Cambridge Advance Level Computer Science Quick Revision Note

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How to read this note:

The note follows the syllabus questions in the form as such:

"Syllabus question"
Answer to such question

e.g.

"Show understanding of binary magnitudes and the difference between binary prefixes and decimal prefixes"
Binary prifix gorws with factors of 2 while Decimal prefix grows with factor of 10

As Exam:

Paper 1 Theory Fundamentals.

90 minutes. Section 1 to 8.
50% of As grade.

1. Infromation representation
2. Communication
3. Hardwar
4. Processor Fundamentals
5. System Software
6. Security privacy and data integrity
7. Ethics and Ownership
8. Databases

Paper 2 Fundamental Problem-solving and Programming Skills.

120 minutes. Section 9 to 12.
50% of As grade.

9. Algorithm Design and Problem-Solving
10. Data Types and structures
11. Programming
12. Software Development

1- Information Representation

Data Representation

Understanding of Base-2,10,16 representations are required.

Binary: 0-1
Denary: 0-9
Hexadecimal: 0-9,A-F

"Understand the difference between Binary and Decimal Prefix:"

Decimal prefix	Symbol	Factor
kilo	K	10^3
mega	M	10^6
giga	G	10^9
tera	T	10^{12}

Binary Prefix	Symbol	Factor
kibi	Ki	2^{10}
mebi	Mi	2^{20}
gibi	Gi	2^{30}
tebi	Ti	2^{40}

"Show understanding of binary magnitudes and the difference between binary prefixes and decimal prefixes"
Binary prifix gorws with factors of 2 while Decimal prefix grows with factor of 10

1 nibble = 4 bits
1 byte = 8 bits

"Describe practical applications where Binary Coded Decimal (BCD) and Hexadecimal are used"
BCD could be used in Scientific Calculators. Hexadecimal could be used to display memory locations for programmers to read easily.

Hexadecimal's applications:

- define locations in memory
- define colors on web pages
- representing MAC addresses
- display error messages
- Assembly languages

"Use one's and two's complement representation for binary numbers"
Process of two's complement:
-Flip ever 1 to 0 and 0 to 1.
-Add 1 to the number.
The result will be the two's complement form of the original binary string.
The process of two's complement is self inversing in function multiplication. And, it is the additive inverse of itself.

"Show understanding of how overflow can occur"
An overflow occurs when you have more bits from calculation than you could store in a register.

Multimedia

Image

"Show understanding of how data for a bitmapped image are encoded"

Pixel. The smallest visible component of an image. Usually composed by multiple color emiting components.

Pixel Depth. defined by number of bits representing for range of intensity of a color(**bit/color**).

Color Depth. defined by number of bits representing per pixel, which is bits per total colors(**bit/pixel**).

As a pixel can be composed by multiple colors(usually **Red** **Green** **Blue**), the **Color Depth=**$\sum$ **Pixel Depth**.

For a **256-color image** (which literarly says it has 256 colors!). We can use $[\log_2 256]$[Binary Permutations] to know that it uses 8 bits in total to get these many combinations into a pixel, hence a color depth of 8 bits.

"Perform calculations to estimate the file size for a bitmap image"

Image resolution. The number of pixels that make up an image, usually shown as a product of hight and width.

Screen resolution. The number of pixels existing on the screen, usually shown as a product of hight and width.

Pixel density. The density of pixels. defined as, on a square image $\frac{\text{number of diagonal pixels}}{\text{length of diagonal}}$

"Show understanding of the effects of changing elements of a bitmap image on the image quality and file size."
Scaling up a bitmap image would lead to a decrease in the quality.

Bitmap and Vector graphics
-**Bitmap**. Stores a matrix of pixel informations. Has a header file to describe it's features (eg. Compression algorithm, size, author name...).
-**Vector graphic**. Programmed by descriptions (eg. Markup). Stores the relative geometric relation of the image. Has a header file to describe it's features.

"Show understanding of how data for a vector graphic are encoded"
The file contains a **drawing list** of command for each **drawing object** in the list. A drawing object can be any visible object of any form. For each object, there are **attributes** that are variables represneting properties of the object.

Sound

"Show understanding of how sound is represented and encoded."

Analogue Data. Defined contiunously.
Digital Data. Defined in countable intervals. Eg. in Binary.

analogue-to-digital converter (**ADC**) is designed to map analogue data to digital data.

