NAME DATE STARTED TARGET END DATE

GCE A LEVEL — COMPUTER SCIENCE UNIT 4 QUESTION PACK

1500U40-1 · 2015 spec Unit 4 Topic 4 · A2 unit, first sat 2017, 100 marks, 2h paper

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COMPUTER SCIENCE — UNIT 4 · Networks — Topologies, Routing & Wireless

Topic 4.4 — Network topologies, lowest-cost routing protocols, internet communication apps and wireless connectivity

Working out routing costs from transmission speeds, choosing lowest-cost routes between nodes, describing different internet communication applications, identifying hardware and protocols required for wireless connectivity, and the disadvantages of public wireless networks.

2015 specification · current

Estimated time for entire question pack: ~45 min

Derived from the Unit 4 pace of ~1.5 min/mark, padded for written-prose answers (30 marks over 5 questions).

*You are advised to **not** attempt to complete all of this in one sitting.*

ABOUT THIS QUESTION PACK

This is a **comprehensive topic question pack**, not a single mock paper. It contains every question from the WJEC A2 Unit 4 papers (Summer 2017 – Summer 2024, COVID gap) that maps onto Topic 4.4 of the 2015 specification.

Questions are ordered by source paper date.

INSTRUCTIONS

Use black ink or black ball-point pen. Show all working. A calculator is allowed where useful.

For Examiner's use only

Q	Source	Max	Mark
1	S18 Q3	6	
2	S22 Q4	7	
3	S22 Q6	9	

Q	Source	Max	Mark
4	S23 Q14	4	
5	S24 Q6	4	
Total		**30**	

Networks — Topologies, Routing & Wireless — what the spec asks

WJEC GCE A Level Computer Science (from 2015) · Unit 4: Computer Architecture, Data, Communication & Applications · Topic 4.4.

Network topologies

- Star: every node connects to a central switch/router; failure of node = local impact only.
- Bus: shared backbone; cheap but a fault breaks the whole bus.
- Ring: each node connected to two others; token passing; orderly access.
- Mesh: every node connected to every other; most resilient, most expensive.

Routing cost calculations

- Routing cost is inversely proportional to transmission speed (cost = 1 at 1 Mbps).
- Compute cost for each link from its speed (cost $\propto$ 1 / speed).
- Total route cost = sum of link costs along the path.
- Pick the route with the lowest total cost (Dijkstra / Bellman-Ford in practice).

Internet communication applications

- Email (SMTP / IMAP) — asynchronous, persistent inbox.
- VoIP / video calls (SIP / RTP) — real-time, low-latency.
- Instant messaging (XMPP / proprietary) — near real-time text.
- File transfer (FTP, HTTP) — bulk download/upload.

Wireless connectivity

- Hardware: WiFi adapter (NIC), wireless access point / router, antennae.
- Protocols: 802.11 (a/b/g/n/ac/ax for WiFi), Bluetooth, Zigbee.
- Security: WPA2/WPA3 with AES; WEP is broken — never use.
- Public WiFi risks: eavesdropping, evil twin APs, weak segregation between clients.

Network protocols

- TCP/IP: connection-oriented (TCP) on top of IP routing.
- UDP: connectionless, low overhead, for streaming / DNS / VoIP.
- HTTP / HTTPS: web request/response (HTTPS adds TLS).
- DNS: maps names to IPs; recursion + caching for efficiency.

Disadvantages of public wireless

- Traffic can be intercepted by anyone within range if not encrypted.
- Rogue access points (evil twin) impersonate legitimate hotspots.
- Shared bandwidth means unpredictable performance at busy times.
- Limited authentication: anyone with the password is in.

Crib sheet »

Networks — Topologies, Routing & Wireless in one page

Quick-reference notes — revisit before each question.

Cost from speed

cost = 1 at 1 Mbps.
Higher speed ⇒ lower cost.
Sum link costs to get total route cost.

Lowest-cost route

Enumerate viable routes.
Add link costs along each.
Pick the smallest total.
Dijkstra in production.

Comms apps

Email: async, persistent.
VoIP/Video: real-time, low-latency.
IM: near real-time.
FTP/HTTP: bulk transfer.

Wireless HW + protocols

Wireless NIC + Access Point.
WiFi: 802.11a/b/g/n/ac/ax.
Bluetooth, Zigbee for short-range / IoT.
Use WPA2/WPA3 (not WEP).

