ASCS Revision Notes P1

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Chapter 0 Methods of Answering

When compare A against B, the drawback for A is the advantage for B.
When no more points to write, try to connect/relate to other chapters/components.
Giving an example sometimes worth 1 mark.
Use as many technical terms as possible.

建议：
Chapter 2 Bit Streaming, 好几年没考了，而且一考就是6分起步
Chapter 1 Vector Graphics, 一定要小心，忘了就没分，而且一般都有4分
Chapter 3 CSMA/CD 近几年的热点，一般都是4分起步，忘了也是没分
Chapter 5 Embedded system 一定要记住 build in microprocessor + solve a small and specific task (in a large system)，一般是1分题但是估计很多人会错
HDD 的机理要背，6分题，其他的storage机理没出过背不背应该无所谓 (????)
实在不行就瞎编吧，围绕考试的syllabus编的合理一般都能拿很多分的

Recommend: https://haoran-jie.github.io/Notes/ 友情推荐，详细程度比这个高多了

Chapter 1 Information Representation

Run Length Encoding (an example of lossless)
Consecutive pixels with same value // Repeated characters
Is stored as a single data value and a count

Vector Graphics vs. Bitmap Image
(file header) = metadata Always answer this in any header like components (data dictionary)
Bitmap is made up of pixels
Bitmap files take up more memory space
Enlarging a bitmap can mean the image is pixelate
Vector graphic can be enlarged without the image becoming pixelated
Bitmap images can be compressed
Vector graphic images do not compress well
Bitmaps are suitable for photographs
Vector graphics are suitable for more geometric shapes
Bitmap graphics use less processing power than vector graphics
A bitmap would be more difficult to edit because each pixel would need to be edited separately
Vector Graphics
(like CSS) Property is the data about the shapes
Black lines, white fill, font of letter
(like HTML) Drawing List A list that stores each separate object, each shape has its own drawing list
triangle, capital letter, rectangle, line, circle

Lossless vs. Lossy Compression
Data is loss and the decompressed file is not the /same as original/loss original details
Smaller file size, informational will bot be noticed
Discard certain information

ASCII
128 character for normal, 256 character for extended.
Each character has its own **unique** integer

The characters are **replaced** by that integer
The codes are stored in the **order** in the word
Only English language

Unicode
8/16/32 bits
Many languages

Sound
To get an approximation of the sound wave
more accurate representation of analogue sound

Compression Methods
Reduce sampling rate
Reduce sampling resolution
Reduce frame rate
Crop the image
Decrease bit depth
Reduce image resolution

Chapter 2 Communication

Network
The employee's computers are the clients
The server hosts the (shared) files
An employee can request a file from the server from any of the client computers
Several employee can access the same file at the same time.

LAN
Device connected over a small geographical area
Uses a dedicated infrastructure// company-owned infrastructure

Public IP vs. Private IP
Public IP
Assigned by ISP
Access by anyone using the internet
Get internet service
Unique
Private IP
Assigned by the router or gateway
Address cannot be accessed by anyone
only used within the local network
Can be duplicated in other LAN

IPv4 vs. IPv6
IPv4
4 groups of 8 bits
Range from 0 to 255

(.) separator
Eg 114.5.1.4

IPv6

8 groups of 16 bits/4 hexadecimals
Range from 0000 to FFFF
Allow zero compression at most once
(:) separator
Eg 1145:1419:1981:00AA:AAAA::

Router vs. Gateway

Connect two or more networks
Connect a local network to WAN
Receive packets and send to detention
Assigned private IP address
Router: used in similar network// same protocol + Store a routing table
Gateway: used in dissimilar network// different protocol

Router Only

store/update/maintain a routing table
find destination of packets using the IP address
forward packets to the destination
Find the most efficient path to destination
Maintain a table of MAC and IP address

(W)NIC (Wireless) Network Interface Card

Is needed to allow a device to connect to a network
Part of the device hardware and frequently contains the MAC address generated at the manufacturing stage

- Provide interface to wireless network
- … as an antenna
- Receives analogue radio waves
- … convert them to digital / binary
- Checks incoming transmissions for correct MAC / IP address
- … ignore transmissions not intended for it
- Encrypts / encodes the data
- Decrypts / decodes the data
- Takes digital/binary input and converts to analogue waves…
- sends the radio waves via the antenna

