EXAMPLE PROGRAM TEMPERATURE CONVERSION PLUS REPORT

1. Requirements

To produce a program that converts air temperature measured on the Centigrade, Fahrenheit or Kelvin scale to some other desired scale (i.e. Centigrade, Fahrenheit or Kelvin). Input must be in whole numbers of degrees, within the range of -50 to 100 degrees Centigrade (or equivalent), and the required output must be accurate to one decimal place.

2. Design

There are six possible conversions that may be required:

1.	Centigrade to Fahrenheit:	$F = (9/5 \times C) + 32$
2.	Centigrade to Kelvin:	$K = C + 273.15$
3.	Fahrenheit to Centigrade:	$C = (F - 32) \times 5/9$
4.	Fahrenheit to Kelvin:	$K = ((F - 32) \times 5/9) + 273.15$
5.	Kelvin to Centigrade:	$C = K - 273.15$
6.	Kelvin to Fahrenheit:	$F = (9/5 \times (C-273.15)) + 32$

From the above we can see that here are essentially two significant arithmetic operations:

1) Centigrade to Fahrenheit conversion, and
2) Fahrenheit to Centigrade conversion.

To convert from Kelvin to Centigrade, and vice-versa, we simply add or subtract the value 273.15 as appropriate. To convert from Fahrenheit to Kelvin we first convert to Centigrade and then add 273. To convert from Kelvin to Fahrenheit we first convert to Centigrade by subtracting 273 and then convert to Fahrenheit. Note also we can make use of code from earlier programs concerned with temperature conversion (Centigrade to Fahrenheit conversion and Centigrade to Fahrenheit conversion and vice-versa).

A top-down analysis of the proposed problem is given in Table 1.

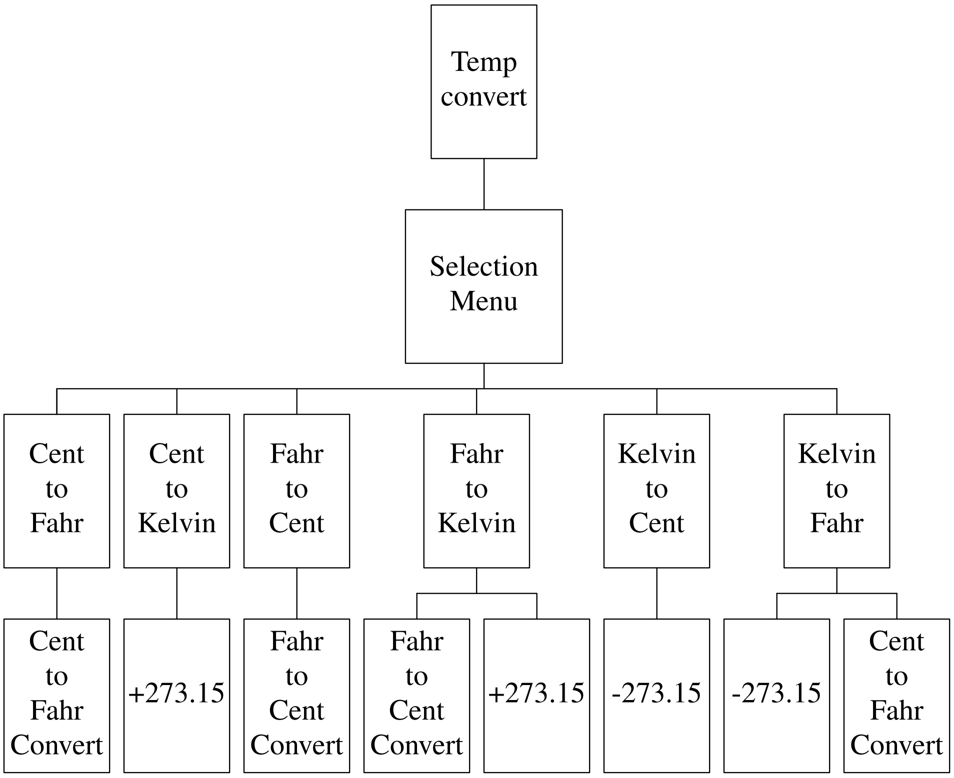
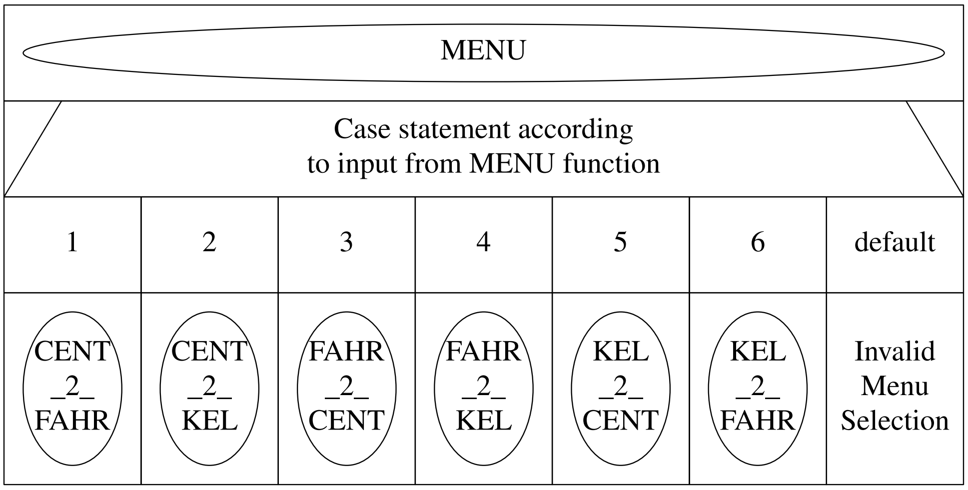


