Instructional Aids for Teaching How to Use the TI-59 Programmable Calculator

by

Ralph E. Hepp

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INSTRUCTIONAL AIDS FOR TEACHING HOW TO USE THE TI-59 PROGRAMMABLE CALCULATOR

By

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1983

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PREFACE

There is a worldwide revolution in small computer technology underway and scientists are struggling to find ways to utilize this new technology to help solve development problems in the Third World. We are pleased to announce a number of papers on microcomputers in international agriculture will be published in our International Development Papers series. The aim of these papers is to provide timely information about the rapidly changing state of the new micro-processing technology and its use in research. The papers are also intended as guides to agricultural and social scientists on choosing, installing, and maintaining microcomputer hardware and software systems in developing countries.

Some of the papers will also document field experiences of selected established projects using new data processing hardware and software. Other papers will concentrate on developing guidelines for establishing and maintaining successful microcomputer and/or programmable calculator installations for agricultural research in developing countries.

The present paper is the fourth of these new papers. It is based on staff work by faculty members and graduate students of the Department of Agricultural Economics, Michigan State University, on cost-effective data collection, management, and analysis techniques for developing country applications. This activity is carried out under the terms of reference of the Alternative Rural Development Strategies Cooperative Agreement--DAN-1190-A-00-2069-00--between the Office of Multi-Sectoral Development, Bureau of Science and Technology of the United States Agency for International Development and the Department of Agricultural Economics at Michigan State University.

Readers are encouraged to submit comments about these new papers on microcomputers and to inform us of their activities in this area. Write directly to: Dr. Michael T. Weber, Acting Director, Alternative Rural Development Strategies Cooperative Agreement, Department of Agricultural Economics, Michigan State University, East Lansing, Michigan 48824-1039.

Eric W. Crawford, Carl K. Eicher, and Carl Liedholm
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INTRODUCTION

Programmable calculators are making mathematical calculations simpler and more accurate for agricultural producers, agribusiness representatives, extension advisors and researchers. Since the introduction of the Texas Instruments 59 calculator, numerous routines and programs have been developed.

The instructional materials on the operation and programming of the TI/59 are an outcome from teaching students, farmers, research and extension workers on how to use and program the calculator. Numerous visual aids are included for easy reproduction as transparencies to assist instructors. The visual aid number corresponds to a text explanation and background information section which is helpful in explaining the concepts covered on the visual aids.

The visual aids and text are organized into eight lesson units by topic. Objectives for the lesson are stated at the outset of each unit. An instructor who is teaching others in the operation and programming of the TI/59 should supplement the enclosed teaching aids with other reference books and personal experiences in using and programming the TI/59.

Material for the visual aids and text has been taken from the Personal Programming and Business Application books listed in the reference section. Special thanks is extended to Michael Beauregard, Forestry Department, Michigan State University who let me use his visual aids on the TI/59 while developing the materials.

LESSON 1 TODAY'S ELECTRONIC CALCULATOR OR HANDHELD COMPUTER

Objectives

-- Develop an understanding of programmable calculators available for use in research, extension and business.

-- Identify the advantages and limitations of programmable calculators

1-1 BASIC CALCULATOR FUNCTIONS

The programmable calculator has the same features as a basic four-function calculator (designed only to add, subtract, multiply and divide) with the additional feature of a memory register which can store and recall instructions and data. Instructions and data can be stored on magnetic cards and reused in the future without keying them back to memory, and with the print cradle, a printout of data, instruction steps and output can be made available. These abilities transform the basic calculator into a computer, one with a limited storage capacity, but capable of performing the minimum computer functions of reading in both data and instruction, storing data and instructions in memory, performing calculations in the manner prescribed by the instruction, reading or writing out the results and controlling all aspects involved in getting an answer.

1-2 ADVANTAGES OF THE PROGRAMMABLE CALCULATOR

1. Economy -- The most advanced Texas Instrument programmable calculator with printer costs less than $400.

2. Portability -- The programmable calculator can literally be carried in a pocket.

3. Speed -- Calculations take seconds. Manual calculations can often involve hours, sometimes days.

4. Accuracy -- Just push the right keys.

5. Problem Solving -- For complicated programs requiring many steps and data entries, a larger computer is necessary. However, for many decision making problems, the programmable calculator is the cheapest, fastest and most accessible.

6. Comprehension -- Almost anyone can use a programmable calculator. Computer science training is not required.

1-3 LIMITATIONS OF THE PROGRAMMABLE CALCULATOR

1. Memory -- Limited memory space for programming steps and data storage.

2. Printed output -- Alpha printed output is confined to a few key words.

3. Data Entry -- Not suited for problems with large data handling requirements.

4. Programming Language -- Restricted to the keyboard language designed for the calculator.

5. Task Applications -- Limited to problems dealing with mathematical expressions -- Does not have the versatility and flexibility for task application of a micro-computer.

1-4 EXAMPLES OF PROGRAMMABLE CALCULATORS/HANDHELD COMPUTERS

TRS-80 PC-1 and PC-2 -- Programmable in Basic

TI/59 -- Keyboard language

1-5 FEATURES OF THE TI/59

Power Adapter: The TI/59 comes with a rechargeable power pack built into the calculator. To recharge the calculator, plug the adapter into a household outlet, with the cord inserted in the right-hand side of the programmable calculator. The power pack will also recharge when it is being used on the printer.

Off-On Switch: The switch is located at the top of the calculator. Push to the right to turn on, left to turn off.

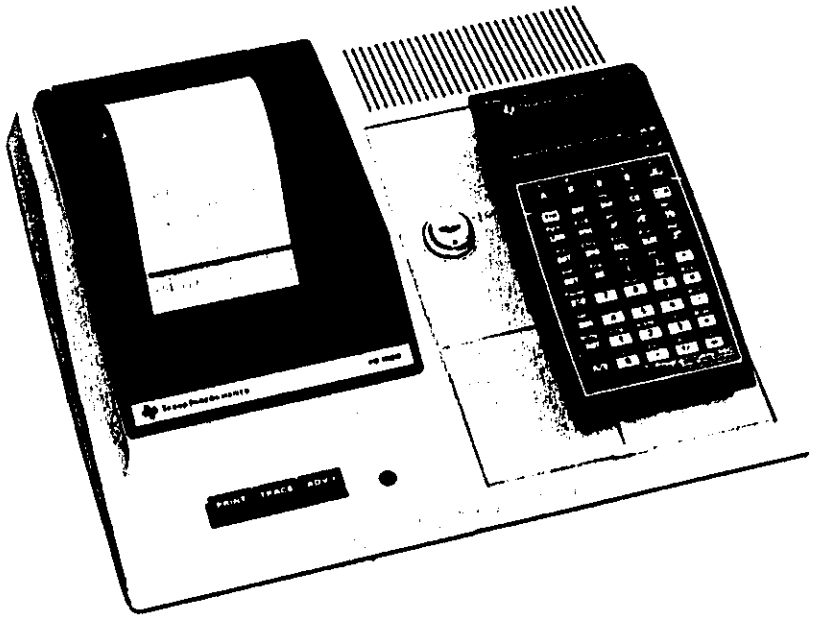
Memory: The TI/59 has 120 memory registers. Each individual memory register can store 8 program steps (or a maximum of 960 program steps) or one number (up to 100 data registers), but not both in one register.

Keyboard: The TI/59 has 45 face keys with the function printed on the key. There are 41 secondary keys with the function printed directly above the key. Face keys are pushed directly, while secondary keys must be preceded by the face key [2nd]. This key is similar in function to the shift key on a typewriter which is used to obtain the higher case letters.

Magnetic Cards: Thin plastic strips are used to record the program steps and/or data. A maximum of two cards (480 program steps) can be recorded in the memory registers at one time. Cards are inserted in the right-hand side. The motor in the calculator will pull the cards through. When the buzzer stops, pull the card out.

Printer (PC-100A Print/Security Cradle): The TI/58 and TI/59 can be used with the printer to provide printouts of data, program steps or output. This capability is useful in searching for problems in the program -- "debugging."

UNDERSTANDING YOUR TI/59
PROGRAMMABLE CALCULATOR



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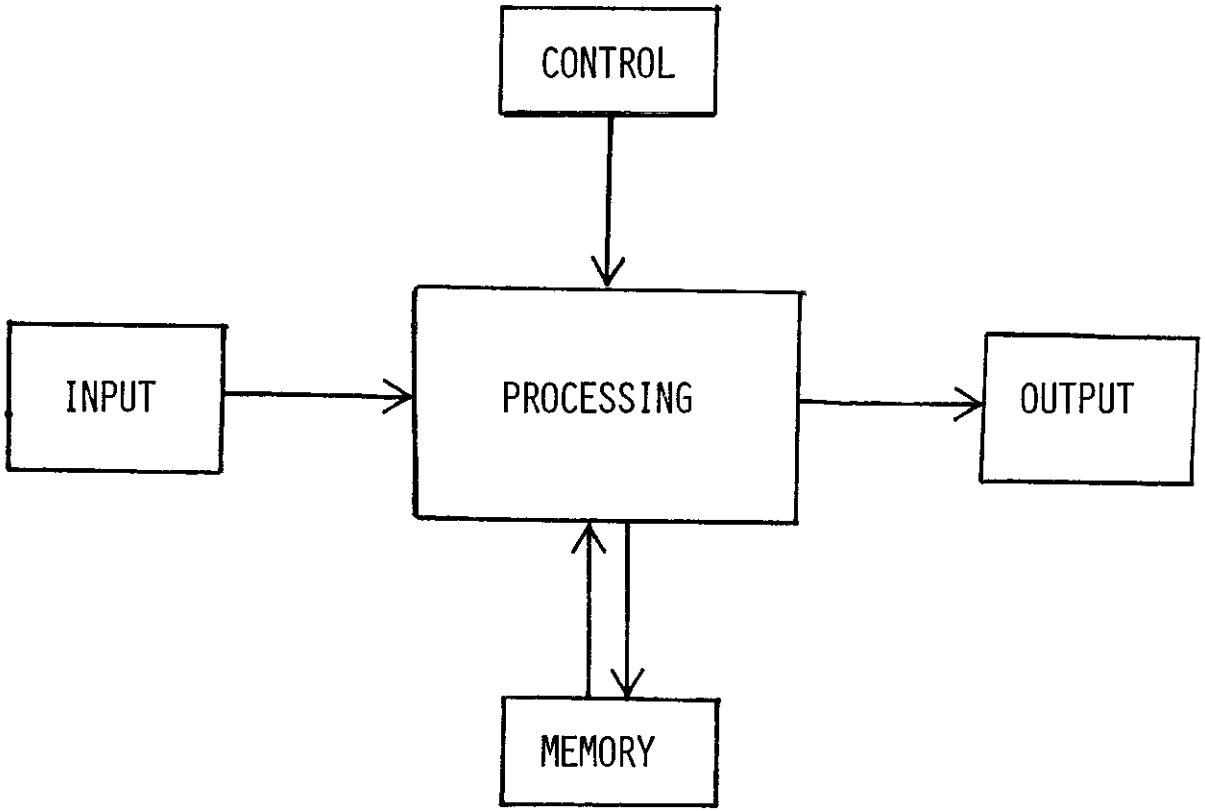
BASIC CALCULATOR FUNCTIONS



