40 mins 9 questions

Exam Questions

Program Design

Structure charts / State-Transition Diagrams

1 A program includes the following assignment statement:

Result ← STR_TO_NUM(x) / STR_TO_NUM(y)

When the program evaluates the expression in the statement, it performs a calculation.

Variable Result is of type real and variables x and y are of type string.

Two checks are required before the calculation is performed:

1. The two strings represent valid numeric values.

2. The numeric value of string y is not zero.

The designer considers implementing the **checks and calculation** as a module (a procedure or a function). One reason for this is that the same checks and calculations are performed at several places in the program.

Give **another** reason why this is a suitable approach **and** state what is avoided by this approach.

Answer

Mark Scheme and Guidance

Answers include:

Reason:

- This part of the algorithm performs a specific task // if the check or calculation is changed it is changed only once
- A (similar) subroutine is already available // Library routine is already available
- The program is simplified / easier to understand / easier to design / code / test / debug / maintain

Max 1 marks for 'Reason'

Avoided:

- Unnecessary code duplication

- Errors caused by differences where several copies of the check and calculation exist

Max 1 marks for 'Avoided'

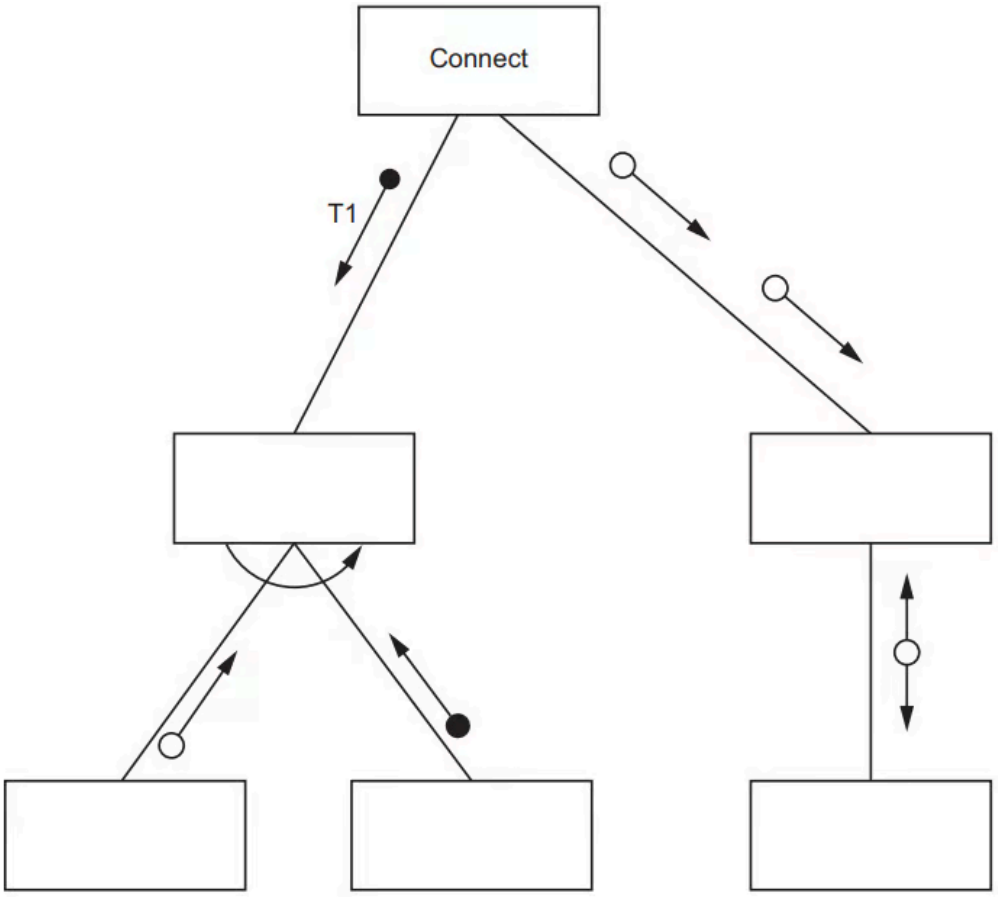
(2 marks)

