Published

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Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

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Question | Answer | Marks
--- | --- | ---
1(a) | ![Diagram](attachment://diagram.png) | 1

Three lines with arrows – one from each device to switch

1(b) | **Statement** | **True** | **False**
--- | --- | --- | ---
The server can send packets to Computer B and Computer C at the same time. | ✓ | 1
The network software on each computer needs to include collision detection and avoidance. | ✓ | 1
Computer B can read the packet sent from the server to Computer C. | ✓ | 1
Computer A can send a packet to Computer B and at the same time the server can be sending a packet to Computer C. | ✓ | 1

1(c)(i) | **Device:** **Server**
The server can provide a (software) firewall // The server can check all internet traffic // Server acts as proxy
**Device:** **Switch**
Internet traffic by passes the server // Server not overloaded with internet traffic // connected to all computers | 1 mark for device, 1 mark for suitable reason

1(c)(ii) | • Router acts as gateway
• Router acts as a firewall
• The LAN and the Internet are two different networks
• (may) operate on different protocols
• Router forwards packets between networks
• Router has a public IP address
• Router holds a list of local addresses
• Router translates local addresses to Internet (IP) addresses (and vice versa) | 1 mark for each point, max 2

1(c)(iii) | • Each packet has the IP address of the web server / destination address
• The routers use routing tables
• Routers on the Internet forward packets towards destination
• Packets can take different routes from source to destination
• Packets are reassembled in order at the web server | 1 mark for each point, max 3
### Question 2(a)

<table>
<thead>
<tr>
<th>Description</th>
<th>Computer architecture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Most parallel computer systems use this architecture.</td>
<td>SIMD</td>
</tr>
<tr>
<td>Widely used to process 3D graphics in video games.</td>
<td>MIMD</td>
</tr>
<tr>
<td>A microprocessor is used to control a washing machine.</td>
<td>MISD</td>
</tr>
<tr>
<td>There are a number of processing units. Each processing unit executes the same instruction but on different data.</td>
<td>SISD</td>
</tr>
</tbody>
</table>

1 mark for each correct line

### Question 2(b)

- Only one (separate) processor / not many separate processors (is not massively parallel) 1
- Quad core computer system // processing units share the same bus 1

1 mark for each point, max 2

### Question 2(c)

- Split into blocks of code …
- … that can be processed simultaneously …
- … instead of sequentially
- Each block is processed by a different processor
- which allows each of the many processors to simultaneously process the different blocks of code independently
- Requires both parallelism and co-ordination

1 mark for each point, max 2

### Question 2(d)

1 mark for identification of hardware issue, for example:
- Communication between the different processors is the issue

1 mark for further explanation from:
- Each processor needs a link to every other processor
- Many processors require many of these links
- Challenging topology

2
<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>3(a)(i)</td>
<td>There should be a colon before the '=&quot; sign</td>
<td>1</td>
</tr>
<tr>
<td>3(a)(ii)</td>
<td>The second operand should be an unsigned integer and not a variable</td>
<td>1</td>
</tr>
<tr>
<td>3(a)(iii)</td>
<td>A32 is not a variable, as a variable should be a letter followed by a single digit</td>
<td>1</td>
</tr>
</tbody>
</table>

3(b)

```latex
<assignment_statement> ::= <variable> :=
<variable> <operator> <unsigned_integer>
<variable> ::= <letter> <digit>
<unsigned_integer> ::= <digit> | <digit> <unsigned_integer>
<letter> ::= A | B | C
<operator> ::= + | - | * | ^
```

3(c)

<table>
<thead>
<tr>
<th></th>
<th>Variable</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Letter</td>
</tr>
<tr>
<td></td>
<td>Digit</td>
</tr>
</tbody>
</table>

Syntax diagram shows one or two letters 1
Syntax diagram shows zero, one or two digits 1

