

IY5512: Coursework 0: Worked solutions

1. *Convert 345 (in decimal representation) to binary and hexadecimal representations.*

$$345 = 256 + 64 + 16 + 8 + 1 = 2^8 + 2^6 + 2^4 + 2^3 + 2^0.$$

Hence 345 is 101011001 in binary.

Dividing the binary representation into groups of 4 bits, we have 1 0101 1001, and hence 345 is 159 in hexadecimal (0x159 or 159H).

2. *Convert FD4 (in hexadecimal) to binary and decimal representations.*

FD4 is 1111 1101 0100 in binary.

$$FD4 = 15 \times 16^2 + 13 \times 16^1 + 4 \times 16^0 = 15 \times 256 + 13 \times 16 + 4 \times 1 = 4052.$$

3. *What are the advantages and disadvantages of using a compiled language by comparison with an interpreted language?*

Advantages of compilers over interpreters include:

- **performance** – once a program has been compiled, no further translations between the high-level language and the machine instructions are required, unlike for an interpreted program;
- **intellectual property protection** is potentially simpler for a compiled program, where the owner of software can choose to distribute only the compiled code, and reverse engineering the source code from the compiled code can be difficult and time-consuming.

Advantages of interpreters over compilers include:

- **convenience** – as soon as a program has been written it can be executed, without the need for a separate compilation step; this is especially useful during the development cycle, where programs are frequently modified;
- **debugging during development** is also potentially simpler, in that a high-level language instruction causing a problem can often be isolated immediately;
- **distribution** of an interpreted program is potentially simpler, since the same high level language program will run on many different platforms without modification, whereas a compiled programme will need to be recompiled for every platform type.

4. *When referring to computer memory, what is a word? What is the difference between a word for a 32-bit and a 64-bit machine?*

In computing, **word** is a term for the unit of data handled by a particular processor. A word is a fixed length string (sequence) of bits that is handled as a unit by the instruction set and/or hardware of the processor. The number of bits in a word (the *word size*, *word width*, or *word length*) is an important characteristic of a specific processor design or computer architecture.

[Answer adapted from the Wikipedia article for 'word'.]

The terms 32-bit and 64-bit refer to the word lengths of the processors concerned, i.e. a word in a 32-bit (64-bit) machine contains 32 (64) bits.

5. *What is the maximum usable amount of main memory (in principle) for a 32-bit machine?*

Typically, each byte in main memory is given a unique address, where the length of the address is equal to the word length. Hence the amount of memory is constrained by the number of available addresses, since each byte of memory must be given a unique address.

In a 32-bit machine (with a word containing 32 bits), the number of possible addresses is the number of possible different strings of 32 bits, i.e. $2^{32} \approx 4$ billion (i.e. 4 thousand million). Hence the maximum amount of memory that could possibly be used by a 32-bit machine is 4 billion bytes, i.e. 4 gigabytes (4 GB). In practice, it is usually a little less than that.

In a 64-bit machine (with a 64-bit word), the number of possible addresses is $2^{64} \approx 18$ million million million = 18 exabytes (20 EB), which is an awful lot of memory!