Ethernet

Is a protocol for wired LANs
Node, medium, and frame
IP address conflict problem -> restarting the router
Collision (broadcast transmission) -> CSMA/CD

CSMA/CD

//2021:
A node (wishing to transmit) listens to the communication channel
...data is only sent when the channel is free // ... if channel is free data is sent
Because there is more than one computer connected to the same transmission medium

... two workstations can start to transmit at the same time, causing a collision
If a collision happens, the workstations send a signal / abort transmission
...and each waits a random amount of time before attempting to resend
//2022:
CSMA/CD is a protocol used to detect and prevent collisions in a bus topology
before transmitting, a device checks if the channel is busy
If the channel is busy the device waits // if the channel is free the data is sent
because there is more than one computer connected to the same transmission medium
... two workstations may start to transmit at the same time, causing a collision
If a collision is detected by the device, transmission is aborted / a jamming signal is transmitted
both devices wait a (different) random time and then try again

Client Side Model
Central security
Password and username to access network
Centralized backup
Centralized file/resources
The server holds the customer account data
and performs the requested tasks / processes.
The computers used by the clients that send requests to the server
Which returns the result of the request
Advantage
Refer to drawback of p2p

Peer to Peer Model
All computers are of equal status
data is distributed across each computer
Computers can communicate and share resources
Each computer is responsible for its own security
Each device both upload and download resources
Peers to participate as equal
Access data form other nodes
No authenticating
Suitable for small size
Drawbacks
Reduced security // no central management of security
... only as secure as the weakest computer on the network
... each computer is at risk from viruses from other computers
(**BACKUP**) No central management of backup
... if the data from one computer is not backed up it is lost to all of them
(**FILE**) No central management of files/software
... consistency may be difficult to maintain
... each computer may have different software from the others
Individual computers may respond slower
... because they are being accessed by other computers
In order to share files etc. all the computers involved need to be switched on
... so the files etc. may not be always available

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Tony Wu 20296

Thin Client vs. Thick Client

Thick

√ more robust, clients have more control
x less secure, each client needs to update data and software
Do not connect to a server
Relies heavily on local resources
More tolerant on slow network connection

Thin

√ Less expensive to expand
√ All devices are linked to a server
√ Server can offer protection
x high reliance on server
x high start up cost
Always relies on a connection
Requires few local resources
Relies on fast network
Data is stored on a remote server

Network Models

Star, Mesh, Bus, Hybrid

Wired vs. Wireless

Wired Connection (Copper/fiber optics)

Faster connection
More stable connection
More Secure connection
Signal does not degrade

Wireless Connection (Wi-Fi/Bluetooth)

The device is free to move
Easy to expand
Easy to set up
Multiple connections at the same time

Satellites

Suitable for long distance
Use a range of frequencies to prevent signal interference

Copper wire

Cheaper
Can travel in two directions
Can bend

Fibre Optics wire

Less interference
Faster transmission speed
More secure
Greater bandwidth
Less signal degrading

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WWW vs. Internet

WWW is a collection of interlinked, hypertext documents/webpages/multimedia resources (accessed via the Internet)
WWW stores HTML pages
Internet is the global infrastructure of interconnected computer networks
The Internet uses TCP/IP protocol
WWW uses HTTP protocols

Cloud Computing

Advantage

Can be accessed anywhere with Internet access
Do not need to install security // security might be better
Do not need to perform backups
Do not need to buy specific software/hardware
Can easily share documents
Can have multiple people working on the same document

Disadvantage

You cannot access it if no internet access
Reliant on someone else to backup
Reliant on someone else for security // can have poorer security
Cannot access if server goes down

Bit streaming (Personally I think its similar to cloud computing, the same answering method can be applied)

sequence of digital signals / bits
over a communication path / Internet
transfer of data at high speed
requires fast broadband connection
requires some form of buffering
bits arrive in the same order as sent

Advantage

no need to wait for a whole file to be downloaded
no need to store large files on user's computer
allows on demand playback
no specialist software is required for playback in browser

Disadvantage

video stops / hangs if very slow Internet / broadband speed low
video stops / hangs if inadequate buffering capacity
loss of Internet means can't access films / files
viruses can be downloaded from the websites

On demanding streaming vs. real time streaming (this is very unpopular topic, only once in 10 years)

On Demand

digital video tape is converted to bit streaming
video files are then uploaded to a dedicated server

a link for the encoded video is placed on a web site
a user clicks on the link to download the encoded streaming video; the streamed video is then broadcast to the user as and when they require it
can be paused / can go back and re-watch / fast-forward, etc

Real life

an event is captured live with a video camera
the video camera is connected to a computer
the video signal is converted to streaming media files (encoded) on the computer
the encoded file is then uploaded from the computer to a dedicated streaming server
the server then sends the live images it to all users requesting it as real-time video streaming cannot be paused etc.