2 (a) A program contains six modules with headers as follows:

Pseudocode module header
PROCEDURE Connect()
FUNCTION Activate(H1 : STRING, Code : INTEGER) RETURNS BOOLEAN
FUNCTION Sync(T1 : BOOLEAN, S2 : REAL) RETURNS INTEGER
PROCEDURE Initialise(BYREF ID : INTEGER, BYVAL CC : INTEGER)
FUNCTION Reset(RA : STRING) RETURNS INTEGER
FUNCTION Enable(SA : INTEGER) RETURNS BOOLEAN

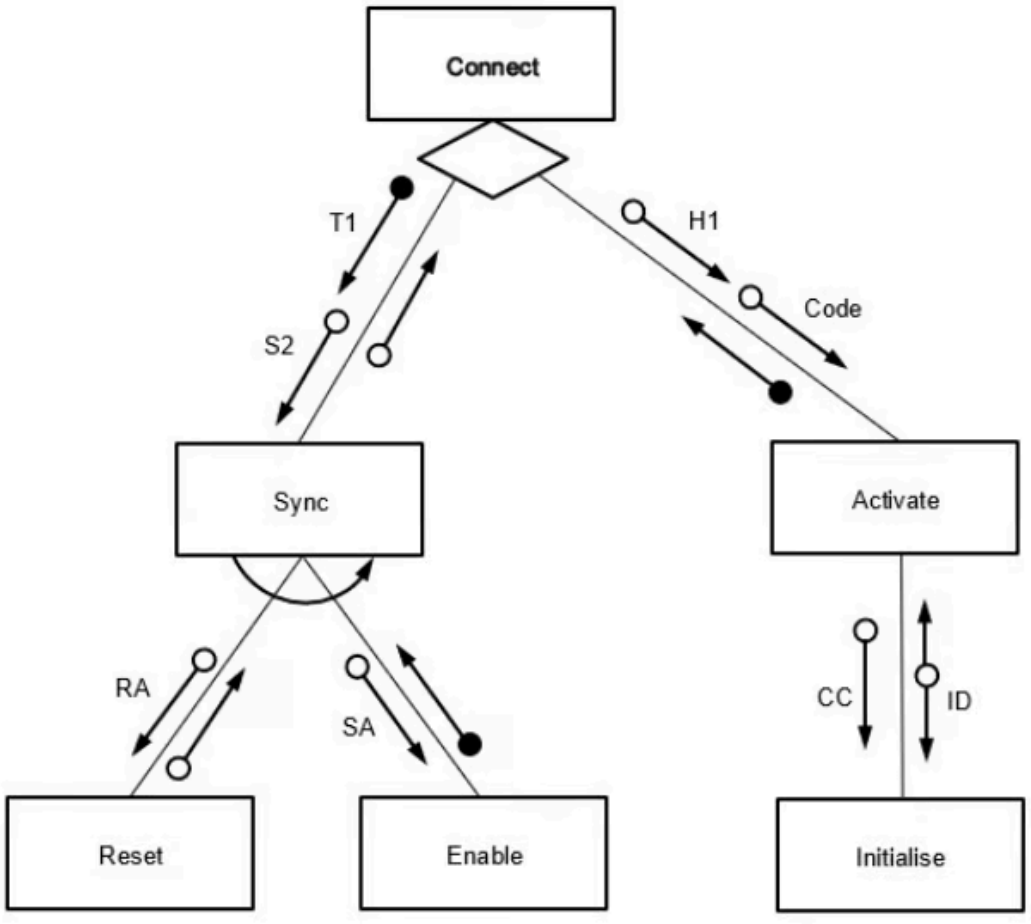
Module Connect() will call either Activate() or Sync(). This is decided at run-time.

Complete the structure chart for these modules.



