Cambridge International AS & A Level

**Cambridge International Examinations**
Cambridge International Advanced Subsidiary and Advanced Level

CANDIDATE NAME

CENTRE NUMBER | | | | | |

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*3220413852*

**COMPUTER SCIENCE** **9608/13**

Paper 1 Theory Fundamentals **October/November 2017**

**1 hour 30 minutes**

Candidates answer on the Question Paper.

No Additional Materials are required.

No calculators allowed.

**READ THESE INSTRUCTIONS FIRST**

Write your Centre number, candidate number and name in the spaces at the top of this page.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
No marks will be awarded for using brand names of software packages or hardware.

At the end of the examination, fasten all your work securely together.

The number of marks is given in brackets [ ] at the end of each question or part question.

The maximum number of marks is 75.



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**1** **(a)** Each of the following bytes represents an integer in two's complement form.

State the denary value.

**(i)** `0111 0111` Denary ..... [1]

**(ii)** `1000 1000` Denary ..... [1]

**(iii)** Express the following integer in two's complement form.

`-17`

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

[1]

**(iv)** State in denary, the range of integer values that it is possible to represent in two's complement integers using a single byte.

Lowest value .....

Highest value ..... [1]

**(b)** **(i)** Convert the following denary integer into Binary Coded Decimal (BCD).

`653`

.....[1]

**(ii)** A 3-digit BCD representation has been incorrectly copied. It is shown as:

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 |

State how you can recognise that this is not a valid BCD representation.

.....

.....[1]

**(iii)** Describe a practical application where BCD is used.

.....

.....[1]

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**2** **(a)** The diagram shows three items of software that translate program code.

Draw **one** line from each context to the correct item of translation software.

| Context | Item of translation software |
| --- | --- |
| A web page contains a client-side script. | Assembler |
| Each instruction in the source code consists of an op code and an operand. | Interpreter |
| The source code is required at run-time. | Compiler |
| When the source code is translated, copies of the executable program can be distributed without the need for the source code. | |

[4]

**(b)** The Java programming language is said to be machine or platform independent.

**(i)** Describe what is meant by **machine independent**.

.....

.....[1]

**(ii)** Describe how a Java source code program is translated.

.....

.....

.....

.....[2]

**3** A Local Area Network is used by staff in a hospital to access data stored in a Database Management System (DBMS).

**(a)** Name **two** security measures to protect computer systems.

1 .....

2 .....
[2]

**(b)** A frequent task for staff is to key in new patient data from a paper document. The document includes the patient's personal ID number.

**(i)** The Patient ID is a seven digit number. The database designer decides to use a check digit to verify each foreign key value that a user keys in for a Patient ID.

When a user assigns a primary key value to a Patient ID, the DBMS adds a modulus-11 check digit as an eighth digit. The DBMS uses the weightings 6, 5, 4, 3, 2 and 1 for calculating the check digit. It uses 6 as the multiplier for the most significant (leftmost) digit.

Show the calculation of the check digit for the Patient ID with the first six digits 786531.

Complete Patient ID .....[4]

**(ii)** Name and describe **two** validation checks that the DBMS could carry out on each primary key value that a user keys in for a Patient ID.

1 Validation check .....

Description .....

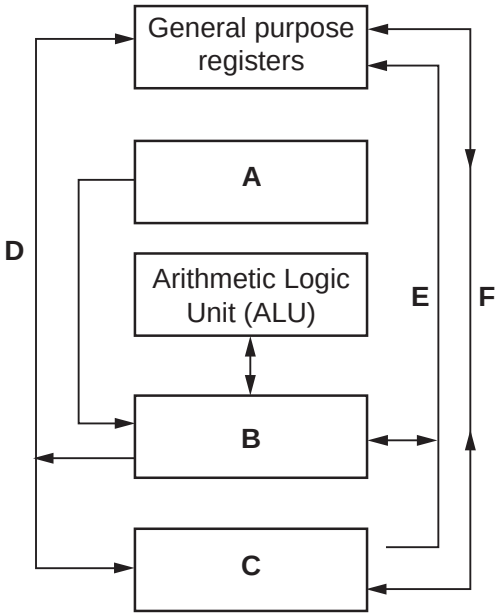
.....

2 Validation check .....

Description .....

.....
[4]

**4** **(a)** The diagram shows the components and buses found inside a typical Personal Computer (PC).




Some components and buses only have labels **A** to **F** to identify them.

For each label, choose the appropriate title from the following list. The title for label **D** is already given.

