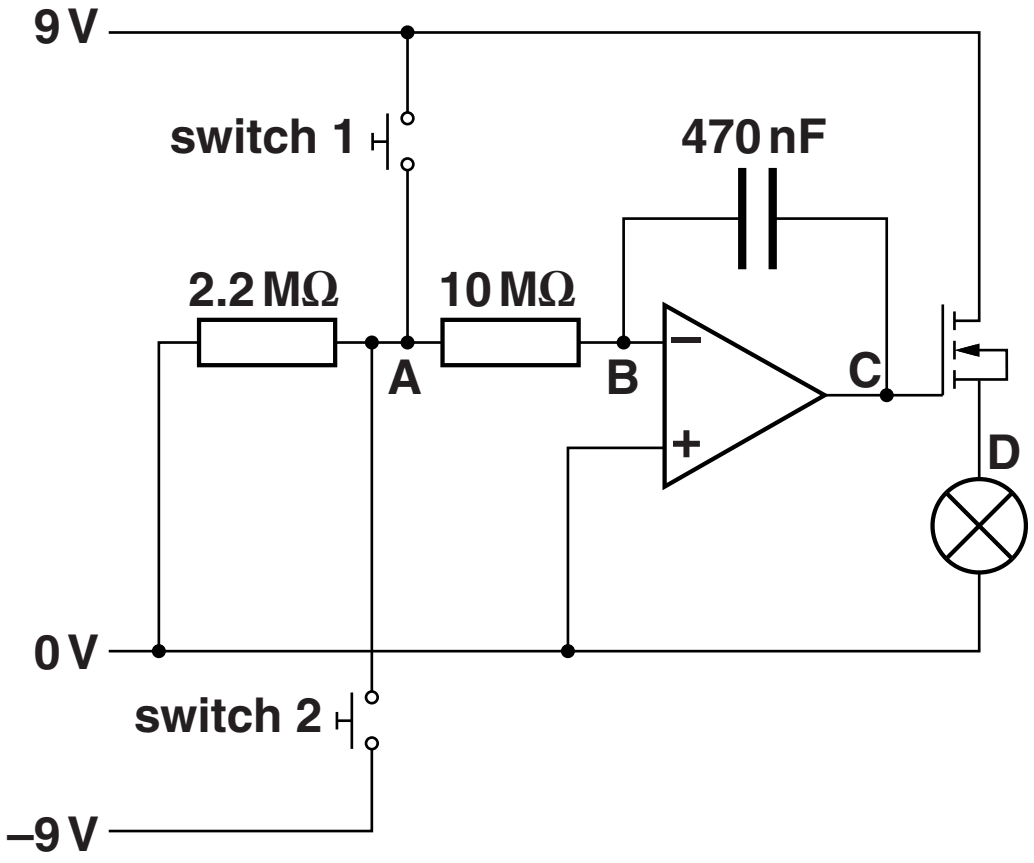


Fig. 2.1

(a) Put a ring around the type of op-amp circuit in Fig. 2.1.

difference amplifier

non-inverting amplifier

ramp generator

voltage follower

[1]

(b) Explain how the circuit works by filling in the gaps using the words below. Each word or phrase can be used once, more than once or not at all.

constant	immediately negative	increasing
decreasing	immediately positive	zero

When the circuit is first turned on, the voltage at C is 0V.

When switch 2 is pressed the voltage at A is

_____ which means that the voltage

at C is _____ and the brightness of

the lamp is _____ .

Then no switches are pressed. The voltage at

A is _____ and the voltage at B is

_____ which means that the voltage

at C is _____ . [6]

(c) Sometime after the start the voltage at C is 5V. Switch 1 is then pressed for 2 s. Calculate the voltage at C.

