Component 2 – Computer Architecture, Data, Communication and Applications
Mark Scheme

Guidance for examiners

Positive marking

It should be remembered that learners are writing under examination conditions and credit should be given for what the learner writes, rather than adopting the approach of penalising him/her for any omissions. It should be possible for a very good response to achieve full marks and a very poor one to achieve zero marks. Marks should not be deducted for a less than perfect answer if it satisfies the criteria of the mark scheme.

For questions that are objective or points-based the mark scheme should be applied precisely. Marks should be awarded as indicated and no further subdivision made.

For band marked questions mark schemes are in two parts.

Part 1 is advice on the indicative content that suggests the range of computer science concepts, theory, issues and arguments which may be included in the learner's answers. These can be used to assess the quality of the learner's response.

Part 2 is an assessment grid advising bands and associated marks that should be given to responses which demonstrate the qualities needed in AO1, AO2 and AO3. Where a response is not credit worthy or not attempted it is indicated on the grid as mark band zero.

Banded mark schemes

Banded mark schemes are divided so that each band has a relevant descriptor. The descriptor for the band provides a description of the performance level for that band. Each band contains marks.

Examiners should first read and annotate a learner's answer to pick out the evidence that is being assessed in that question. Once the annotation is complete, the mark scheme can be applied.

This is done as a two stage process.

Stage 1 – Deciding on the band

When deciding on a band, the answer should be viewed holistically. Beginning at the lowest band, examiners should look at the learner's answer and check whether it matches the descriptor for that band. Examiners should look at the descriptor for that band and see if it matches the qualities shown in the learner's answer. If the descriptor at the lowest band is satisfied, examiners should move up to the next band and repeat this process for each band until the descriptor matches the answer.

If an answer covers different aspects of different bands within the mark scheme, a 'best fit' approach should be adopted to decide on the band and then the learner's response should be used to decide on the mark within the band. For instance if a response is mainly in band 2 but with a limited amount of band 3 content, the answer would be placed in band 2, but the mark awarded would be close to the top of band 2 as a result of the band 3 content. Examiners should not seek to mark candidates down as a result of small omissions in minor areas of an answer.

Stage 2 – Deciding on the mark

Once the band has been decided, examiners can then assign a mark. During standardising (marking conference), detailed advice from the Principal Examiner on the qualities of each mark band will be given. Examiners will then receive examples of answers in each mark band that have been awarded a mark by the Principal Examiner. Examiners should mark the examples and compare their marks with those of the Principal Examiner.

When marking, examiners can use these examples to decide whether a learner's response is of a superior, inferior or comparable standard to the example. Examiners are reminded of the need to revisit the answer as they apply the mark scheme in order to confirm that the band and the mark allocated is appropriate to the response provided.

Indicative content is also provided for banded mark schemes. Indicative content is not exhaustive, and any other valid points must be credited. In order to reach the highest bands of the mark scheme a learner need not cover all of the points mentioned in the indicative content but must meet the requirements of the highest mark band. Where a response is not creditworthy, that is contains nothing of any significance to the mark scheme, or where no response has been provided, no marks should be awarded.

Qu	Answer	Mark	AO1	AO2	AO3	TOT
1 (a)	-9 (Correct answer only)	1		2.1a		1
1 (b)	One method is: • From RHS, rewrite it up to and including the first one ⎤ • Change other 1 digits to 0 and 0 digits to 1 ⎦ • Correct working and answer for example 00001000 -> xxxx1000 -> 11111000 Alternatively • Flip the bits • Add one • (Ignore carry (ninth bit)) • Correct working and answer for example (as above) (Other methods equally acceptable)	1 1	1.1b	 2.1a		2

1 (c)	MANTISSA EXPONENT
	0101101100000000 0101 (spacing unimportant)
	          22 -> 10110
	          .75 -> .11
	
	Marking: for correct mantissa
	              for correct exponent
		
		1
		1
				
				2.1a
				2.1a
						2

1 (d)	A greater range of (positive / negative) numbers can be stored in the same number of bits using FP form However, numbers in FP form (unlike integer form); any 1 of: • are not normally stored completely accurately e.g. 7 might effectively be stored as 7.000000000001 • require more complex processing • allow for no exact representation of zero	1 1	1.1b 1.1b			2
2 (a)	The address of the next instruction is copied from the PC to the MAR The instruction is copied to the MDR The PC is incremented so that it holds the address of the next instruction	1 1 1	1.1b 1.1b 1.1b			3
2 (b)	d1 1001 0110 1110 1100 (original value) d2 1110 1011 1010 0011 (original value) Register 1 1001 0110 1110 1100 (after instruction LOAD 1,d1) Register 2 1110 1011 1010 0011 (after instruction LOAD 2,d2) Register 1 0111 1101 0100 1111 (after instruction XORR 1,2) d3 0111 1101 0100 1111 (after instruction STORR 1,d3) Register 1 1001 0110 1110 1100 (after instruction XORR 1,2)	 1 1 1 1		 2.1a 2.1a 2.1a 2.1a		4

