

**IBM**<sup>®</sup>

**FORTRAN for the IBM 1130**

**Problem Book**

**Programmed Instruction Course**

**IBM**

**FORTTRAN for the IBM 1130**  
**Problem Book**

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APPLIED PROBLEMS

Exercise 1.1

Write the following expressions in FORTRAN notation (always use capital letters for the symbols in the expressions).

a)  $x + y - z$

\_\_\_\_\_

b)  $ax + by + cz$

\_\_\_\_\_

c)  $\frac{a}{b} + \frac{c}{d}$

\_\_\_\_\_

Solution on page 4  
Return to frame 26

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Exercise 1.2

In each of the following expressions, which operation is performed first?

a)  $A + B - C$

\_\_\_\_\_

b)  $A * B * C * * 2$

\_\_\_\_\_

c)  $X * Y + A / B$

\_\_\_\_\_

d)  $C * D * X * * 3 + A + B$

\_\_\_\_\_

Solution on page 4  
Return to frame 54

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Exercise 1.3

In each of the following expressions, which two quantities are involved in the first operation performed?

a)  $(A + B) + (C + D)$

\_\_\_\_\_

b)  $(X * Y + A + B) * Z$

\_\_\_\_\_

c)  $X * (Y + Z)$

\_\_\_\_\_

d)  $A / B / (C * D * * 2)$

\_\_\_\_\_

Solution on page 4  
Return to frame 81

Exercise 1.4

Identify the mode of the variables and constants below and state whether a variable or a constant.

- a) XSUB1 \_\_\_\_\_
- b) 0.333333 \_\_\_\_\_
- c) JAMES \_\_\_\_\_
- d) 5280. \_\_\_\_\_
- e) KOUNT \_\_\_\_\_
- f) 5280 \_\_\_\_\_
- g) MASS \_\_\_\_\_
- h) OPERN \_\_\_\_\_
- i) B58 \_\_\_\_\_
- j) INSID \_\_\_\_\_

Solution on page 4  
Return to frame 122



Exercise 1.5

Identify each of the following expressions as integer, real, or mixed modes.

- a)  $(A + B) * (A - B)$  \_\_\_\_\_
- b)  $(I * J + N * K) * P$  \_\_\_\_\_
- c)  $XI * R$  \_\_\_\_\_
- d)  $JOE + JIM + HENRY$  \_\_\_\_\_
- e)  $JEAN + JANE + LOIS - KATHY$  \_\_\_\_\_

Solution on page 4  
Return to frame 149

Exercise 1.6

Write the following common formulae as FORTRAN Arithmetic statements. Do not mix modes.

- a)  $f = m a$  \_\_\_\_\_
- b)  $v = \frac{4}{3} \pi r^3$  ( $\pi = 3.141592$ ) \_\_\_\_\_
- c)  $y = ax^2 + bx + c$  \_\_\_\_\_
- d)  $s = s_0 + v_0 t + \frac{1}{2} g t^2$  \_\_\_\_\_

Solution on page 4  
Return to frame 158



Exercise 1.7

Identify the correct examples of subscripting shown below with a "+" sign and the incorrect ones with a "-" sign.

- a) ARRAY (LIST) \_\_\_\_\_
- b) NAME (M\*N) \_\_\_\_\_
- c) A (2 \* I + 1) \_\_\_\_\_
- d) ANSWR (K - 25) \_\_\_\_\_
- e) BLOCK (I + J) \_\_\_\_\_

Solution on page 4  
Return to frame 189

## SOLUTIONS TO APPLIED PROBLEMS

NOTE: Spaces between constants, variables, and operators do not affect the logic or the operation of a statement: For example,  $X+Y-Z$  is equivalent to  $X + Y - Z$ .

- 1.1 a)  $X + Y - Z$   
 b)  $A * X + B * Y + C * Z$   
 c)  $A/B+C/D$
- 1.2 a) addition ( $A + B$ )  
 b) exponentiation ( $C * * 2$ )  
 c) multiplication ( $X * Y$ )  
 d) exponentiation ( $X * * 3$ )
- 1.3 a) A,B  
 b) X,Y  
 c) Y,Z  
 d) D,2
- 1.4 a) real, variable                      f) integer, constant  
 b) real, constant                      g) integer, variable  
 c) integer, variable                  h) real, variable  
 d) real, constant                      i) real, variable  
 e) integer, variable                  j) integer, variable
- 1.5 a) real                                      d) mixed  
 b) mixed                                    e) integer  
 c) real
- 1.6 a)  $F = XM * A$   
 b)  $V = 4./3. * 3.141592 * R**3$   
 c)  $Y = A * X ** 2 + B * X + C$   
 d)  $S = S0 + V0 * T + 0.5*G*T**2$
- 1.7 a) +  
 b) -  
 c) +  
 d) +  
 e) -

## APPLIED PROBLEMS

Exercise 2.1

Given four variables, A, B, C, and D, with previously defined values, write a sequence of IF statements to tell the computer to execute statement number 15 if all four variables have the exact value of 25.0. If one or more variables have a different value, tell the computer to execute statement number 30 instead.