ADVANTAGES OF THE PROGRAMMABLE CALCULATOR

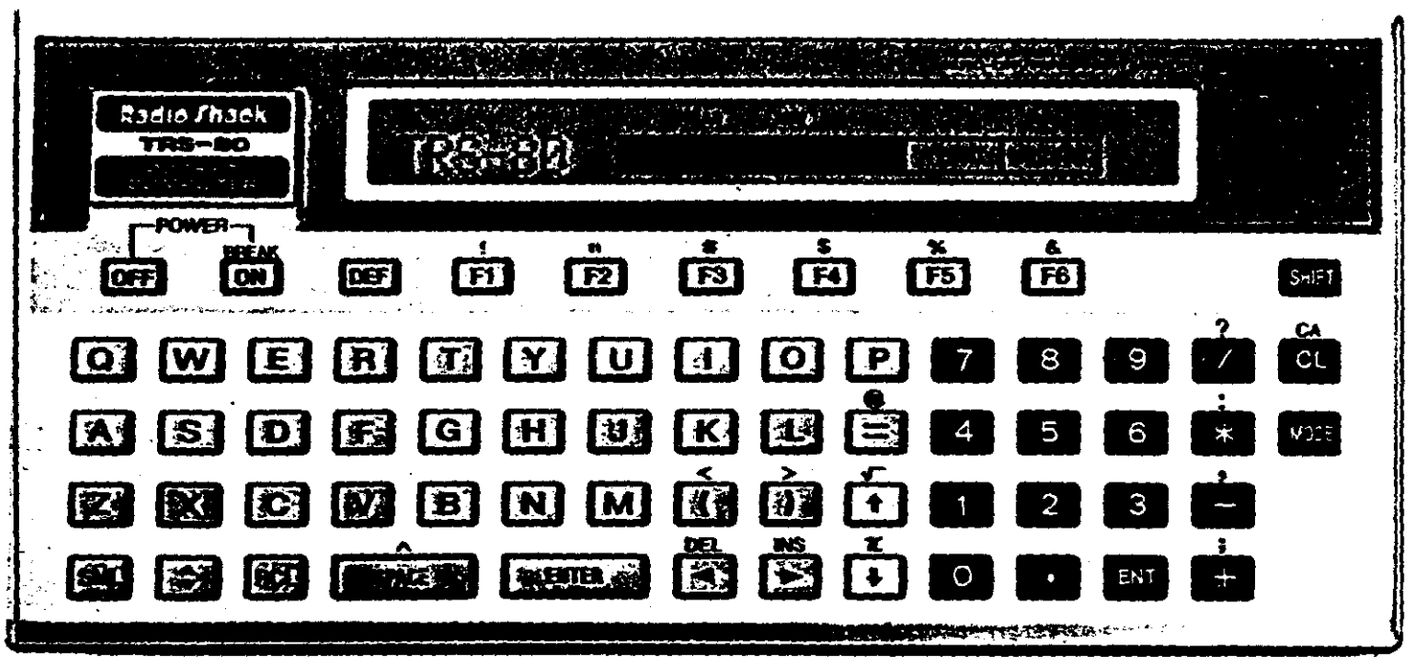
1. ECONOMY
2. PORTABILITY
3. SPEED
4. ACCURACY
5. PROBLEM SOLVING
6. COMPREHENSION

LIMITATIONS OF THE PROGRAMMABLE CALCULATOR

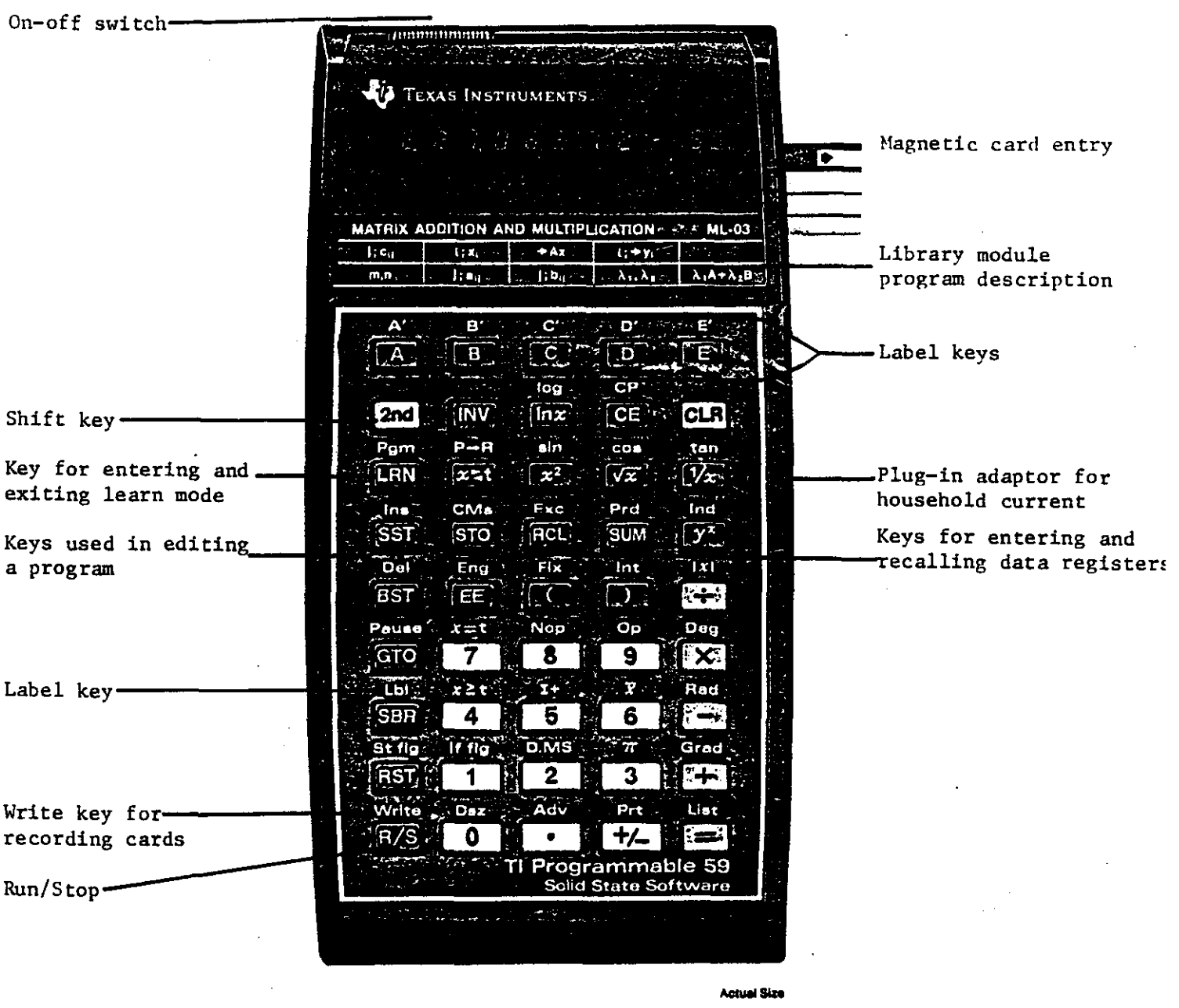
1. MEMORY
2. PRINTED OUTPUT
3. DATA ENTRY
4. PROGRAMMING LANGUAGE
5. TASK APPLICATION

TRS-80 POCKET COMPUTER MODEL PC-2

NEW! SECOND GENERATION!



FEATURES OF THE TI/59



LESSON 2 MANUAL OPERATIONS

Objectives

-- To become familiar with the features and functions of the keys.

-- To perform arithmetic calculations.

-- To use basic function keys in manual calculations.

-- To be able to store and recall data in calculator memory.

2-1 KEYBOARD BASICS

Clearing the Display

[CE] -- Clear entry

[CLR] -- Clear all calculations in progress

Data Entry Keys

[0] – [9] -- Numbers

[•] -- Floating decimal point

[+/-] -- Changes the sign of display number

*

[π] -- Places π into the display

Basic Operation Keys

[+], [-], [x], [÷], [=]

The AOS (Algebraic Operating System) Entry Method

1. Special single variable function Keys -- acts on the displayed number immediately as the function key is pressed -- i.e.: trig and log functions,

2. Powers and roots are handled next,

3. Multiplication and division are completed,

4. Additions and subtractions are completed, and

5. Equals key completes all pending operations.

Parentheses Keys

[(], [)] -- Used to cluster numbers and operations to change the AOS hierachy with the intermost parentheses operation completed first.

Dual Function Keys

[2nd] -- The 2nd Key must preceed the second function key (written above the key)

*Denotes a second key

2-2 INVERSE KEY FUNCTIONS

Inv -- The inverse key increases the number of functions when it precedes the function key

Function	Inverse Function
EE	removes EE
ENG	removes ENG
Fix	removes Fix
log	10^x
ln x	e^x
y^x	$\sqrt[x]{y}$
Int	fractional part
sin	$\sin^{-1}$
cos	$\cos^{-1}$
tan	$\tan^{-1}$
Prod	divide into memory
SUM	subtract from memory
D.MS	decimal to D.MS
P→R	R→P
$\Sigma+$	$\Sigma-$
$\bar{x}$	standard deviation
list	list data registers
SBR	return
$x = t$	$x \neq t$
$x \geq t$	$x < t$
if flg	if no flag
st flg	reset flag
Dsz	skip on nonzero
Write	read

2-3 MEMORY KEYS

* [CMs] -- Clears all data registers simultaneously.

[STO] XX -- Stores the number in the display into data register XX (A two digit data register must be pressed; 00 -- 99)

[RCL] XX -- Recalls the contents of data register XX to the display

* [Exc] XX -- Exchanges the contents in data register XX with the number in the display.

2-4 MEMORY ARITHMETIC KEYS

[SUM] XX -- Sums the contents in the display to the value in data register XX

[INV] [SUM] XX -- Subtracts the contents in the display to the value in data register XX

* Prd XX -- Multiples the contents in the display by the value in data register XX

INV * Prd XX -- Divides the value in data register XX by the contents in the display

2-5 DISPLAY CONTROL -- STANDARD DISPLAY

Display -- 10 digits shown in the display window

Display Register -- Internal register that retains results to 13 digits

Display Form

1. Standard number -- 271124

   or

2. Scientific notation -- 800,000,000,000 is shown as 8. 11 or 8×10^{11}

2-6 SCIENTIFIC NOTATION KEY -- EE

Form -- Number = Mantissa x $10^{exponent}$

Key Sequence

1. Enter the mantissa up to 8 digits (press +/- if negative)

2. Press EE -- Sets up the scientific notation format

3. Enter the exponent up to 2 digits (press [+/-] if negative

4. Press any operation key

2-7 ENGINEERING NOTATION KEY -- *[Eng]

1. Engineering notation is a modified form of scientific notation.

2. The exponent is always adjusted to a multiple of three (ie, 10^3, 10^6, 10^{-3}).

3. The display is converted to engineering notation by pressing *[Eng] .

4. The display returns to the standard format by pressing [INV] *[Eng] .

5. A number cannot be entered in engineering notation like scientific notation -- the number must be converted to engineering notation.

2-8 FIX-DECIMAL CONTROL -- *[Fix]

1. Controls the display of digits to the right of the decimal point.

2. Key sequence -- *[Fix] X where X is the number of digits to the right of the decimal point in the display. X can be from 0-8.