Voltage = _____ V [4]

[Total: 11]

3 Fig. 3.1 shows the block diagram of a switched mode power supply.

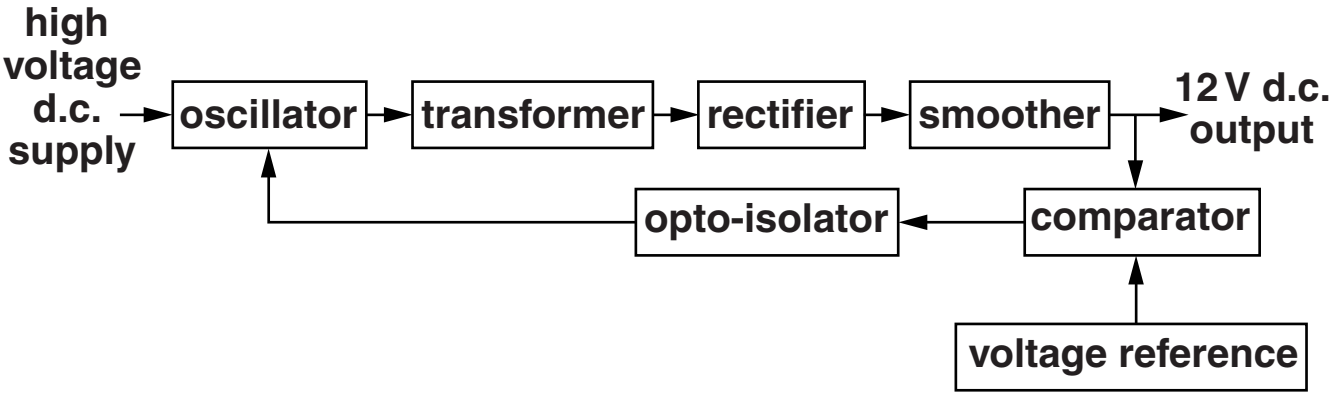


Fig. 3.1

(a) The system in Fig. 3.1 is a closed-loop control system.
State how the block diagram shows this.

_____

_____ [1]

(b) Explain the advantage of using closed-loop systems over open-loop systems.

_____

_____

_____ [2]

(c) Complete Fig. 3.2 by drawing the circuit diagram of the rectifier and smoother part of the switched-mode power supply.

[3]

Fig. 3.2

(d) By stating the two components in an opto-isolator explain how it works.

_____

_____

_____

_____ [4]

(e) Explain why the opto-isolator is used in the switched mode power supply.

_____

_____

_____ [3]

(f) Fig. 3.3 shows the voltage reference and comparator of the switched mode power supply. The output of the comparator saturates at +12V and 0V.