Qu	Answer	Mark	AO1	AO2	AO3	TOT
3 *(a)*	A foreign key is a field in a table which links to a primary key (or part of a primary key) in another table	1	1.1b			2
	It enables data in different tables to be linked together	1	1.1b			
3 *(b)*	Remove any transitive dependencies (or Ensure that each attribute/field depends only the primary key)	1	1.1a			1
3 *(c)* (i)	SELECT StuName, TutNum FROM STUDENTS	1			3.1b	1
3 *(c)* (ii)	SELECT StuName FROM STUDENTS WHERE TutNum = '378'	1			3.1b	1
3 *(c)* (iii)	UPDATE STUDENTS SET TutNum = '345' WHERE TutNum = '378' 1 mark for update; 1 mark for changing TutNum	2			3.1b	2
3 *(c)* (iv)	SELECT StuName FROM STUDENTS WHERE TutNum = (SELECT TutNum FROM STUDENTS WHERE StuNum = '13777') 1 mark for each select (1 mark for main select and one from sub-select)	2			3.1b	2
3 *(c)* (v)	SELECT StuName, TutName FROM STUDENTS, TUTORS WHERE STUDENTS.TutNum = TUTORS.TutNum 1 mark for each select (1 mark for main select and 1 mark from sub-select)	2			3.1b	2
3 *(c)* (vi)	CREATE TABLE PHONES (RoomNum Char(5) PhoneNum Char(5)) 1 mark for table; 1 mark for fields (any suitable field size acceptable)	2			3.1b	2
3 *(c)* (vii)	INSERT INTO PHONES VALUES ('106' , '625') INSERT INTO PHONES VALUES ('113' , '670') 1 mark for insert; 1 mark for values inserted	2			3.1b	2
3 *(c)* (viii)	SELECT StuName, DateBirth FROM STUDENTS ORDER BY DateBirth 1 mark for select; 1 mark for ordering	2			3.1b	2

Qu	Answer	Mark	AO1	AO2	AO3	TOT

4 *(a)*	<u>Sequential</u>
	
	• Records are stored and accessed in key sequence order
	• Easier to program / fewer overheads than indexed sequential
	• Particularly suitable (and faster) if access only ever needs to be sequential
	
	Addition of a record:
	• Make a new copy of the records until in the correct place to add the new record
	• Add the new record to the new copy
	• Continue until the end of the file
	• If multiple records to be added, these should preferably be sorted before the above process to avoid multiple updates
	
	Deletion of a record:
	• Make a new copy of the records until in the correct place for deletion
	• Do not copy the record to be deleted
	• Continue until the end of the file
	• If multiple records to be deleted, these should preferably be sorted before the above process to avoid multiple updates
	• Allows faster access than sequential because can move directly to individual records
	
	<u>Indexed Sequential</u>
	• Records are stored in key order in the file
	• Records are normally organised into blocks
	• An index allows data to be accessed directly
	• Multilevel index usually used:
	    • There is a main index which contains the location of the next index
	    • This process may extend to several levels and the last index contains the physical address of the record
	• Blocks are originally normally partially filled to allow for more entries
	
	Addition of a record:
	• Place in a block if possible
	• If a block becomes full, an overflow area is used
	• Access may become slow as more records are in overflow area, so re-organisation may become necessary
	
	Deletion of a record
	• Record is normally marked as deleted but not physically removed
	
	[Sample response worth full marks:]
	
	In a sequential file, records are stored and accessed in key sequence order. When a record is to be added, a copy is made of the records until it is in the correct place to add the new record, then the new record is added to the copy. The process is continued until the next new record is detected or the end of the file is reached. If multiple records are to be added, these should preferably be sorted before the above process to
		5	1.1b			5