3. The display register retains the internal accuracy to 13 digits.

4. Pressing [INV] [*Fix] removes the fix-decimal.

2-9 SQUARE, SQUARE ROOT, RECIPROCAL KEYS

Key Sequence

1. Enter a number in display
2. Enter the algebraic function

2-10 POWERS AND ROOTS

Key Sequence for Powers y^x

1. Enter the number y you want raised
2. Press [y^x]
3. Enter the power x
4. Press [=] (or any operation key)

2-11 OTHER ALGEBRAIC FUNCTIONS

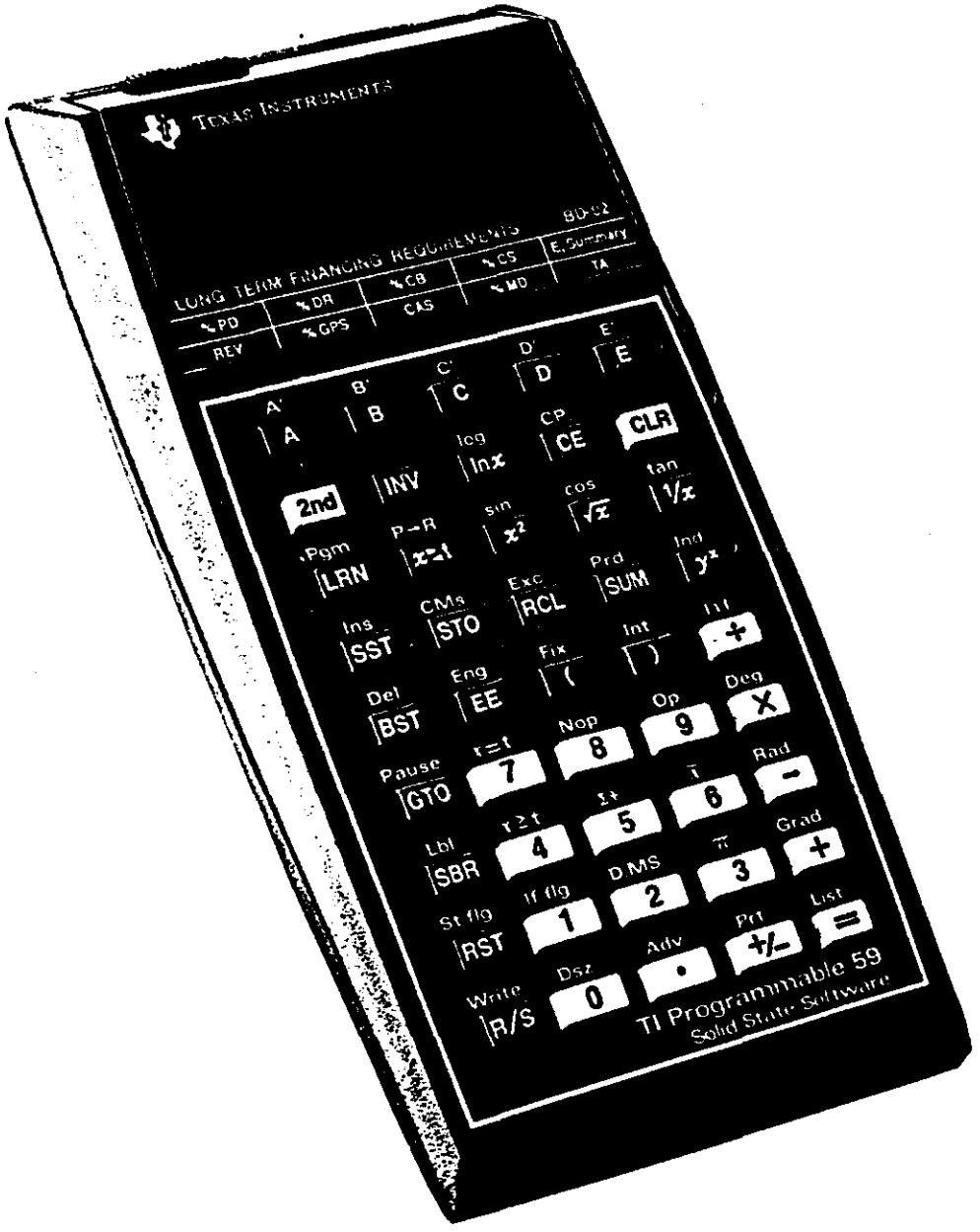
Logarithm -- [ln x], [*log]

Angular Mode Keys -- [*Deg], [*Rad], [*Grad]

Trigonometic Keys -- [*sin], [*cos], [*tan]

See p. II-13 & II-14 of Personal Programming for explanation

TI/59 KEYBOARD BASICS



INVERSE KEY FUNCTIONS

Function	Inverse Function
EE	removes EE
ENG	removes ENG
Fix	removes Fix
log	10^x
ln x	e^x
y^x	$\sqrt[x]{y}$
Int	fractional part
sin	$\sin^{-1}$
cos	$\cos^{-1}$
tan	$\tan^{-1}$
Prod	divide into memory
SUM	subtract from memory
D.MS	decimal to D.MS
P→R	R→P
$\Sigma+$	$\Sigma-$
$\bar{x}$	standard deviation
list	list data registers
SBR	return
$x = t$	$x \neq t$
$x \geq t$	$x < t$
if flg	if no flag
st flg	reset flag
Dsz	skip on nonzero
Write	read

* [CMs] -- CLEAR MEMORY

[STO] xx -- STORE

[RCL] xx -- RECALL

* [Exc] xx -- MEMORY EXCHANGE

EXAMPLE

PRESS	DISPLAY
3.21 [STO] 08	3.21
[CLR]	0
[RCL] 08	3.21
98	98
* [Exc] 08	3.21

MEMORY ARITHMETIC KEYS

[SUM] xx -- MEMORY SUM

[INV] [SUM] xx

*[PRD] xx -- MEMORY PRODUCT

[INV] *[PRD] xx

EXAMPLE

PRESS	DISPLAY
25 [STO] 10	25
30.5 [SUM] 10	30.5
[RCL] 10	55.5
2 *[PRD] 10	2
[RCL] 10	111

STANDARD DISPLAY

EXAMPLE

PRESS	DISPLAY
842 X 322 =	271124
400000 X	400000
2000000 =	8.11

SCIENTIFIC NOTATION KEY -- [EE]

FORM -- NUMBER = MANTISSA X 10 $^{\text{EXPONENT}}$

KEY SEQUENCE FOR ENTRY -- EXAMPLE

PRESS	DISPLAY
3.8901448	3.8901448
[+/-]	-3.8901448
[EE]	-3.8901448 00
32	-3.8901448 32
[+/-]	-3.8901448 -32

ENGINEERING NOTATION KEY -- *[ENG]

EXAMPLE

PRESS	DISPLAY
*[ENG] [CLR]	0.00
8 [X] 98 [X]	784.00
30 [=]	23.52 03
*[ENG] [INV]	23520

FIX - DECIMAL CONTROL -- *[Fix]

KEY SEQUENCE -- *[Fix] x

EXAMPLE

PRESS	DISPLAY
[CLR]	0.
2 [÷] 3 [=]	.6666666667
*[Fix] 6	0.666667
*[Fix] 2	0.67
*[Fix] 0	1.
[INV] *[Fix]	.6666666667

SQUARE, SQUARE ROOT, RECIPROCAL KEYS

EXAMPLE: $\sqrt{4}\ \left(\frac{1}{5}\right)^2 = 50$

PRESS	DISPLAY
[CLR]	0
4 [$\sqrt{x}$]	2
[÷] 5 [1/x]	0.2
[x^2]	0.04
[=]	50.

POWERS AND ROOTS -- [Y^x]

EXAMPLES: 2^6 AND $\sqrt[6]{64}$

PRESS	DISPLAY
[CLR]	0
2 [Y^x] 6 [=]	64
[CLR]	0
64 [INV] [Y^x] 6 [=]	2.

OTHER ALGEBRAIC FUNCTIONS

LOGARITHMS -- [LMX], *[LOG]

ANGULAR MODE KEYS -- [DEG], *[RAD], *[GRAD]

TRIGONOMETIC KEYS -- *[SIN], *[COS], *[TAN]

CONVERSIONS

DEGREE FORMAT CONVERSIONS -- *D.MS

POLAR/RECTANGULAR CONVERSIONS -- *P→R

LESSON 3. CALCULATOR OPERATION USING EXISTING PROGRAMS

Objectives

-- To become familiar with memory basics

-- To be able to keystroke program steps into memory

-- To be able to enter data into data registers

-- To practice problem solution using existing programs

-- To practice recording and reading magnetic cards and using the printer

3-1 BASIC PROGRAM CONTROL FUNCTIONS

[LRN] - LEARN -- Pressing the learn key puts the calculator in learn mode of operation. This allows an operator to keystroke program steps into memory. Pressing the learn key again puts the calculator back under keyboard control or run mode of operation.

*[CP] - CLEAR PROGRAM -- From the keyboard, the key clears the program steps, T-register, and the subroutine return register and resets all flags. When the key is encountered in the program, it zeros the T-register.

[R/S] - RUN/STOP -- Reverses the status (Start/stop) of processing (run mode) when the key is encountered from the keyboard or within the program.

RST - RESET -- Resets the program pointer to location 000 of program memory, clears the subroutine return register and resets all flags.

*

Pause - PAUSE -- When encountered within the program during program execution, the current value in the display register is shown for 1/2 second. Multiple pauses causes a longer display. When encountered from the keyboard during program execution, the display shows the result from the program step.

3-2 MEMORY STORAGE CAPACITY

1. Memory is composed of two areas:
   -- Program memory locations
   -- Data memory registers
2. The memory has 120 registers for storage in the memory storage area
3. Initially, there is an even split between program and data registers with 60 for each.
4. Program memory contains eight program steps (Pressing 8 keys) for each program memory location or 480 program steps. Program steps are numbered from 000 through 479.
5. A data memory register will accept up to eight digits. If the number is greater than eight digits, the data register stores the number in scientific notation. Data registers are numbered from 00 through 59.

6. Memory storage area is divided into four banks as follows:

Bank	Program Memory Locations	Data Memory Registers
1	000-239	90-99
2	240-479	60-89
3	480-719	30-59
4	720-959	00-29

An understanding of banks is needed for recording on magnetic cards.

3-3 PARTITIONING MEMORY

1. To determine present memory partition, press keys *[Op] 16. When the on switch has been engaged, the memory should automatically partition at program step line 479, data register 59. When the keys *[Op] 16 are pressed, the display should read 479.59. The number to the left of the decimal indicates the maximum number of program steps (480). The number to the right of the decimal point indicates the maximum number of data registers (60).

2. When the number of program steps is greater than 480 or the number of data registers is greater than 60, the memory must be repartitioned. Repartitioning is set by the number of data registers. This can best be

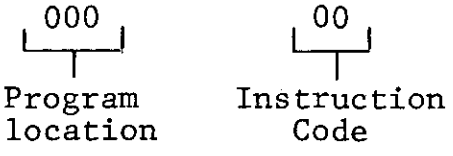
explained with examples. Key in X [*] [Op] 17 where X represents the desired set of data registers. Each data register set has 10 data registers. Therefore if we needed 50 data registers, key in 5 [*] [Op] 17 and the memory storage area changes to 559.49. If we needed 80 data registers, key in 8 [*] [Op] 17 and the memory storage area changes to 319.79.

3. Refer back to visual 3-2 and practice other partitioning combinations.

3-4 LEARN MODE

1. Enter learn mode

2. Display format



3. Program location starts at 000 and is numbered consecutively up to the partition.

4. The instruction code contains zeros until program steps are entered.

5. Each time a key is pressed in learn mode an instruction code is entered at the program location.

3-5 INSTRUCTION CODES

Numeric Keys

1. Represented by the appropriate number
2. Example -- 8 is recorded as 08

First Function Keys

1. Assigned key codes based on location of the keys on the keyboard.
2. The first digit is the row location numbered from 1-9 from top to bottom.
3. The second digit is the column location numbered from 1-5 from left to right.

Second Function Keys

1. The row number is not changed.
2. The column digit is the column location plus five numbered from 6-0 from left to right.
3. Example -- *Sin is recorded as 38.

3-6 ENTER PROGRAM IN MEMORY

1. Turn calculator off and on

2. Enter program

Press	Display
*LRN	000 00
*Lbl	001 00
A	002 00
6	003 00
+	004 00
9	005 00
=	006 00
R/S	007 00
LRN	0

3. Run program

Press	Display
A	15

3-7 EDITING A PROGRAM

- Use previous example
- Keys -- The first four keys do not register an instruction code when pressed in learn mode.

  [SST] -- Moves line counter to next program step

  [BST] -- Moves line counter back one step.