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Solution on page 10  
Return to frame 32

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Exercise 2.2

Assume that values have been computed for three variables X, Y, and Z. (No two values alike)

If the value of X is:

- a) greater than Y and greater than Z go to statement number 10
- b) less than Y but greater than Z go to statement number 20
- c) greater than Y but less than Z go to statement number 30
- d) less than Y and less than Z go to statement number 40

Write a sequence of IF statements to make the decisions outlined above (the second statement number option is irrelevant in each IF statement since it is given that no two values are alike).

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Solution on page 10  
Return to frame 38



Exercise 2.3

Write a program to set each value of an array called INDEX equal to the order of that value in the array (that is, INDEX (1) = 1, INDEX (2) = 2, etc.). The INDEX array has a total length of 2000 numbers.

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Solution on page 10  
Return to frame 54



Exercise 2.4

Write a DO-loop to find the smallest absolute value in a block of 100 numbers called X. Use a variable called SMALX for this quantity. Assume the first number in the block is positive if you wish. It is not necessary to maintain the original values of the numbers in the block.

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Solution on page 10  
Return to frame 90

Exercise 2.5

Write a DO-loop to copy the contents of an array called A into an array called B, both of which are 1000 numbers long, placing the numbers in the reverse order to that which they occupied in the original array. That is, B(1000) will contain A (1), B (999) will contain A (2), etc.

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Solution on page 10  
Return to frame 105



Exercise 2.6

Write a DO-loop to make a count of all the numbers greater than 10.0 in a 1000-number array called A. Use N as the name of the count variable and I as the loop index.

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Solution on page 10  
Return to frame 114

Exercise 2.7

Write a program to compute all the possible products of the A and B arrays, each of which contains 20 numbers, placing these products in an array called C (which must hold 400 numbers). Use two nested DO-loops such that C(1) through C(20) contains the products of A(1) times B(1) through B(20), C(21) through C(40) contain the products of A(2) times B(1) through B(20); etc.

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Solution on page 11  
Return to frame 122



Exercise 2.8

Write the first two statements of a DO-loop which will cycle ten times and execute statement number 10 on the first pass; number 20, the second pass; number 30, the third pass, etc.

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Solution on page 11  
Return to frame 131

Exercise 2.9

Write a DO-loop to divide the corresponding numbers in the A and B arrays (i.e., A(1)/B(1),A(2)/B(2), etc.) placing each quotient in corresponding order in the C array. Before dividing, test each B value to see if it is zero. If it is, halt the computer with 0000 printed on the printer. Also, if the B value is not zero, test the corresponding A value for zero, and if so, halt the computer with 0055 printed. In either case, do not divide and do not place anything in the C array. The computer should continue the loop when the start button is pushed. The arrays contain 1500 numbers each.

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Solution on page 11  
Return to frame 137

## SOLUTIONS TO APPLIED PROBLEMS

2.1

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      IF (A - 25.0) 30, 1, 30
1     IF (B - 25.0) 30, 2, 30
2     IF (C - 25.0) 30, 3, 30
3     IF (D - 25.0) 30, 15, 30

```

2.2

```

      IF (X - Y) 1, 1, 2
2     IF (X - Z) 30, 10, 10
1     IF (X - Z) 40, 20, 20

```

2.3

```

      I = 0
10    I = I + 1
      INDEX (I) = I
      IF (I - 2000) 10, 20, 20
20    (continue on in program)

```

2.4

```

      SMALX = X(1)
      DO 40 I = 2,100
      IF (X(I))10, 20, 20
10    X(I) = -X(I)
20    IF (X(I) - SMALX) 30, 40, 40
30    SMALX = X(I)
40    CONTINUE

```

2.5