Answer

Mark Scheme and Guidance



One mark per point:

1. All module identified in correct hierarchy
2. Parameters to both Sync and Activate and return values
3. Parameters to both Reset and Enable
4. Parameters to Initialise
5. Decision diamond

(5 marks)

(b) Explain the meaning of the curved arrow symbol used in the diagram in part (a).

Answer

Mark Scheme and Guidance

Explanation:

Means that Sync repeatedly calls Reset and (then) Enable

One mark for each point:

MP1: reference to iteration

MP2: naming all three modules correctly including correct sequence of calls

(2 marks)

3 (a) A coffee shop runs a computerised loyalty card system.

Customers are issued with a loyalty card with their name together with a unique customer ID.

Loyalty points are added to their card each time they spend money at the shop.

The following information is stored for each customer: ID, name, home address, email address, mobile phone number, date of birth, number of points, date of last visit and amount of money spent at last visit.

A new module will generate a personalised email message to each loyalty card customer who has not visited the coffee shop in the last three months. The message will include a unique voucher code which can be used to authorise a discount if the customer goes to the shop within the next two weeks.

It is decided to adopt a formal program development life cycle model for the development of the new module.

The analysis of the new module is complete and the project moves on to the design stage. During this stage all the necessary algorithms and module designs will be defined.

State **three other** items that will be defined for the new module during the design stage.

Answer

Mark Scheme and Guidance

MP1 Data structures // data dictionary // identifier table(s) // validation rules

MP2 Data-flow diagram // state-transition diagram

MP3 User interface // Format for the email

MP4 Testing method / Test plan / Test data / Trace tables

MP5 Choice of email protocol to be used // Programming language to be used // Development environment

MP6 Use of library routines // program to send the email

Max 3 marks

(3 marks)

(b) Part of the coffee shop program contains three program modules as follows:

Module Init() has no parameters and returns a Boolean.

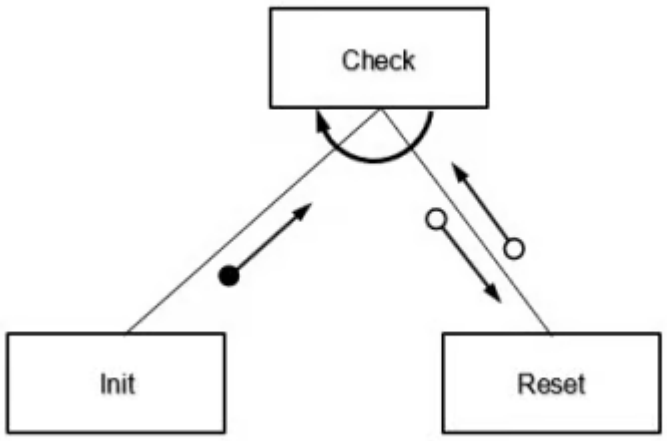
Module Reset() takes a string as a parameter and returns an Integer.

Module Check() repeatedly calls Init() followed by Reset().

Draw a structure chart to represent the relationship between the **three** modules, including all parameters and return values.

Answer

Mark Scheme and Guidance



MP1 Three boxes correctly labelled **and** correct hierarchy

MP2 Parameter **and** return values

MP3 Iteration arrow

(3 marks)

4 A coffee shop owner wants to introduce a computerised loyalty card system.

A programmer discusses the details of the system with the shop owner.

The shop will give each customer a loyalty card that displays a unique customer ID as a bar code. A customer will be able to present their card each time they make a purchase. The system will scan the bar code, calculate points, and add them to the customer's total. When the customer next makes a purchase and presents their card, they will have the option to exchange points for a discount.

The designer decides that this activity will be handled by a new module. Decomposition will be used to break the problem of designing the new module down into sub-problems (sub-modules).

Identify **four** sub-modules that could be used in the design of the new module and describe their use.