  * [Ins] -- Inserts a new line at display point

  * [Del] -- Deletes the displayed line

  * [Nop] -- Deletes instruction and provides a blank space (No operation code)

- Correcting an error on any line can be completed by moving the program pointer to the incorrect line and pressing the correct key (Will not work for keystroke code exceptions)

3-8 COMBINED INSTRUCTION CODES

1. When two or more keys are used for a single instruction, the key code is not based on key location.
2. A single location code number is assigned for combined instructions. A numeric key location is used for this purpose.

3. Combined instruction codes

Key Sequence	Key Codes
* Pgm * Ind	62
* Exc * Ind	63
* Prd * Ind	64
* STO * Ind	72
* RCL * Ind	73
* SUM * Ind	74
* GTO * Ind	83
* Op * Ind	84
INV SBR	92

4. 2nd key -- Combined with other instructions.

3-9 TWO-DIGIT ADDRESSES

1. Two-digit addresses following select keys occupy one location.

2. Instructions for:

   -- Data memory (STO, RCL, SUM, Prd, Exc)

   -- Program library access (Pgm)

   -- Special control operations (Op)

3. Examples -- [STO] 25 is recorded as:

   |42|, |25| rather than |42|, |02|, |05|

3-10 TRANSFER ADDRESSES

1. Transfer addresses to a three digit program location are stored in two locations with the first digit stored in the first location and the remaining two digits stored in the second location.

2. Transfer addresses (GTO, SBR, x=t, x≥t, Dsz, If Flg)

3. Example -- [GTO] 125 is recorded as:

   |61|, |01|, |25| rather than |61|, |01|, |02|, |05|

3-11 DATA ENTRY PROCEDURES

- Function -- Store a number in a data register

- Methods

  1. Direct -- 3 [STO] 01 stores a 3 in data register 01 and 5 [STO] 02

  2. Programmed -- Create steps in the program to store a displayed number

- Example of programmed method

    1. Input program steps

        Lbl A

        STO 01

        R/S

        Lbl B

        STO 02

        R/S

    2. Input numbers

        3 A

        5 B

- Use recall key to check if numbers are in the assigned data registers.

3-12 LOAN PAYMENT PROGRAM LIST

1. Problem -- Calculate the annual payment on an equal payment amortized loan given the interest rate, principal borrowed and the number of annual payments

2. Method

$$A = \frac{r}{1 - \left(\frac{1}{1+r}\right)^n}$$

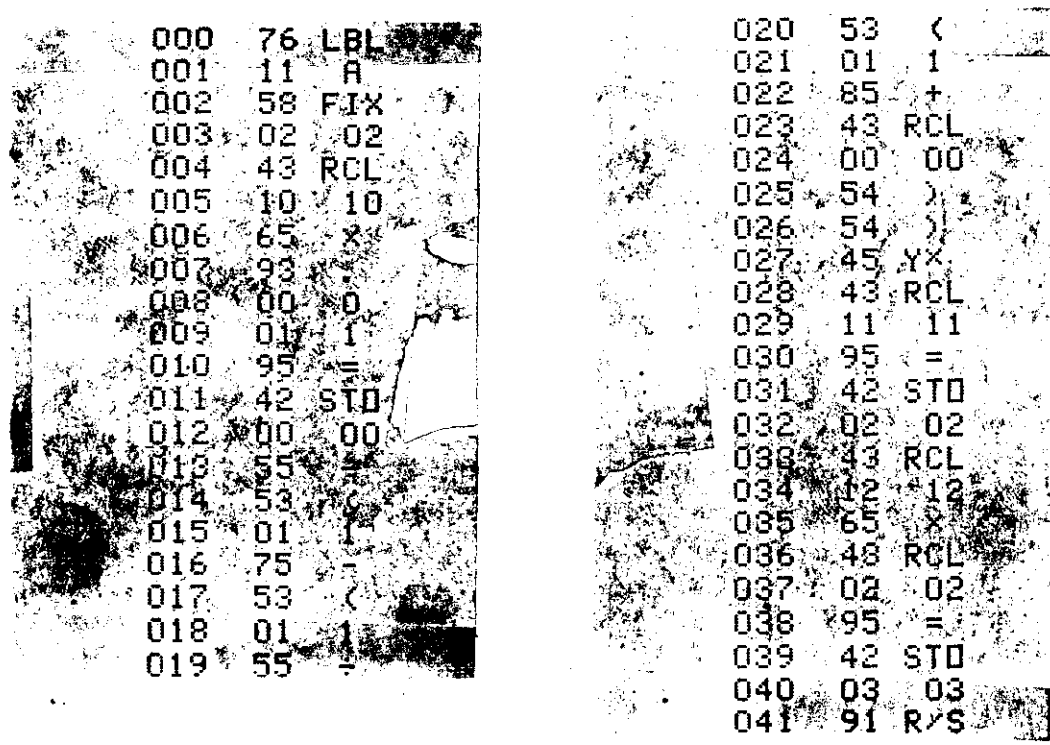
Where:

A = annual payment for a $1 loan

r = annual interest rate

n = number of payments

3. Program List



```
000  76 LBL
001  11  A
002  58 FIX
003  02  02
004  43 RCL
005  10  10
006  65  ×
007  93  .
008  00  0
009  01  1
010  95  =
011  42 STO
012  00  00
013  55  ÷
014  53  (
015  01  1
016  75  -
017  53  (
018  01  1
019  55  ÷
020  53  (
021  01  1
022  85  +
023  43 RCL
024  00  00
025  54  )
026  54  )
027  45 YX
028  43 RCL
029  11  11
030  95  =
031  42 STO
032  02  02
033  43 RCL
034  12  12
035  65  ×
036  43 RCL
037  02  02
038  95  =
039  42 STO
040  03  03
041  91 R/S
```

3-13 LOAN PAYMENT PROGRAM -- RUN MODE

Input Data

1.	Interest rate in percent	15 STO 10
2.	Number of annual payments	3 STO 11
3.	Amount of loan	1000 STO 12

Output

1. Press A
2. Answer $437.98 payment per year

3-14 MEMORY AREA AND MAGNETIC CARD RECORDING

The 120 memory registers of the calculator are split into 4 banks of 30. Each card records 2 banks, one to a side.

Therefore, each side is capable of storing 240 program steps or 30 data registers. The program steps and data registers are recorded on the cards in a specific manner, although the order in which they are recorded does not matter.

Assume a program contains 960 steps (the maximum) and no data registers:

Card side one records steps	000 to 239
Card side two records steps	240 to 479
Card side three records steps	480 to 719
Card side four records steps	720 to 959

Assume a program contains 160 steps and 100 data registers (the maximum):

Card side four records data registers	00 to 29
Card side three records data registers	30 to 59
Card side two records data registers	60 to 89
Card side one records data registers	90 to 99
and steps	000 to 159

3-15 RECORDING AND READING MAGNETIC CARDS

Recording

1. Use previous example
2. Remove Fix, EE or Eng
3. Press 1 * [Write]
4. Insert card side 1 in the slot at the right side of the calculator
5. Remove card from left side
6. Identify card
7. Flashing number -- An error

Reading

1. Turn calculator off and on
2. Insert card side 1 in the slot at the right side of the calculator
3. Remove card
4. Bank number shows in the display
5. Operate the program -- Visual 3-13
6. Flashing number -- Card not properly read

3-16 PRINTER CONTROL

Printer Keys

Print -- Display value is printed when pressed

Trace -- Down position results in every step of a calculation to be printed

ADV ↑ -- Advances paper

Keyboard

RST *List -- Program list

RST INV *LIST -- List contents of data registers

R/S -- Stop listing

BASIC PROGRAM CONTROL FUNCTIONS

[LRN] -- LEARN

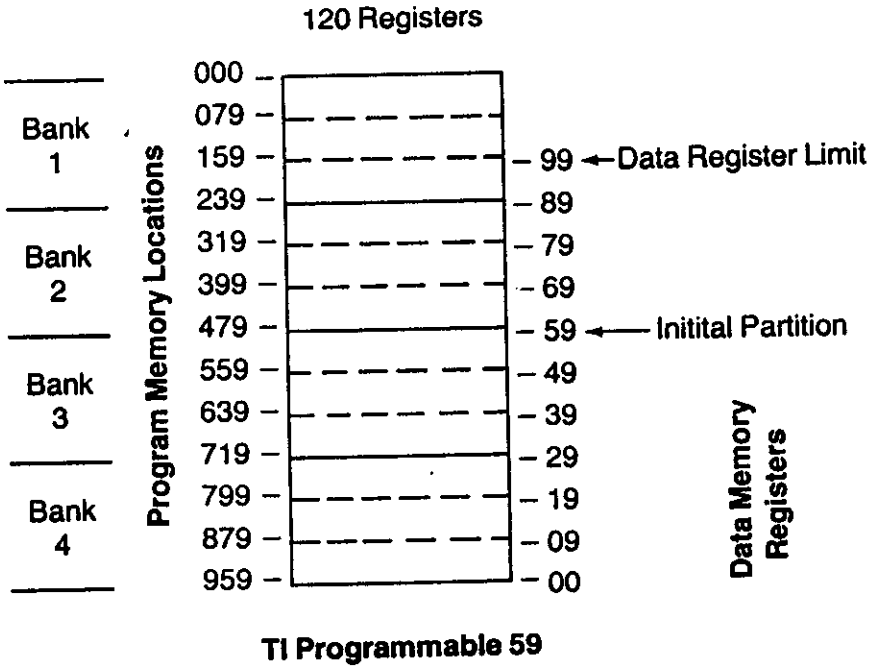
*[CP] -- CLEAR PROGRAM

[R/S] -- RUN/STOP

[RST] -- RESET

*[PAUSE] -- PAUSE

MEMORY STORAGE CAPACITY



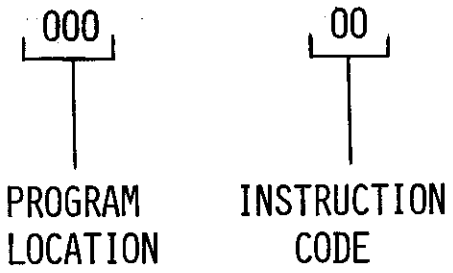
TI Programmable 59

PARTITIONING MEMORY

ACTION	PRESS	DISPLAY
CHECK CURRENT PARTITION	* [0P] 16	479.59
PARTITION STORAGE AREA FOR 50 DATA REGISTERS	5 * [0P] 17	559.49
PARTITION STORAGE AREA FOR 80 DATA REGISTERS	8 * [0P] 17	319.79

LEARN MODE

DISPLAY FORMAT



Keyboard And Instruction Key Codes

Key	Key Code	Key	Key Code	Key	Key Code	Key	Key Code	Key	Key Code
A'	16	B'	17	C'	18	D'	19	E'	10
A	11	B	12	C	13	D	14	E	15
		INV	27	log	28	CP	29	CLR	20
2nd	Merged	INV	22	lnx	23	CE	24	CLR	25
Pgm	36*	P→R	37	sin	38	cos	39	tan	30
LRN	None	x≥t	32	x^2	33	$\sqrt{x}$	34	1/x	35
Ins	None	CMs	47	Exc	48*	Prd	49*	Ind	40 (or merged)
SST	None	STO	42*	RCL	43*	SUM	44*	y^x	45
Del	None	Eng	57	Fix	58*	Int	59	|x|	50
BST	None	EE	52	(	53	)	54	÷	55
Pause	66	x=t	67*	Nop	68	Op	69*	Deg	60
GTO	61*	7	07	8	08	9	09	×	65
Lbl	76*	x≠t	77*	Σ+	78	$\bar{x}$	79	Rad	70
SBR	71*	4	04	5	05	6	06	−	75
St flg	86*	If flg	87*	D.MS	88	π	89	Grad	80
RST	81	1	01	2	02	3	03	+	85
Write	96	Dsz	97*	Adv	98	Prt	99	List	90
R/S	91	0	00	•	93	+/−	94	=	95