3(d)

```latex
<assignment_statement> ::= 1
<variable> ::= <variable> <operator> <real> 1
<real> ::= <unsigned_integer> . <unsigned_integer> 1
```
<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
<th>Marks</th>
</tr>
</thead>
</table>
| 4(a)(i)  | A (known) set of rules  
Agreed/standard method for data transmission // governs how two devices communicate | 1 |
|          | Max 2 marks for purpose:  
• Purpose of TLS is to provide for secure communication (over a network)  
• maintain data integrity  
• additional layer of security  
Max 2 marks for further explanation from:  
• TLS provides improved security over SSL  
• TLS is composed of two layers / record protocol and handshake protocol  
• TLS protects this information by using encryption  
• Also allows for authentication of servers and clients | Max 3 |
| 4(b)     | The client validates (the server’s) TLS Certificate  
The client sends its digital certificate (to the server if requested)  
Client sends an encrypted message to the server using the server’s public key  
The server can use its private key to decrypt the message …  
…. and get data needed for generating symmetric key  
Both server and client compute symmetric key (to be used for encrypting messages) // session key established  
The client sends back a digitally signed acknowledgement to start an encrypted session  
The server sends back a digitally signed acknowledgement to start an encrypted session | 3 |
| 4(c)     | Applications, for example:  
• online banking  
• private email  
• online shopping  
• online messaging etc. | 2 |

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
<th>Marks</th>
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</thead>
<tbody>
<tr>
<td>5(a)(i)</td>
<td></td>
<td>1</td>
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<tr>
<td>Question</td>
<td>Answer</td>
<td>Marks</td>
</tr>
<tr>
<td>----------</td>
<td>--------</td>
<td>-------</td>
</tr>
<tr>
<td>5(a)(ii)</td>
<td><img src="image" alt="Truth Table" /></td>
<td>1</td>
</tr>
<tr>
<td>5(b)(i)</td>
<td><img src="image" alt="State Transition Table" /></td>
<td>3</td>
</tr>
</tbody>
</table>
| 5(b)(ii) | - Q and \( \overline{Q} \) have same value  
- Q and \( \overline{Q} \) should be complements of each other  
- Flip-flop becomes unstable | 2 |
| 5(c)(i)  | ![J-K Flip-Flop Table](image) | 4 |
| 5(c)(ii) | - S-R flip-flop has an invalid combination of S and R // The S_R flip flop allows both Q and \( \overline{Q} \) to have the same value // S-R flip-flop inputs may arrive at different times  
- The J-K flip-flop does not allow for Q and \( \overline{Q} \) to have the same value // All four combination of values for J and K are valid // J-K flip-flop incorporates a clock pulse for synchronisation | 2 |
5(d)  
- A flip-flop can store either a 0 or a 1  
- Computers use bits to store data  
- Flip-flops can therefore be used to store bits (of data)  
- Memory can be created from flip-flops  

1 mark for valid point, max 2

6(a)(i)  
Control system

6(a)(ii)  
System is controlling devices // turns heaters on and off // use of actuators maintain the environment // makes use of feedback  

6(b)  
Computer/microprocessor  
... to process the sensor readings  
Analogue to digital convertor  
... Sensor produces analogue signal but processor requires digital data  
Digital to analogue convertor  
... Processor produces digital signal but actuator may require analogue signal  
Actuator  
... May be required to turn heater on or off  
1 mark for device, 1 mark for justification, max 2 devices

6(c)(i)  
One mark per column excluding LOWTEMP

<table>
<thead>
<tr>
<th>LOWTEMP</th>
<th>LOWREG</th>
<th>COUNTER</th>
<th>ACC</th>
<th>IX</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>B00000000</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>17</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
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<td>2</td>
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<td>2</td>
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<tr>
<td></td>
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<td></td>
<td>14</td>
<td></td>
</tr>
<tr>
<td></td>
<td>B00000000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>B00000010</td>
<td>B00000010</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

6(c)(ii)  
- COUNTER has an initial value of 1  
- Test for final value is before COUNTER updated  
- COUNTER is doubled in value each time around loop  
- six sensors values/bits to check  
- COUNTER is doubled in value 6 times // $2^5$  
- Values of COUNTER at test will therefore be 1 – 2 – 4 – 8 – 16 – 32  

1 mark for valid point, max 2
<table>
<thead>
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<th>Question</th>
<th>Answer</th>
<th>Marks</th>
</tr>
</thead>
</table>
| 6(c)(iii)  | • Load the contents of **LOWREG** into **ACC**  
  • Check bit position in **LOWREG**  
  • For each of the least significant 6 bits  
  • Use **AND** operation / mask to isolate a bit  
  • Jump to code corresponding to bit being looked at  
  • if value of bit is 1  
  • Send signal to appropriate actuator to turn on the heater  
  ![1 mark for valid point, max 3](image1.png) | 3     |