DNS

DNS = Domain name system // Domain name service // Domain name server
the true domain name (e.g. cie_exams.co.uk) is resolved/turned into an IP address by DNS
DNS server stores a database/list of URLs with matching IP address
a DNS server may need to pass a request onto another DNS server
DNS server adds returned IP address and URL to its cache/database
DNS server may return an error message if requested domain name is invalid or does not exist
DNS server returns IP address to browser

URL

Uniform resource locator
Reference address to a resource/website on the Internet
Includes protocol used /includes domain name
HTTP + domain name + file path

Chapter 3 Hardware

Buses

Control (two direction)
Address (one direction)
Data (two direction)

RAM vs. ROM

RAM is volatile ROM is permanent
RAM can read and write ROM can only read
RAM = running data ROM = boot up instructions (BIOS)

DRAM vs. SRAM

DRAM has to be refreshed SRAM do not has to be refreshed
DRAM use single transistor and capacitor SRAM use many transistor and capacitor
DRAM store bits with charge SRAM store bits with flip flop
DRAM more power < SRAM less power
DRAM cheap > SRAM expensive
DRAM slow access time < SRAM fast access time
DRAM high storage > SRAM low storage
aHard drive

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Alternative MS

Hard Drive

Large capacity...
to store videos / images / sound files with large file sizes
Reasonably fast access speed…
Users will not have to wait for videos to load
Inexpensive per unit storage...
If a large number of needed for different exhibits, the cost can be kept low
Does not need to be moved
So moving parts unlikely to be damaged
Slower degradation of data
So will last longer / be more reliable under heavy use

Solid state

Large capacity
To store videos/images/sound files with large file sizes
Fast access speed...
Users will not have to wait for videos to load
Reliable...
Can be dropped/damaged and will likely still work / no moving parts
Quiet...
No moving parts

Embedded System

Built in system that includes a microprocessor that performs one specific task
(Built in + microprocessor + one specific task)
+ small in size easy to fit in device
+ Cheap
+ Dedicated to one task
+ Consume less power
- difficult to upgrade
- Wasteful
- Not secure

Hard Disk Drive

Platter made of aluminum glass.
Platters rotate at high speed.
Electronic circuits control the movement of the **arm** and the **head**
The surface of the platter is divided into **concentric** tracks and sectors
One track in one sector is the basic unit of storage called **block**
Writing: variation in current (head) -> magnetic field (disk)
Reading: variation in magnetic field (disk) -> current (head)
Cheap per unit and large

Solid State Drive

No moving parts
Robust
Low latency
Less power

Run much cooler
Lighter
Flash memory (NAND)

EEPROM (NOR), EPROM, PROM
PROM can be set once, EPROM and EEPROM can be overwritten multiple times.
EPROM needs to be removed from device EEPROM can be erased in situ.
EPROM and can be erased using UV light, EEPROM can be erased using voltage (without removing it from the device)
EPROM must be entirely erased before rewriting, EEPROM does not have to be entirely erased before rewriting.

USB
A devices automatically detected and configured when first attached/plug and play
it is nearly impossible to wrongly connect a device
USB has become an industrial standard
supported by many operating systems
USB 3.0 allows full duplex data transfer
later versions are backwards compatible with earlier USB systems
allows power to be drawn to charge portable devices

Microphone
The microphone has a **diaphragm**
The incoming sound wave cause vibration of the **diaphragm**
Causing a magnet to move past a coil
An electric signal is produced

Speaker
The digital data pass trough a **digital to analogue converter**
This is them passed through an **amplifier** to create a large current
This electric current is converted to sound by the **loudspeaker**
Takes an electrical signal and translates it into physical vibrations to create sound waves
An electric current in the coil creates an electro-magnetic field
Changes in the audio signal causes the direction of the electric current to change
The direction of the current determines the polarity of the electromagnet
The electro-magnet is repelled by or attracted to the permanent magnet
Causing the coil to vibrate
The movement of the coil causes the cone/diaphragm to vibrate
That vibration is transmitted to the air in front of the cone
The amount of movement will determine the frequency and amplitude of the sound wave produced

