VCE VET ELECTROTECHNOLOGY

Written examination

Thursday 8 November 2007

Reading time: 9.00 am to 9.15 am (15 minutes)
Writing time: 9.15 am to 10.45 am (1 hour 30 minutes)

QUESTION AND ANSWER BOOK

Structure of book

<table>
<thead>
<tr>
<th>Section</th>
<th>Number of questions</th>
<th>Number of questions to be answered</th>
<th>Number of marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>B</td>
<td>11</td>
<td>11</td>
<td>80</td>
</tr>
<tr>
<td></td>
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<td>Total 100</td>
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</table>

• Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners, rulers, one scientific calculator.
• Students are NOT permitted to bring into the examination room: blank sheets of paper and/or white out liquid/tape.

Materials supplied
• Question and answer book of 23 pages including a formula sheet on page 23.
• Answer sheet for multiple-choice questions.

Instructions
• Write your student number in the space provided above on this page.
• Check that your name and student number as printed on your answer sheet for multiple-choice questions are correct, and sign your name in the space provided to verify this.
• All written responses must be in English.

At the end of the examination
• Place the answer sheet for multiple-choice questions inside the front cover of this book.

Students are NOT permitted to bring mobile phones and/or any other unauthorised electronic devices into the examination room.

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SECTION A – Multiple-choice questions

Instructions for Section A

Answer all questions in pencil on the answer sheet provided for multiple-choice questions. Choose the response that is correct or that best answers the question. A correct answer scores 1, an incorrect answer scores 0. Marks will not be deducted for incorrect answers. No marks will be given if more than one answer is completed for any question.

Question 1
How many individual cells are contained in a standard 12 volt lead-acid battery?
A. 2
B. 6
C. 8
D. 10

Question 2

What is the name of the device represented by the symbol above?
A. potentiometer
B. thermistor
C. light-dependent resistor
D. fusible link

Question 3

What is the name of the device represented by the symbol above?
A. single pole switch
B. opto-coupler
C. diode
D. transistor
Question 4

The light-dependent resistor LDR1 in Figure 1a has the resistance characteristic shown in Figure 1b. If the light intensity falling upon LDR1 increases, the voltage across R1 will

A. increase.
B. become negative.
C. decrease.
D. equal 0 V.

Question 5

A remote-controlled model electric racing car is powered by rechargeable batteries. Under acceleration, the motor draws up to 1.0 amp. If the car is operated for an average of one hour per week over a 12-month period, the most suitable type of battery for this application is

A. sealed lead acid.
B. carbon zinc.
C. alkaline.
D. nickel metal hydride.

Question 6

The main reason for fitting a residual current detector (RCD) to a switchboard is to

A. protect people from possible electrocution.
B. protect the circuit wiring against the effects of excessive fault currents.
C. balance the current being drawn by the active and neutral conductors.
D. remove earth leakage currents.

Question 7

Before disassembling mains-powered computer equipment, you should ensure that

A. one of your hands is touching the equipment case at all times.
B. one of your hands is behind your back at all times.
C. all test equipment is effectively earthed.
D. the equipment is unplugged from the power outlet.
Question 8
A metal object inside a piece of equipment becomes loose and makes contact between the mains active conductor and the earthed metal case.
What is the most likely consequence?
A. The equipment will continue to operate.
B. The switchboard circuit breaker will immediately activate.
C. The equipment will stop working but the circuit breaker will not activate.
D. The neutral wire will provide a bypass circuit for the fault current.

Question 9
To provide personal protection against electric shock, double-insulated portable power tools rely on
A. motor winding resistance opposing fault current.
B. the switchboard fuse blowing before the fault current is harmful.
C. insulation layers blocking fault currents to the operator.
D. effective earthing offering a low resistance path for fault currents.

Question 10
Which truth table summarises the logical operation of gate 1?