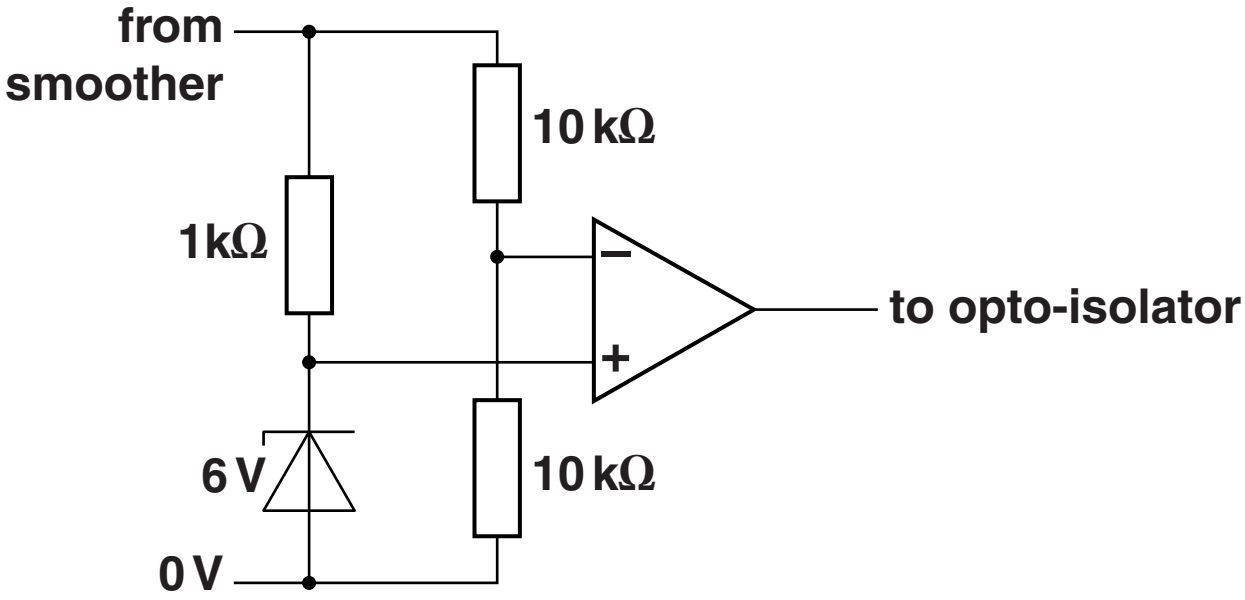
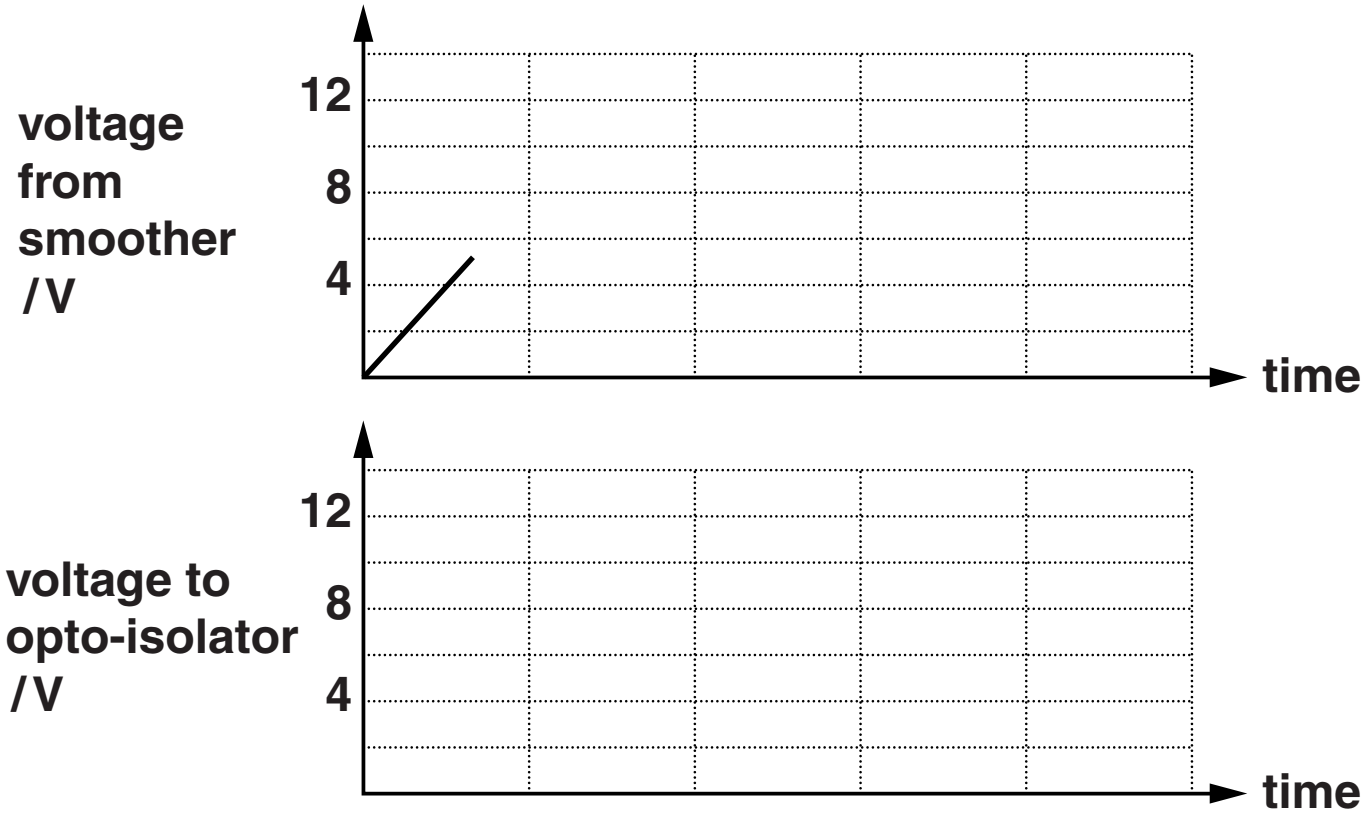


Fig. 3.3

Complete the graphs on the facing page to show how the voltage from the smoother and the voltage from the comparator vary with time after the power supply is turned on.



