Level 3 Software design fundamentals

(7540-033/7630-348)

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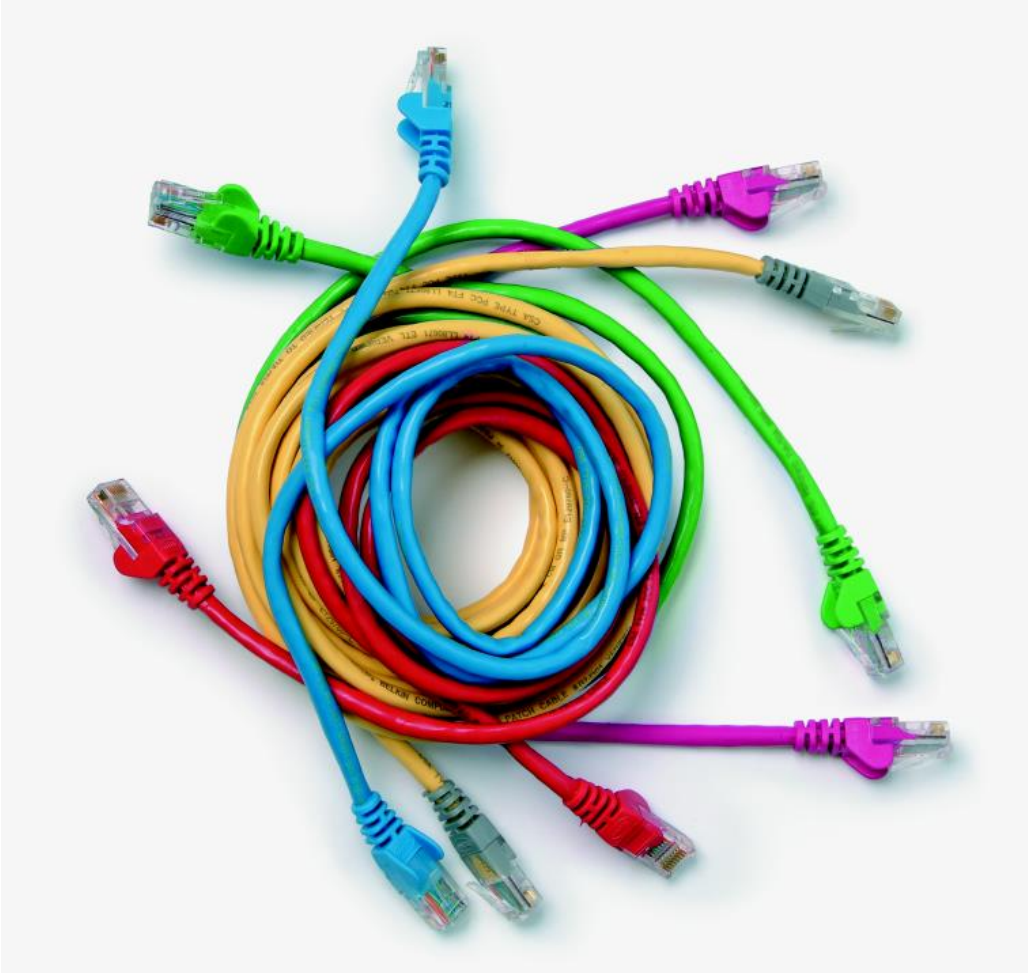
Systems and Principles
Assignment guide for Candidates
Assignment C



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Level 3 Software design fundamentals (7540-033/7630-348) Assignment C

Introduction – Information for Candidates

About this document

This assignment comprises all of the assessment for Software design fundamentals (7540-033/7630-348).

Health and safety

You are asked to consider the importance of safe working practices at all times.

You are responsible for maintaining the safety of others as well as your own. Anyone behaving in an unsafe fashion will be stopped and a suitable warning given. You will **not** be allowed to continue with an assignment if you compromise any of the Health and Safety requirements. This may seem rather strict but, apart from the potentially unpleasant consequences, you must acquire the habits required for the workplace.

