Potential Problems

1. *Periods must be used in the logical operators* `.NOT.`, `.AND.`, `.OR.`, `.EQV.`, *and* `.NEQV.`.
2. *Parentheses must enclose the logical expression in an* `IF` *construct or in a logical* `IF` *statement.*
3. *Parentheses must enclose the selector and each label-list in a* `CASE` *construct.*
4. *Real quantities that are algebraically equal may yield a false logical expression when compared with == because most real values are not stored exactly.* For example, even though the two real expressions `X * (1.0 / X)` and `1.0` are algebraically equal, the logical expression `X * (1.0 / X) == 1.0` is usually false. Thus, if two real values `RealNumber_1` and `RealNumber_2` are subject to roundoff error, it is usually not advisable to check whether they are equal. It is better to check whether the absolute value of their difference is small:

```
IF (ABS(RealNumber_1 - RealNumber_2) < Tolerance) THEN
                  ⋮
```

   where Tolerance is some small positive real value such as `1E-6`.
5. *Each* `IF` *construct (but not logical* `IF` *statements) must be closed with an* `END IF` *statement.*
6. *Each* `CASE` *construct must be closed with an* `END SELECT` *statement.*

PROGRAMMING PROBLEMS

Sections 3.2–3.4

1. Modify the program in Figure 3.1 for solving quadratic equations so that when the discriminant is negative, the complex roots of the equation are displayed. If the discriminant D is negative, these roots are given by

$$\frac{-B \pm \sqrt{-D}\, i}{2A}$$

   where $i^2 = -1$.
2. Write a program that reads values for the coefficients A, B, C, D, E, and F of the equations

$$Ax + By = C$$

$$Dx + Ey = F$$

   of two straight lines. Then determine whether the lines are parallel (their slopes are equal) or the lines intersect. If they intersect, determine whether the lines are perpendicular (the product of their slopes is equal to -1).

3. Suppose the following formulas give the safe loading L in pounds per square inch for a column with slimness ratio S:

$$L = \begin{cases} 16500 - .475S^2 & \text{if } S < 100 \\ \dfrac{17900}{2 + (S^2/17900)} & \text{if } S \geq 100 \end{cases}$$

Write a program that reads a slimness ratio and then calculates the safe loading.

4. Suppose that a gas company bases its charges on consumption according to the following table:

Gas Used	Rate
First 70 cubic meters	\$5.00 minimum cost
Next 100 cubic meters	5.0¢ per cubic meter
Next 230 cubic meters	2.5¢ per cubic meter
Above 400 cubic meters	1.5¢ per cubic meter

Meter readings are four-digit numbers that represent cubic meters. Write a program in which the meter reading for the previous month and the current meter reading are entered and then the amount of the bill is calculated. *Note*: The current reading may be less than the previous one; for example, the previous reading may have been 9897, and the current one is 0103.

Section 3.5

5. Proceed as in Problem 4 but use a CASE construct to determine the applicable rate.

6. A computer supply company discounts the price of each of its products depending on the number of units bought and the price per unit. The discount increases as the number of units bought and/or the unit price increases. These discounts are given in the following table:

Number Bought	Unit Price (dollars) 0–10.00	10.01–100.00	100.01–
1–9	0%	2%	5%
10–19	5%	7%	9%
20–49	9%	15%	21%
50–99	14%	23%	32%
100–	21%	32%	43%

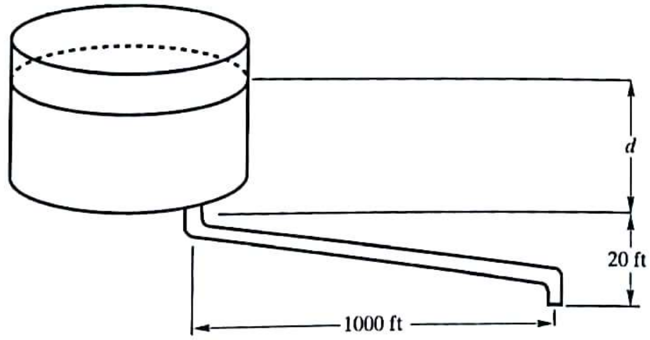
Write a program that reads the number of units bought and the unit price and then calculates and prints the total full cost, the total amount of the discount, and the total discounted cost.