- Control bus
- System clock
- Data bus
- Control unit
- Main memory
- Secondary storage

**A** .....

**B** .....

**C** .....

**D** Address bus

**E** .....

**F** .....

[5]

**(b)** The following table shows part of the instruction set for a processor. The processor has one general purpose register, the Accumulator (ACC), and an Index Register (IX).

| Instruction | | | Explanation |
|---|---|---|---|
| **Op code (mnemonic)** | **Operand** | **Op code (binary)** | |
| LDM | #n | 1100 0001 | Immediate addressing. Load number n to ACC. |
| LDD | <address> | 1100 0010 | Direct addressing. Load the contents of the given address to ACC. |
| LDV | #n | 1100 0011 | Relative addressing. Move to the address n locations from the address of the current instruction. Load the contents of this address to ACC. |
| STO | <address> | 1100 0100 | Store the contents of ACC at the given address. |
| DEC | | 1100 0101 | Decrement the contents of ACC. |
| OUTCH | | 1100 0111 | Output the character corresponding to the ASCII character code in ACC. |
| JNE | <address> | 1110 0110 | Following a compare instruction, jump to <address> if the compare was False. |
| JMP | <address> | 1110 0011 | (Unconditionally) jump to the given address. |
| CMP | #n | 1110 0100 | Compare the contents of ACC with number n. |

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Complete the trace table for the following assembly language program.

| Label | Instruction |
|---|---|
| StartProg: | LDV #CountDown |
| | CMP Num1 |
| | JNE CarryOn |
| | JMP Finish |
| CarryOn: | OUTCH |
| | LDD CountDown |
| | DEC |
| | STO CountDown |
| | JMP StartProg |
| Finish: | LDM #88 |
| | OUTCH |
| | END |
| CountDown: | 15 |
| | 32 |
| | 51 |
| | 67 |
| Num1: | 32 |

| ASCII code table (selected codes only) | | | | |
|---|---|---|---|---|
| <Space> | 3 | B | C | X |
| 32 | 51 | 66 | 67 | 88 |

**Trace table:**

| ACC | CountDown | OUTPUT |
|---|---|---|
| | 15 | |
| 67 | | C |
| 15 | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

[5]

**(c)** The program given in **part (b)** is to be translated using a two-pass assembler.

The program has been copied here for you. The program now starts with a directive which tells the assembler to load the first instruction of the program to address 100.

| Label | | |
|---|---|---|
| | ORG | #0100 |
| StartProg: | LDV | #CountDown |
| | CMP | Num1 |
| | JNE | CarryOn |
| | JMP | Finish |
| CarryOn: | OUTCH | |
| | LDD | CountDown |
| | DEC | |
| | STO | CountDown |
| | JMP | StartProg |
| Finish: | LDM | #88 |
| | OUTCH | |
| | END | |
| CountDown: | | 15 |
| | | 32 |
| | | 51 |
| | | 67 |
| Num1: | | 32 |

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On the first pass of the two-pass process, the assembler adds entries to a symbol table.

The following symbol table shows the first eleven entries, part way through the first pass.

The circular labels show the order in which the assembler made the entries to the symbol table.

**Symbol table**

| Symbolic address | Absolute address |
|---|---|
| `StartProg` (1) | 100 (2) |
| `CountDown` (3) | UNKNOWN (4) |
| `Num1` (5) | UNKNOWN (6) |
| `CarryOn` (7) | ~~UNKNOWN~~ (8) 104 (11) |
| `Finish` (9) | UNKNOWN (10) |

Explain how the assembler made these entries to the symbol table.

.....

.....

.....

.....

.....

.....[3]

**(d)** The assembler software must then complete the second pass building up the executable file.

**(i)** Name the second table needed when the assembler software carries out the second pass.

.....[1]

The following shows two of the program instructions in machine code.

| Instruction | Machine code | |
|---|---|---|
| | Binary | Hexadecimal |
| OUTCH | 1100 0111 | C7 |
| JNE CarryOn | **A** | **B** |

Each of the numbers **A** and **B** represents the complete instruction in two bytes, one byte for the op code and one byte for the operand.

**(ii)** Use the following instruction set to write the numbers for **A** and **B**.

**A** (binary) .....

**B** (hexadecimal) .....

[3]

| Instruction | | | Explanation |
|---|---|---|---|
| Op code (mnemonic) | Operand | Op code (binary) | |
| LDM | #n | 1100 0001 | Immediate addressing. Load number n to ACC. |
| LDD | <address> | 1100 0010 | Direct addressing. Load the contents of the given address to ACC. |
| LDV | #n | 1100 0011 | Relative addressing. Move to the address n locations from the address of the current instruction. Load the contents of this address to ACC. |
| STO | <address> | 1100 0100 | Store the contents of ACC at the given address. |
| DEC | | 1100 0101 | Decrement the contents of ACC. |
| OUTCH | | 1100 0111 | Output the character corresponding to the ASCII character code in ACC. |
| JNE | <address> | 1110 0110 | Following a compare instruction, jump to <address> if the compare was False. |
| JMP | <address> | 1110 0011 | (Unconditionally) jump to the given address. |
| CMP | #n | 1110 0100 | Compare the contents of ACC with number n. |

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**5** A Personal Computer (PC) has a number of input and output devices.