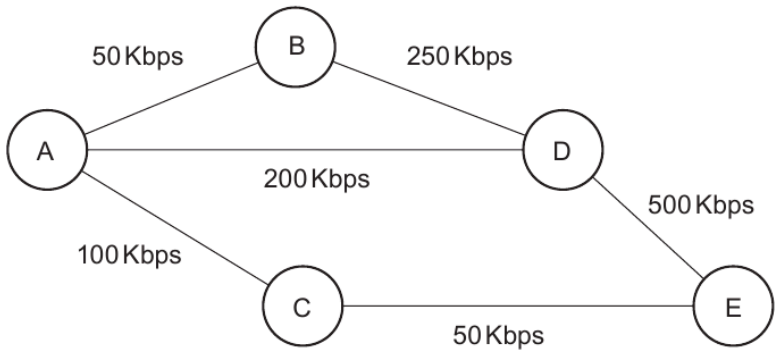
Public WiFi risks

Eavesdropping if unencrypted.
Evil-twin APs.
Shared bandwidth => slow at peak.
Open auth = anyone joins.

Topologies

Star (central switch), bus (shared line), ring (token), mesh (every-to-every).
Trade resilience vs cost vs cabling.

3. The transmission speeds between the nodes of a network have the values shown in the diagram below.



A cost for routing data packets between nodes is calculated by dividing 1Mbps by the transmission speed of the link. For example:

$$\text{cost for the link A to B} = \frac{1\,Mbps}{50\,Kbps} = \frac{1\,000\,000}{50\,000} = 20$$

Packets are transmitted between source and destination by the route which has the lowest total cost.

(a) Calculate the costs for each of the remaining 5 links in the network. [2]

(b) Copy and complete the table below to show the routes that would be taken by packets from node A to each of the other nodes B to E. [4]

Destination node	Route, listing any intermediate nodes	Total cost
B		
C		
D		
E		

4. *(a)* The table below shows a design for storing hotel bookings in a database.

Name	Address	Date	Room
John Smith	27 High Street, Bala	16 April 2018	102
Anita Patel	Ty Gwyn, Porthmadog	29 April 2018	216
John Smith	7 Laurel Drive, Bolton	4 May 2018	133, 134
…	…	…	…

(i) This table is not in normal form. Explain why there may be problems when searching or sorting this table. [2]

(ii) Re-design the table so that it is in first normal form. [2]

(b) A local community group organises volunteer drivers to collect elderly residents from their homes and take them on trips. The group has a number of minibuses available which can be allocated for trips on particular dates. Each trip has one driver allocated.

(i) Produce an entity-relationship diagram to show the relational links between drivers, residents, vehicles and trips. [3]

(ii) Assume residents individually book seats on trips. Design a database in third normal form for this situation. [6]

4. The Internet enables the use of many communication applications. Describe the distinguishing characteristics of these communication applications:

- Podcast
- Blog
- Instant messaging
- Webcast [8]

5. A certain computer uses this 16 bit floating point representation:

Mantissa	**Exponent**
8 bits in two's complement form. The binary point in the mantissa is immediately after the leftmost bit.	8 bits in two's complement form.

(a) Convert the number 7.1875_{10} into this floating point representation. [3]

(b) Determine the most accurate representation possible for 19.3_{10} using this floating point representation. [2]

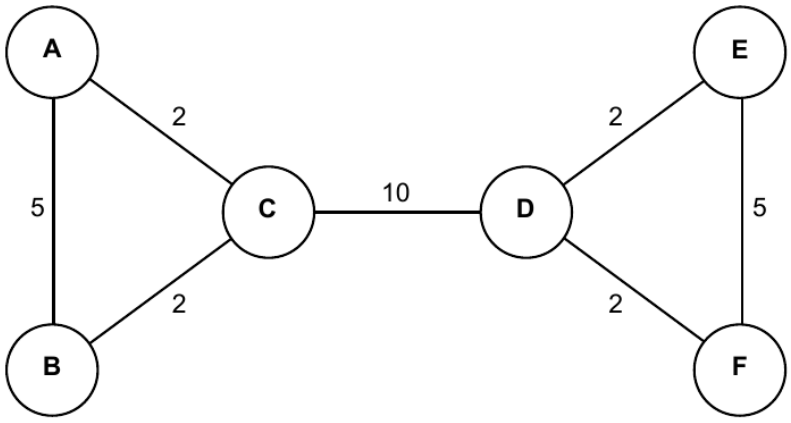
(c) Calculate the absolute and relative errors in denary for this floating point representation of 19.3_{10}. [4]

(d) Describe the relationship between the size of the mantissa and exponent in the representation of a floating point number. [3]

6. In a certain computer network the protocol used to determine lowest cost routes is based on transfer rates and delays. Transfer rates are based on bandwidth of network links. Delays represent the overhead arising from the time taken for a router to process, queue and transmit a data packet.