8. Write a loop to read values for A, B, and C and print their sum, repeating this procedure while none of A, B, or C is negative.
9. Write a loop to calculate and print the squares of consecutive positive integers until the difference between a square and the preceding one is greater than 50.
10. Design an algorithm that uses a loop to count the number of digits in a given integer.
11. Write Fortran statements to implement the algorithm in Exercise 10.
12. Develop an algorithm to approximate the value of e^x using the infinite series

$$e^x = \sum_{n=0}^{\infty} \frac{x^n}{n!}$$

For each of the problems described in Exercises 13–16, specify the input and output for the problem, make a list of variables you will use in describing a solution to the problem, and then design an algorithm to solve the problem.

13. A car manufacturer wants to determine average noise levels for the 10 different models of cars the company produces. Each can be purchased with one of five different engines. Design an algorithm to enter the noise levels (in decibels) that were recorded for each possible model and engine configuration and to calculate the average noise level for each model as well as the average noise level over all models and engines.
14. Dispatch Die-Casting currently produces 200 castings per month and realizes a profit of $300 per casting. The company now spends $2000 per month on research and development and has a fixed operating cost of $20,000 per month that does not depend on the amount of production. If the company doubles the amount spent on research and development, it is estimated that production will increase by 20 percent. The company president would like to know, beginning with the current status and successively doubling the amount spent on research and development, at what point the net profit will begin to decline.
15. Consider a cylindrical reservoir with a radius of 30.0 feet and a height of 30.0 feet that is filled and emptied by a 12-inch-diameter pipe. The pipe has a 1000.0-foot-long run and discharges at an elevation 20.0 feet lower than the bottom of the reservoir. The pipe has been tested and has a roughness factor of 0.0130.



Several formulas have been developed experimentally to determine the velocity at which fluids flow through such pipes. One of these, the *Manning formula*, is

$$V = \frac{1.486}{N} R^{2/3} S^{1/2}$$

where

V = velocity in feet per second

N = roughness coefficient

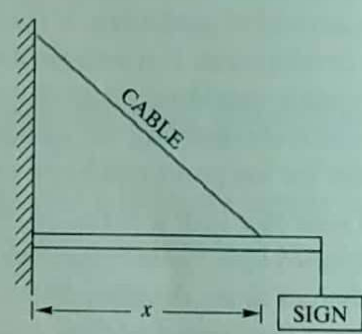
R = hydraulic radius = $\frac{\text{cross-sectional area}}{\text{wetted perimeter}}$

S = slope of the energy gradient $\left(= \frac{d + 20}{1000} \text{ for this problem} \right)$

The rate of fluid flow is equal to the cross-sectional area of the pipe multiplied by the velocity.

Design an algorithm to estimate the time required to empty the reservoir, given the reservoir's height, roughness coefficient, hydraulic radius, and pipe radius. Do this by assuming a constant flow rate for 5-minute segments.

16. A 100.0-pound sign is hung from the end of a horizontal pole of negligible mass. The pole is attached to the building by a pin and is supported by a cable, as shown in the following diagram. The pole and cable are each 6.0 feet long.



Design an algorithm to find the appropriate place (indicated by x in the diagram) to attach the cable to the pole so that the tension in the cable will be minimized. The equation governing static equilibrium tells us that

$$\text{tension} = \frac{100 \cdot 6 \cdot 6}{x\sqrt{36 - x^2}}$$

Calculate the tension for x starting at 1.0 feet and incrementing it by 0.1 feet until the approximate minimum value is located.

the sum of the first data set is correctly displayed as 60, but the sum of the second data set is 140, and not 200 as shown. The error is caused by the fact that when the second set of numbers is processed, `Sum` is not reset to 0, because the initialization is done at compile time, not during execution. The obvious solution is to insert the statement

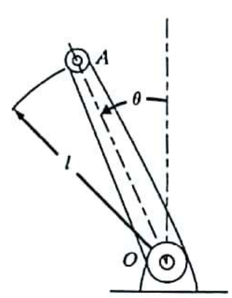
```
Sum = 0
```

between the two `DO` statements.

