CS118 PROGRAMMING II, 1992

ASSIGNMENT 2

Submit your solution to one problem by noon Friday 11 December 1992. The problems are in roughly ascending order of difficulty.

1 Magic Square

A magic square of order n is an arrangement of the integers 1 through n^2 in a square array so that the sum of each row, column and diagonal is the same. A magic square of order 5 is shown at right. Knuth gives the following rule for generating a magic square: "Start with a 1 in the middle of the top row, then go up and to the left diagonally (when running off the edge imagine an entire plane tiled with squares) until reaching a filled square; then drop down one space and continue. This method works whenever n is odd." (*Art of Computer Programming*, Vol. 1, p. 158).

15	8	1	24	17
16	14	7	5	23
22	20	13	6	4
3	21	19	12	10
9	2	25	18	11

Write a program to print a magic square of order n, where n is supplied by the user. Extra credit will be awarded for programs that print magic squares for both odd and even n.

2 Text Formatting

Write a program which reads in unformatted text and formats it into fully justified form. The line length is to be specified as the first line of the input. An example of unformatted input and the formatted output is given below; your program should achieve results at least as good as this. Explain your justification algorithm carefully.

Example input
```
60
If, unwarned        by my example ,
any man shall undertake and shall succeed in really constructing an engine
embodying
in itself the whole of the executive department of mathematical analysis
upon different principles or by simpler means,
I have no fear of leaving my reputation in his charge for he alone will be
fully able to appreciate the nature of my efforts and the value of their
results.
(Charles Babbage, "Passages from the Life of a Philosopher", 1864 .)
```

Example output
```
If, unwarned by my example,  any  man  shall  undertake  and
shall  succeed in really constructing an engine embodying in
itself the whole of the executive department of mathematical
analysis upon different principles or by  simpler  means,  I
have  no   fear of leaving my reputation in his charge for he
alone will be fully able to  appreciate  the  nature  of  my
efforts  and   the  value of their results. (Charles Babbage,
"Passages from the Life of a Philosopher", 1864.)
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3 The n-stamps Problem

We require the denominations of a set of n stamps which will maximise the continuous range of postages that can be obtained, subject to the restriction that no more than three stamps can be placed on an envelope. Some solutions are:
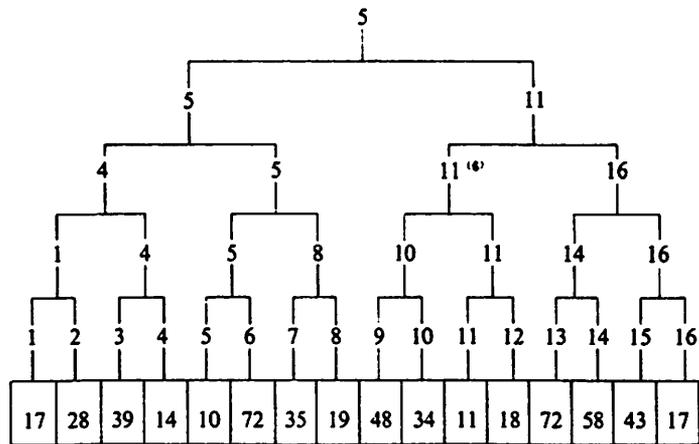
n	Denominations	Range
2	1, 3	7
3	1, 4, 5	15
4	1, 4, 7, 8	24

Write a program to determine the optimum denominations for any reasonable value of n.

4 Tournament Sort

Write a program to perform a tournament sort, described below. Do not assume that the number of records to be sorted is of the form 2^n.

Tournament sort: The tournament sort is a method which is efficient and whose speed is completely independent of the data. Initially a hierarchy of comparisons is made, as in a tennis tournament, adjacent items being 'played' against one another, and a record kept of the winners. Adjacent winners are then played against one another, and so on until a champion is found (see diagram, right). The champion in the tournament is the item which should come first in the sorted list. In terms of the tournament analogy it is then disqualified. Certain matches must then be replayed. These are in fact the matches in which the champion took part, one for each level of the hierarchy. At the lowest level the immediate neighbour of the champion will now win, as the champion has now been disqualified. When all the replays have been performed, a new champion is found, which is the second item of the sorted list, and so on.

5 The Pentomino Problem

There are twelve different (ie. non-congruent) pentominos, shown below left. The pentomino problem is to fit them into a tray of dimensions 6 x 10 without overlapping. Some of the 2339 possible solutions are shown below right. Write a program to find a solution to the pentomino problem. (*Note.* Pretty output is not required.)