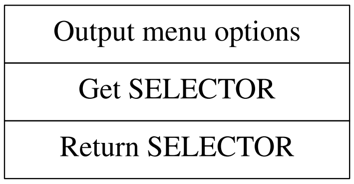
Table 1: *Top-down analysis*

From the design we note that the "Centigrade to Fahrenheit conversion" and "Fahrenheit to Centigrade conversion" operations are called twice and thus should be implemented at a level such that only one procedure is required. The +/-273.15 operations are too trivial to warrant separate procedures.

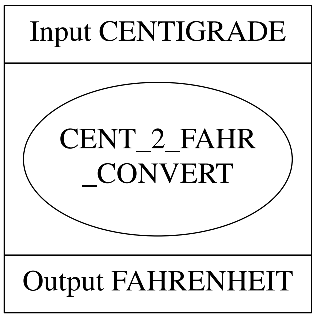
A complete Nassi-Schneiderman design for the above is given in Table 2.



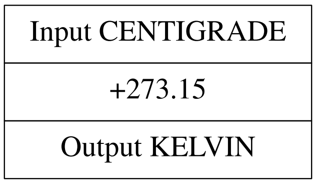
TEMP_CONVERT_PLUS
(Top level Procedure)



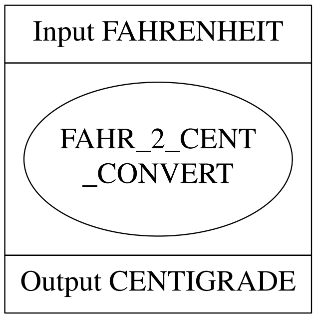
MENU
(Level 2 Procedure)



CENT_2_FAHR
(Level 3 Procedure)



CENT_2_KEL
(Level 3 Procedure)



FAHR_2_CENT
(Level 3 Procedure)