Example of ADCing

-**Sampling resolution**. Defined as the number of available amplitudes. Which is the amount of horizontal lines availbe on the above diagram. Which is a natural number value. In **bit/sample**
-**Sampling rate**. Defines the rate of samples. In **Hz**, ***sample/second***.

"Show understanding of the impact of changing the sampling rate and resolution."
By increasing the sampling resolution:

Benefits	Drawbacks
Larger range of dynamics(minimum varience of amplitudes)	Produces a larger file
a better sound quality	takes longer to process and transmit
better reasembles the source, less distortion	using more process power

Compression

"Show understanding of the need for and examples of the use of compression"
Compression is needed to reduce file storage capacity and reduce pressures in the transmissions of large files.

"Show understanding of lossy and lossless compression and justify the use of a method in a given situation"
Loseless compression: Coding techniques taht allow later decoding to recreate exactly the original file.
Lossy compression: Coding techniques that cause some information to be lost leading that the exact original file cannot be recovered in later decoding.

"Show understanding of how a text file, image, sound file can be compressed"
Text file usually requires loseless since the meaning may change in lossy. The others could use lossy to get rid of ultra sound or colors that are beyond human sensations.

Examples of Compression Techniques:

-**RUN-TIME ENCODING**. Files with consequencial repetitions, denote how many repetitions of a text and send it.

eg. 01100110 01100110 01100110 01100110 can be 00000100 01100110 (saying having 4 01100110)

-**HUFFMAN CODING**. Analyze the text and map the frequently used ones to shorter bits. Prefix are put down for decoding. Coded files are sent as bit stream than bytes.

2- Communication

"Show understanding of the characteristics and benefits of a LAN and a WAN"
LAN(local area network) covers a small area such as a single building.
LAN is usually owned by organisations or companies.
Informations in LAN is passed by twisted pair cable or WIFi.
LAN could reduce cost by centralising applications on server rather than on individual PCs.
LAN allows multiple computers to access one printer which further reduces the cost and boost efficiency.
LAN allows electric mails to be passed around within the network.

WAN(wide area network) covers a very large geographical area, such as a city or contry.

"Explain the client-server and peer-to-peer models of networked computers"

Clinet-server: Network that uses separate dedicated servers and specific client workstations. All clients are linked to the dedicated servers.
Roles:
Benefits and Drawbacks: Good security, less risks in data loss, organized data; High cost, require maintainence, high computational stress on the server.
Applications: Online library. Video streaming. Amazon and Taobao shops.

Peer-toPeer: Network which each node can share its files directly to other nodes. Having no centralized server while each note stores their own data.
Roles:
Benefits and Drawbacks: Easy to set up, free from server, cheaper; Lack of security, lack of management.
Applications: Small team that need high file sharing efficiency.

"Show understanding of thin-client and thick-client and the differences between them"
Thin: Device that need access to the network for it to work (Depending on stronger remote computers or other reasons.)
Thick: Device that can work both off and on line. Can process without internet.

"Show understanding of the differences between and implications of the use of wireless and wired networks"
A Description of the characteristics of copper cable, fibre-optic cable, radio waves and microwaves.
Factors like cost, bandwidth, data rate, attenuation, interference and need for repeaters.

"Describe the hardware that is used to support a LAN."
NIC(Network interface card); Switch, Sever, cables, bridge, repeater...

"Show understanding of the differences between the WWW and the internet."
The internet is the global system of interconnected networks that follows the TCP/IP standard protocol.
The World Wide Web is a system of interlinked hypertext documents accessable through the internet.

"Explain the use of IP adresses in the transmission of data over the internet"
format of IPv4: a 32-bit address written in four 8 bit numbers separated by 'column/dot'.
format of IPv6: a 128-bit hexadecimal address in eight 16 bit numbers separeted by 'column/dot'.
For convinience, IPv6 is displayed in base-16 while IPv4 is in base-10.

Stuff you put in you house

Gateway-Device that connects LANs which use different protocols.
Bridge-Device that connects LANs which use identical protocols.
Hub- Hardware to connect number of devices to form a LAN that directs incoming data to all devices in the network.
Switch- Hub that only direct data to specific destination address.
Router- Device which enables data packets to be routed between different networks (e.g. join LANs into WAN)
Repeater-Device used to boost a signal on both wired and wireless networks.
Repeating hubs-Repeater+Hubs.
Modem- modulator demodulator, an ADC and an DAC.

