

## Mock Major Quiz 2 (Weeks 7, 8, 9)

Total questions: 16

Unless stated otherwise, each question is worth 1 mark.

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### Question 1 (short answer)

You need to send the ASCII string

Hello\r

over a TCP connection using

```
array<unsigned char>^ SendData =  
    System::Text::Encoding::ASCII->GetBytes("Hello\r");
```

Give the hexadecimal values of the bytes that will be placed in `SendData`, **excluding** the terminating null character.

Write them in order, separated by spaces.

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### Question 2 (short answer)

The command sent from the external laptop to the UGV internal computer has the format

```
# <steer> <speed> <flag> #
```

where

- `<steer>` is between -40 and +40 degrees,
- `<speed>` is between -2 and +2 meters per second,
- both `<steer>` and `<speed>` are written with up to three digits after the decimal point,

- `<flag>` is a single character 0 or 1,
  - each `<spc>` is a single space, and
  - there is **no** newline at the end.
- Q7,8,9,10 part 2

Assuming the formatting uses a minus sign only for negative numbers and no leading plus sign, what is the **maximum possible number of bytes** in a single message?

Give your answer as a decimal integer.

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### Question 3 (multiple choice)

In your TCP client code on the UGV internal computer you create a connection to the Galil controller with

```
TcpClient^ Client = gcnew TcpClient("192.168.0.120", 23);
NetworkStream^ Stream = Client->GetStream();
```

From the point of view of the UGV internal computer, which description is correct?

- A. The Galil controller is a client and the UGV internal computer is a server.
  - B. The Galil controller is a server and the UGV internal computer is a client.
  - C. Both are servers.
  - D. Both are clients.
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### Question 4 (multiple choice)

Still from the UGV internal computer's point of view, which objects does it instantiate for network communication?

1. To connect to the Galil motion controller.
2. To accept incoming commands from the external laptop.

Choose the correct pair.

- A. (1) `TcpListener`, (2) `TcpClient`
  - B. (1) `TcpClient`, (2) `TcpListener`
  - C. (1) `TcpClient`, (2) `TcpClient`
  - D. (1) `TcpListener`, (2) `TcpListener`
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### Question 5 (multiple choice)

In the internal computer's software, the variable `IncomingClient` refers to:

Q7,8,9,10 part 2

- A. A connection request from the Galil motion controller.
  - B. A connection request from the external laptop.
  - C. A connection request from the LiDAR.
  - D. A connection request from the GNSS receiver.
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### Question 6 (short answer)

A binary data record is known to contain **two `double` values followed by two `float` values**, in that order. All values are transmitted in little endian form (least significant byte first).

What is the total length of this record in bytes?

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### Question 7 (short answer)

A certain binary data record coming from a sensor is 96 bytes long and records are streaming continuously. You first collect data into a serial port receive buffer and then scan it for complete records.

What is the **smallest receive buffer size** (in bytes) that guarantees that at least one complete 96 byte record will always be present in the buffer, no matter where record boundaries fall?

q7,8,9,10 part 1

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### Question 8 (short answer, code)

To detect the GNSS data header `0xAA 0x44 0x12 0x1C` in a byte array `RecvData`, the following code fragment is used:

```
unsigned int Header = 0;    // 4 bytes
int i = 0;
int Start;

do
{
    unsigned char Data = RecvData[i++];
    Header = (Header << 8) ? Data;    // replace ? with the correct
operator
} while (Header != 0xAA44121C);

Start = i - 4;
```

What operator should replace `?` so that this code works as intended?

Give the operator only.

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### Question 9 (multiple choice, code)

You want to copy one complete GNSS record from `RecvData` into a structure `GNSS NovatelGNSS`. The code is

```
GNSS NovatelGNSS;
unsigned char* BytePtr = nullptr;
BytePtr = (unsigned char*)NovatelGNSS;

for (int i = Start; i < Start + sizeof(GNSS); i++)
{
    *(BytePtr++) = RecvData[i];
}
```

This program crashes. Which single change fixes the problem?