Screen Comments
Cost, Visibility, Muti-touch, durable, stylus
Capacitive Screen
Made up of many layers of glass that act like capacitors creating a electric field
Microprocessor determines the coordinate of where the screen was touched
√ cost, visibility, durability, multi touch
x stylus

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Tony Wu 20296

Resistive Screen
Upper layer polyester
Lower layer glass
Microprocessor determines the coordinate of where the screen was touched
√ cost stylus
x visibility durability multi touch

Sensors
Sensors sends to microprocessor…
Converted by ADC
(analogue to digital converter) …
Compare with set value ….
If inside of range then …
If out side of range then …
This process is continuous

Laser Printer
Drum is given a positive charge
Drum rotates
Laser beam give negative charge on drum
The negative charge position is the text/file
Drum is coated with **toner** (positive)
Paper (negative) roll over the **drum**
Paper go through **fuser** to melt the ink
(Laser->toner->drum->fuser)
MS
The revolving drum is initially given an electrical charge
A laser beam (bounces off moving mirrors) scans back and forth across the drum
...discharging certain points (i.e. 'drawing' the letters and images to be
printed as a pattern of electrical charges)
The drum is coated with oppositely charged toner
The drum rolls over electro-statically charged paper
The 'pattern' on the drum is transferred to the paper
The paper is passed through the fuser to seal the image
The electrical charge is removed from the drum
(经典的瞎编题) 直接写出 Laser Toner Drum Fuser 拿到四分然后剩下瞎编就行

Inkjet Printer
Printer head moves from side to side across the paper printing the text/image
The paper is advanced very slightly to print next line
Thermo bubble (heat)/Piezoelectric (electricity)
Different methods to expand the bubble and eject ink on paper

Chapter 4 Processor Fundamentals

Address bus, Data bus, memory bus
Register transfer notation
MAR <- [PC]

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MDR <- [[MAR]]
CIR <- [MDR]
PC <- [PC]+1
Answering technique, What's before? What's after? What's transferred? 1+1+(1) = 2+(1)pts

SR
Store the
MAR
Stores the next addressed to be fetched
Held in the PC, the data at this address is then retched
(Before = PC, After = MDR, data = Address) = 2+1pts

MDR
Stores the data rom the address pointed to by the MAR
The data in it is copied to the CIR
(Before = MAR, After = CIR, data = Data) = 2+1pts

Control Unit
to synchronise the actions of other components in the CPU
to send / receive control signals along the control bus
to manage the execution of instructions (in sequence)
to control the communication between the components of the CPU

Interrupts
At the end of each F-E cycle check interrupts
Processor check priority of interrupt
If the interrupt has high priority then
Save current content of registers in stacks
type of interrupt identified
call the appropriate Interrupt Service Routine
When ISR finished, restore registers from stacks
And check for further interrupts
Processor treat next F-E cycle

PSTN Public Switched Telephone Network
Uses multiple telephone lines
Data is transmitted in both directions at the same time
The communication passes through different switching centers

Assembler
Pass 1: Symbol table
Pass 2: Object code

Assembly Language Instructions
Data Movement
Input and output instructions
Arithmetic operation instructions
Compare instructions

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Conditional and Unconditional Jumps

Addressing Methods
Absolute, **Direct, Indirect, Indexed, Immediate**, Relative, Symbolic

System clock
Ensure synchronization
Each instruction is executed on a clock pulse // one F-E cycle is run on each clock pulse
so the clock speed dictates the number of instructions that can be run per second

Clock Speed
Higher clock speed means more FE cycles per second
Determines the number of cycles the CPU can execute per second
Increasing clock speed increases the number of operations/number of fetch-execute
Cycles that can be carried out per unit of time
...however, there is a limit on clock speed because the heat generated by higher clock speeds cannot be removed fast enough

Cores
Each core processes one instruction per clock pulse
More/multiple cores mean that sequences of instructions can be split between them

Bus width
allows the transfer of more data each time
the width of the data bus determines the number of bits that can be simultaneously transferred
increasing the width of the data bus increases the number of bits/amount of data that can be moved at one time (or equivalent)
...hence improving processing speed as fewer transfers are needed