3- Hardware

A computer consists both input and output.
Input Devices: Keyboard, Mouse, Scanner, Sensor, Webcam.
Output Devices: Actuator, Printer, Monitor, Speakers.

Computers and their components

"Show understanding of embedded systems"
Systems dedicated to do certain work that consists micro processors and memories.
Easy to be massly produced, have special purpose.
Limited memory, require replacement instead of update. Single application.

"Explain the differences between RAM and ROM"
RAM is random access memory, it can allows read and write. While ROM is read only. RAM is volatile while ROM is not.

"Explain the differences between StaticRAM and DynamicRAM"

Name	Dynamic RAM	Static RAM
Made from	**Capacitors**	**Flip-flops**
Price	Cheaper	Expansive
Memory Capacity	Higher	Less
Charge Leak	Yes	No
Power consumption	Higher	Lower
Power consumed in Excess use	Lower	Higher
Constant Refresh	Yes	No
Access Spead	Slower	Faster

Primary Storage: The main memory of a computer; RAM * ROM.
Secondary Storage: Externally added devices such as Optical disks, Hard disk(Magnetic memory), SSD(flash memory)...

"Explain the difference between ROMs."
-**PROM (Programmable)**. System Designer can do stuff to it. Read only in a system level
-**EPROM (Erasable PROM)**. Erased using UV light when removed from the device.
-**EEPROM (Electrically Erasable PROM)**. Easily Erased using Electric signal without removing from the device.
Despite modifiable, it's still read only for the users.
Application: Bootstrap programmes, BIOS(Built-In Operating System).

Monitoring and Control system

"Show an understanding of monitoring and control systems"

Mention the idea of intefering or not; Use of sensors and actuators; Importance of feedback.

4- Processor Fundamentals

CPU Architecutre

"Show understanding of the baisc Von Neumann model for a computer system and the stored program concept."
1. Data and Programms are indistinguishable, hence uses the same memory.
2. Single processor.
3. It follows a linear sequence of fetch-decode-excute operations for the instruction set.
4. Uses registers to achieve the fetch--excute cycle.

"Show understanding of the purpose and role of registers, including the difference between general purpose and special purpose registers."
Special purpose registers such as: PC, MDR, MAR, ACC, IX, CIR, Status Register.

"Show understadnning of the purpose and roles of the ALU, CU, system clock, Immediate Access Store(IAS)."
ALU: Arithmatic logic unit, thata does arithmatics like addition, multiplications... also make logic comparisons.
CU: Control unit: Part of the processor that fetches instructions from memory, decode and synchronize operations before sending the information to other parts of the computer.
System Clock: timing device that synchronizes the fetch-execute cycle.

"Show understanding of how data are transferred between various components of the system using adress but, daa bus and control bus"

"Show understadning of how factors contribute to the performance of the computer system"
Core: a unit made up of ALU, CU and registers. The more the more process/data_threads a processor can run in parrallel.
System clock: over clocking is cool~. You can get more things done quicker but it may screw up your computer.
Bus width: determines maximum possible memory capacity of the system. Wider bus width means more bits can be transferred simultaneously.
Cache memory: Allows more data to be panding for process.

Understaadn how different ports provide connection to peripheral devices
Universal Serial Bus(USB): allows multiple devices to be connected in series.
High Definition Multimedia Interface(HDMI): allows transmission of high definition videos from graphic processors to the display.
Video Graphic Array: Similar to HDMI but lower definition and lower refresh rate.

"Describe the staes of the Fetch-Execute cycle (using register transfer notation)"

```
MAR <- [PC] # contents of PC copied into MAR
PC <- [PC]+1 # PC incremented
MDR <- [[MAR]] # data in the adress in MAR is copied into MDR
CIR <- [MDR] # content in MDR becomes the current instruction.
```

"Show understadning of the purpose of interrupts"
[Possible causes of interrupts]; [Applications of interrupts]; [Interrupt service handling routine];...

Cause of interrupts:
-Hardware failures.
-Bugs in the programs.
-User Keyboard interrupts...