Time allowance

The recommended time allowance for this assignment is **3 hours**.

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Candidate instructions

Time allowance: 3 hours

Assignment set up:

This assignment is made up of **one** task

Task A – interpret documentation and design software components from a given specification

Scenario

You work as a software developer for Complex Solutions. You have been asked to work as a team member to help design a prototype for a new compiler that the company are developing. The compiler is to compile the source code from a new programming language and convert the source code so that the software can be run via the Internet on any computer. The specification for the compiler is in Appendix A.

Task A

In this task you are required to design part of the software for the prototype compiler.
The following Event/Action chart has been provided by your team leader.

Event/Action chart			
Event/function/ procedure	**Parameters**	**Action**	**Function/ procedure calls**
private void mnuOpen		Opens the source code file and reads and displays the data in the editor window	
private void mnuSave		Saves the source code file	
private void mnuSaveAs		Saves the source code file with the entered filename	
private void mnuClose		Prompts to save source code file if it has changed and then closes the file	

private void mnuExit		**Prompts to save source code file if it has changed and then exits the software**	
private void mnuCompile		Compiles the source code	Init InitResWords ReadLines CheckSyntax
private void Init		Initialises arrays	
private void InitResWords		Sets up the reserved words in the symbol table	
private void ReadLines		Reads the lines in the source code file	GetWord CheckValidIdent HashSymbol
private boolean GetWord	by value: integer LineCounter - contains source code line number by reference: char array Line – the input source code line boolean Comment – contains true if a comment spans more than one line otherwise false char array Word – the word found in a line	Finds a word or string in the passed Line parameter Removes comment text Replaces a comma with a space Outputs error message 003 or 004 if an error found Returns in the Comment parameter true if a comment spans more than one line or false Returns in the Word parameter the word or string found or an empty string Returns in the Line parameter the input line with the word, string or comment removed or an empty string Returns a boolean value true if no error found, false if an error found	
private boolean CheckValidIdent	by value: integer LineCounter – contains source code line number char array Word – holds the identifier to be checked	Checks that the Word parameter passed is a valid identifier ie contains valid letters a..z or A..Z or digits 0..9 but does not have a digit in the first position Outputs error message 005 if an error found Returns a boolean value true if no error found, false if an error found	
private void HashSymbol	by value char array InWord – holds the identifier to be hashed into the symbol table	Hashes the identifier into the symbol table and inserts data into the lexical records	CalcHash

	integer LineCounter - contains source code line number		
private integer CalcHash	by value WordIn	Calculates the hash value for the data in WordIn and returns the hashed value	
private void CheckSynTax		Works through the symbol table checking the syntax of the records against the syntax list for each instruction	
private void mnuRun		Runs the program using the data in the lexical records	

1 **Produce the design language algorithms for the following functions/procedures:**

- **mnuClose**
- **CheckValidIdent**
- **GetWord.**

2 Make sure that error messages as specified in the specification are output if an error occurs.

3 Make sure that the design follows the criteria listed below:

- the design conforms to the specification
- the program design language clearly shows
  - variable names and data types,
  - argument/parameter names and data types,
  - return value data types
- the design is consistent and complete
- quality criteria are met by the design.

4 Please use the Answer Sheet provided to complete Task A4.
Give a brief description of the role of software design in the IT Systems Development Life Cycle (SDLC).

5 Please use the Answer Sheet provided to complete Task A5.
Explain the purpose of encapsulation.

6 Please use the Answer Sheet provided to complete Task A6.
Explain which type of software is used to support the whole SDLC.

7 Please use the Answer Sheet provided to complete Task A7.
Explain **two** advantages of using pre-written library routines.

8 Please use the Answer Sheet provided to complete Task A8.
Describe **two** types of validation check and give an example for each.