[6]

(g) Suggest why a 12V zener diode was not used in the comparator and voltage reference circuit.

_____

_____ **[2]**

[Total: 21]

4 Fig. 4.1 on a loose sheet shows the circuit and main program for controlling an electric hand drier.

(a) Use the first two lines of the main program to explain how the hand drier shows that it is ready to operate when it is first turned on.

_____

_____

_____ **[3]**

(b) The subroutine 'dry' turns on the motor & heater driver and the blue LED. Write the code for the subroutine dry. Use the microcontroller instructions on the loose sheet.

dry: _____

_____

_____ **[4]**

(c) The first two lines of the subroutine 'check' tests if the system has overheated. Complete the subroutine below.

```
check:  MOVI   S0,    _____
        IN     S1,    I
        AND    S0,    S1

        _____  _____________
        RCALL fault
skip:   RET
```

[3]

(d) Explain how the subroutine 'fault' works and describe what it does to the outputs.

```
fault:   MOVI    S4,  00
         MOVI    S5,  01
stop:    OUT     Q,   S4 _____

         EOR     S4,  S5 _____

         MOVI    S7,  64 _____

repeat:  RCALL   wait1ms _____

         DEC     S7      _____

         JNZ     repeat  _____

         JP      stop    _____
```

Description of the effect on the outputs: _____

_____

_____ **[9]**

(e) The program for controlling the hand drier uses subroutines.

(i) State two advantages of using subroutines when writing programs.

_____

_____

_____ **[2]**

(ii) Describe what happens to the program counter and the stack pointer when the microcontroller executes the RET function/ returns from a subroutine.

_____

_____

_____

_____ **[3]**

(f) State and explain what happens to the output devices of Fig. 4.1 when the switch is pressed and released.

_____

_____

_____

_____ **[3]**

[Total: 27]

5 Fig. 5.1 shows the circuit for an amplifier built by a teacher.

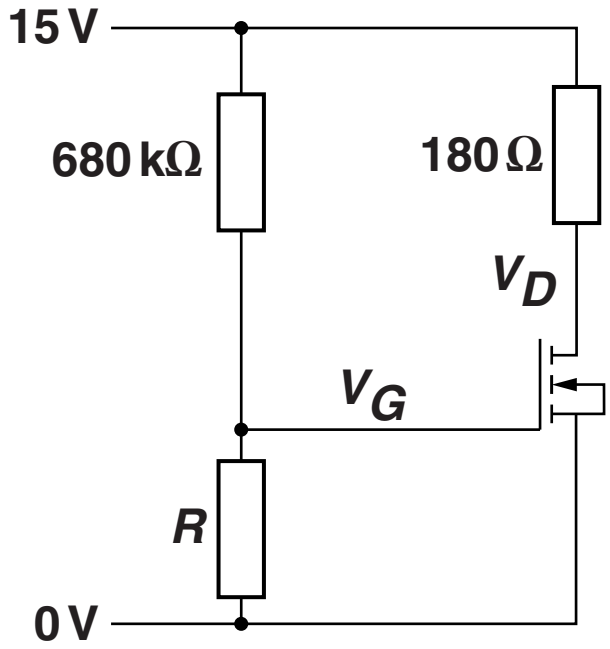


Fig. 5.1

(a) Draw on Fig. 5.1 to show how two capacitors can be added to the circuit to connect a.c. input and output circuits. Label the input and the output. [4]

(b) Calculate the value of the resistor *R* to make the voltage V_G = 3V.

R = _____ kΩ [3]

(c) The graph in Fig. 5.2 shows I_{DS} against V_{GS} for the MOSFET in Fig. 5.1.

