Programming Assignment 6:
Numerical Solution of Laplace's Equation
CS 2073, Computer Programming with Engineering Applications
Spring Semester, 1992

For this assignment, please first read the attached informal description, taken from a 1978 Fortran textbook: *A FORTRAN Coloring Book,* by Roger E. Kaufman, MIT Press. This assignment starts with a region filled with liquid. There are fixed temperatures maintained on the boundaries. An interative method determines the final steady-state temperature distribution. The portion studied is just a two-dimensional slice through the liquid-filled region. Please study this nine page write-up carefully because, along with the bad jokes, it describes the program very well.

In general you should try to write flexible programs, using named constants. A sample set of constants and types to use for this assignments is the following:

```
const (* below, m's used for rows, n's for columns *)
      m1 = 20;  (* top of inner space at 212 degrees*)
      m2 = 40;  (* bottom of inner space at 212 degrees*)
      m3 = 60; (* lower boundary at 32 degrees *)
      m0 = 30;  (* start of liquid on the outside "bath" at 32 degrees*)
      n1 = 20;  (* left side of inner space at 212 degrees *)
      n2 = 40;  (* right side of inner space at 212 degrees *)
      n3 = 60; (* far right boundary *)
      border = '#'; blank = ' ';
      templow = 32.0; (* low temp along edges in the "bath" *)
      temphigh = 212.0; (* high temp in the central rectangle *)
      tempmed = 100.0; (* medium temp at the top *)
type atype = array[0..m3+1, 0..n3+1] of real;  (* rows and columns *)
     (* assumes that [0,0] is upper left corner *)
     ctype = array[0..m3+1, 0..n3+1] of char;  (* matching character array *)
var a: atype;
    c: ctype;
```

You should also use reasonable procedures and functions to implement the various parts of the program. Again a sample of some header declarations follows:

```
procedure initialize(var a:atype; var c: ctype);
procedure step(var a:atype; var change: real); (* one iteration *)
procedure store(var a:atype; var c: ctype); (* stores proper char in c *)
procedure display(var c: ctype); (* prints c out *)
```

When you run your program, use 0.25 degrees for the criterion for deciding when to

terminate, as discussed by Kaufman. Print the number of steps needed to meet the criterion.

Finally, your program should use letters from A to Z to indicate the temperature range in the final output, inserting the proper character in the array c, and the printing c. You should also output a temperature "key," showing which letter is used for a given temperature range. An example key is shown below.

```
Temperature key

Temp    Letter

    32    Z
    36    Y
    40    Y
    44    X
    48    X
    52    W
    56    W
    60    V
    64    V
    68    U
    72    T
    76    T
    80    S
    84    S
    88    R
    92    R
    96    Q
   100    Q
   104    P
   108    O
   112    O
   116    N
   120    N
   124    M
   128    M
   132    L
   136    L
   140    K
   144    J
   148    J
   152    I
   156    I
   160    H
   164    H
   168    G
   172    G
   176    F
   180    E
   184    E
   188    D
   192    D
   196    C
   200    C
   204    B
   208    B
   212    A
```

Number of steps: 105