Note

- Candidates should produce the following for their assessor:
  - program design language algorithms for the functions/procedures mnuClose, CheckValidIdent and GetWord

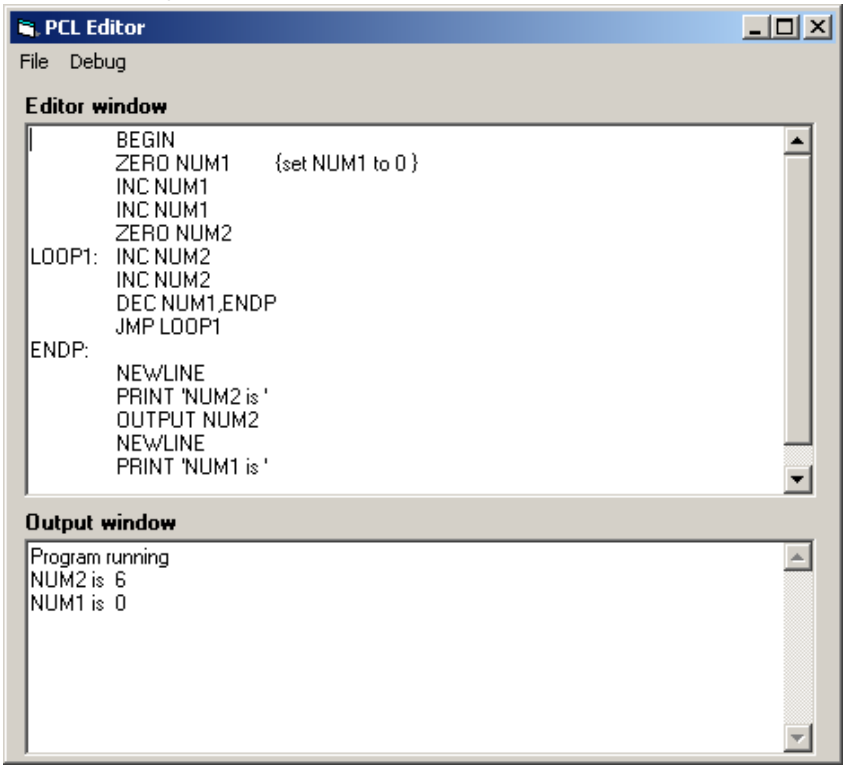
- Completed Answer Sheet.

- Ensure that your name is on all documentation
- If the assignment is taken over more than one period, all paperwork must be returned to the test supervisor at the end of each sitting.

Specification

A compiler is required for a new programming language called Intermediate Computer Programming Language (ICPL) which is under development. The new programming language is intended for use on the Internet. The instructions are compiled into tokens and it is intended that the program can then be run on any computer.

The screen layout for the software is shown below.



The File menu contains the menu options - Open, Save, Save As, Close and Exit.

The Debug menu contains the menu options – Compile and Run.

The source code files that are input and output by the compiler have the extension **.cpl**

There is an Editor window and an Output window. The source code for a program can be entered into the Editor window and saved or an existing file can be read from disk.

When the Compile menu option is selected the source code is compiled and the compiler checks each line word by word. Comment lines are removed and any comma found is replaced by a space. For string data the start and end quote are checked for. If an error is found an error message is output. A lexical analysis is done to check that identifier names are valid. No entry is made in the symbol table or lexical record if an error is found. When the lexical analysis is complete, if no errors are found the compiler performs a syntax analysis. If any errors are found in the syntax of the code an error message is output.

The Run menu option will not run the program unless a compilation has been performed successfully first.

Instruction set

The ICPL contains the following instruction set which is used to create a program.

ZERO variablename
Sets a specified variable to 0 and continues to the next instruction.

INC variablename
increases the specified variable by 1 and continues to the next instruction.

DEC variablename,label
This is a conditional instruction. It checks the contents of the specified variable. If the contents of the specified variable are not zero then the contents of the specified variable are decreased by 1 and the next instruction is executed. If the specified variable contains zero then a jump is made to the specified label. This instruction is useful for executing and terminating a loop.

MOV variablename, variablename
This instruction moves the value in the first specified variable to the second specified variable and then continues to the next instruction. This instruction is useful for saving values in a variable before executing a loop.