ENTER PROGRAM IN MEMORY

PRESS	DISPLAY
LRN	000 00
*LBL	001 00
A	002 00
6	003 00
+	004 00
9	005 00
=	006 00
R/S	007 00
LRN	0
A	15

ACTION	PRESS	DISPLAY
	CLR	0
	RST	0
	LRN	000 76
	SST	001 11
	BST	000 76
MOVE TO LINE 003	SST	003 85
	* INS	003 00
	* DEL	003 85

COMBINED INSTRUCTION CODES

Key	Key Code	Key	Key Code	Key	Key Code	Key	Key Code	Key	Key Code
A'	16	B'	17	C'	18	D'	19	E'	10
A	11	B	12	C	13	D	14	E	15
		INV	27	log	28	x^p	29	CLR	20
2nd	Merged	INV	22	ln x	23	CE	24	CLR	25
Pgm	36*	P→R	37	sin	38	cos	39	tan	30
LRN	None	x≥t	32	x^2	33	$\sqrt{x}$	34	1/x	35
Ins	None	CMs	47	Exc	48*	Prd	49*	Ind	40 (or merged)
SST	None	STO	42*	RCL	43*	SUM	44*	y^x	45
Del	None	Eng	57	Fix	58*	Int	59	|x|	50
BST	None	EE	52	(	53	)	54	÷	55
Pause	66	x=t	67*	Nop	68	Op	69*	Deg	60
GTO	61*	7	07	8	08	9	09	×	65
Lbl	76*	x≠t	77*	Σ+	78	$\bar{x}$	79	Rad	70
SBR	71*	4	04	5	05	6	06	−	75
St flg	86*	If flg	87*	D.MS	88	π	89	Grad	80
RST	81	1	01	2	02	3	03	+	85
Write	96	Dsz	97*	Adv	98	Prt	99	List	90
R/S	91	0	00	•	93	+/−	94	=	95

TWO-DIGIT ADDRESSES

DATA MEMORY

[STO] XX

[RCL] XX

[SUM] XX

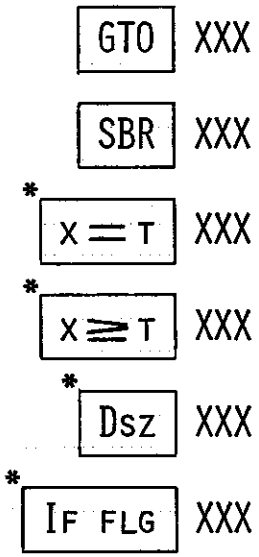
*[PRD] XX

*[Exc] XX

PROGRAM LIBRARY ACCESS -- -- [PGM] XX

SPECIAL CONTROL OPERATIONS -- [OP] XX

TRANSFER ADDRESSES



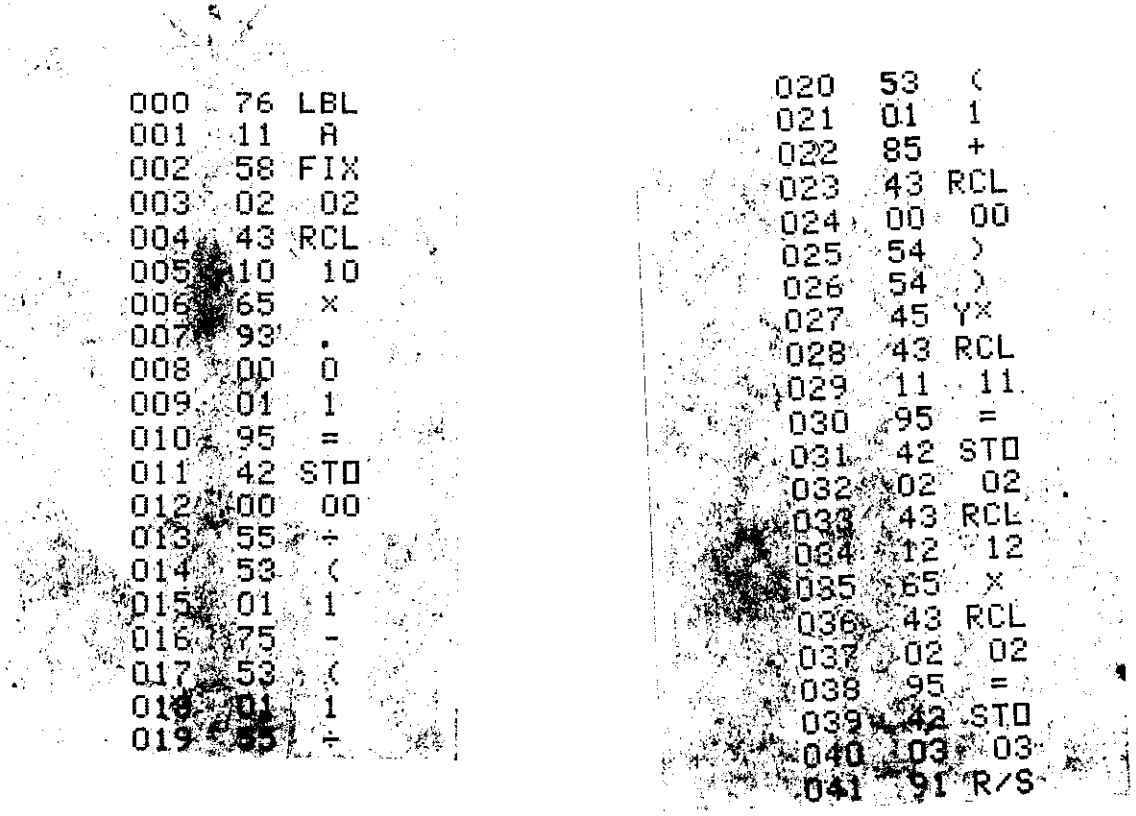
1. DIRECT 3 [STO] 01

5 [STO] 02

2. PROGRAMMED

INPUT PROGRAM	LBL A
	STO 01
	R/S
	LBL B
	STO 02
	R/S
3. INPUT NUMBERS	3
	A
	5
	B

LOAN PAYMENT PROGRAM LIST



```
000  76  LBL
001  11   A
002  58  FIX
003  02   02
004  43  RCL
005  10   10
006  65   ×
007  93   .
008  00   0
009  01   1
010  95   =
011  42  STO
012  00   00
013  55   ÷
014  53   (
015  01   1
016  75   -
017  53   (
018  01   1
019  85   +
020  53   (
021  01   1
022  85   +
023  43  RCL
024  00   00
025  54   )
026  54   )
027  45   Y^x
028  43  RCL
029  11   11
030  95   =
031  42  STO
032  02   02
033  43  RCL
034  12   12
035  65   ×
036  43  RCL
037  02   02
038  95   =
039  42  STO
040  03   03
041  91  R/S
```

LOAN PAYMENT PROGRAM -- RUN MODE

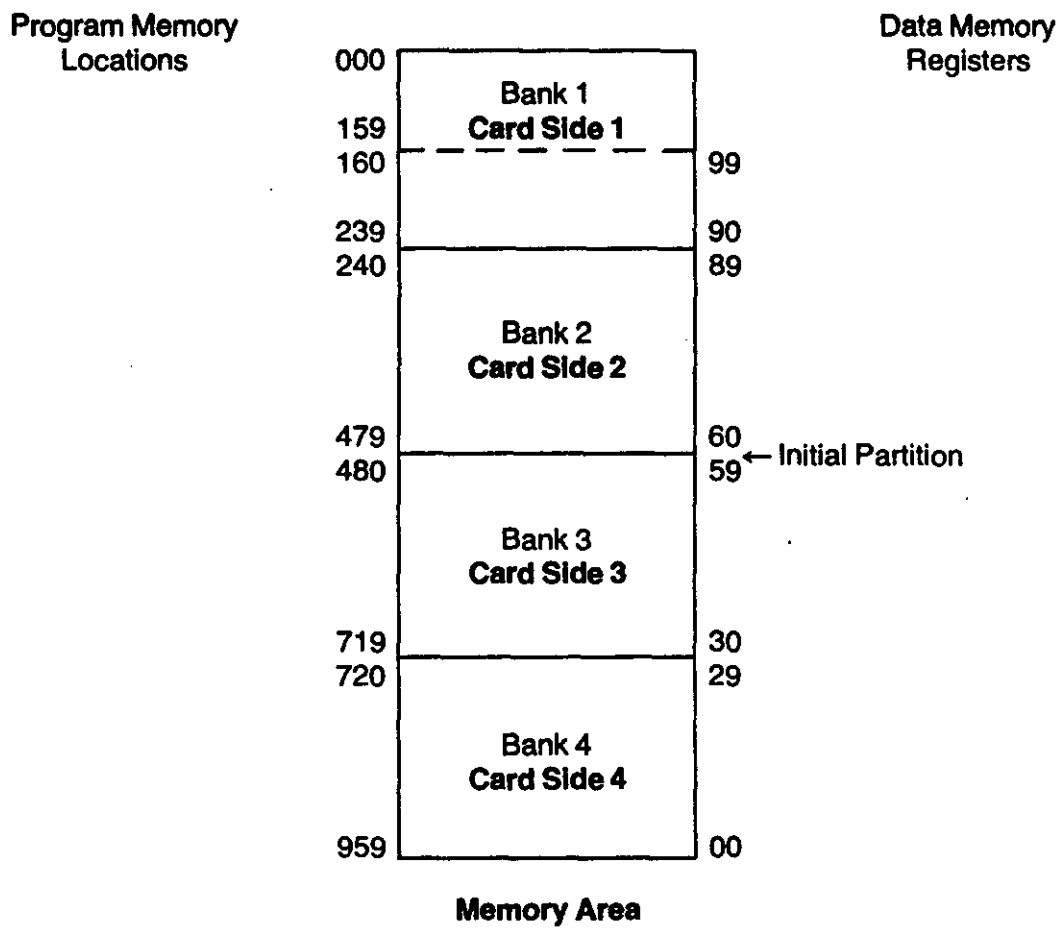
INPUT DATA

1. INTEREST RATE IN PERCENT: 15 [STO] 10
2. NUMBER OF ANNUAL PAYMENTS: 3 [STO] 11
3. AMOUNT OF LOAN: 1000 [STO] 12

OUTPUT

1. PRESS [A]
2. DISPLAY: 437.98

MEMORY AREA AND MAGNETIC CARD RECORDING



RECORDING AND READING MAGNETIC CARDS

RECORDING

1. PRESS 1 *WRITE
2. INSERT CARD

READING

1. TURN CALCULATOR OFF AND ON
2. INSERT CARD
3. OPERATE THE LOAN PAYMENT PROGRAM

PRINTER CONTROL

PRINTER KEYS

PRINT -- PRINT DISPLAY VALUE

TRACE -- TRACE CALCULATION

ADV ↑ -- ADVANCE PAPER

KEYBOARD

RST * LIST -- PROGRAM LIST

RST INV * LIST -- DATA REGISTER LIST

R/S -- STOP LISTING

LESSON 4. PROGRAMMING BASICS

Objectives

-- To understand the mechanics of programming

-- To learn how to structure a problem and develop a sequence for problem solution

-- To be able to use labels, variables, transfers and addresses in a program

4-1 MECHANICS OF PROGRAMMING

The versatile arithmetic language permits both simple and complex programming. Simple programs may be entered, checked, and run with little effort or difficulty. Even though the language is designed to be as straightforward as possible a complex program requires forethought and planning.

If you have done little programming, you will find the following ideas useful. If you are familiar with programming concepts, the ideas will serve as a review and orient you toward calculator programming. You should interpret the following only as a list of suggestions since you will undoubtedly develop your own programming style.