- A. Change `GNSS NovatelGNSS;` to `GNSS& NovatelGNSS;`.
- B. Change `BytePtr = (unsigned char*)NovatelGNSS;` to

BytePtr = (unsigned char\*)&NovatelGNSS;  
C. Change sizeof(GNSS) to sizeof(NovatelGNSS).  
D. Both B and C are required.

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### Question 10 (true or false)

Consider the structure used to store GNSS data (header excluded):

```
struct GNSS
{
    unsigned char Discards1[40];
    double Northing;
    double Easting;
    double Height;
    unsigned char Discards2[40];
    unsigned int Checksum;
};
```

Assume `#pragma pack(8)` is in effect and you copy the **112 bytes of GNSS data after the 4 byte header** directly into a `GNSS` object.

Statement: "This structure will store `Northing`, `Easting`, `Height` and `Checksum` at the correct locations."

Is this statement **True** or **False**?

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### Question 11 (short answer)

The following structure is defined with a packing boundary of 4:

```
#pragma pack(push,4)
struct Data
{
    double A;
    int    B;
    char   C;
};
```

```
#pragma pack(pop,4)
```

What is the size of `struct Data` in bytes?

How many bytes inside this structure are unused (padding)?

Give two decimal integers separated by a space:

```
<total_size> <unused_bytes>
```

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### Question 12 (short answer)

Another structure is defined with a packing boundary of 8:

```
#pragma pack(push,8)
struct Data2
{
    char  A;
    double B;
    int   C;
};
#pragma pack(pop,8)
```

1. What is the size of `Data2` in bytes?
2. How many bytes are unused near member `A`?
3. How many bytes are unused near member `C`?

Give three decimal integers separated by spaces in the order above:

```
<size> <unused_near_A> <unused_near_C>
```

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### Question 13 (short answer, LiDAR)

A partial SICK LMS151 LiDAR measurement message is decoded into a string and then split into `StringArray` using `Split(' ')` as in the lectures.

According to the manual and code given in the slides, which elements of `StringArray` contain the following values?

- Start angle
- Angular step width
- Number of range data points

Give your answer as three array indices in order, for example

10 11 12

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### Question 14 (short answer, LiDAR)

For one LMS151 configuration the three relevant fields in the `LMDscandata` string are

- Start angle field: 0 (hex)
- Angular step width field: 1388 (hex)
- Number of data points field: 169 (hex)

The angle fields are given in units of  $1/10000$  of a degree.

Compute:

1. The angular resolution between consecutive range measurements in degrees.
2. The starting angle in degrees.
3. The angle corresponding to the final range measurement.

Give your three answers as decimal numbers (not hexadecimal), separated by spaces.

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### Question 15 (multiple choice, quadcopter)

Ignore gravity compensation. A positive **roll** motion is applied to a quadcopter (using the convention from the lecture slides). What motion will the quadcopter exhibit?

Week 9 Slides-updated

- A. Move horizontally to the right (viewed from behind) while maintaining height.
  - B. Move horizontally to the left (viewed from behind) while maintaining height.
  - C. Move to the left (viewed from behind) and descend.
  - D. Move to the right (viewed from behind) and descend.
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### Question 16 (short answer, quadcopter control)

Complete the following description using the correct physical quantity for each controller:

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- The **height** controller contributes to a net \_\_\_\_\_.
- The **roll** controller contributes to a net \_\_\_\_\_.
- The **pitch** controller contributes to a net \_\_\_\_\_.
- The **yaw** controller contributes to a net \_\_\_\_\_.

Each blank must be filled with either “force” or “torque about a specific axis”, expressed clearly (for example, “torque about body x axis”).

Write the four phrases in order, separated by semicolons.

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## Answer key

Do not look until you have attempted the questions.

1. 48 65 6C 6C 6F 0D
2. 20
3. B

4. B
5. B
6. 24
7. 192
8. Bitwise OR operator: |
9. B
10. True
11. 16 3
12. 24 7 4
13. 23 24 25
14. 0.5 0 180
15. D
16.
  - Height: net **force** along the vertical axis
  - Roll: **torque about body x axis**
  - Pitch: **torque about body y axis**
  - Yaw: **torque about body z axis**

If you want, next step I can turn this into a filled in LMS style quiz (for example with explicit answer boxes) or we can build a second variant for extra practice.