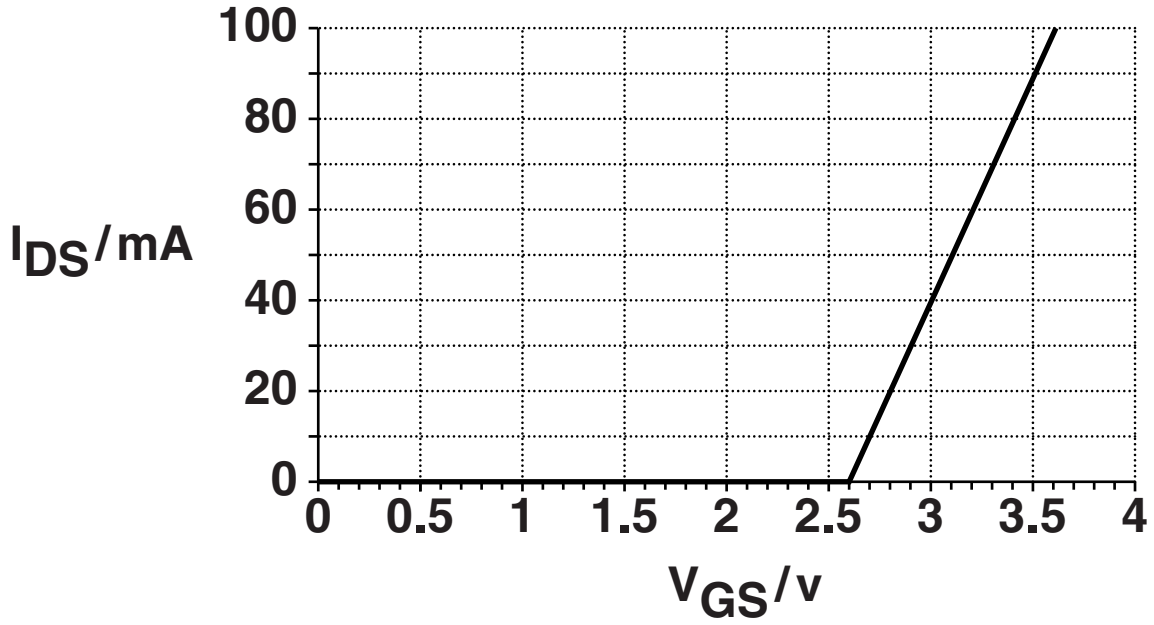


Fig. 5.2

Use information from the graph in Fig. 5.2 to show that the voltage V_D is about half the supply voltage.

_____

_____

_____ [3]

(d) Suggest why the circuit has been designed to have V_D at this value.

_____

_____

_____ **[2]**

(e) Use the graph in Fig. 5.2 to find the threshold voltage of the MOSFET.

MOSFET threshold voltage = _____ **V [1]**

(f) Use the graph to calculate the gain of the amplifier.

gain = _____ **[4]**

(g) A student accurately builds a copy of the teacher's circuit in Fig. 5.1 using new components. The circuit does not work well as an amplifier. When the student tests their circuit they find that V_D = 1 V. Suggest why the student's circuit is not operating in the same way as the teacher's circuit.

_____

_____

_____ **[3]**

(h) Draw a MOSFET amplifier design that could be copied and would still work well. You do not need to show component values.

[2]

[Total: 22]

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6 Fig. 6.1 shows an 8 × 2 bit memory module.

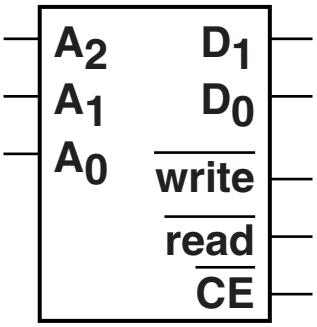


Fig. 6.1

(a) State the number of memory cells there are in this 8 × 2 bit memory module.