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Qu	Answer	Mark	AO1	AO2	AO3	TOT
	avoid multiple updates. When a record is to be deleted, a copy is made until in the correct place for deletion. The record to be deleted is not copied to the new copy. The process continues to the end of the file as above In an indexed sequential file, records are stored in key order in the file. Records are normally organised into blocks and an index (probably multilevel) allows data to be accessed directly. This indexing process may extend to several levels and the last index contains the physical address of the record. Blocks are originally normally partially filled to allow for more entries. When a record is to be added, it is placed in a block if possible, but an overflow area is used if necessary. Access may become slow as more records are located in the overflow area, so re-organisation may become necessary. When a record is to be deleted, it is normally marked as deleted but not physically removed. The advantages of a sequential file are that it is generally easier to program than the indexed sequential. It is particularly suitable (and faster) if access only ever needs to be sequential. The advantages of an indexed sequential file are that it allows faster access than sequential because it can move directly to individual records. Marking 5 valid points comparing access methods and addition and deletion of records for 5 marks If addition and deletion of records not discussed, max 4 marks Must compare both access types for 3 marks or more If only one access type discussed, max 2 marks					
4 (b) (i)	123^2 = 015129, so the output is 51 223^2 = 049729, so the output is 97	2		2.1a		2
4 (b) (ii)	123^2 = 015129, so the output is 29 223^2 = 049729, so the output is 29	2		2.1a		2
4 (b) (iii)	The second algorithm is weaker As it will always give the same output if the two right hand digits in the key are the same. The first algorithm does not do this so is preferable (further example 323^2 -> 104329 for first algorithm and 104329 for second)	1 1		2.1b 2.1b		2
5	.... set a = b * c set d = b * e set f = b * g .... 1 mark for first two statements which can be run in parallel, with second statement excluding first set value (a in this instance) 1 mark for third statement excluding first two set values (a and d in this instance)	2			3.1b	2

Qu	Answer	Mark	AO1	AO2	AO3	TOT
6 (a)	Simplex: Data transmission is possible in one direction only	1	1.1a			3
	Half duplex: Data transmission is possible in both directions, but only in one direction at a time	1	1.1a			
	Full duplex: Data transmission is possible in both directions simultaneously	1	1.1a			
6 (b)	Data collision occurs when two sets of data are transmitted on the network simultaneously	1	1.1b			3
	The network detects the error	1	1.1b			
	Each computer waits for a short / random time then sends the data again	1	1.1b			
7 (a) (i)	01111000	1		2.1a		2
	Effect is multiplying by 4 (or doubling twice, or multiply by 100_2 – subscript needed)	1		2.1b		
7 (a) (ii)	Number becomes (1) 00111100 - left hand digit lost as the resulting number is now too large to be contained in the eight bits available	1		2.1b		2
	Any 1 of: • More digits are required • An error should be reported rather than producing an inaccuracy	1		2.1b		
7 (b)	Hexadecimal is easier (for humans) to read / copy etc.	1	1.1b			2
	Example eg 2AD -> 0010 1010 1101 or 001010101101	1		2.1b		

Qu	Answer	Mark	AO1	AO2	AO3	TOT
8 (a)	The estate agent will hold a huge amount of data altogether. It may be more efficient to store data on a number of different computers to maximise performance. (For instance info on properties in each town could be stored on the computer in that town with links to other branches)	1		2.1a		3
	It will be difficult for the estate agent to ensure that all the data in all the computers is always up-to-date / maintain integrity	1		2.1b		
	Both <u>processing</u> and <u>data</u> are distributed	1	1.1a			
8 (b)	Big Data refers to data sets so large and complex that it becomes difficult to process using standard database techniques	1	1.1b			1
8 (c)	Data mining: the analysis of (a large amount of) data (in a data warehouse)	1	1.1b			4
	This can provide <u>new information / find patterns / trends</u> in the data	1	1.1b			
	Supermarket: could use data mining on data extracted from loyalty card data to attract customer to make additional purchases via targeted special offers, etc. placement of products to attract customers etc.	1 1		2.1a 2.1a		
9 (a)	Real-time control system – a control system which reacts quickly enough to affect behaviour outside the system	1	1.1b			6
	Example: a chemical plant where the computer can react to a (possibly dangerous) temperature rise by employing cooling measures very rapidly	2		2.1a		
	Real-time transaction processing system - a system which quickly locks records or fields to avoid accidental update and possible loss of integrity	1	1.1b			
	Example: an online theatre booking system where records / fields are locked during a transaction to avoid the possibility of double booking	2		2.1a		