The total route cost is calculated as the cost of each link multiplied by the total of the delay factors of each intermediate router visited.

This is a diagram of the network. The delay at each intermediate router = 1.2.



(a) Calculate the lowest cost route from router A to router F. [2]

(b) (i) A new link of bandwidth cost = 14 is to be added from B to F. Re-calculate the lowest cost route from router A to router F. [2]

(ii) The link from router C to router D is then upgraded to a network cost of 5. Describe the effect the upgrade will have on overall network costs. [2]

7. Phishing is the most common cyber-attack vector.

(a) Explain what is meant by the term 'cyber-attack vector'. [2]

(b) Describe **two** other cyber-attack vectors. [4]

8. Penetration testing is an important aspect of computer security.

(a) State what is meant by the term penetration testing. [1]

(b) Describe **three** penetration testing strategies. [6]

12. (a) Explain what is meant by a distributed system and describe what will be distributed in the system. [2]

(b) A car manufacturer has a number of dealerships across the UK. Car owners take their cars for servicing each year to a convenient dealership. Records are kept of servicing, any faults found, and replacement parts fitted.

Explain the advantages to the company of implementing a distributed database system across its dealerships compared with using a single centralised database. [4]

13. (a) Explain the advantages and disadvantages of single key (symmetric) encryption compared with double key (asymmetric) encryption, giving an example, for each method, of a situation where that method would be the most suitable. [6]

(b) Text is stored in 8-bit binary ASCII format, with numeric codes representing each character:

A = 65_{10} $0100\ 0001_2$

B = 66_{10} $0100\ 0010_2$

C = 67_{10} $0100\ 0011_2$

The text is encrypted using a sequential XOR method:

- The first character is encrypted by XOR with the key value $0110\ 1010_2$
- The second character is encrypted by XOR with the encrypted value of the first character
- The third character is encrypted by XOR with the encrypted value of the second character

Using this algorithm, encrypt the word CAB. [3]

14. (a) Identify **two** hardware devices required to make a wireless connection to a network. [2]

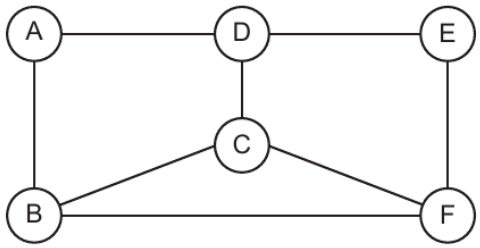
(b) State **two** protocols used for wireless digital communication. [2]

(c) Describe **one** disadvantage of using a public wireless network. [2]

15. Information and advice on medical and health issues are readily available to the public through the internet, including online expert systems. Discuss the possible effects of using the internet for this purpose on health professionals and the wider community. [9]

END OF PAPER

6. A series of nodes are connected in a network, as shown:



For this network a node-to-node transmission speed of 1 Mbps would produce a routing cost = 1. The costs for routing data packets between nodes are given in the table.

Network links	Transmission speed (Kbps)	Routing cost
A–B	250	4
A–D	(i)	20
B–C	100	10
B–F	80	(ii)
C–D	250	4
C–F	500	(iii)
D–E	100	10
E–F	250	4

(a) State the values that should be in cells (i), (ii) and (iii) of the table. [3]

(b) Packets are transmitted using the route that has the lowest total cost. State the route that packets would take from node A to node F. [1]

7. A secure display cabinet in AJ Jewellers' showroom has an electronic lock which is opened by entering a four-digit code number using a keypad.

A copy of the correct code number is stored in a computer at memory location 01A0.

The cabinet is opened when the computer sends a numeric value of –1 to the electronic lock.

A control program for the lock is to be written in assembly language. The required algorithm is:

Repeat

input a code number from the keypad

subtract the value stored in 01A0 from the input

Until the remainder is zero

output –1

The assembly language used by the computer has an instruction set, which includes the following commands:

Assembly Language Command	Description
IN	Input a numeric code from the keypad to the accumulator
OUT R	Output a numeric value R to the electronic lock
ADD N	Add the numeric value in location N to the accumulator, leaving the result in the accumulator
SUB N	Subtract the numeric value in location N from the accumulator, leaving the result in the accumulator
JMP LABEL	Jump to LABEL
JZE LABEL	Jump to LABEL if the contents of the accumulator are equal to zero

Using the given algorithm and instruction set, write a program to control the electronic lock. [6]

END OF QUESTION PACK

5 questions · 30 marks · ~45 min
Source: WJEC A2 Computer Science Unit 4 (1500U40-1), Summer 2017–2024, COVID gap
Curated for WJEC Computer Science 2015 spec A2 Unit 4 — Topic 4 (4.4)