JMP label
This instruction is an unconditional jump to a specified label in the program. This allows the order in which instructions are executed to be altered.

HALT
This instruction signals the end of the program instructions.

{ text }
This format is used to insert comments into the program. Multiple line comments can be used.

INPUT variablename
This instruction inputs a numeric integer in the range 0 to 500 into the specified variable and continues to the next instruction.

OUTPUT variablename
This instruction outputs the contents of the specified variable and continues to the next instruction. This is useful to allow calculated results to be output.

PRINT 'text'
This instruction outputs the text contained within the single quotes and then continues to the next instruction. It is used to make the output values meaningful.

NEWLINE
This instruction outputs a newline and continues to the next instruction. It is required so that data is not output on a continuous line.

*LABEL***:**
This instruction is used for a label that can be branched to by the conditional and unconditional branch instructions (DEC and JMP).

Error messages

Error messages are displayed in the Output window.

Error Code	Error message
001:	Cannot open file *filename*
002:	Cannot save file
003:	2 begin comment symbols, line no *linenumber*
004:	No end QUOTE found, line no *linenumber*
005:	Invalid identifier name *name*, line no *linenumber*
006:	*Line input* Syntax Error: Invalid label, line no *linenumber*
007:	*Line input* Syntax Error: Reserved word mis-spelt or missing, line no *linenumber*
008:	*Line input* Syntax Error: String expected, line no *linenumber*
009:	*Line input* Syntax Error: Identifier expected, line no *linenumber*
010:	*Line input* Syntax Error: Label name expected, line no *linenumber*
011:	No end comment symbol found
012:	Invalid data entered
013:	Must have successful compilation first
014:	Cannot run, file not open
015:	Syntax errors found: Compilation terminated
016:	Lexical Analysis errors found: Compilation terminated

Note that when the program is run one syntax error can cause several other syntax errors to be signalled. This is because the compiler becomes out of step with the start of an instruction and is a normal result for a syntax analysis. Also the line number may point to the line below where the actual error occurred.