'Be aware of the interrupt priority. This will determine whether or not an interupt will be handled in ISR(Interrupt service routine)'

Assembly Language (Theory)

"Show understanding of the relationship between assembly language and machine code"
Assembly language: a low-level language with instructions made up of an opcode and an operand.
Machine code: Binary codes that uses processor's basic machine operations.
Their is a one to one corospondence between them.

Absolute adressing & Symbolic addressing:
Symbolic addressing: Mnemonics used to represent operation codes and lables for addresses. (e.g. MOV PRICE)
Absolute addressing: A fixed address in memory is used as the operand.

Directives, Macros:
Assembly directives: Information of: the Starting address and End text of the programs; The Initial values in memory.
Macros: Any sequence of instructions assigned by a name and could be called anywhere.

"Describe the different stages of the assembly process for a two-pass assembler"
Assembler: Software that translates assembly into machine code. All mnemonics and labels are replaced.
One pass assembler: Convert mnemonic source code into machine code at once. Cannot handle forward refrencing.
Two pass assembkler:
First Pass: Symbol table is created first entering symbolic adresses and labels into specific addresses. All errors are suppressed.
Second Pass: Jump instructions can access memory addresses based on the table. Substitute macros by instructions, translate everything into machine code.Errors are reported if exist.

"Show understanding that a set of instructions are grouped"
Data Movement; Input and Output; Arithmetic operations; Un/Conditional instructions; Compare instructions;

5- System Software

Operating system

"Explain why a computer system requires an OS"
Because, it provides:
Programms to manage resources of the computer.(Processor management, File management, I/O management)
An interface between the user and the machine.
Basic security for the data on the system.
Utility sotware for further maintenance.

"Explain the key management tasks carried out by the OS"

- Process management: decide which job will get the next use of the processor.
- File management: maintaing a list of files and directories.
- Hardware management: Control all input and output devices attached to the computer.
- Security management: Looking for bugs and reminding for system updates...
- Memory management: Monitoring the memory use and wich addresses shall be allocated.

"Show understadning of the need for typical utility software provided with an OS."

typical utility softwares: Type of system sotfware designed to help analyze, configure, optimize and maintain computer.

- Disk formatter: Carrier process of preparing a data storage device. Controls the disk movements.
- Disk analyzer: Analyze the size of a disk and give out visualization showing distributions by folders and other criterias.
- Defragmenter software: Files are stored in multiple secotors. Deframenting takes information from multiple sectors and put them back into a files, or into a contiguous sector.
- Virus checker: Find and remove viruses. Warning messages. Continue searching for viruses.
- File compression software: Reduces the size of a file. Decompress compressed files. Causes improvements in performance.
- Back-up software: Duplicate and save the important data. Could be used for servers or personals.

"Show understanding of program libraries"
Software under development is often constructed usng existing code from program libraries. Dynamic link library(DLL) can benefits the developer by reducing the size of the code.

Library Programs: A collection of programmes used to develop software. Providing pre-written complex programs.
This can save time, reduces the need for testing, allowing the developer not to know what's behind the programme..

DLL(Dynamic Link Library): Instead of importing the entire file from the library, a pointer to the library is set. Hence only including one copy of such file in the RAM.
Pro: Saves storage in RAM. Suitable for large projects. Save disk space as well.
Con: Requires the computer to contain such file in the library. The imported file is not contained that if the

file is update, it may be incompadible.

Language Translators

Assembler, Compiler, Interpreter:
Assembler: Translates assembly language into machine code. Translate mnemonics and labels into opcode and operand.
Compiler: Translates high-level language program into lower level code. Creating an executable program.
Interpreter: Translate high-level language line by line.

"Explain the benefits and drawbacks of using eithre a compiler or interpreter and justify the use of each"
compiler: The exe. file from a compiler can run independent from the environment. Users won't be able to change the source code. | Uses a lot of resources. Only produces exe when all errors are fixed. Takes a while to locate all the errors in the source code.
interpreter: Can run program any time before code is finished. Easier to debug since it shows the order which bugs accurs. | However, not distributable unless environment is installed elsewhere. Requires the interpreter. Execution is very slow.

"Show awareness that high-level language programs may be partially compiled and partially interpreted. e.g. Java"

"Describe features found in a typical IDE"
An integrated development environment: include features such as initial error detection, dynamic syntax chess, personalized color themes, collapse code blocs, debuging programme...