1. **Define the problem very clearly and carefully.** Identify the formulas, variables and desired results. What is known? What is to be determined? How are the known and the unknown related?
2. **Develop a method of solution** (sometimes called an **algorithm**). Define the operation sequence of the numerical approach you want to use keeping in mind the calculating and programming capabilities of the calculator. (Remember, strictly speaking, calculators do not solve problems, you do. Your calculator carries out your solutions precisely the way you tell it to!)
3. **Develop a flow diagram.** It is often useful to develop drawings that help you visualize the flow of the program. Here, you can picture interactions between various parts of the solution. It may even be possible to simplify the program structure after it is flow charted.
4. **Begin making data register assignments.** Assign data registers to the numerous things you'll be operating on. You'll continue this task throughout the programming process. It is a good idea to never store a quantity in memory without making a written note that the data register in question contains that quantity.
5. **Translate the flow diagram into keystrokes.** The coding forms are provided to help you here. It is useful to list all labels and memory registers in the space indicated on the form. Use the comments column for easy reference to various segments of the program.
6. **Enter the program.** Press [2nd] [CE] [LRN] and key in the complete program from the coding form. When entry is complete, press [LRN] to remove the calculator from the learn mode.
7. **Test the program.** Check out the program using test problems representing as many cases as practical.
8. **Correct errors.** Correct the coding form for any errors discovered while testing the program.

9. **Edit the program.** Place the calculator in the learn mode, complete the required corrections and press [LRN] to return to the keyboard operation. See page IV-21 for more information.
10. **Retest the program.** Repeat steps 7-9 as needed.
11. **Record the program.** If your calculator has magnetic card capability, record the program on magnetic cards. See Section VII for more information.
12. **Document user instructions.** It's always a good idea to carefully write down step-by-step instructions describing how to use your program. Even the most powerful programs are useless if you don't remember how to use them. Fill out a User Instructions form, detailing information required to run the program.

4-2 PROGRAM EXECUTION FLOW -- NORMAL

- Program execution starts with program location 000 and sequentially performs the calculations until a R/S is encountered.
- The sequence for problem solution and, therefore, the program steps must be sequentially from beginning to end.
- The normal flow of a program is changed with transfers and addresses.
- Intermediate calculations used as input for latter calculations must be performed first.

4-3 LABELS

1. Labels provide an easy access to any location within a program. Labels are reference points when used within a program.
2. User-defined labels -- [A] - [E], *[A] - *[E]

3. When a user-defined label is pressed from the keyboard, the program pointer searches the program list starting with 000 until the label is located. Program execution starts with the first instruction following the label.

4. Common labels -- all remaining keys except: 2nd, SST, Ins, LRN, BST, Del, Ind, and numbers 0-9.

5. Common labels can only be used within a program as a reference point. Pressing a common label key from the keyboard only performs that operation.

6. When common labels are used within a program as a reference point, the operation (or definition of the key) is not acted upon in the program.

7. A label key within a program must be preceded by the key Lbl.

8. A label may only be used once within a program segment.

4-4 VARIABLES IN A PROGRAM

- Rather than specify data in a program (3 and 5), a variable may be included in the program and recalled from a data register.
- Form -- RCL XX
- Calculations made within a program can be stored in a data register.
- Form -- STO XX

4-5 TRANSFERS

- Unconditional transfers branch the program flow to the label or the program location.
- Conditional transfers test a value and transfer to a label or program location based on the test value.

4-6 UNCONDITIONAL TRANSFERS

- GTO n or xxx -- Diverts the flow of processing to label n or program location xxx when encountered in a program -- From the keyboard, the program location printer is positioned at label n or program location xxx.
- RST -- Resets pointer at program location 000 when encountered in a program or from the keyboard.
- SBR n or xxx -- From the keyboard, the program location pointer is positioned at label n or program location xxx -- When encountered in a program, it diverts the flow of processing to label n or program location xxx, executes instructions at that point until a RETURN (INV SBR) instruction is located and returns to the original point in the main program.

4-7 CONDITIONAL TRANSFERS

1. Instructions that are capable of making decisions within a program -- A transfer is made depending upon the outcome of a test.

2. Four types of test questions:
   a. Is one number equal to or greater than the other?
   b. Is one number less than another?
   c. Are the two numbers equal?
   d. Are the two numbers unequal?

3. Types of conditional transfer instructions:
   a. Compare display register contents to T - register: $x = t$, $x \geq t$
   b. Test contents of data register 0-9: Dsz
   c. Test status of program flags: If flg

4. A transfer address follows each of these instructions. When the answer to the test is "yes" (test positive), transfer is made to that address. If the answer to the test is "no" (test negative), the transfer is skipped.

4-8 T - REGISTER

- Special data memory register
- Used to "Test" a number
- Number is placed in the T - register with the "exchange" key: [x ⇆ t]
- Activated from keyboard or within a program

4-9 EQUAL TO OR GREATER THAN TEST

1. [*] [x ≥ t] n or xxx -- This command compares the display value with the "T" value. If the display value "x" is greater than or equal to the "T" value, the program segment transfers to the label n or program location xxx. If the display value "x" is not greater than or equal to "T," the program skips the location transfer and continues with the next instruction.

2. Key sequence

   T value

   Exchange key

   x value

   Test -- [*] [x ≥ t]

   Label or program location

   Next instruction

3. [INV] [*] [x ≥ t] -- Reverses the answer

4-10 EQUAL TO TEST

1. [*] [x = t] n or xxx -- This command compares the display value with the "T" value. If the display value "x" is equal to the "T" value, the program segment transfers to the label n or program location xxx. If the display value "x" is not equal to "T", the program skips the location transfer and continues with the next instruction.

2. Key sequence

   T value

   Exchange key

   x value

   Test -- $\boxed{x = t}^{*}$

   Label or program location

   Next instruction

3. $\boxed{\text{INV}}\ \boxed{x = t}^{*}$ -- Reverses the answer

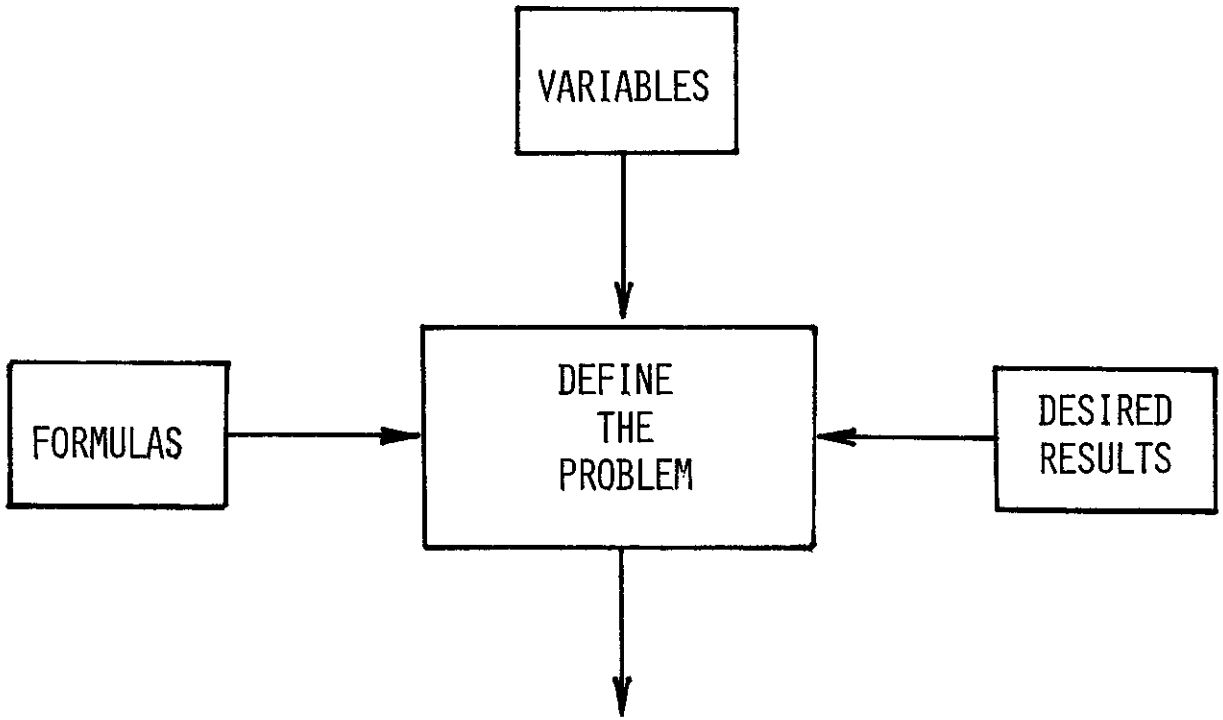
4-11 CONDITIONAL TRANSFER EXAMPLE

1. A borrower can obtain a loan from a financial institution with simple interest. The interest rate on the loan varies with the length of the repayment period as follows:
   a. Repayment period less than one year
   b. Repayment period one year or more, but less than ten years, or
   c. Repayment period ten years or more

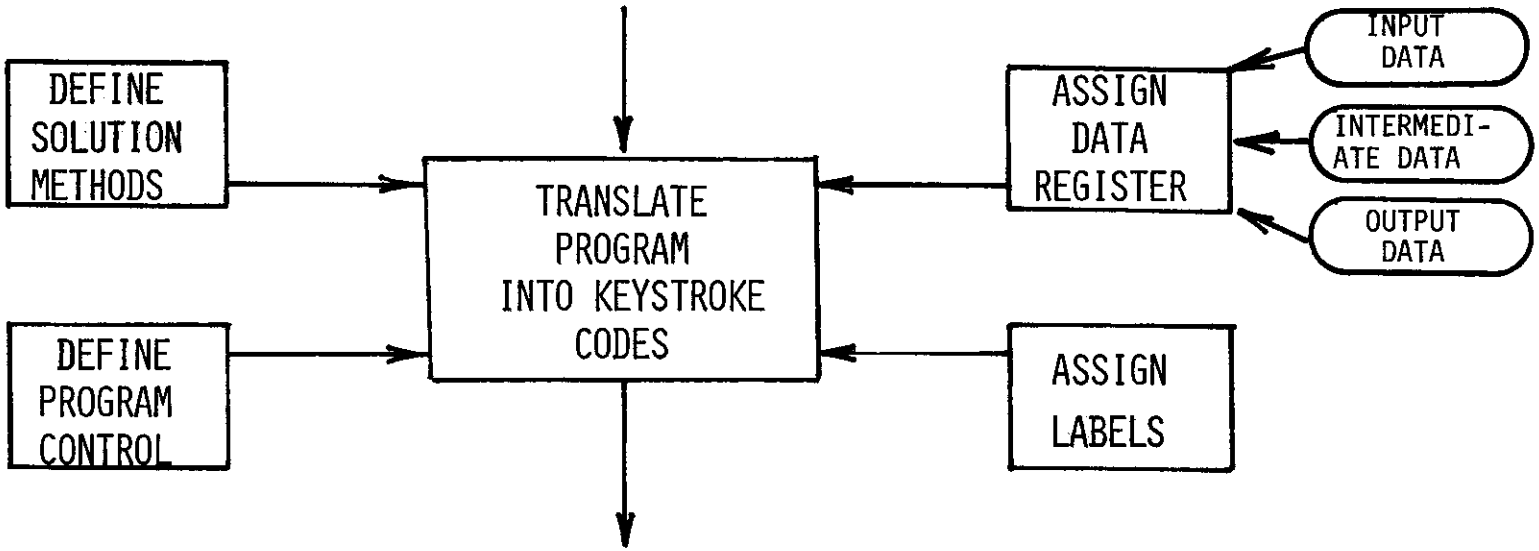
2. Problem -- Determine the amount of interest paid on the first year of the loan

3. Programming process
   a. Assign the data registers with the variable input
   b. Write the program instructions
   c. Key program instructions into memory
   d. Enter variable data
   e. Run program