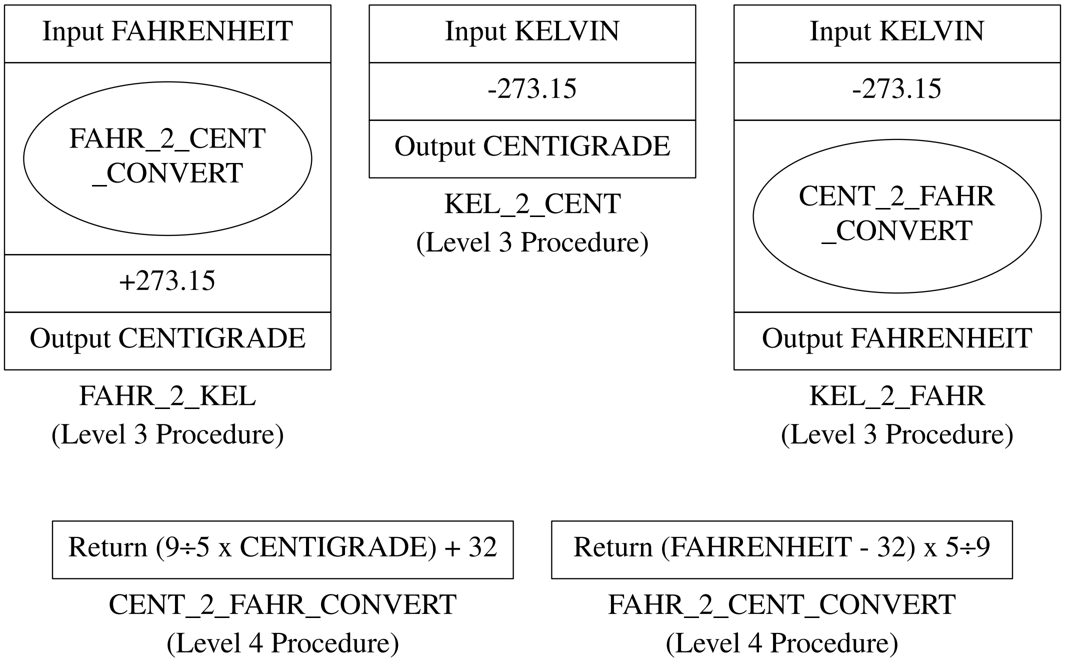


Table 2: *Nassi-Schneiderman Charts*

From the above design we can identify the following input data items:

Name	Type	Range
SELECTOR	INTEGER	DEFAULT
CENTIGRADE	INTGER	-50..100
FAHRENHEIT	INTGER	-58..212
KELVIN	INTGER	223..373

3. Implementation

Top down implementation commencing with level 1 top level procedure and continuing through levels 2, 3 and 4. Final implementation will be as shown in Table 3:

```
-- TEMPERATURE CONVERSION PLUS
-- 7 August 1997
-- Frans Coenen
-- Dept Computer Science, University of Liverpool

with TEXT_IO;
use TEXT_IO;

procedure TEMP_CONVERT_PLUS is
        package INTEGER_INOUT is new INTEGER_IO(INTEGER);
        use INTEGER_INOUT;
        package FLOAT_INOUT is new FLOAT_IO(FLOAT);
        use FLOAT_INOUT;
        SELECTOR: INTEGER;

-----------------------------------------------------------------------
-- MENU FUNCTION
        function MENU return INTEGER is
                MENU_ITEM: INTEGER;
        begin
-- Output Menu
                PUT_LINE("MENU OPTIONS");
                PUT_LINE("1 - Centigrade to Fahrenheit conversion");
                PUT_LINE("2 - Centigrade to Kelvin conversion");
                PUT_LINE("3 - Fahrenheit to Centigrade conversion");
                PUT_LINE("4 - Fahrenheit to Kelvin conversion");
                PUT_LINE("5 - Kelvin to Centigrade conversion");
                PUT_LINE("6 - Kelvin to Fahrenheit conversion");
                GET(MENU_ITEM);
                RETURN(MENU_ITEM);
        end MENU;

-----------------------------------------------------------------------
-- CENTIGRADE TO FAHRENHEIT CONVERSION FUNCTION
        function CENT_2_FAHR_FUN(CENT_TEMP: FLOAT) return FLOAT is
        begin
-- Conversion and return
                RETURN(CENT_TEMP * (9.0/5.0) + 32.0);
        end CENT_2_FAHR_FUN;

-----------------------------------------------------------------------
-- CENTIGRADE TO FAHRENHEIT CONVERSION
        procedure CENT_2_FAHR return FLOAT is
                CENTIGRADE: INTEGER is range -50..100;
        begin
-- Input Centigrade value
                PUT_LINE("Input temperature in degrees Centigrade: ");
                GET(CENTIGRADE);
-- Conversion and return
                PUT("The equivalent in degrees Fahrenheit is: ");
                PUT(CENT_2_FAHR_FUN(FLOAT(CENTIGRADE)),FORE=>3,AFT=>2,
                                EXP=>0);
        end CENT_2_FAHR;
```