```

      DO 10 I = 1,1000
      J = 1001 - I
10    B(J) = A(I)

```

2.6

```

      N = 0
      DO 100 I = 1,1000
      IF (A(I) - 10.0) 100, 100, 50
50    N = N + 1
100   CONTINUE

```

2.7

```
      K = 0
      DO 10 I = 1,20
      DO 10 J = 1,20
      K = K+1
10    C(K) = A(I)*B(J)
```

2.8

```
      DO 1 I = 1,10
      GO TO (10,20,30,40,50,60,70,80,90,100), I
```

2.9

```
      DO 40 I = 1,1500
      IF (B(I)) 36, 24, 36
24    PAUSE
      GO TO 40
36    IF (A(I)) 38, 26, 38
26    PAUSE 55
      GO TO 40
38    C(I) = A(I)/B(I)
40    CONTINUE
```



## APPLIED PROBLEMS

Exercise 3.1

Write a statement to read ten numbers from a card and place them in the variables A, B, C, D, E, F, G, H, O, and P, respectively. Use associated statement number 1 in the READ statement.

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Solution on page 19  
Return to frame 22

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Exercise 3.2

Given 100 cards containing 3 numbers each, write a program to read each card and place the three numbers in arrays A, B, and C, respectively, in the order read (first three to A(1), B(1), C(1); next three to A(2), B(2), etc.)

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Solution on page 19  
Return to frame 33

ooo

Exercise 3.3

Write a single statement to read 200 numbers, placing the first 100 numbers in the X array and the next 100 numbers read in the Y array. The card reader will be referenced by the number "2".

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Solution on page 19  
Return to frame 49



Exercise 3.4

Given a deck of 500 cards containing four real numbers each, write a self-indexed READ statement to read each card and place the four numbers respectively in the W, X, Y, and Z arrays in the position indicated by the index value. Use "2" as the input reference number.

Solution on page 19  
Return to frame 59

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Exercise 3.5

The paper tape unit contains 50 integer numbers. Write a statement to read these 50 numbers into the K array in every other position (odd-numbered positions) from 1 to 99 inclusive (K(1), K(3), K(5), etc.). Assume the input reference number is 4, and FORMAT number is 1.

Solution on page 19  
Return to frame 76

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Exercise 3.6

Write a FORMAT statement for each condition described below: (all real numbers). Use "1" as the statement number for all FORMAT statements.

- |                                |       |
|--------------------------------|-------|
| a) 8 digits, 1 decimal place   | _____ |
| b) 10 digits, 8 decimal places | _____ |
| c) 6 digits, 2 decimal places  | _____ |
| d) 7 digits, no decimal places | _____ |
| e) 4 digits, 1 decimal place   | _____ |

Solution on page 19  
Return to frame 99

Exercise 3.7

Write a FORMAT statement to control the reading of three real numbers on a card, according to the following specification:

first number: 10 digits, 5 decimal places  
second number: 8 digits, 3 decimal places  
third number: 12 digits, no decimal places

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Solution on page 19  
Return to frame 105

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Exercise 3.8

Suppose you have written the statement READ(2,1)A,B,C,D,E . Construct a suitable FORMAT to specify the card location of five real numbers on a card, 14 card columns per number with 3 decimal places each.

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Solution on page 19  
Return to frame 113

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Exercise 3.9

Suppose that the following ten numbers are to be read into the X array in positions 11 to 20.

11)	04.5392	16)	10.0835
12)	12.6120	17)	00.8917
13)	00.7090	18)	00.0001
14)	07.0000	19)	99.9999
15)	18.4031	20)	06.8329

Write a READ and FORMAT statement combination that will read all ten numbers on a single card, noting that the decimal point is included in the column count of the FORMAT. Use "2" as the input reference number for the card reader.

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Solution on page 19  
Return to frame 122

Exercise 3.10

Write a pair of statements to read 100 cards where each card contains 2 integers and 3 real numbers to be placed in the JOE, JIM, ANDY, BOB, and FRANK arrays, respectively. Each integer occupies 5 card columns and each real number occupies 10 columns including 3 decimal places. The real numbers being placed in the FRANK array are written in E notation. The numbers being read should be placed in the arrays in the order in which they are read.

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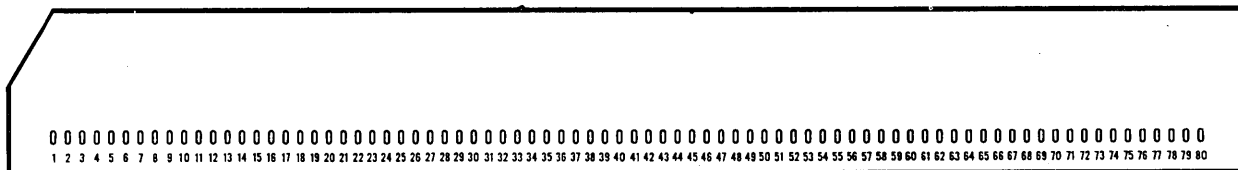
Solution on page 19  
 Return to frame 150

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Exercise 3.11

Assuming the FORMAT (6F12.4) is to be used, show on an imaginary card layout the position of the following six numbers. Use the "natural" or right-shifted position with the decimal point punched.

- |             |           |
|-------------|-----------|
| 1) 1.3841   | 4) 1.2345 |
| 2) 128.7801 | 5) 0.0001 |
| 3) 1000000. | 6) 9.9999 |



Solution on page 20  
 Return to frame 156

Exercise 3.12

Write a READ statement to read 1000 numbers (with E notation) from cards into the first 1000 locations of the X array. The FORMAT should specify ten numbers per card, 8 columns per number with three decimal places. Write a statement using the same FORMAT to read 1500 numbers from paper tape into the next 1500 positions of the same X array. Show all three statements required.

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Solution on page 20  
Return to frame 180

ooo

Exercise 3.13

Given three 100 number-arrays - A, B, and C - write a WRITE and FORMAT combination to list these arrays in three parallel columns of numbers. Each column of numbers should occupy 20 character columns of the printer with four decimal places provided. This should result in 100 lines being printed, each line having 3 numbers.

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Solution on page 20  
Return to frame 214

Exercise 3.14

The card reader contains 100 cards, each consisting of 10 real numbers, 7 digits per number with 3 decimal places (no E notation). Write a program to print these 100 cards on the typewriter exactly as they appear on cards (hint: same FORMAT). Use a ten-number array as a buffer; that is, read ten numbers into the array and then write them on the typewriter before reading the next ten numbers.

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Solution on page 20  
Return to frame 240

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Exercise 3.15

Write a combination of statements to print the heading shown below:

bFINALbCOMPUTEDbRESULTS

Note: b means blank

Following this heading, skip a line and print on separate lines ten values of the ANSWR array, using 20 print positions with 7 decimal places included. Use a single FORMAT statement for this problem, and FORMAT code E.

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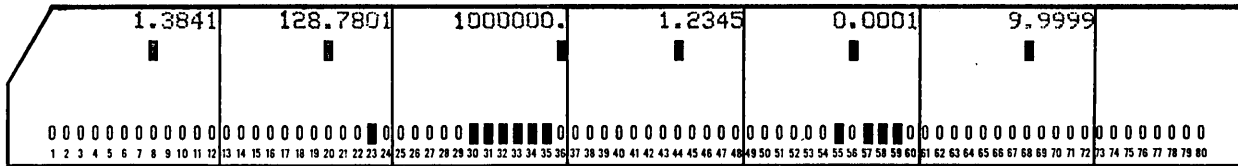
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Solution on page 20  
Return to frame 268

## SOLUTIONS TO APPLIED PROBLEMS

- 3.1 READ(2,1)A,B,C,D,E,F,G,H,O,P
- 3.2 DO 10 I = 1,100  
10 READ(2,1)A(I),B(I),C(I)
- 3.3 READ(2,1)(X(I),I = 1,100),(Y(I),I = 1,100)
- 3.4 READ(2,1)(W(I),X(I),Y(I),Z(I),I=1,500)
- 3.5 READ(4,1)(K(I),I = 1,99,2)
- 3.6 a) 1 FORMAT (F8.1)  
b) 1 FORMAT (F10.8)  
c) 1 FORMAT (F6.2)  
d) 1 FORMAT (F7.0)  
e) 1 FORMAT (F4.1)
- 3.7 1 FORMAT (F10.5,F8.3,F12.0)
- 3.8 1 FORMAT (5F14.3)
- 3.9 READ(2,1)(X(I),I = 11,20)  
1 FORMAT (10F7.4)
- 3.10 READ(2,1)(JOE(I),JIM(I),ANDY(I),BOB(I),FRANK(I),  
I = 1,100)  
1 FORMAT (2I5,2F10.3,E10.3)

3.11



3.12