Cache
cache is fast access memory (close to the CPU)
cache stores frequently used instructions / data
... more cache means more instructions / data can be transferred faster
... less swapping between RAM and cache
prevents the CPU idling while waiting for data

Chapter 5 System Software

Operation System (记住首字母就很好背了)
File management
Storage space is divides into file allocation units
Space is allocated for particular files
Maintain directory structure
Provide file naming conventions (.txt .mp3 .jpeg)
Implement access rights
Read, Close, Delete files
Process management *Chapter 16 Not covered*
Multitasking
Hardware management

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Communicating with all inputs and output devices
Using device drivers
Translating data from a file into a format that IO device can understand
Give priority to hardware resources
Handle interrupt and error messages
Memory management
Memory optimization, allocate **dynamically** memory for a number of running application.
Keep tract of free memory and allocated memory.
Memory organization, determine how much memory is allocated.
Memory protection, ensures that two competing applications cannot use same memory.
Through FENCE which defines the boundary for applications.
Security Management *Chapter 6*

Utility Software
Disk formatter - sets up a disk so it is ready to store files
Antivirus - put harmful programs into quarantine and remove them, make more space in RAM
Defragmentation - make memory location of files continuous, less time taken to access files
Disk repair - scan for errors in a disk, prevent bad sectors because it identifies
Compression - reduce file size
Back up - create a copy of data in regular routine in case the original is lost

Dynamic Link Library **（注意DDL和Library Routine的区别）**
(main) memory requirements for program are reduced as dynamic link library is loaded only once / when required
the executable file size is smaller because the executable does not contain all the library routines
maintenance not needed to be done by the programmer because the DLL is separate from program
no need to recompile the main program when changes are made to DLL because changes / improvements/ error correction to the DLL file code are done independently of the main program

Library Routines
Program libraries store pre-written functions and routines
The program library can be referenced/imported
The functions/routines can be called in her own program
Benefits
Saves programming time as code does not have to be written/re-written from scratch
Code is already tested so it is more robust/likely to work
If there is an improvement in the library routine the program updates automatically
can perform complex calculations that the programmer may be unable to do
Remember the difference between library routines and ddl

Compiler **(这里要看情况瞎编，没有万能的写法)**
Translate as a whole
Generate exceptionable file
When program is complete
repeatedly test the same section do not need to recompile
Interpreter
Translate line by line

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When writing the code
Aid debugging the partially completed program
Errors are identified one at a time

IDE
Source code editor
Compiler, interpreter
Auto documenter
Run time environment with debugger
Color coding
Auto complete
Auto correct
Context sensitive prompt
Expand and collapse code blocks
IDE Debugging
Break point, Report window, Single stepping
(3pts!) if you don't know you loss it

Chapter 6 Data Security Privacy Integrity

Data Security Privacy Integrity
Security ensures that data is safe from loss
Privacy is prevent unauthorized access to data
Integrity ensures that data is accurate / consistent / up to date
*(Privacy belongs to Security if not mentioned **together**)*
Uninterrupted Power Supply (UPS)
CCTV
User Accounts
Authentication
Access rights
Passwords
Firewall
Examine the traffic between the user's computer and a public network
Checking whether incoming or outgoing data meets a given set of criteria
Blocking the traffic if the data fails to meet the criteria
Give the network manager a warning
Preventing access to certain undesirable sites
Preventing viruses or hackers entering the user's computer
Warning the user if some software on their system is trying to access an external data source.
Antivirus
Check software or files before they are run or leaded on a computer
Compare possible viruses
Heuristic checking
Quarantine files or grams which are infected
Delete viruses and alert the user
Encryption / Digital Signature
(email) message put through hashing algorithm (? This does not make sense at all because hashing is irreversible but its from the fucking mark scheme so take it) to produce a digest
Digest encrypted with sender's private key (to create the digital signature)

the (digital) signature can only be decrypted with matching sender's public key

Biometrics
Fingerprint scan
Retina scans

Chapter 7 Ethnics and Ownership
Legal, morality, ethnics, and culture
Intellectual property rights
Privacy issues

Ethnics Company
What employees can do
What employees cannot do
Responsibilities of employees
Identify company's values
To identify repercussions of employees performing activities they should not

Ethnics Team
To make sure the team members feel valued
To get the best work out of team
To enable them to work together
To enable them to create the best product for the client

