Syllabus Content:

12.3 Program testing and maintenance:

Candidates should be able to:

Show understanding of ways of exposing and avoiding faults in programs

Notes and guidance

Locate and identify the different types of errors

- syntax errors
- logic errors
- run-time errors

Show understanding of the methods of testing available and select appropriate data for a given method Including:

- dry run, walkthrough, white-box, black-box, integration, alpha, beta, acceptance, stub
- Show understanding of the need for a test strategy and test plan and their likely contents
- Choose appropriate test data for a test plan Including normal, abnormal and extreme/boundary
- Show understanding of the need for continuing maintenance of a system and the differences between each type of maintenance including
  - perfective, adaptive, corrective
- Analyse an existing program and make amendments to enhance functionality

Testing strategies

Finding syntax errors is easy. The compiler/ interpreter will find them for you and usually gives you a hint as to what is wrong.

Syntax Error:

A **syntax error** is a 'grammatical' error, in which a program statement does not follow the rules of the high-level language constructs.

Syntax error: an error in which a program statement does not follow the rules of the language

```
(General)                                                    (Declarat
Module Module1

    Sub Main()
        Dim number As Integer
        Consolee.writeelinee()
        Console.WriteLine("Hello Dear,  Enter your lucky number")
        Console.WriteLine("If your Lucky numbner is correct, you will win a car ")
        number = Console.ReadLine()

        While number <> -1
            Console.WriteLine("Sorry Dear, You lost Enter your lucky number again ")
            number = Console.ReadLine()
            End

            Console.WriteLine("HURRAAYYY, You've just won a HONDA CIVIC")
            Console.WriteLine("The Lucky number you've entered is " & number)

            Console.ReadKey()
    End Sub

End Module
```

When Syntax error occurs, VB IDE underlines wrong syntax, and gives options for corrections.

Much more difficult to find are **logic errors** and **run-time errors.**

A run -time error occurs when program execution comes to an unexpected ha lt or 'crash' or it goes into an infinite loop and 'freezes'.

Logical Error:

Logic error: an error in the logic of the solution that causes it not to behave as intended

Run-time Error:

Run-time error: an error that causes program execution to crash or freeze

Testing

Both of these types of errors can only be found by careful testing. The danger of such errors is that they may only manifest themselves under certain circumstances. If a program crashes every time it is executed, it is obvious there is an error.

```
Module1                                                    Main
Module Module1
    Dim MenuChoice As String
    Dim ProgramEnd As Boolean = False

    Sub ShowMenu() ...
    Sub EnterNewStudent()
        Console.WriteLine("EnterNewStudent routine called")
    End Sub
    Sub AmendDetails()
        Console.WriteLine("AmendDetails routine called")
    End Sub
    Sub PrintList()
        Console.WriteLine("PrintList routine called")
    End Sub
    Sub SearchByName()
        Console.WriteLine("SearchByName routine called")
    End Sub

    Sub Main()
        Do
            ShowMenu()
            MenuChoice = Console.ReadLine()
            Select Case MenuChoice
                Case "1"
                    EnterNewStudent()
                Case "2"
                    AmendDetails()
                Case "3"
                    PrintList()
                Case "4"
                    SearchByName()
                Case "5"
                    ProgramEnd = True
                Case Else
                    Console.WriteLine("Invalid choice. Try again")
            End Select
        Loop Until ProgramEnd

    End Sub

End Module
100 %
```

If the program is used frequently and appears to work until a certain set of data causes a malfunction.

That is much more difficult to discover without perhaps serious consequences.

Stub testing

When you develop a user interface, you may wish to test it before you have implemented all the facilities.

You can write a **'stub'** for each procedure (see Figure).

The procedure body only contains an output statement to acknowledge that the call was made. Each option the user chooses in the main program will call the relevant procedure.

Black-box Testing:

As the programmer, you can see your program code and your testing will involve knowledge of the code (see the next section, about white-box testing).

As part of thorough testing, a program should also be tested by other people, who do not see the program code and don't know how the solution was coded.

Such program testers will look at the program specification to see what the program is meant to do, devise test data and work out expected results.

Test data usually consists of normal data values, boundary data values and erroneous data values.

The tester then runs the program with the test data and records their results. This method of testing is called black-box testing because the tester can't see inside the program code: the program is a 'black box'.

Where the actual results don't match the expected results, a problem exists. This needs further investigation by the programmer to find the reason for this discrepancy and correct the program.

Once black-box testing has established that there is an error, other methods have to be employed to find the lines of code that need correcting.

KEY TERMS

Test data: carefully chosen values that will test a program

Black-box testing: comparing expected results with actual results when a program is run

White-box Testing:

How can we check that code works correctly? We choose suitable test data that checks every path through the code

KEY TERMS

White-box testing: testing every path through the program code

Dry-running an algorithm:

A good way of checking that an algorithm works as intended is to **dry-run** the algorithm using a **trace table** and different test data.
The idea is to write down the current contents of all variables and conditional values at each step of the algorithm.

KEY TERMS

Dry-run: the process of checking the execution of an algorithm or program by recording variable values in a trace table

Trace table: a table with a column for each variable that records their changing values

WORKED EXAMPLE 15.02

Tracing an algorithm

Here is the algorithm of the number-guessing game:

```
SecretNumber ← 34
INPUT "Guess a number: " Guess
NumberOfGuesses ← 1
REPEAT
   IF Guess = SecretNumber
      THEN
         OUTPUT "You took" NumberOfGuesses "guesses"
      ELSE
         IF Guess > SecretNumber
            THEN
               INPUT "Guess a smaller number: " Guess
            ELSE
               INPUT "Guess a larger number: " Guess
         ENDIF
         NumberOfGuesses ← NumberOfGuesses + 1
   ENDIF
UNTIL Guess = SecretNumber
```

To test the algorithm, construct a trace table (Table 15.02) with one column for each variable used in the algorithm and also for the condition `Guess > SecretNumber`

Now carefully look at each step of the algorithm and record what happens. Note that we do not tend to write down values that don't change. Here `SecretNumber` does not change after the initial assignment, so the column is left blank in subsequent rows.

SecretNumber	Guess	NumberOfGuesses	Guess > SecretNumber	Message
34	5	1	FALSE	...larger...
	55	2	TRUE	...smaller...
	30	3	FALSE	...larger...
	42	4	TRUE	...smaller...
	36	5	TRUE	...smaller...
	33	6	FALSE	...larger...
	34	7		... 7 guesses

Table 15.02 Trace table for number-guessing game

References:

- Cambridge International AS & A level Computer Science Course book by Sylvia Langfield and Dave Duddell
- Visual Basics Console Mode Editor Window from notes of Sir Majid Tahir