Answer

Mark Scheme and Guidance

One mark for name **and** use

Mark as follows:
Examples include:

Sub-module: ScanCard()/ GetID()
Use: Read the barcode from the loyalty card / Get the customer ID from the barcode

Sub-module: GetPoints()
Use: Get the number of points the customer has

Sub-module: ExchangePoints() / UpdateCard()
Use: Reduce the number of loyalty points

Sub-module: GetDiscount() / CalculateDiscount()
Use: Calculate the discount

Sub-module: CalculatePoints()
Use: Calculate points (following a purchase)

Sub-module: UpdatePoints()
Use: Update total points a customer has (following a purchase)

Sub-module: ShowDiscount()
Use: Display the discount

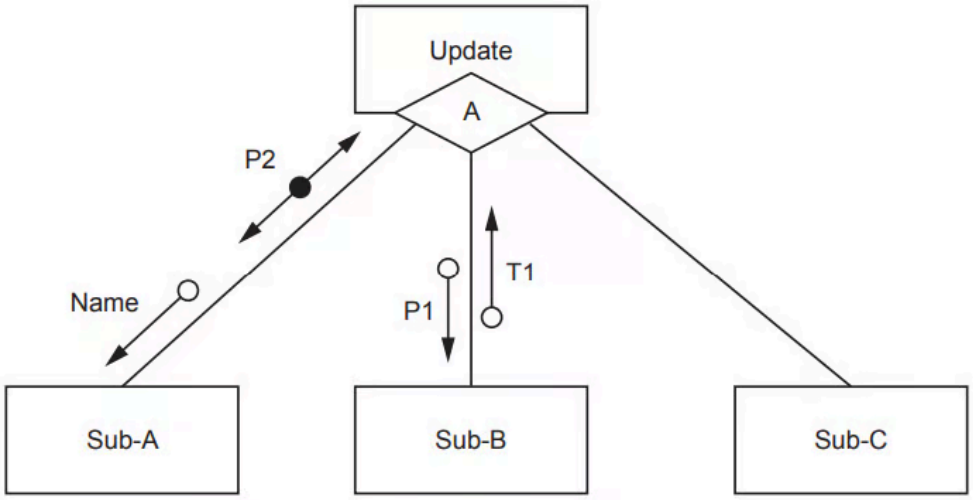
Max 4 marks

(4 marks)

5 A fitness club has a computerised membership system. The fitness club offers a number of different exercise classes.

The following information is stored for each club member: name, home address, email address, mobile phone number, date of birth and the exercise(s) they are interested in.

The structure chart illustrates part of the membership program:



Data item notes:

- Name contains the name of a club member
- P1 and T1 are of type real.

Explain the meaning of the diamond symbol (labelled with the letter A) in the chart.

Answer

Mark Scheme and Guidance

Means that Update calls (one of) either Sub-A, Sub-B or Sub-C

One mark for each point:

- reference to selection / decision / if
- naming all four modules correctly

(2 marks)

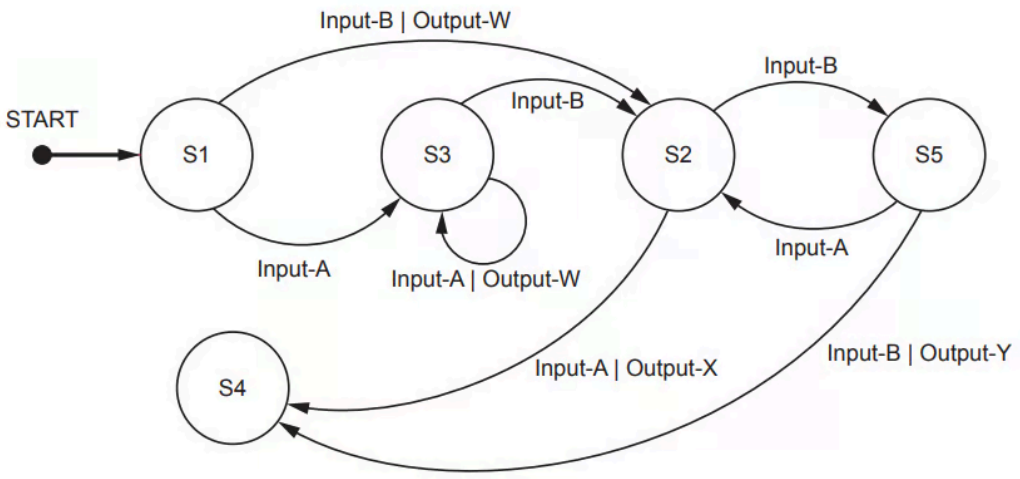
6 A fitness club has a computerised membership system.