```

READ(2,1)(X(I),I = 1,1000)
READ(4,1)(X(I),I = 1001,2500)
1  FORMAT (10E8.3)
    
```

3.13

```

1  WRITE(3,1)(A(I),B(I),C(I),I = 1,100)
   FORMAT (3F20.4)
    
```

3.14

```

DO 10 J = 1,100
READ(2,1)(A(I),I = 1,10)
10 WRITE(2,1)(A(I),I = 1,10)
1  FORMAT (10F7.3)
    
```

3.15

```

1  WRITE(3,1)(ANSWER(I),I = 1,10)
   FORMAT ('bFINALbCOMPUTEDbRESULTS'//(E20.7))
    
```

APPLIED PROBLEMS

Exercise 4.1

Solve the trigonometric formula shown below for all 100 angles in the ANGLE array, placing the answers in the Y array. The ANGLE values are all in degrees (57.29578 degrees per radian) and the library functions use radians as the proper dimension for their arguments.

$$y = \tan^{-1} (\sin^2 x + \tan^3 x)$$

NOTE:

$$\tan x = \sin x / \cos x$$

$$\tan^{-1} A = \arctangent A \neq \frac{1}{\tan A}$$

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Solution on page 25  
Return to frame 30



Exercise 4.2

Assuming the Type statements:

```
REAL INTGR
INTEGER SIMPL, BOGGL
```

identify the mode of the functions' value in the list below:

- |          |       |          |       |
|----------|-------|----------|-------|
| a) XACT  | _____ | d) INTGR | _____ |
| b) NUMBR | _____ | e) XCESS | _____ |
| c) SIMPL | _____ | f) BOGGL | _____ |

Solution on page 25  
Return to frame 52



Exercise 4.3

Write a statement which will direct the computer to statement number 10 if the absolute value of X is greater than 0.001 or go to statement 100 if the absolute value of X is less than or equal to that quantity.

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Solution on page 25  
Return to frame 57

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Exercise 4.4

Write a function defining statement to compute the expression  $\tan^{-1} \left( \frac{x}{y} \right)$  where  $\tan^{-1}$  signifies arctangent. Use the name ANGLE.

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Solution on page 25  
Return to frame 84

Exercise 4.5

Write a complete FUNCTION subprogram including a DIMENSION statement to find the algebraically smallest quantity in an array of 1000 or less values. The FUNCTION is to be called SMALL, and it will have two arguments: the dummy array name and integer variable telling how many numbers in the array. The answer will, of course, be made the value of the function.

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Solution on page 25  
Return to frame 128

Exercise 4.6

Write a complete SUBROUTINE subprogram to invert an array; that is, place the first number of the first array at the end of the second array, the second number of the first array next to the end of the second array, etc. Use three arguments: the given array, the array into which the inverted array will be placed, and an integer quantity which tells how long the arrays are. The SUBROUTINE is to be called INVRT. Don't forget the DIMENSION statement.

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Solution on page 25  
 Return to frame 148



Exercise 4.7

Given 10 cards, each containing a row of a 10 by 10 matrix (10F7.1 in the FORMAT), write the necessary DIMENSION, READ, and FORMAT statements to place the matrix in the array called BLOCK.

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Solution on page 25  
 Return to frame 209

## SOLUTIONS TO APPLIED PROBLEMS

- 4.1 DO 10 I = 1,100  
X = ANGLE(I)/57.29578  
10 Y (I) = ATAN ((SIN(X)\*\*2) + ((SIN(X)/COS(X))\*\*3))
- 4.2 a) real d) real  
b) integer e) real  
c) integer f) integer
- 4.3 IF (ABS(X) - .001) 100, 100, 10
- 4.4 ANGLE(X,Y) = ATAN (X/Y)
- 4.5 FUNCTION SMALL (A,N)  
DIMENSION A(1000)  
SMALL = A(1)  
DO 10 I = 2,N  
IF (SMALL - A(I))10,10,5  
5 SMALL = A(I)  
10 CONTINUE  
RETURN  
END
- 4.6 SUBROUTINE INVRT (A,B,N)  
DIMENSION A(1000), B(1000)  
DO 10 I = 1,N  
J = N - I + 1  
10 B(J) = A(I)  
RETURN  
END
- 4.7 DIMENSION BLOCK(10,10)  
1 FORMAT (10F7.1)  
READ(2,1) ((BLOCK(I,J), J = 1,10), I = 1,10)



EXAMINATION  
(Open Book)

1. 20 Points

Given the following table of variable values:

<u>Name</u>	<u>Value</u>
A	1.0
B	3.0
C	5.0
D	2.0

Indicate each of the numeric values which the variable X would represent after the computer had completed each of the Arithmetic statements below. (For example, the statement  $X = A + B + C + D$  would tell the computer to add 1.0, 3.0, 5.0, and 2.0 and set the value of X equal to 11.0).

<u>STATEMENT</u>	<u>X-value</u>
a) $X = C + D - 1.0$	_____
b) $X = B * C * D$	_____
c) $X = A + B/C$	_____
d) $X = B + C - A - D$	_____
e) $X = B * C / D * A$	_____
f) $X = B * B / B$	_____
g) $X = 3.0*B * * 2 - B * C - A - D$	_____
h) $X = X + A$ (assuming the computer has just executed b above)	_____
i) $X = D * D * D * D / 32.0$	_____
j) $X = -D$	_____

2. 20 Points

Assume a projectile is launched from a reference point with coordinates (0,0). It has an initial velocity  $v_x$  in the horizontal direction, and an initial vertical velocity of  $v_y$ . The  $x$  and  $y$  coordinate distances are governed by the following formulae:

$$x = (v_x) (t)$$

$$y = (v_y) (t) - 0.5 (g) (t^2)$$

Where  $v_x$  and  $v_y$  are velocity in feet-per-second,  $t$  is the time in seconds, and  $g$  is the acceleration of gravity (32.174), and  $X$  and  $Y$  come out in feet. Write a suitable pair of Arithmetic statements to compute the above formulas for  $X$  and  $Y$  in miles (5280 feet per mile) assuming that suitable values exist for the variables  $VX$ ,  $VY$ , and  $T$ .

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3. 10 Points