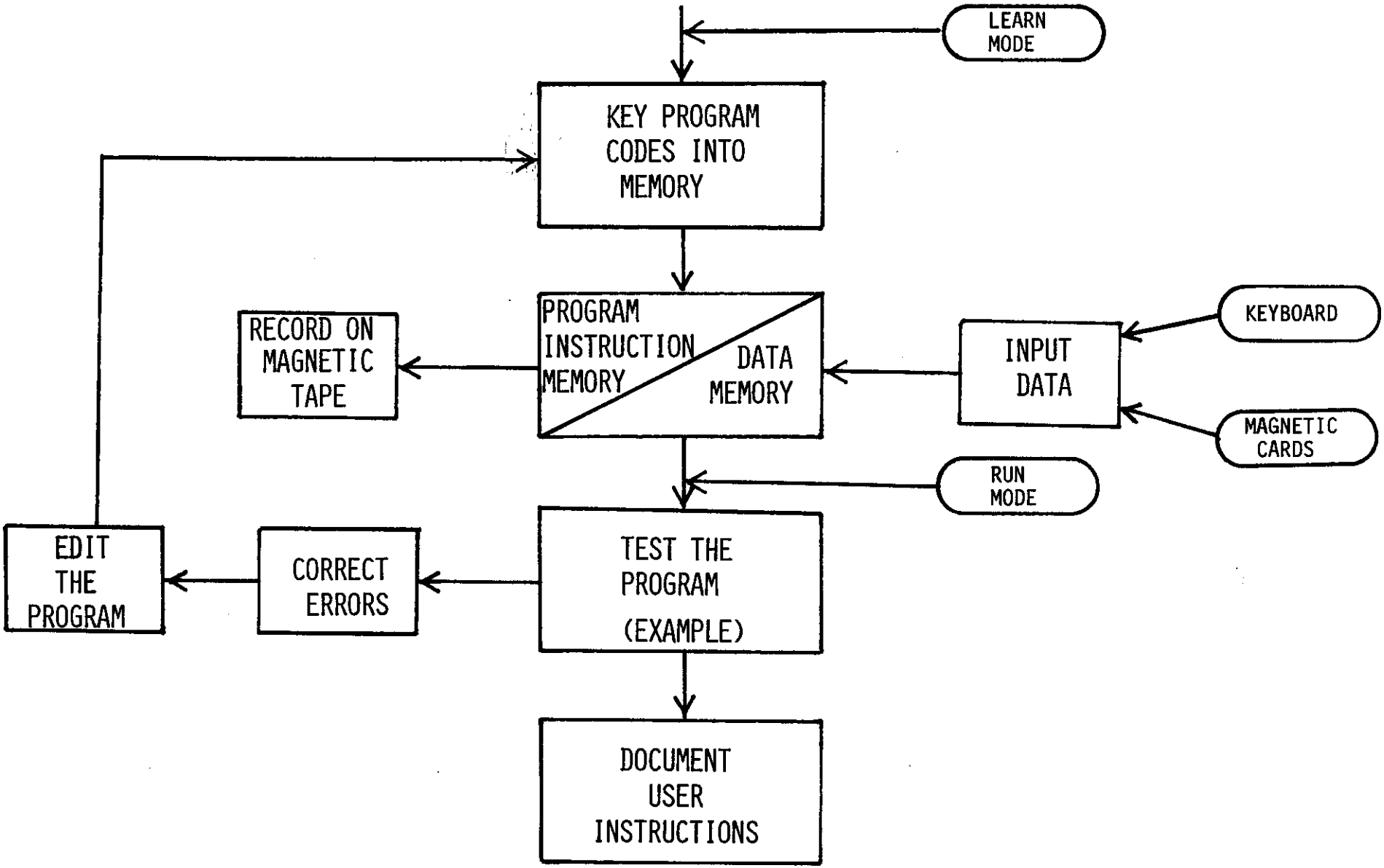
MECHANICS OF PROGRAMMING

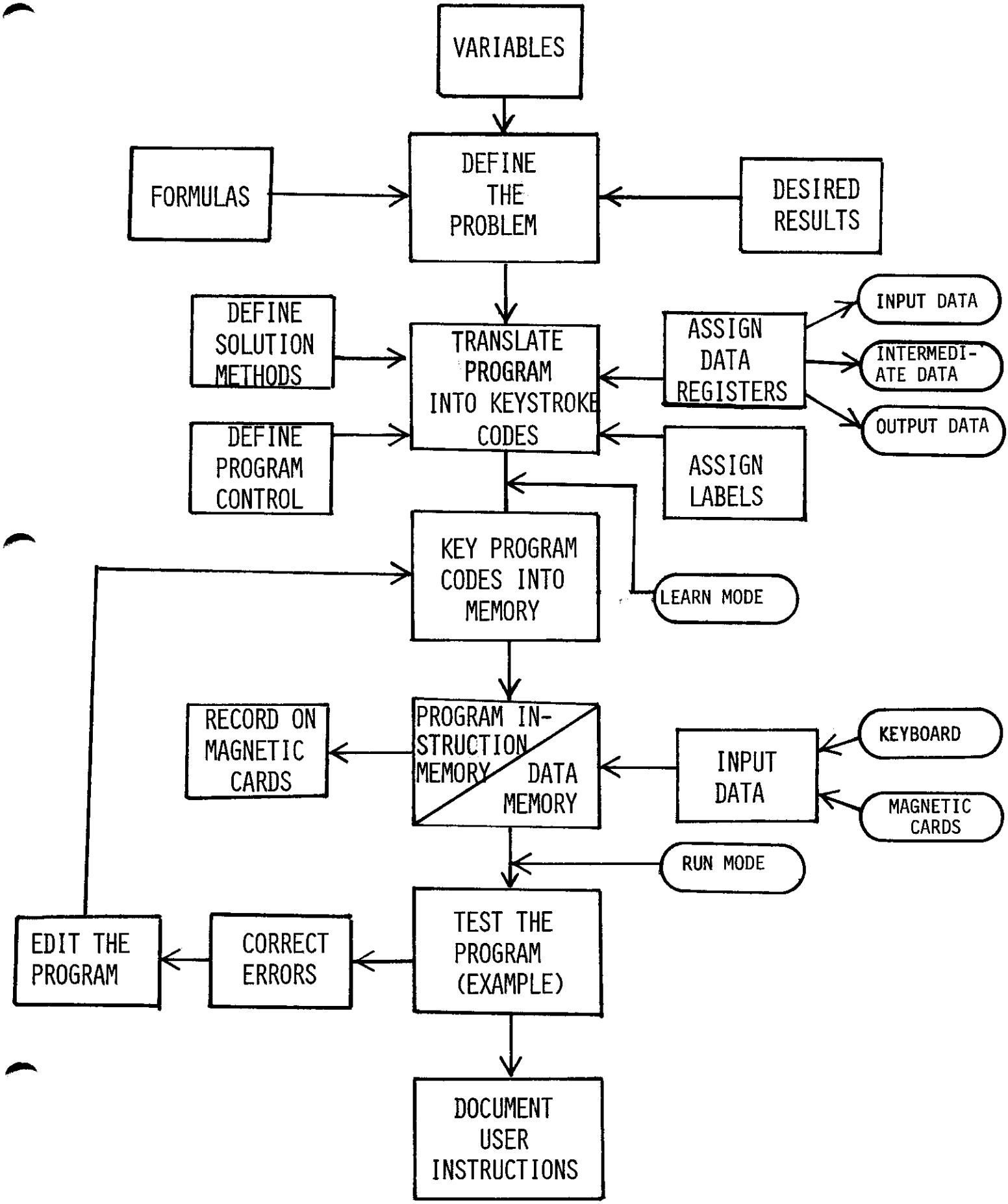


MECHANICS OF PROGRAMMING
(CONT.)

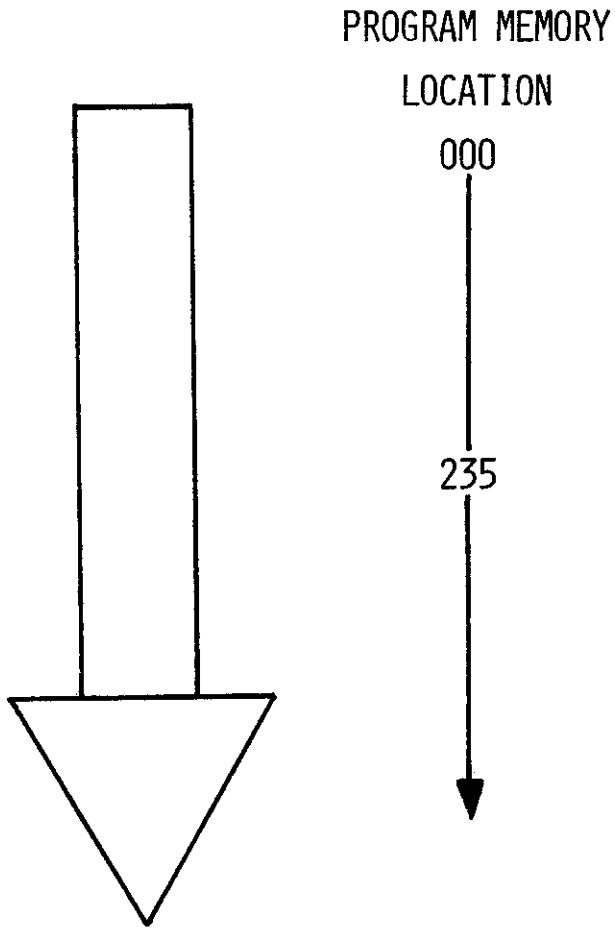


MECHANICS OF PROGRAMMING (CONT.)




VARIABLES
FORMULAS
DEFINE THE PROBLEM
DESIRED RESULTS
DEFINE SOLUTION METHODS
TRANSLATE PROGRAM INTO KEYSTROKE CODES
ASSIGN DATA REGISTERS
INPUT DATA
INTERMEDI-ATE DATA
OUTPUT DATA
DEFINE PROGRAM CONTROL
ASSIGN LABELS
KEY PROGRAM CODES INTO MEMORY
LEARN MODE
RECORD ON MAGNETIC CARDS
PROGRAM IN-STRUCTION MEMORY
DATA MEMORY
INPUT DATA
KEYBOARD
MAGNETIC CARDS
RUN MODE
EDIT THE PROGRAM
CORRECT ERRORS
TEST THE PROGRAM (EXAMPLE)
DOCUMENT USER INSTRUCTIONS

PROGRAM EXECUTION FLOW -- NORMAL



LABELS

- USER-DEFINED LABELS -- [A] – [E], *[A] – *[E]
- COMMON LABELS -- ALL KEYS EXCEPT:

  [2ND], [SST], *[INS], [LRN], [BST], *[DEL], *[IND]
  AND THE NUMERICAL KEYS [0] THROUGH [9]

- EXAMPLE PROGRAM

  LBL A

  3 + 5 =

  R/S

- RUN MODE -- PRESS A
  ANSWER 8

VARIABLES IN A PROGRAM

- EXAMPLE PROGRAM

  LBL A

  RCL 01 + RCL 02 = STO 10

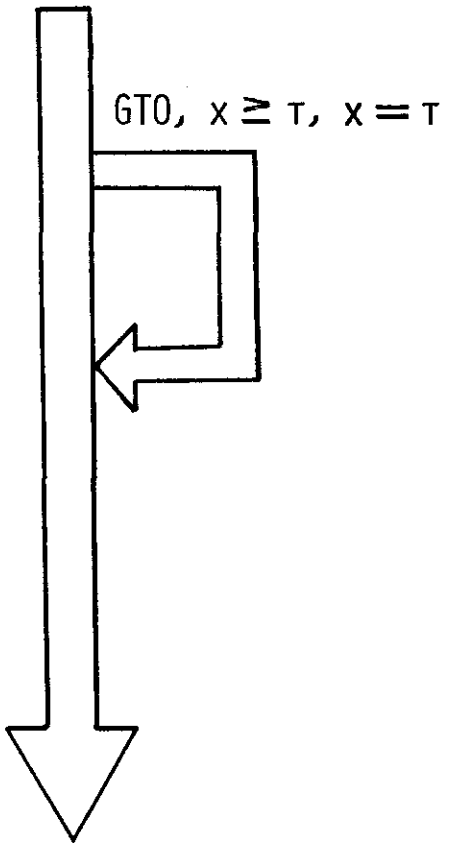
  R/S

- RUN MODE

  1. ENTER NUMBERS IN DATA REGISTER 01 AND 02
  2. PRESS A
  3. WHAT IS YOUR ANSWER?

PROGRAM EXECUTION FLOW

TRANSFERS



UNCONDITIONAL TRANSFERS

- GO TO INSTRUCTION -- [GTO] N OR xxx
- RESET INSTRUCTION -- [RST]
- SUBROUTINE -- [SBR] N OR xxx
- EXAMPLE PROGRAM

```
LBL SUM
+ 4 =
PAUSE
PAUSE
PAUSE
GTO SUM
```

