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# Model Solutions

## ENGR 101: Test 1

3 May, 2017

### Instructions

- Time allowed: **50 minutes**.
- Answer **all** the questions. There are 50 marks in total.
- Write your answers in the boxes in this test paper and hand in all sheets.
- If you think some question is unclear, ask for clarification.
- This test contributes 20% of your final grade.
- You may use paper translation dictionaries, and calculators.
- You may write notes and working on this paper, but make sure your answers are clear.

### Questions

### Marks

1. Little Man Computer (LMC) and Memory

[9]

2. Binary

[10]

3. Signals and ADC

[13]

4. Networking

[10]

5. Engineering Ethics

[8]

TOTAL:

**Question 1. Little Man Computer (LMC) and Memory****[9 marks]**(a) **[2 marks]** State the function of the **Result register** in the Little Man Computer (LMC).

The function of the register in the little man computer is to hold values hold values that the little man computer can transfer between different registers

(b) The following questions require you to interpret commands for the LMC.

i. **[2 marks]** State both the output of the code, and the memory address used to store the value of variable  $a$  in the following LMC code. If you do not have enough information to answer the question then explain what information you would need in order to answer it.

```
LDA a
OUT
HLT
a DAT 12
```

Output:  
12  
Memory Address:  
3

ii. **[2 marks]** State the output of the following code. If you do not have enough information to answer the question then explain what information you would need in order to answer it.

```
LDA a
SUB 98
OUT
HLT
a DAT 12
```

Output:  
Unclear because we also need to know the value of memory address 98 to perform the subtraction from 12

(c) **[3 marks]** Explain the difference between a program being 'compiled' and a program being 'executed'.

Compiling a program is checking a program, then converting it from human-readable machine code to assembly and then to binary. Executing a program is simply running it once it has been compiled

**Question 2. Binary****[10 marks]**

(a) [2 marks] Convert the decimal number 27 to an 8-bit unsigned binary number. Show your working.

00011011 (1 mark only for 11011 because it's not 8-bit)

(b) [2 marks] Convert the decimal number -27 to an 8-bit 2's complement binary number. Show your working.

11100101

(c) [2 marks] Add the 4-bit unsigned binary numbers, 5 and 6, together using binary arithmetic. Show your working clearly.

5: 0101, 6:0110, 11:1011

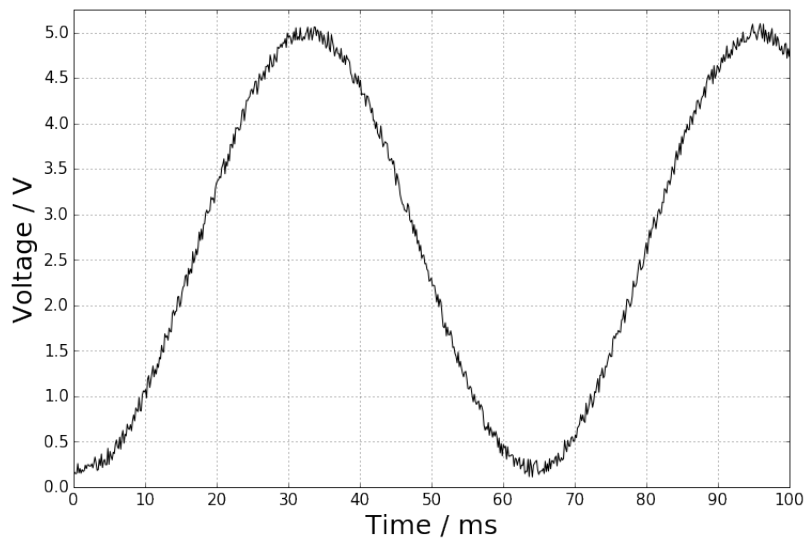
(d) [2 marks] State the relationship between binary addition and the logic gates AND and XOR.

AND gate gives the carry bits and XOR gate gives the sum bits.

(e) [2 marks] Bit shift the unsigned, 8-bit number 00011000 two places to the right. What does this do to the decimal value of that number?

Bit-shifted value:  
00000110 = 6

Effect of bit-shifting to the right on a decimal number:  
Each bit shift to the right divides the number in half.

**Question 3. Signals, ADC and PWM****[13 marks]**

(a) [4 marks] What value will an 8-bit ADC read at 50ms on the plot above? Show your working.

Number of values read by 8-bit ADC:

$$2^8 = 256$$

Smallest detectable voltage change (step height):

$$5/255 = 0.02 \text{ V (full marks for 256)}$$

ADC output from the signal at 50ms:

any of 2.20, 2.22, 2.24, 2.26, 2.28 or 2.30 - or some whole number multiple of 0.0196...

(b) [2 marks] Give a reason why the transmission of information via binary signals is preferable to transmission via analog signals in many cases.

Binary signals are less prone to noise errors because they can only adopt 2 values, ON or OFF. Binary signals also make use of error correcting codes. Computers also primarily communicate using binary signals.

(c) [3 marks] Blu-ray uses 24-bit audio captured at a rate of 44.1kHz. How much data will one second of uncompressed Blu-ray audio recording generate (in bytes)

3 bytes in 24 bits so :  $3 \times 44.1 \times 1000 = 132,300$  bytes. (assuming mono)

(d) [2 marks] What would the average voltage be on a pin with a 75% duty cycle on a 3.3V digital signal.

$0.75 \times 3.3 = 2.475V$

(e) [2 marks] On the RPi, how many bytes of memory will the following script use to store its variable values? (ignore any memory requirements contained within the (init()) function)

```
#include <stdio.h>
#include <time.h>
#include "E101.h"

int main(){
    init();
    int adc_reading;
    char d = 'x';
    adc_reading = read_analog(0);
    printf("%d\n",adc_reading);
    sleep(0,500000);
return 0;}
```

Show your working:

int = 4 bytes, char = 1 byte so total of 5 bytes (ignoring the int returned by the main method).