Qu	Answer	Mark	AO1	AO2	AO3	TOT
9 (b)	More than one job is in memory at same time A time-slice is the amount of time allocated to each job by the operating system Scheduling allocates time-slices to the jobs Polling is the sequential checking of jobs so that each gets its appropriate share of time Partitioning is a division of a computer's memory for different jobs One job is halted if e.g. waiting for a peripheral device – other jobs can now be processed - this is achieved by use of interrupts	4	1.1b			4
9 (c)	The operating system would have to halt the execution of the low priority task currently running	1		2.1b		4
	The operating system (scheduler) would then have to service the required high priority Interrupt Service Routine (ISR)	1				
	The new medium priority Interrupt Service Routine would be held until the high priority has been dealt with and then the medium priority interrupt would be serviced	1				
	When both interrupts are serviced then executing the original low priority task is resumed	1				

Qu	Answer	Mark	AO1	AO2	AO3	TOT
10 (a)	Marking: Diagram 3 marks - each error minus 1 mark	3		2.1b		3

10 (b)	DRIVER (<u>DriverID</u>, DriverName, DriverHomeAddress, <u>DepotTown</u>)
	
	VEHICLE (<u>RegNumber</u>, Make, Model, <u>DepotTown</u>)
	
	DEPOT (<u>DepotTown</u>, Address, TelNumber, <u>SupervisorID</u>)
	
	SUPERVISOR (<u>SupervisorID</u>, SupervisorName, SupervisorHomeAddress)
	
	Marking:
	  Four suitably named tables 1 mark
	  Each table with suitable primary key shown 2 marks (3 correct = 1 mark)
	  Correct foreign keys 3 marks
		6		2.1b		6

Qu	Answer	Mark	AO1	AO2	AO3	TOT
11	**Indicative content:** General issues: • perform the required operations consistently / reliably / accurately • operates in real time so has feedback / can respond to (possibly dangerous) conditions very quickly • human workers will be less subject to dangerous working conditions • system can operate 24 hours / 365 days per year / doesn't get tired etc • system may be very energy / resource efficient • system may effectively monitor operations / provide useful management data • cheap to run once installed (reduced salary costs) • there will be a need for some highly qualified maintenance staff, but generally staff numbers will be cut • system may not react to obvious fault conditions / cannot adapt to changes. Security issues: • security will need to be incorporated from initial analysis and design of system and constantly monitored / updated • techniques such as penetration testing should be employed – deliberately attempting to identify security vulnerabilities • white hat (ethical) hackers employed to carry out penetration testing and other testing techniques • danger of viruses / worms being deliberately introduced by USB sticks, remote access to system • need to consider loss of production / damage to equipment • need to consider injury / death of employees / persons in the community • need to consider company's reputation in the community • motivation of malicious behaviour could be standard criminality such as blackmail or could be terrorism • staff vetted to attempt to prevent internal malicious damage • security staff / physical locks / biometric methods to prevent unauthorised physical access.	13	1.1b			13

Band	AO1.1b
	Max 13 marks
3	**10-13 marks**
	The candidate has:
	• written an extended response that has a sustained line of reasoning which is coherent, relevant, and logically structured
	• shown clear understanding of the requirements of the question and a clear knowledge of the topics as specified in the indicative content. Clear knowledge is defined as a response that makes six or seven points in both areas signalled in the indicative content. The top of the mark range would require a clear response in both areas.
	• addressed the question appropriately with minimal repetition and no irrelevant material
	• has presented a balanced argument and justified their arguments
	• effectively drawn together different areas of knowledge, skills and understanding from all relevant areas across the course of study
	• used appropriate technical terminology referring to the indicative content confidently and accurately.
2	**5-9 marks**
	The candidate has:
	• written a response that has an adequate line of reasoning with elements of coherence, relevance, and logical structure
	• shown adequate understanding of the requirements of the question and a satisfactory knowledge of the topics as specified in the indicative content. Satisfactory knowledge is defined as a response that makes four or five points in both areas signalled in the indicative content. The top of the mark range would require a satisfactory response in both areas
	• presented an argument with limited justification
	• drawn together different areas of knowledge, skills and understanding from at least two areas across the course of study
	• used appropriate technical terminology referring to the indicative content.
1	**1-4 marks**
	The candidate has:
	• written a response that that lacks sufficient reasoning and structure
	• produced a discussion which is not well developed, and the justification is weak
	• attempted to address the question but has demonstrated superficial knowledge of the topics specified in the indicative content. Superficial knowledge is defined as a response that makes two points in both areas as signalled in the indicative content. The top of the mark range would require a superficial response in both areas.
	• used limited technical terminology referring to the indicative content.
0	**0 marks**
	Response not credit worthy or not attempted.