The system stores information for each club member: name, home address, email address, mobile phone number, date of birth and exercise preferences.

Many classes are full, and the club creates a waiting list for each class. The club adds details of members who want to join a class that is full to the waiting list for that class.

When the system identifies that a space is available in one of the classes, a new module will send a text message to each member who is on the waiting list.

A different part of the program is represented by the following state-transition diagram.



(i) Complete the table to show the inputs, outputs and next states.

Assume that the current state for each row is given by the 'Next state' on the previous row. For example, the first Input-A is made when in state S1.

If there is no output for a given transition, then the output cell should contain 'none'.

The first two rows have been completed.

Input	Output	Next state
		S1
Input-A	none	S3
	Output-W	
	none	
Input-B		
Input-A		
		S4

(5)

(ii) Identify the input sequence that will cause the minimum number of state changes in the transition from S1 to S4.

(1)

Answer

Mark Scheme and Guidance

(i)

Input	Output	Next state
		S1
Input-A	none	S3
Input-A	Output-W	**S3**
Input-B	none	**S2**
Input-B	**none**	**S5**
Input-A	**none**	**S2**
Input-A	**Output-X**	S4

One mark per row 3 to 7

(ii) Input-B, Input-A

(6 marks)

7 A teacher is designing a program to process pseudocode projects written by her students.

Each student project is stored in a text file.

The process is split into a number of stages. Each stage performs a different task and creates a new file.

For example:

File name	Comment
MichaelAday_src.txt	Student project file produced by student Michael Aday
MichaelAday_S1.txt	File produced by stage 1
MichaelAday_S2.txt	File produced by stage 2

Suggest a reason why the teacher's program has been split into a number of stages **and** give the benefit of producing a different file from each stage.

Answer

Mark Scheme and Guidance

One mark for reason, one for benefit

Reason: (Program is) easier to design / implement / test / debug / modify

Benefit: Easier to check that **each stage** works as expected

(2 marks)

8 Seven program modules form part of a program. A description of the relationship between the modules is summarised below. Any return values are stated in the description.

Module name	Description
Mod-A	calls Mod-B followed by Mod-C
Mod-B	• called with parameters Par1 and Par2 • calls either Mod-D or Mod-E, determined when the program runs • returns a Boolean value
Mod-C	• called with parameters Par1 and Par3 • Par3 is passed by reference • repeatedly calls Mod-F followed by Mod-G
Mod-D	called with parameter Par2
Mod-E	• called with parameter Par3 • returns an integer value
Mod-F	called with parameter Par3
Mod-G	• called with parameter Par3 • Par3 is passed by reference