A. B. C. D.

<table>
<thead>
<tr>
<th>X</th>
<th>Y</th>
<th>Z</th>
<th>X</th>
<th>Y</th>
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<th>X</th>
<th>Y</th>
<th>Z</th>
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<th>Y</th>
<th>Z</th>
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</tbody>
</table>

Question 11
What is the base number of the hexadecimal number system?
A. 2
B. 8
C. 16
D. 60

Question 12
The term BIOS, when related to a PC operating system, is used to describe
A. firmware code run when the PC is first powered on.
B. application software installed on the PC.
C. hardware code programmed into the CPU chip and executed on system boot-up.
D. a BASIC software interpreter installed on the system board.
Question 13
Which one of the following memory types is volatile?
A. ROM
B. Flash
C. RAM
D. EPROM

Question 14
What type of capacitor is shown above?
A. electrolytic
B. ceramic
C. polystyrene
D. polyester

Question 15
A resistor has coloured bands as shown above.
What is the value of the resistor?
A. 2 k7
B. 4 k7
C. 270 k
D. 470 k
Question 16

Given the primary turns, secondary turns and input voltage shown above, what is the output voltage?

A. 3.75 V  
B. 30.0 V  
C. 120 V  
D. 1.92 kV

Use the following information to answer Questions 17–20.

The voltage waveform across the load resistor R1 in Figure 3a is shown in Figure 3b.

Figure 2

Figure 3a

Figure 3b
Question 17
The name of the rectifier circuit in Figure 3a is a
A. half-wave rectifier.
B. capacitive rectifier.
C. full-wave bridge rectifier.
D. centre tapped full-wave rectifier.

Question 18
The appropriate voltage rating for capacitor C1 is
A. 11 V
B. 13 V
C. 15 V
D. 25 V

Question 19
The frequency of the 240 V input voltage is
A. 120 Hz
B. 60 Hz
C. 50 Hz
D. 30 Hz

Question 20
What is the most likely consequence if the load resistor R1 becomes a short circuit?
A. The load voltage will equal 15 V.
B. Capacitor C1 may overheat.
C. The fuse will blow.
D. The output voltage will rise.
SECTION B

Instructions for Section B

Answer all questions in the spaces provided.
State all formulas and calculations.
All units must be specified in the answers.

Question 1

Refer to the circuit in Figure 4.

a. Calculate the current through R2 when switch S1 is open (as shown).

b. Calculate the voltage across R1 when switch S1 is open (as shown).
c. What is the current through R1 when switch S1 is closed?

______________________________________________________________________________

1 mark

d. Determine the current through R2 when switch S1 is closed.

______________________________________________________________________________

______________________________________________________________________________

______________________________________________________________________________

2 marks

Question 2

Figure 5

The resistance–force characteristic of a strain gauge is displayed in Figure 5.

a. What is the resistance of the strain gauge when zero force is applied?

______________________________________________________________________________

1 mark

b. What is the applied force when the strain gauge resistance is 360 ohm?

______________________________________________________________________________

1 mark

c. State the approximate range of applied forces over which the resistance varies linearly.

______________________________________________________________________________

1 mark
Question 3

a. Determine the approximate peak-to-peak voltage of the signal on the oscilloscope display.

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

2 marks
b. Determine the frequency of the signal on the oscilloscope display.

3 marks

c. What is the approximate peak-to-peak voltage of the signal from the microphone?

1 mark

d. What is the frequency of the signal from the microphone?

1 mark
Question 4

a. List three dangers associated with the incorrect handling of batteries. For each danger, explain one possible effect it may have on personnel.

<table>
<thead>
<tr>
<th>Danger</th>
<th>Explanation of effect on personnel</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

6 marks

b. The microcontroller circuit in Figure 7 requires a supply of 3.0 volts. Draw the appropriate connections between the cells and the microcontroller PCB. All cells are to be used. Draw your connection lines on Figure 7.

Figure 7

2 marks
**Question 5**

An insulated box was recently removed from a refrigerator. Measurements of the interior temperature of the box were taken as the box was warmed by the surrounding air. A plot of the interior temperature of the box against time is shown in the graph of Figure 8b.

**Figure 8a**

**Figure 8b**

**a.** You are required to design an electric circuit that models the thermal system described above. The maximum voltage in your model circuit is limited to +5 V. Complete the circuit in Figure 8c to show your design.

**Figure 8c**

3 marks

**b.** Show on Figure 8c where the oscilloscope input lead should be connected to the circuit in order to display a voltage graph similar to Figure 8b.

1 mark

**c.** If the voltage waveform takes 15 minutes to reach the battery voltage, determine the time constant of the circuit.

2 marks
Question 6

The component-side view of a printed circuit board layout is shown in Figure 9.

a. Complete the schematic diagram for this circuit board on the diagram below.

b. Explain the function of BR1.
c. Name the component IC1.