**Question 4. Networking**

**[10 marks]**

(a) **[1 mark]** State the major functional difference between a router and a switch.

Router allows inter-network traffic whereas switches are only intra-network traffic

(b) **[2 marks]** What is the difference between a MAC and an IP address? Why are both necessary?

Difference between MAC and IP:

One (MAC) is a unique identifier, the other (IP) is a variable address assigned by a network

Why both are necessary:

IP address follows geographic arrangement, whereas MAC addresses are randomly distributed. You need to IP to find the right location or network and MAC to find the right machine.

(c) **[2 marks]** Describe a situation when a switch would broadcast a message out through all of its ports.

If it received a broadcast packet, or if it received a packet aimed for a MAC address not in the switch's FIB

(d) **[2 marks]** TCP and UDP are two standard data transmission systems. State which of these two is more suited to SSH and HTTPS traffic and which is more suited to video and VoIP (Voice over IP) traffic. Justify your answers.

Transmission system for SSH and HTTPS:

TCP

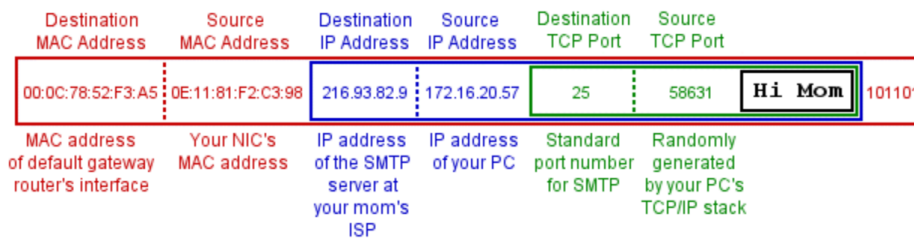
Transmission system for VoIP and video:

UDP

Explanation:

TCP ensures the correctness and completeness of transmission and is slower, UDP allows fast transmission but less accuracy and possibly out of order. It's ok to drop video or audio packets but not data packets for SSH or HTTP/S

**Outgoing E-mail Frame**



(e) [3 marks] The figure above shows an example of a wrapped SMTP packet. Why do packets have multiple layers in this fashion? Explain what each layer's function is in your answer.



Why are packets encapsulated this way?

Allows data to be broken up, sent separately through a network and reassembled at the other end. Packets are passed down through the layers in the IP stack to the physical layer where they are transmitted. Each layer provides one form of encapsulation and layers are unwrapped by specific parts of the network as the packet is transmitted.

Each layer represents:

Application, Transport, Network, Data link, Physical

**Question 5. Engineering Ethics****[8 marks]**

Throughout 2016, Facebook CEO Mark Zuckerberg fought widespread accusations that his social networking company propagated fake news. Some accusers went so far as to suggest this had an impact on the result of the 2016 American election. The following is an excerpt from a Guardian article about this. Read the article and then answer the questions on the following page.

...Currently, the truth of a piece of content is less important than whether it is shared, liked and monetized. These engagement metrics distort the media landscape, allowing clickbait, hyperbole and misinformation to proliferate. And on Facebook's voracious news feed, the emphasis is on the quantity of posts, not spending time on powerful, authoritative, well-researched journalism.

The more we click, like and share stuff that resonates with our own world views the more Facebook feeds us with similar posts. This has progressively divided the political narrative into two distinct filter bubbles one for conservatives and one for liberals ... pulling further and further apart in the run-up to election day...

"There is a cottage industry of websites that just fabricate fake news designed to make one group or another group particularly riled up," said Fil Menczer, a professor at Indiana University who studies the spread of misinformation. "These things are very hard to detect automatically if they are true or not," said Menczer. "Even professional fact-checkers cant keep up."...

According to Menczer's research there is a lag of around 13 hours between the publication of a false report and the subsequent debunking. That's enough time for a story to be read by hundreds of thousands if not millions of people. Within Facebook's digital echo chamber, misinformation that aligns with our beliefs spreads like wildfire, thanks to confirmation bias. "People are more prone to accept false information and ignore dissenting information, ... We are just looking for what we want to hear."

While it's human nature to believe what we want to hear, Facebook's algorithms reinforce political polarization. "You are being manipulated by the system [for falling for the fake news] and you become the perpetrator because you share it to your friends who trust you and so the outbreak continues" said Menczer.

Despite continually insisting that it is a neutral technology platform and not a media company, Facebook is all-too aware of the influence it has to drive footfall to the polling stations. Around 340,000 extra people turned out to vote in the 2010 US congressional elections because of a single election-day Facebook message, according to a study published in Nature.

So what should Facebook do? It's certainly not going to be easy. It has tried and failed to get a grip on the problem before, launching a tool to let users report false information in January 2015. (That ultimately failed because it relied on users, who turned out not to be very good at spotting fake news and also to falsely report a story as "fake" if they didn't agree with it.)...

- The Guardian, Nov 2016

Please, in your opinion, outline:

(a) **[4 marks]** Whether you believe it should be Facebook's responsibility to police news posted through their service (Please explain your answer).

[Answer to be discussed in lectures](#)

(b) **[4 marks]** Whether you believe a private company should control what news the public has access to. (Please explain your answer).

[Answer to be discussed in lectures](#)

**SPARE PAGE FOR EXTRA ANSWERS**

Cross out rough working that you do not want marked.  
Specify the question number for work that you do want marked.

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