Consider the following sequence of arithmetic statements to be a "program" to be executed in the order they are written. After each statement has been executed show the current values of the variables A, B, and C, assuming each was originally zero.

	A	B	C
A = 5.0	_____	_____	_____
B = -A	_____	_____	_____
C = A/B - 1.0	_____	_____	_____
C = C + 1.0	_____	_____	_____
B = B * B + C	_____	_____	_____
A = A ** 2 - B	_____	_____	_____
B = B - C + A	_____	_____	_____
C = B * C	_____	_____	_____
B = B / 2.0	_____	_____	_____
A = C / B + 12.0	_____	_____	_____

4. 10 Points

Indicate which two variables and/or constants are involved in the first operation performed within the following expressions:

- a)  $A * X ** 2 + B * X + C$  \_\_\_\_\_
- b)  $X ** (A + B)$  \_\_\_\_\_
- c)  $A**(K ** (I + 1))$  \_\_\_\_\_
- d)  $A / B / C$  \_\_\_\_\_
- e)  $((A + B) * X + C) * X + D) * X$  \_\_\_\_\_

5. 10 Points

Point out the "bug" in each of the following statements (there is one, and only one, error in each).

- a)  $X + Y = A$  \_\_\_\_\_
- b)  $V = (I * J$  \_\_\_\_\_
- c)  $N = N + 1,000$  \_\_\_\_\_
- d)  $3.141592 = PI$  \_\_\_\_\_
- e)  $J = N** 1.5 + 1K$  \_\_\_\_\_
- f)  $R = (X**2) + Y **2) **0.5$  \_\_\_\_\_
- g)  $A = B**(N - 2))$  \_\_\_\_\_
- h)  $F + 2 = 1./ (A + B + C)$  \_\_\_\_\_
- i)  $TEMP =-RECORDS$  \_\_\_\_\_
- j)  $A = K** (J + 2N)$  \_\_\_\_\_



6. 20 Points

Given the formulas:

$$V = \frac{\frac{X}{R} - i + \frac{a}{S} + \frac{b}{T} + \frac{c}{U}}{\frac{1}{R} + \frac{1}{S} + \frac{1}{T} + \frac{1}{U}}$$

$$f = \frac{V-a}{S}$$

$$g = \frac{X-V}{(R)(\beta)} \quad (\text{NOTE: } \beta \text{ is the Greek letter Beta})$$

$$h = f-g$$

Write a suitable sequence of at least four Arithmetic statements to compute these formulas, being aware of the fact that variables are being defined and used in subsequent formulas. Do not mix modes by assigning a name of the wrong mode to a variable by misuse of the first letter. Assume that values already exist for all the variables except those four on the left of the equal signs.

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7. 10 Points

Identify the incorrect subscript usage in one (and only one) of the following statements:

- a)  $A(I) = B(I) * C(I)$
- b)  $J = N(K) ** (3 * K ** 2)$
- c)  $B(L) = \text{SAMPL}(4 * L - K)$
- d)  $A(I) = B1 - \text{ANUM}(J)$
- e)  $X = A(I) * B(J) / C(\text{INDEX})$

Ans. \_\_\_\_\_

Contact your advisor



EXAMINATION  
(Open Book)

1. 20 Points

Given the following conditions:

X equals - 22.5  
Y equals + 16.9  
Z equals + 5.6  
I equals 3

Indicate the statement number to be executed next after each of the following statements:

Note: If a sequence of statements is given, indicate the statement number to be executed next after the first statement in the sequence.

- a) IF (X) 20, 30, 40 \_\_\_\_\_
- b) PAUSE 28 \_\_\_\_\_  
34 GO TO 196 \_\_\_\_\_  
28 A = B + C \_\_\_\_\_
- c) GO TO 101 \_\_\_\_\_
- d) GO TO (3,3,20,9,3,16,546),I \_\_\_\_\_
- e) IF (X + Y + Z) 11, 12, 13 \_\_\_\_\_
- f) IF (Y - X) 942,1,2 \_\_\_\_\_
- g) GO TO (11, 12, 13, 14), I \_\_\_\_\_
- h) IF (I\*\*I) 4, 2, 8 \_\_\_\_\_
- i) IF (I - 1) 16,26,36 \_\_\_\_\_
- j) DO 58 L = 4,96,3 \_\_\_\_\_  
26 X = Y\*\*2 \_\_\_\_\_

2. 20 Points

Indicate which FORTRAN statements below have "bugs" and point out each error (there is no more than one per statement):

- a) IF (X\*\*2 - 1.0),1,1,2 \_\_\_\_\_
- b) GO TO (1,2,3) K \_\_\_\_\_
- c) DO 10 X = 1,40 \_\_\_\_\_
- d) IF (QUANTUM) 1,6,9 \_\_\_\_\_
- e) DO 30 INDEX = 5,J,3 \_\_\_\_\_
- f) IF (JKLM-2) 1111,4896,3 \_\_\_\_\_
- g) IF (NUMBR) 10, 20, 30, 40 \_\_\_\_\_
- h) DO 40 J = 1,20,3,9 \_\_\_\_\_
- i) A(K) = X(I) + Y(A) \_\_\_\_\_
- j) PAWS 77777 \_\_\_\_\_

3. 10 Points

Write a program to compute the square roots of the real whole numbers ranging from 1.0 to 100.0 and place these roots in the 100-number array called ROOT.

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4. 20 Points

Assume that the program shown below has been completely executed. Indicate the number of times each statement will have been executed.

5	X = 0.0	
10	DO 500 I = 1,100	
50	X = X + 1.0	
55	IF (X - 20.0) 101, 101, 100	
100	IF (X - 80.0) 102, 102, 103	
101	A(I) = 3.0 * X ** 2 + 4.0 * X	
75	GO TO 500	
102	A(I) = 5.0 * X ** 2 + 6.0 * X	
76	GO TO 500	
103	A(I) = 7.0 * X ** 2 + 8.0*X	
500	CONTINUE	
1000	STOP	

5. 30 Points

Given an array called A containing 1000 numbers, write a program to compute the polynomial  $4a_i^4 - 3a_i^3 + 2a_i^2 - 16$  for all values