PROGRAMMING PROBLEMS

Sections 4.1 and 4.2

1. A certain product is to sell for `Price` dollars per item. Write a program that reads values for `Price` and the `Number` of items sold and then produces a table showing the total price of from 1 through `TotalNumber` units.
2. The mechanism shown below is part of a machine that a company is designing:



During operation, the rod OA will oscillate according to $\theta = \theta_0 \sin(2\pi t / \tau)$, where θ is measured in radians, θ_0 is the maximum angular displacement, τ is the period of motion, and t = time in seconds measured from $t = 0$ when OA is vertical. If l is the length OA, the magnitude of the acceleration of point A is given by

$$|a_A| = \frac{4\pi^2 l \theta_0}{\tau^2}\sqrt{\theta_0^2 \cos^4\left(\frac{2\pi t}{\tau}\right) + \sin^2\left(\frac{2\pi t}{\tau}\right)}$$

Write a program that will read values for θ_0, l, and τ and that will then calculate a table of values of t, θ, and $|a_A|$ for $t = 0.0$ to 0.5 in steps of 0.05 (in seconds). Execute the program with $\tau = 2$ sec, $\theta_0 = \pi/2$, and $l = 0.1$ m.

3. Suppose that at a given time, genotypes AA, AB, and BB appear in the proportions x, y, and z, respectively, where $x = 0.25$, $y = 0.5$, and $z = 0.25$. If individuals of type AA cannot reproduce, the probability that one parent will donate gene A to an offspring is

$$p = \frac{1}{2}\left(\frac{y}{y+z}\right)$$

since $y/(y + z)$ is the probability that the parent is of type AB and 1/2 is the probability that such a parent will donate gene A. Then the proportions x', y', and z' of AA, AB, and BB, respectively, in each succeeding generation are given by

$$x' = p^2, \qquad y' = 2p(1 - p), \qquad z' = (1 - p)^2$$

and the new probability is given by

$$p' = \frac{1}{2}\left(\frac{y'}{y' + z'}\right)$$

Write a program to calculate and print the generation number and the proportions of AA, AB, and BB under appropriate headings until the proportions of both AA and AB are less than some small positive value.

4. The sequence of **Fibonacci numbers** begins with the integers

   1, 1, 2, 3, 5, 8, 13, 21, . . .

   where each number after the first two is the sum of the two preceding numbers. Write a program that reads a positive integer n and then displays the first n Fibonacci numbers.

5. One property of the Fibonacci sequence (see Problem 4) is that the ratios of consecutive Fibonacci numbers (1/1, 1/2, 2/3, 3/5, . . .) approach the "golden ratio"

   $$\frac{\sqrt{5} - 1}{2}$$

   Modify the program in Problem 4 to display Fibonacci numbers and the decimal values of the ratios of consecutive Fibonacci numbers.

6. If a loan of A dollars, which carries a monthly interest rate of R (expressed as a decimal), is to be paid off in N months, then the monthly payment P will be

   $$P = A\left[\frac{R(1 + R)^N}{(1 + R)^N - 1}\right]$$

   During this time period, some of each monthly payment will be used to repay that month's accrued interest, and the rest will be used to reduce the balance owed.

   Write a program to print an *amortization table* that displays the payment number, the amount of the monthly payment, the interest for that month, the amount of the payment applied to the principal, and the new balance. Use your program to produce an amortization table for a loan of $50,000 to be repaid in 36 months at 1 percent per month.

Sections 4.3 and 4.4

7. Write a program to calculate all the Fibonacci numbers less than 5000 and the decimal values of the ratios of consecutive Fibonacci numbers (see Problem 4).
8. Write a program to read the data values shown in the following table, calculate the miles per gallon in each case, and print the values with appropriate labels:

Miles Traveled	Gallons of Gasoline Used
231	14.8
248	15.1
302	12.8
147	9.25
88	7
265	13.3

9. Write a program to read a set of numbers, count them, and find and print the largest and smallest numbers in the list and their positions in the list.
10. Suppose that a ball dropped from a building bounces off the pavement and that on each bounce it returns to a certain constant percentage of its previous height. Write a program to read the height from which the ball was dropped and the percentage of rebound. Then let the ball bounce repeatedly, and print the height of the ball at the top of each bounce, the distance traveled during that bounce, and the total distance traveled thus far, terminating when the height of the ball is almost zero (less than some small positive value).
11. Write a program to read a set of numbers, count them, and calculate the mean, variance, and standard deviation of the set of numbers. The *mean* and *variance* of numbers $x_1, x_2, \ldots, x_n$ can be calculated using the following formulas:

$$\text{mean} = \frac{1}{n}\sum_{i=1}^{n} x_i \qquad \text{variance} = \frac{1}{n}\sum_{i=1}^{n} x_i^2 - \frac{1}{n^2}\left(\sum_{i=1}^{n} x_i\right)^2$$

The *standard deviation* is the square root of the variance.