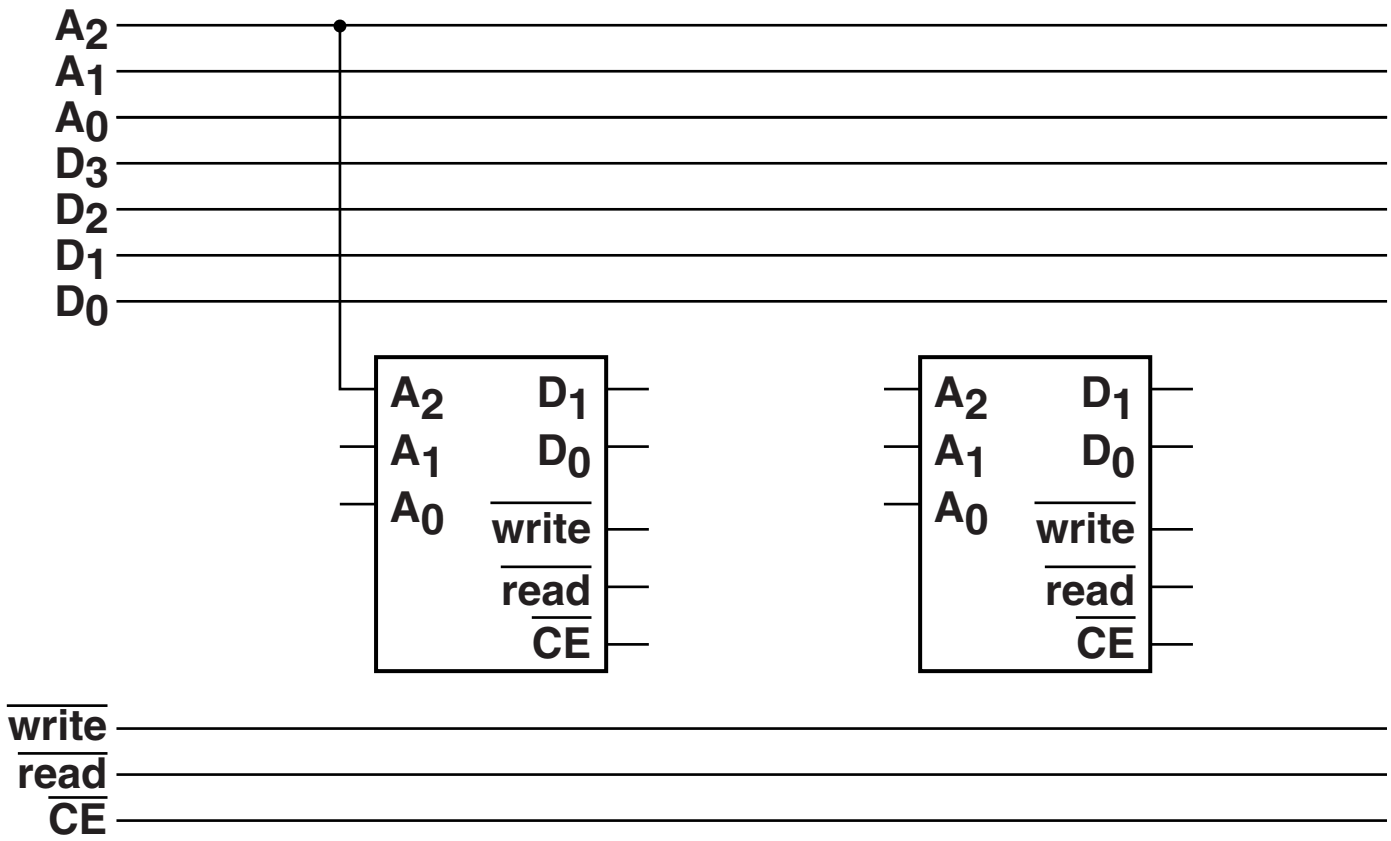
_____ [1]

(b) Explain why an 8 × 2 bit memory module has three address lines (A_0, A_1 and A_2) and two data lines (D_0 and D_1).