of the A array. If the polynomial value is positive or zero, place that number in the array called XPOS in the next available position; if the computed value is negative, place it in similar fashion in an array called XNEG.

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EXAMINATION  
(Open Book)

1. 10 Points

Indicate the number of numerical values read or written by each of the following statement groups:

- a) READ(2,1) A, B, C, D \_\_\_\_\_
- b) WRITE(3,1) (Y(I), I = 1, 25), Z \_\_\_\_\_
- c) I = 11  
J = 20  
READ (2,1) (X(N), N = I,J) \_\_\_\_\_
- d) WRITE \_\_\_\_\_
- e) READ(2,1) (A(I), B(I), C(I), I=1,5) \_\_\_\_\_
- f) WRITE(3,4) (J,X(J), J = 1, 100) \_\_\_\_\_
- g) WRITE (3,50) (X(I),I=1,10), (Y(J),J=1,15,2) \_\_\_\_\_
- h) I = 1  
J = 10  
K = 21  
L = 2  
WRITE(3,1) (BLOCK(N), N=I,K,J), (ARRAY(M),M=I,K,L) \_\_\_\_\_
- i) READ(2,2) I,J,K, (A(L), L = 1, 10) \_\_\_\_\_
- j) I = 20  
J = 50  
K = 3 \* I/J  
N = I\*J  
WRITE(3,101) (X(M), M = K,N,1), Y,Z \_\_\_\_\_



2. 10 Points

How many numbers per line or card will be read or written according to the following FORMAT statements?

Note: All FORMATS using more than 80 positions are assumed to be output formats.

- a) FORMAT (X4,6F12.4) \_\_\_\_\_
- b) FORMAT (F10.2, 20X, 3I5) \_\_\_\_\_
- c) FORMAT ('bTABULARbOUTPUTbNO.b',I2) \_\_\_\_\_
- d) FORMAT (6(E15.7, I5)) \_\_\_\_\_
- e) FORMAT (F16.0, 10X, E18.6, 7I8) \_\_\_\_\_
- f) FORMAT (F12.6, 2(3F6.2, 10X, I6)) \_\_\_\_\_
- g) FORMAT ('bX=', F10.4, 3X, 'bY=', F10.4) \_\_\_\_\_
- h) FORMAT (X40,F12.4/ (12X, F12.4)) \_\_\_\_\_
- i) FORMAT (72('\*')) \_\_\_\_\_
- j) FORMAT (2(F12.6, 6X, I4), 6E10.4) \_\_\_\_\_

3. 30 Points

Write a complete program (with STOP and END statements included) to do the following:

- a) Read a card containing an integer number ranging from 1 to 2000 in card columns 1-4.
- b) Read that many real numbers from successive cards, six numbers per card, twelve columns per number (including four decimal places), to make up the A array. Use F notation.
- c) Sort the array values into algebraically ascending order without using a separate array (use the technique of comparing adjacent values, swapping if they are out of order).
- d) Print out the re-ordered array, on a 120-position printer, ten numbers per line, 12 columns (four decimal places), per number. Use F notation.
- e) Stop the computer.

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4. 50 points

Write a program to read 100 cards from the card reader. These cards contain current information about an employee stock-purchasing plan. Each card is laid out as follows:

<u>Column</u>	<u>Contents</u>	<u>Range</u>
1-5	Employee serial number	10000-29999
11-16	Current account balance	\$0.00-\$999.99
20-22	Number of shares owned	0-999

Your program should read these quantities into 3 individual 100-number arrays, and then read 100 more cards, each containing the following updated information:

<u>Column</u>	<u>Contents</u>	<u>Range</u>
1-5	Employee serial number	10000-29999
11-16	Amount deposited this period	\$0.00-\$999.99

reading these values into 2 additional 100-number arrays.

Finally, your program is to read a single card containing the current stock price, six columns with two decimal positions provided. Then, taking each employee updating (card) record in turn, find each card serial number's position in the first card list and add the corresponding new deposit to the corresponding account balance. Check this total against the current price, and subtract out the current price if the employee has purchased a share, simultaneously updating his "shares owned" total and printing his serial number on the attached printer (output reference 3). When this has been done for all 100 employees, punch out 100 new cards containing the updated version of the three 100-number arrays, using the same FORMAT as before.

(Assume that no new deposit will exceed the stock price and that the old balance will be less than the current stock price, and also that every serial number in the updating card deck will be found in the corresponding card list.)

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EXAMINATION  
(Open Book)

1. 10 Points

Write a single Arithmetic statement function definition for the following formulae:

<u>Name</u>	<u>Formula</u>	<u>Arguments</u>
CUBRT	cube root = $x^{.333333}$	X
SIN2X	$\sin(2x) = 2 \sin(x) \cos(x)$	X
ROOT	root = $\frac{-b + \sqrt{b^2 - 4ac}}{2a}$	A, B, C
LOG10	$\log_{10}(x) = 0.4342945 \log_e(x)$	X