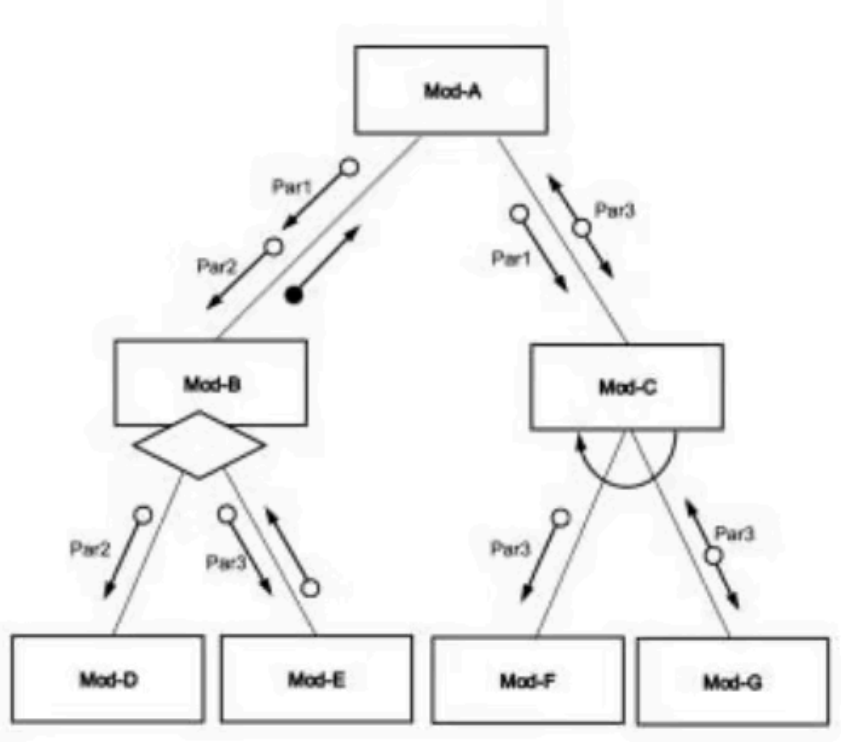
Parameters in the table are as follows:

- Par1 and Par3 are of type string.
- Par2 is of type integer.

Draw a structure chart to show the relationship between the seven modules and the parameters passed between them.

Answer

Mark Scheme and Guidance



One mark per bullet:

1. All modules correctly labelled and interconnected
2. Parameters between Mod-A and Mod-B and return value from Mod-B
3. Parameters between Mod-A and Mod-C
4. Diamond applied to Mod-B only
5. Iteration arrow applied to Mod-C only
6. All parameters at lower level and return value

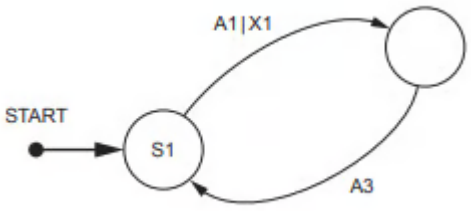
(6 marks)

9 An algorithm is represented by a state-transition diagram.

The table shows the inputs, outputs and states for the algorithm:

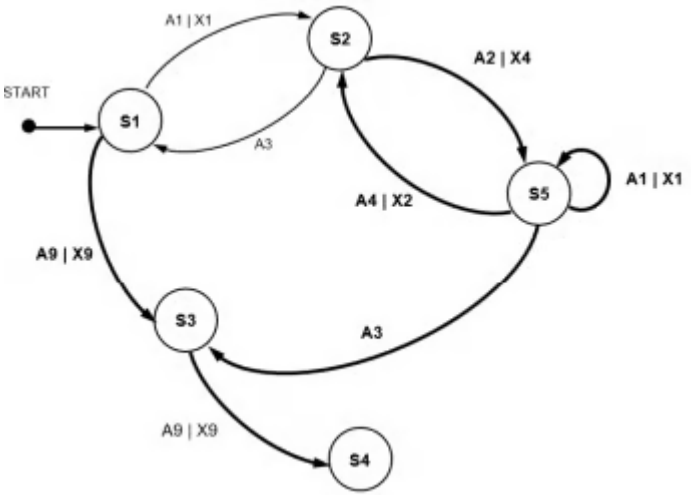
Current state	Input	Output	Next state
S1	A1	X1	S2
S2	A3	none	S1
S2	A2	X4	S5
S5	A1	X1	S5
S5	A4	X2	S2
S5	A3	none	S3
S1	A9	X9	S3
S3	A9	X9	S4

Complete the state-transition diagram to represent the information given in the table.



Answer

Mark Scheme and Guidance



- **MP1** S2 labelled
- **MP2** S3, S4 and S5 added
- **MP3** Line from S1 to S3
- **MP4** All three lines between S2 and S5 (including S5 to S5)
- **MP5** Line from S5 to S3 AND from S3 to S4

(5 marks)