Table 3: *Implementation*

```
------------------------------------------------------------------------
-- CENTIGRADE TO KELVIN CONVERSION
        procedure CENT_2_KEL is
                CENTIGRADE: INTEGER is range -50..100;
        begin
-- Input Centigrade value
                PUT_LINE("Input temperature in degrees Centigrade: ");
                GET(CENTIGRADE);
-- Conversion and return
                PUT("The equivalent in degrees Kelvin is: ");
                PUT(FLOAT(CENTIGRADE)+273.15,FORE=>3,AFT=>2,EXP=>0);
        end CENT_2_KEL;

------------------------------------------------------------------------
-- FAHRENHEIT TO CENTIGRADE CONVERSION FUNCTION
        function FAHR_2_CENT_FUN(FAHR_TEMP: FLOAT) return FLOAT is
        begin
-- Conversion and return
                RETURN((FAHR_TEMP-32.0) * (5.0/9.0));
        end FAHR_2_CENT_FUN;

------------------------------------------------------------------------
-- FAHRENHEIT TO CENTIGRADE CONVERSION
        procedure FAHR_2_CENT is
                FAHRENHEIT: INTEGER is range -58..212;
        begin
-- Input Fahrenheit value
                PUT_LINE("Input temperature in degrees Fahrenheit: ");
                GET(FAHRENHEIT);
-- Conversion and return
                PUT("The equivalent in degrees Centigrade is: ");
                PUT(FAHR_2_CENT_FUN(FLOAT(FAHRENHEIT)),FORE=>3,AFT=>2,
                                EXP=>0);
        end FAHR_2_CENT;

------------------------------------------------------------------------
-- FAHRENHEIT TO KELVIN CONVERSION
        procedure FAHR_2_KEL is
                FAHRENHEIT: INTEGER is range -58..212;
        begin
-- Input Fahrenheit value
                PUT_LINE("Input temperature in degrees Fahrenheit: ");
                GET(FAHRENHEIT);
-- Convert with call to FAHR_2_CENT, add 273.15 and output
                PUT("The equivalent in degrees Kelvin is: ");
                PUT(FAHR_2_CENT_FUN(FLOAT(FAHRENHEIT))+273.15,FORE=>3,AFT=>2,
                                EXP=>0);
        end FAHR_2_KEL;
```

Table 3 Continued

```
------------------------------------------------------------------------
-- KELVIN TO CENTIGRADE CONVERSION
        procedure KEL_2_CENT is
                KELVIN: INTEGER is range 223..373;
        begin
-- Input Kelvin value
                PUT_LINE("Input temperature in degrees Kelvin: ");
                GET(KELVIN);
-- Conversion and return
                PUT("The equivalent in degrees Centigrade is: ");
                PUT(FLOAT(KELVIN)-273.15,FORE=>3,AFT=>2,EXP=>0);
        end KEL_2_CENT;

------------------------------------------------------------------------
-- KELVIN TO FAHRENHEIT CONVERSION
        procedure KEL_2_FAHR is
                KELVIN: INTEGER is range 223..373;
        begin
-- Input Kelvin value
                PUT_LINE("Input temperature in degrees Kelvin: ");
                GET(KELVIN);
-- Convert to Centigrade, then call to CENT_2_FAHR_CONVERSION
                PUT("The equivalent in degrees Fahrenheit is: ");
                PUT(CENT_2_FAHR_CONVERSION(FLOAT(KELVIN)-273.15),FORE=>3,AFT=>2,
                                EXP=>0);
        end KEL_2_FAHR;

------------------------------------------------------------------------
-- TOP LEVEL
begin
        SELECTOR := MENU;
        case SELECTOR is
                when 1 =>
                        CENT_2_FAHR;
                when 2 =>
                        CENT_2_KEL;
                when 3 =>
                        FAHR_2_CENT;
                when 4 =>
                        FAHR_2_KEL;
                when 5 =>
                        KEL_2_CENT;
                when 6 =>
                        KEL_2_FAHR;
                when others =>
                        PUT("Invalid menu selection: ");
                        PUT(SELECTOR);
        end case;
        NEW_LINE;
end TEMP_CONVERT_PLUS;
```