CUBRT (X) = \_\_\_\_\_

SIN2X (X) = \_\_\_\_\_

ROOT (A,B,C) = \_\_\_\_\_

LOG10 (X) = \_\_\_\_\_

2. 20 Points

Given an array of positive numbers, 500 in all, called LIST (integer) compute the fourth root of each value. Place the results in the real array called ARRAY in the same order that the original values were found in LIST. Include an appropriate DIMENSION statement.

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3. 10 Points

Indicate by listing subscripts the order of the lists in the following DIMENSION statements. For example, DIMENSION A(2,2) would result in the order: (1,1), (2,1), (1,2), (2,2)

DIMENSION X(5,4)    \_\_\_\_\_  
                                  \_\_\_\_\_

DIMENSION ARRAY (2,5)    \_\_\_\_\_  
                                  \_\_\_\_\_

DIMENSION QUOTA (2,2,2)    \_\_\_\_\_  
                                  \_\_\_\_\_

4. 20 Points

Write a FUNCTION subprogram called G with two arguments X and A. The FUNCTION is to be programmed to give the value  $ax^2$  if x is less than zero or the value  $ax^3$  if x is equal to or greater than zero.

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5. 20 Points

Write a SUBROUTINE subprogram called MATMY which will multiply two matrices, each of which is 10 by 10 in size, having as arguments A, B, and C, where A and B are the matrices to be multiplied and C is the product matrix. Remember, the argument variables are arrays (must appear in DIMENSION statement) and they are listed in the SUBROUTINE statement by name only (without any subscripts). In general, the product of two matrices is formed by multiplying each number in a row by a number in a column and adding the products, repeating for all combinations of rows and columns. In formula form it is:

$$c_{ij} = \sum_{k=1}^{10} (a_{ik}) (b_{kj}) \quad (\text{for all combinations of } i \text{ and } j)$$



or, for example:

$$c_{1,1} = a_{1,1} b_{1,1} + a_{1,2} b_{2,1} + a_{1,3} b_{3,1} + a_{1,4} b_{4,1} + \dots + a_{1,10} b_{10,1}$$

$$c_{1,2} = a_{1,1} b_{1,2} + a_{1,2} b_{2,2} + a_{1,3} b_{3,2} + a_{1,4} b_{4,2} + \dots + a_{1,10} b_{10,2}$$

$\cdot$   $\cdot$   $\cdot$   $\cdot$   
 $\cdot$   $\cdot$   $\cdot$   $\cdot$   
 $\cdot$   $\cdot$   $\cdot$   $\cdot$   
 $\cdot$   $\cdot$   $\cdot$   $\cdot$   
 $\cdot$   $\cdot$   $\cdot$   $\cdot$   
 $\cdot$   $\cdot$   $\cdot$   $\cdot$

$$c_{1,10} = a_{1,1} b_{1,10} + a_{1,2} b_{2,10} + a_{1,3} b_{3,10} + a_{1,4} b_{4,10} + \dots + a_{1,10} b_{10,10}$$

$$c_{2,1} = a_{2,1} b_{1,1} + a_{2,2} b_{2,1} + a_{2,3} b_{3,1} + a_{2,4} b_{4,1} + \dots + a_{2,10} b_{10,1} \text{ etc.}$$

$\cdot$   $\cdot$   $\cdot$   $\cdot$   
 $\cdot$   $\cdot$   $\cdot$   $\cdot$   
 $\cdot$   $\cdot$   $\cdot$   $\cdot$

In other words, any  $ij$ -th element of the  $c$  matrix is composed of ten products added together, the products being corresponding elements of the  $i$ -th row of the  $a$  matrix and the  $j$ -th column of the  $b$  matrix multiplied together. Notice that the examples above show the first subscript of the  $a$  matrix always agrees with first subscript of the desired  $c$  element, while the second subscript of the  $b$  matrix always agrees with the second subscript of the  $c$  element. The column subscript of  $a$  and the row subscript of  $b$  are always the same, also. Thus, this problem can be handled with three nested DO-loops, the innermost of which controls the summation.

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6. 20 Points

Write a program that uses the FUNCTION of problem 4 and the SUBROUTINE of problem 5 in the following manner:

NOTE: Use F notation in all FORMAT statements.

1. Read from cards a 10 by 10 array called BLOCK, reading column-wise (first subscript cycled most rapidly), reading 6 twelve-position numbers per card with 4 decimal places.
2. Read from paper tape a 10 by 10 array called BMTRX, reading row-wise (second subscript cycled most rapidly) with the same card FORMAT.
3. Call on MATMY to multiply the two matrices, giving BLOCK as the first argument (pre-multiplier) and BMTRX as the second (post-multiplier), and place the result in an array called ARRAY.
4. For each element of ARRAY, compute the value of  $G(D, ARRAY(I, J))$  using the FUNCTION of problem 4, with D having a value of 5.0, and replace the original value of ARRAY with the one computed with the FUNCTION.
5. Print on the typewriter the entire ARRAY contents (row-wise), ten numbers per line with four decimal places.

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