_________________________________________________________________________

1 mark

d. Explain the function of component IC1.

_________________________________________________________________________

_________________________________________________________________________

2 marks

e. IC1 is found to be failing due to overheating under operational conditions. Identify two strategies that could be implemented to overcome this problem.

_________________________________________________________________________

_________________________________________________________________________

_________________________________________________________________________

2 marks
Question 7
The boom gate on a car park entrance is controlled by a microcontroller system as shown in Figure 10.

The system consists of the following hardware components.
1. microcontroller
2. inground loop vehicle sensor
3. boom motor to raise and lower boom
4. boom up limit switch
5. boom down limit switch
6. ID-card bar code reader

The operating sequence is summarised in the flow chart shown.

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SECTION B – Question 7 – continued
a. The presence of a vehicle is detected by the loop sensor. What actions must occur and what condition(s) must be met before the boom gate goes to the up position?

b. The boom up limit switch fails. As a result, the microcontroller does not receive a signal to indicate the boom has reached the up position. What effect does this fault have on the operation of the boom gate?

c. To allow vehicles to leave the car park via the boom gate, what additional hardware is required and where might it be located?

Additional hardware

Location

3 marks

2 marks

2 marks
**Question 8**

A farmer wants an electronic system that will turn on a heater in his barn if the temperature at night falls below 6°C.

**a.** The truth table below summarises the operating conditions of the farmer’s barn. Complete the truth table shown below.

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Time of day</th>
<th>Heater</th>
</tr>
</thead>
<tbody>
<tr>
<td>Logic 0 = below 6°C</td>
<td>Logic 0 = night-time</td>
<td>Logic 0 = heater off</td>
</tr>
<tr>
<td>Logic 1 = equal to or above 6°C</td>
<td>Logic 1 = daytime</td>
<td>Logic 1 = heater on</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>1</td>
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<td>1</td>
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</tbody>
</table>

**b.** Name the logic gate that can perform this logical function.

**c.** Draw the logic symbol of the gate that can perform this logic function.

4 marks

1 mark

1 mark
Question 9

Analogue to digital converters (ADCs) and digital to analogue converters (DACs) are used in many digital devices and systems; for example in the sound card of a PC. A sound card converts analogue audio signals into digital data and digital data into analogue audio signals.

a. Other than the sound card in a PC, state two systems or devices that use a DAC.

b. Other than the sound card in a PC, state two systems or devices that use an ADC.

c. State the number of output codes possible from an 8-bit ADC.

d. Name the connection interface which is most commonly used when interfacing an MP3 player to a PC.
Question 10

ASCII code chart

<table>
<thead>
<tr>
<th>byte 1</th>
<th>byte 2</th>
<th>byte 3</th>
<th>byte 4</th>
<th>byte 5</th>
<th>byte 6</th>
<th>byte 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>01001000</td>
<td>01000101</td>
<td>01001100</td>
<td>01010000</td>
<td>00100000</td>
<td>01101101</td>
<td>01000101</td>
</tr>
</tbody>
</table>

The data bytes 1–7 listed above represent a message in ASCII code.

a. State the character represented by byte 1.

b. State the character represented by byte 6.

c. Determine the decimal value of byte 7.

d. Express the number 927 in BCD (binary coded decimal).
**Question 11**

By accessing the device manager on a PC you may view details of devices used by a personal computer.

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### a. Name an external device that may be connected to a NIC adaptor.

1 mark

### b. What is the purpose of a NIC adaptor?

2 marks

### c. What does I/O stand for?

1 mark
d. What is meant by the term ‘device conflict’?

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

2 marks

e. How many memory locations are used by this device?

________________________________________________________________________

________________________________________________________________________

2 marks
\[ R_T = R_1 + R_2 + R_3 \]

\[ \frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \]

\[ V = I \times R \]

\[ P = V \times I \]

\[ Q = C \times V \]

\[ V_{PK} = \sqrt{2} \times V_{RMS} \]

Turns ratio \( = \frac{N_1}{N_2} \)

\[ \frac{V_{primary}}{V_{secondary}} = \frac{N_{primary}}{N_{secondary}} \]

\[ V_{REG} = V_{IN} - V_{OUT} \]

Time constant \( \tau = R \times C \)

Time constant \( \tau = \frac{L}{R} \)

\[ f = \frac{1}{T} \]