(Ethnic题核心价值观，用这个编很好)
Ethnics Action /IEEE To the best interest of ….
PUBLIC / Software engineers shall act consistently with the public interest.
CLIENT AND EMPLOYER / Software engineers shall act in a manner that is in the best interests of their client and employer (consistent with the public interest.)
PRODUCT / Software engineers shall ensure that their products and related modifications meet the highest professional standards possible.
JUDGEMENT / Software engineers shall maintain integrity and independence in their professional judgment.
MANAGEMENT / Software engineering managers and leaders shall subscribe to and promote an ethical approach to the management of software development and maintenance.
PROFESSION / Software engineers shall advance the integrity and reputation of the profession (consistent with the public interest).
COLLEAGUES / Software engineers shall be fair to and supportive of their colleagues.
SELF / Software engineers shall participate in lifelong learning regarding the practice of their profession and shall promote an ethical approach to the practice of the profession.

Ethnics Benefits [3]
Give guidelines to follow
So client know the standard being applied
So he(self) does not have to decide what is ethical, since its written down
Client know he is reputable
Recognition of his(self) skill and knowledge
Because there may be requirement for entry

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They(colleagues) provide help and support
Such as legal service
They provide training courses
To keep skills up to date

Licence
Free Software Foundation, Open Source Initiative
Commercial Software
Freeware
Shareware
Cost, Modification, Redistribution, Copyright

Risks to security
Hacking, Malware, Viruses, Worms, Logic bombs, Trojan horses, Bots, Spyware
Phishing
Legitimate looking email
With links or attachments
Fake website
Appears to come from a trusted source
Pharming
Malicious code installed on user's computer
Fake website
Leak to fraud or identity theft

Data Integrity
Validation
Check the data is reasonable
Verification
Correctness
Prevent errors when entering or transmission
Validation checks data is reasonable/within bounds **it does not check that accurate data has been entered**
Verification checks if the data matches the data given (accurate) **it does not check if the original data is accurate**
Visual Check
The user checks
Double Entry
The computer/system checks
Parity check
uses even or odd parity which is decided before data sent
each byte has a parity bit
parity bit is set to 0 or 1 to make parity for byte correct
after transmission, parity of each byte re-checked
if it is different, then an error is flagged
any reference to use of parity blocks/parity byte to (identify position of incorrect bit)

checksum
a calculation is carried out on the data to be sent (checksum)

the result is sent, along with data to recipient
checksum is re-calculated at receiving end
if both sums are the same, no error has occurred
if the sums are different, the data has been corrupted during transmission
request is sent to re-send data

Chapter 8 Database

Relational database [6]
Allow data independence: changes to the data do not require programs to be re-written
Reduce data redundancy: because each item of data is only stored once
Improve data consistency: changes in one table will automatically update in another
Improve data security: different views, composed of one or more tables

Data Dictionary [6]
Metadata of the database
Field - column
Entity - a value
Tuple - a row = record
Foreign key - a primary key from another table that is **linked** to this key
Access rights
Password
Data type
Table name

Security
Using usernames and passwords
Using access rights to manage actions
Encryption of the data stored
Chapter 6

Data Modelling/Logical Schema
the overview of a database structure
models the problem / situation
... by using methods such as an ER diagram
independent of any particular DBMS

SQL
SELECT <Field>
FROM <Table>
WHERE <Expression>
AND <Expression>

Alternative
SELECT COUNT(STAFF.StaffID)
FROM STAFF
INNER JOIN DEVICE
ON STAFF.StaffId = DEVICE.StaffID

```
WHERE STAFF.FirstName = "Ali"
AND STAFF.LastName = “Khan";

UPDATE <Table>
SET <Expression>
WHERE <Expression>

ALTER TABLE <Table>
ADD <Field> <Type> ;

CREATE TABLE <Table> (
        <Field> <Type>,
        PRIMARY KEY (<Field>),
        FOREIGN KEY (<Field>) REFERENCE PRIMARY <Table>(<Field>)
);

INSERT INTO <Table>
VALUES(<Identifiers>);
```

Normal Forms

no repeating groups of attributes
2NF no partial dependency
3NF no non key dependency/fully depending on primary key

Referential Integrity

Each foreign key value must have a matching value in the primary key of the linked table
No reference data not exist
Primary key cannot delete unless all dependent records delete
Foreign key value match corresponding primary key
Cascading update/delete