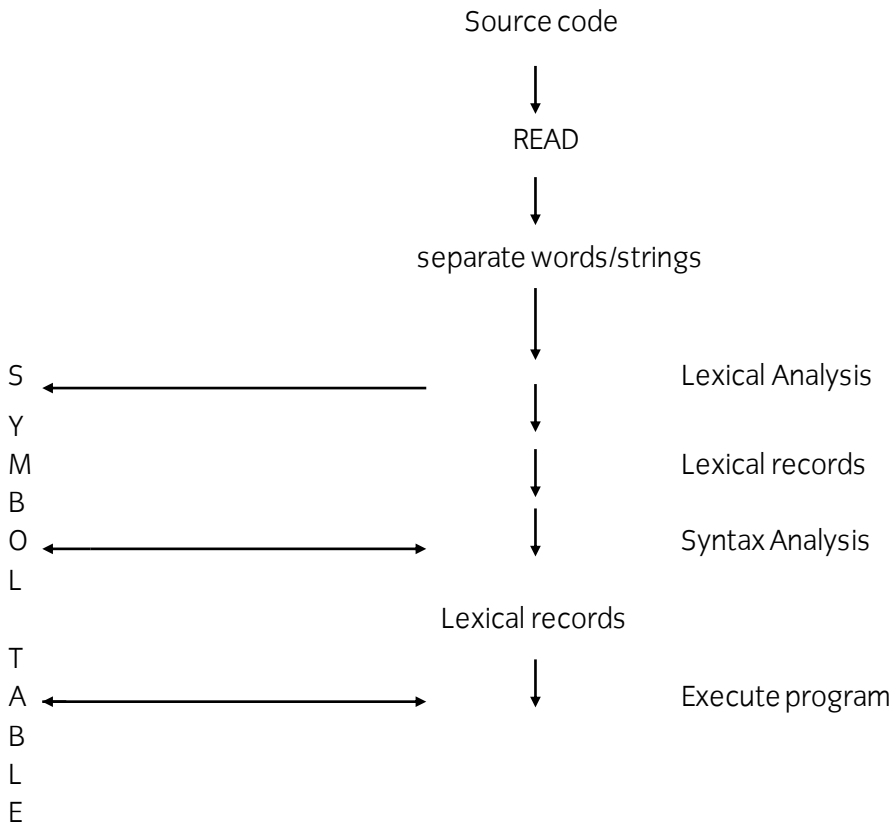
BNF Definition

<program>	::=	BEGIN<vsep><statementseq><vsep>END
<statementseq>	::=	<statement>|<statement><vsep><statementseq>
<statement>	::=	<sep><stat>|<sep><label>:<spaces><stat>|<sep><label>:
<label>	::=	<letter>|<label><letter>|<label><digit>
<letter>	::=	A|B|C……Y|Z|a|b|c……y|z
<digit>	::=	0|1|2|3|4|5|6|7|8|9
<sep>	::=	<spaces>|<null>|<tab>
<null>	::=	
<stat>	::=	<IOstat>|<calcstat>|<haltstat>
<haltstat>	::=	HALT
<IOstat>	::=	<INstat>|<OUTVstat>|<OUTPstat>|<NEWLstat>
<calcstat>	::=	<zerostat>|<incstat>|<jmpstat>|<movstat>|<decstat>
<INstat>	::=	INPUT<spaces><varname>
<OUTVstat>	::=	OUTPUT<spaces><varname>
<OUTPstat>	::=	PRINT<spaces>'<text>'
<NEWLstat>	::=	NEWLINE
<zerostat>	::=	ZERO<spaces><varname>
<incstat>	::=	INC<spaces><varname>
<jmpstat>	::=	JMP<spaces><label>
<movstat>	::=	MOV<spaces><varname>,<varname>
<decstat>	::=	DEC<spaces><varname>,<label>
<varname>	::=	<letter>|<varname><digit>|<varname><letter>
<vsep>	::=	<CR>|{<text>}<vsep>|<CR><vsep>|<spaces><vsep> where CR is an implementation of carriage return/linefeed
<text>	::=	<text><char>|<char>
<char>	::=	any ASCII char except{}'
<spaces>	::=	b|b<spaces> where b represents a space

The | symbol represents OR
The definition restricts labels and variables so that they cannot start with a digit.

A sample program

```
BEGIN
        { filename TEST.CPL }

{The syntax in this program is correct as defined for the language}

{ A program to multiply 2 positive integers input into variables
  NUM1 and NUM2. The multiplication is done by using multiple additions.
  The value in NUM1 is added to RESULT for the number of times in NUM1 }

        NEWLINE
        PRINT 'This program will multiply 2 positive integers'
        NEWLINE
        NEWLINE
        PRINT 'Input first number'
        INPUT NUM1
        NEWLINE
        PRINT 'Input second number'
        INPUT NUM2
        ZERO RESULT         { set RESULT to 0 }
        MOV NUM2,STORE

{Store the contents of the variable NUM2 in the variable STORE }

LOOP1:  DEC NUM1,ENDP
        DEC NUM2,ENDP       { test if initial values = 0 }
LOOP2:
        INC RESULT  { Increase RESULT by 1 }
        DEC NUM2,LOOP3     { If NUM2 = 0 then exit loop }
        JMP LOOP2   { If NUM2 not = 0 repeat loop }
LOOP3:
        MOV STORE,NUM2

{ Restore the value from STORE to NUM2 }

        JMP LOOP1   { Jump to repeat loop1 }
ENDP:
        NEWLINE
        PRINT 'Result = '
        OUTPUT RESULT     { Output the result from RESULT }
        NEWLINE
        HALT
END
```



The source code file is read and for each line, comments are removed, a comma is replaced by a space and each word or string in the line is separated. The word in the line is checked to make sure that it is a valid identifier and then stored in the symbol table. The subscript for the string array is stored in the lexical record and the string is stored in the string array.

Symbol table

Reserved words are hashed into the symbol table each time the compiler is run using the same algorithm as is used to search for and insert identifiers into the symbol table.

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