Table 3 Continued

4. Testing

To test the above code each path through the code must be tested, the limits must be tested and we should also carry out some numeric testing. We will combine the required testing into one set of test cases as shown in Table 4.

TEST CASE		EXPECTED RESULT
SELECTOR	CENTIGRADE, FAHRENHEIT OR KELVIN	OUTPUT
1	-51	CONSTRAINT ERROR
1	-49	-56.20
1	99	210.20
1	101	CONSTRAINT ERROR
1	0	32.00
2	-51	CONSTRAINT ERROR
2	-49	224.15
2	99	372.15
2	-101	CONSTRAINT ERROR
2	0	273.15
3	-59	CONSTRAINT ERROR
3	-57	-49.44
3	211	99.44
3	213	CONSTRAINT ERROR
3	0	-17.78
4	-59	CONSTRAINT ERROR
4	-57	223.71
4	211	372.59
4	213	CONSTRAINT ERROR
4	0	255.37
5	222	CONSTRAINT ERROR
5	224	-49.15
5	372	98.85
5	374	CONSTRAINT ERROR
6	222	CONSTRAINT ERROR
6	224	-56.47
6	372	209.93
6	374	CONSTRAINT ERROR
7	*	Invalid menu selection: 7

Table 4: *Test cases*

Some sample test results are given in Table 5.

```
kuban-261 $ temp_convert_plus
MENU OPTIONS
1 - Centigrade to Fahrenheit conversion
2 - Centigrade to Kelvin conversion
3 - Fahrenheit to Centigrade conversion
4 - Fahrenheit to Kelvin conversion
5 - Kelvin to Centigrade conversion
6 - Kelvin to Fahrenheit conversion
1
Input temperature in degrees Centigrade:
101
Ada-runtime: Exception CONSTRAINT_ERROR raised in
/tmp_mnt/home/staff2/ra/frans/public_html/2CS21/week6/tempConvertPlus.ada
on line 48. Rangecheck error: 101 not in range -50..100.

kuban-262 $ temp_convert_plus
MENU OPTIONS
1 - Centigrade to Fahrenheit conversion
2 - Centigrade to Kelvin conversion
3 - Fahrenheit to Centigrade conversion
4 - Fahrenheit to Kelvin conversion
5 - Kelvin to Centigrade conversion
6 - Kelvin to Fahrenheit conversion
1
Input temperature in degrees Centigrade:
0
The equivalent in degrees Fahrenheit is:  32.0

kuban-263 $ temp_convert_plus
MENU OPTIONS
1 - Centigrade to Fahrenheit conversion
2 - Centigrade to Kelvin conversion
3 - Fahrenheit to Centigrade conversion
4 - Fahrenheit to Kelvin conversion
5 - Kelvin to Centigrade conversion
6 - Kelvin to Fahrenheit conversion
2
Input temperature in degrees Centigrade:
-51
Ada-runtime: Exception CONSTRAINT_ERROR raised in
/tmp_mnt/home/staff2/ra/frans/public_html/2CS21/week6/tempConvertPlus.ada
on line 61. Rangecheck error: -51 not in range -50..100.
```

Table 5: *Sample test case results*