_____

_____ [2]

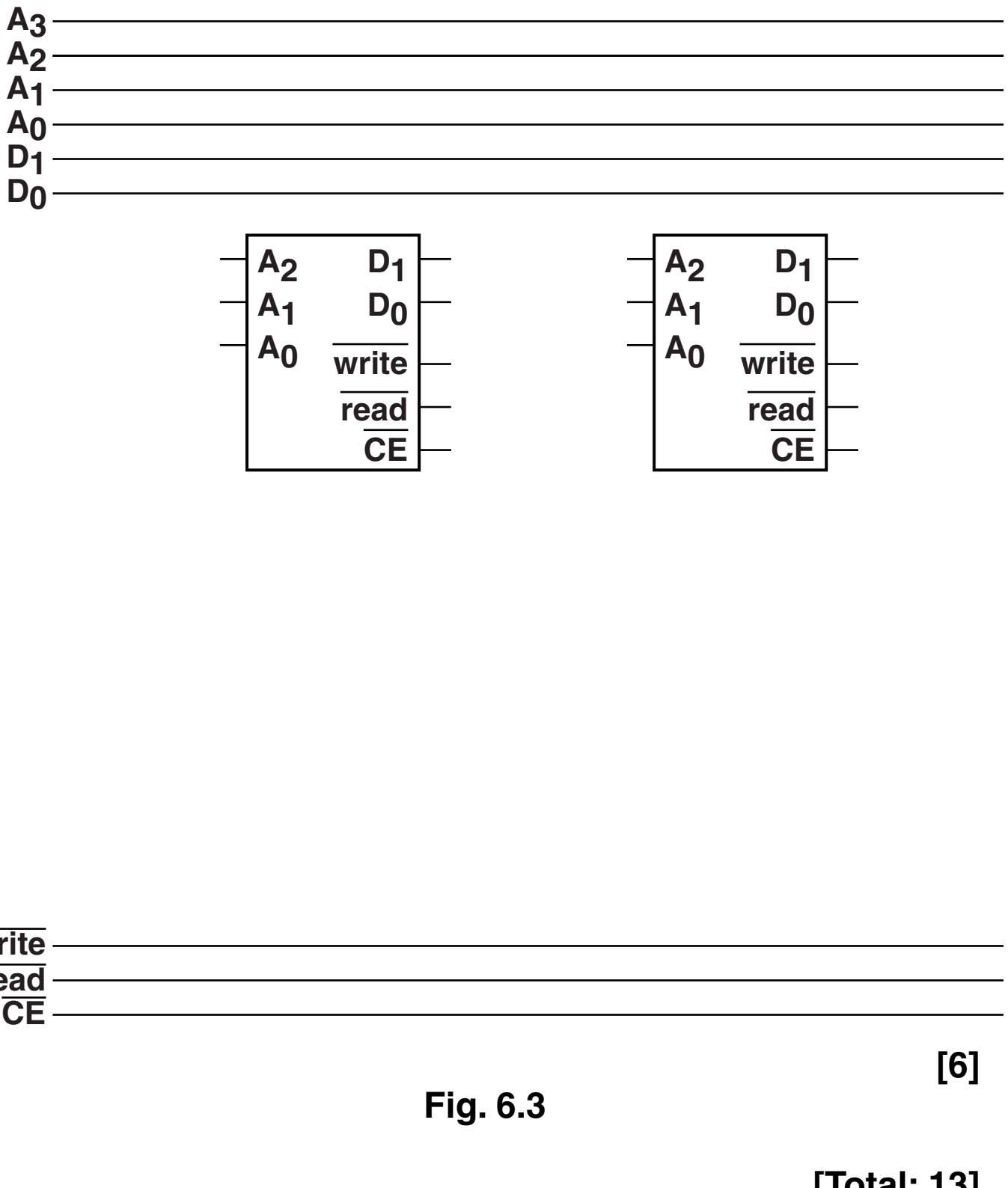
(c) Complete the diagram in Fig. 6.2 to show how two of these 8 × 2 memory modules can be combined to make a 8 × 4 bit memory.



[4]

Fig. 6.2

(d) Complete the diagram in Fig. 6.3 to show how two of these 8 × 2 memory modules can be combined to make a 16 × 2 bit memory.



[6]

Fig. 6.3

[Total: 13]

Quality of Written Communication [3]

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