**(a) (i)** Name **three** components of a speaker.

1 .....

2 .....

3 .....
[3]

**(ii)** Explain the basic internal operation of a speaker.

.....

.....

.....

.....

.....

.....

.....[4]

**(b) (i)** The user is considering the purchase of a removable device for secondary storage.

Name **one** suitable device.

.....[1]

**(ii)** Describe **two** possible uses for this device on a home Personal Computer (PC).

1 .....

.....

2 .....

.....
[2]

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**[Turn over**

**6** Raj has joined a software company as a trainee programmer. He was given the company's Code of Conduct document during his induction training. The handbook has a section headed 'Ethical Behaviour'.

**(a)** Describe what is meant by **ethics**.

.....

.....

.....[2]

**(b)** Raj is assigned to work as a new member of a development team.

In his first week, Raj feels uncomfortable working with one of his colleagues. He is unfamiliar with the programming language used by the team. Next week, he will be working on the site of one of the company's clients with a colleague. Raj is very nervous about working in an unfamiliar workplace.

Raj has a review with his manager after his first three weeks.

The Code of Conduct document was produced by the Human Resources section. It closely follows the ACM/IEEE Software Engineering Code of Ethics that uses these eight key principles:

| | | | |
|---|---|---|---|
| Public | Client and Employer | Product | Judgement |
| Management | Profession | Colleagues | Self |

There are issues Raj will want to raise with his manager.

- Describe **two** of these issues.
- Circle the key ACM/IEEE principle this comes under.
- Suggest what action should be taken to demonstrate ethical behaviour.

**Issue 1**

Description .....

.....

.....

ACM/IEEE principle (Circle one only)

| | | | |
|---|---|---|---|
| Public | Client and Employer | Product | Judgement |
| Management | Profession | Colleagues | Self |

Possible action .....

.....

.....

**Issue 2**

Description .....

.....

.....

ACM/IEEE principle (Circle one only)

| | | | |
|---|---|---|---|
| Public | Client and Employer | Product | Judgement |
| Management | Profession | Colleagues | Self |

Possible action .....

.....

.....

[6]

**Question 7 begins on the next page.**

**7** A clinic is staffed by several doctors. The clinic serves thousands of patients. Each day and at any one time, there is only one doctor in the clinic available for appointments.

The clinic stores patient, doctor and appointment data in a relational database.

**(a) (i)** Underline the primary key for each table in the following suggested table designs.

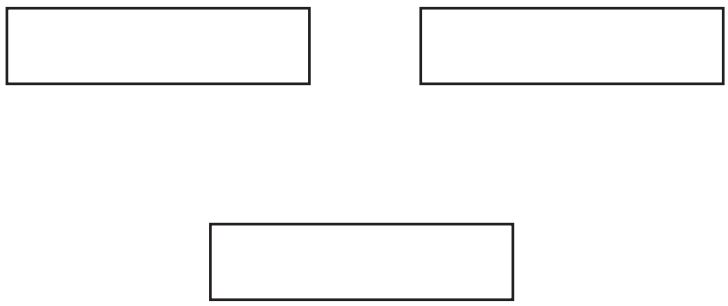
```
PATIENT(PatientID, PatientName, Address, Gender)

DOCTOR(DoctorID, Gender, Qualification)

APPOINTMENT(AppointmentDate, AppointmentTime, DoctorID, PatientID)
```

[2]

**(ii)** Complete the following entity-relationship (E-R) diagram for this design.



[2]

**(b)** The doctors are concerned that many patients make appointments but do not attend them.

Describe the changes to the table designs that could be made to store this information.

.....

.....[2]

**(c)** The doctors are about to set up a new clinic in the neighbouring village, SITE-B.

The original location is identified as SITE-A.

A new table is designed to store the ID of the doctor who is able to work at each site.

DOCTOR-AVAILABILITY(DoctorID, Site)

Five entries stored in the table are:

| DoctorID | Site |
|---|---|
| 098 | SITE-A |
| 074 | SITE-A |
| 117 | SITE-B |
| 098 | SITE-B |
| 033 | SITE-B |

**(i)** State what this data shows about the availability of the doctor with the ID of 098.

.....

.....[1]

**(ii)** Opening a new clinic in the neighbouring village will not require any additional table for storing appointments. It will need a change to the existing appointment table design.

Show the revised APPOINTMENT table.

APPOINTMENT( .....

..... ) [1]

**(d)** The doctor with the ID of 117 has recently been allocated a new DoctorID of 017.

**(i)** Write an SQL script to update this doctor's record in the database.

UPDATE .....

SET.....

WHERE .....
[3]

**(ii)** Describe why this update could cause problems with the existing data stored.

.....

.....

.....[2]

**(e)** Write an SQL script to display the date and time of all appointments made by the patient with the `PatientID` of 556.

.....

.....

.....[3]

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