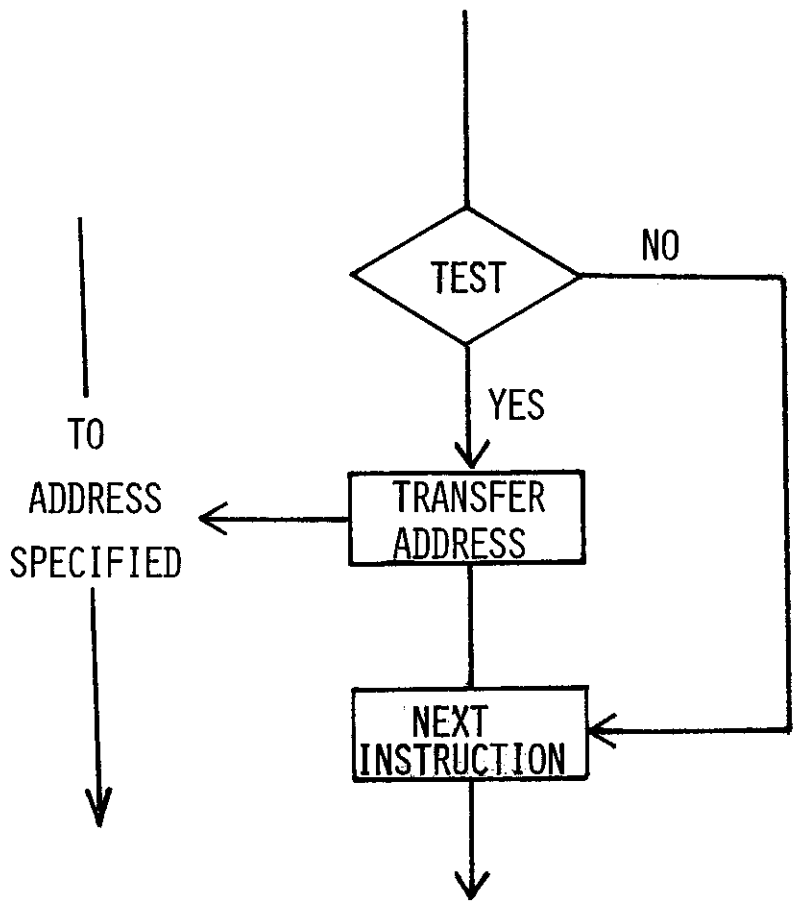
- RUN MODE -- PRESS
  RST
  R/S
- WHAT IS YOUR ANSWER?

CONDITIONAL TRANSFERS

TEST KEYS

- * X = T
- * X ≥ T
- * Dsz
- * IF FLG

PROGRAM EXECUTION FLOW



T-REGISTER

- DATA MEMORY REGISTER -- T
- EXCHANGE KEY -- [x⇆t]
- EXAMPLES -- CALCULATOR MODE

  5

  x⇆t

  4

  x⇆t

- WHAT NUMBER IS IN THE DISPLAY AFTER YOU PRESS THE EXCHANGE KEY?

EQUAL TO OR GREATER THAN TEST

- *[X≥T] N OR XXX

- POSITIVE TEST EXAMPLE

6		IS 7≥6?
X⇆T		
7	OR	
X≥T		YES -- TRANSFER TO LABEL [SIN] AND
SIN		CONTINUE EXECUTION AT THAT
RCL		POINT

- NEGATIVE TEST EXAMPLE

10		IS 3≥10?
X⇆T		
3	OR	
X≥T		NO -- CONTINUE EXECUTION WITH THE
SIN		INSTRUCTION [RCL]
RCL		

- [INV] *[X≥T] N OR XXX

- * [x=t] N OR XXX

- POSITIVE TEST EXAMPLE

14		IS 14=14?
x=t		
14	OR	
x=t		YES -- TRANSFER TO PROGRAM LOCATION
324		324 AND CONTINUE EXECUTION AT
RCL		THAT POINT

- NEGATIVE TEST EXAMPLE

23		IS 26=23?
x⇆t		
26	OR	
x=t		NO -- CONTINUE EXECUTION WITH THE
324		INSTRUCTION [RCL]
RCL		

- [INV] * [x=t] N OR XXX

CONDITIONAL TRANSFER EXAMPLE

1. ASSIGN DATA REGISTERS

   AMOUNT OF LOAN -- REGISTER 10

   LOAN REPAYMENT PERIOD (YEARS) -- REGISTER 11

   INTEREST RATE (%) -- LOAN LESS THAN 1 YEAR -- REGISTER 12

   INTEREST RATE (%) -- LOAN 1 TO 10 YEARS -- REGISTER 13

   INTEREST RATE (%) -- LOAN 10 YEARS OR MORE -- REGISTER 14

   FIRST YEAR INTEREST -- REGISTER 20

2. PROGRAM INSTRUCTION

   LBL A

   RCL 11 x⇆t

   1

   INV x≥t SIN

   RCL 10 x RCL 12 x .01 x RCL 11= STO 20

   R/S

   GTO cos

   LBL SIN

   10

```
x≥T  TAN
RCL 10 x RCL 14 x .01= STO 20
R/S
GTO cos
LBL TAN
RCL 10 x RCL 13 x .01= STO 20
LBL cos
R/S
```

3. INPUT DATA -- RUN MODE

```
10000 STO 10
   .5 STO 11
   18 STO 12
   15 STO 13
   12 STO 14
```

4. PRESS A

   WHAT IS YOUR ANSWER?

5. CHANGE REGISTER 11 TO 7

   WHAT IS YOUR ANSWER?

6. CHANGE REGISTER 11 TO 20

   WHAT IS YOUR ANSWER?

LESSON 5. ADVANCED PROGRAMMING TECHNIQUES

Objectives

-- To learn how to use loops in a program

-- To understand the use and programming of subroutines, indirect instructions, and other techniques

-- To practice programming and operating advanced programming techniques

5-1 LOOPING

1. Loop -- Programming technique to allow program execution to perform a sequence of instructions many times until a calculation is complete. To create a loop, the program includes an instruction that transfers the program pointer to an earlier location.

2. Unconditional Transfer Loop -- The use of the following keys:

   [RST] -- loops back to program location 000

   [GTO] -- loops back to instruction program location or label.

   An unconditional loop must include a test and transfer out of the loop or the program will not terminate.

3. Conditional Transfer Loop -- Creation of a loop where it is know how many times a calculation should be made.

A conditional loop uses the *[Dsz] key -- decrement and skip on zero.

5-2 LOOPING WITH CONDITIONAL TRANSFER

- Statement

  Dsz X, n or xxx

  Where:

  X = Data register 0-9

  n = Label

  xxx - Program location

5-3 LOOP EXAMPLE

- Key Sequence

  1. Initialize data registers
  2. Label for the loop address
  3. Calculations to be made
  4. Decrement key
  5. Data register counter number
  6. Label or program location

- Change the example to sum the numbers from 1 to X. What program steps need changing? What additions are needed?

  -- Store a number in register 10

  -- RCL 10 STO 00

5-4 LOOP USING OPERATION CODES

1. Operation codes -- Operation codes that have special functions built into the calculator.

2. General Form -- *[Op] nn; where the nn represents a two digit number.

3. Increment/Decrement Data registers -- Op 20-29 and Op 30-39.

4. Increment -- To increment register n by 1, press *[Op] 2n, where n is a data register number 0-9.

5. Decrement -- To decrement register n by 1, press *[Op] 3n, where n is a data register number 0-9.

6. Change the example to start with 15 and add the numbers back to 1. Changes?
   -- Store 15 in register 00
   -- 15 STO 02
   -- *[Op] 32

5-5 NESTED LOOP

- One loop inside another loop
- Flow diagram
- Example will follow the indirect instruction

5-6 INDIRECT INSTRUCTIONS

1. Key sequence -- Instruction Ind nn

   Where: Instruction = Store, recall, sum or any instruction

   Ind = indirect command

   nn = a data register number

2. Basic concept -- The indirect instruction is a two stage inquiry of data register memory. The command goes to a data register to find the data register number where information is to be found. It's just like telling someone to "go ask Sam where Fred is" instead of telling the person to "go find Fred."

3. Refer to p. V-68 of Personal Programming for a complete list of indirect addresses.

5-7 LOOP USING INDIRECT COMMAND TO RECALL DATA

1. Problem -- A person has five fields growing five different crops. Calculate the cash value of the crops given the acres in each field, the yield per acre of each field and the price per unit for each crop.

2. Calculation equation

$$\text{Cash receipts} = \sum_{i=1}^{5} A_i \times Y_i \times P_i$$

   where: A = acres

   Y = yield per acre

   P = price per unit

3. Write a program to calculate the cash receipts without using an indirect recall.

   a. Data register assignment

Data registers	Factor	Fields
18-22	Acres	1-5
24-28	Yield	1-5
30-34	Price	1-5

   b. Program

```
Lbl A
0 STO 06
RCL 18 x RCL 24 x RCL 30 = SUM 06
RCL 19 x RCL 25 x RCL 31 = SUM 06
RCL 20 x RCL 26 x RCL 32 = SUM 06
RCL 21 x RCL 27 x RCL 33 = SUM 06
RCL 22 x RCL 28 x RCL 34 = SUM 06
RCL 06
R/S
```

   c. 63 program steps

4. Write a program to calculate the cash receipts using an indirect recall

   a. Data register assignment -- same as previous

   b. Program

```
Lbl A
0 STO 06
5 STO 04
18 STO 00
```

```
24 STO 01
30 STO 02
Lbl lnx
RCL Ind 00 x RCL Ind 01 x RCL Ind 02 = SUM 06
Op 20  Op 21  Op 22
Dsz 4 lnx
RCL 06
R/S
```

c. 45 program steps

5-8 LOOP USING INDIRECT COMMAND TO STORE DATA

1. STO Ind nn: where nn is a register

2. Example -- Sum of years-digits depreciation

   5 years useful life

   $15,000 machine cost

   No salvage

   Sum of years = 15

3. Calculation procedure

Year	Calculation
1	5 ÷ 15 x 15,000 = 5,000
2	4 ÷ 15 x 15,000 = 4,000
3	3 ÷ 15 x 15,000 = 3,000
4	2 ÷ 15 x 15,000 = 2,000
5	1 ÷ 15 x 15,000 = 1,000

5-9 MULTIPLE TECHNIQUE PROBLEM

1. Problem -- A farmer grows three crops (corn, soybeans and wheat) in a number of fields, calculate the average yield, total production, total acres and cash receipts for each crop. Calculate the cash receipts and total acres for all the crops.

2. Techniques to use in the program --
   - Nested loop
   - Indirect command to store data
   - Indirect command to recall data
   - Increment operation code

5-10 MULTIPLE TECHNIQUE PROBLEM SOLUTION

1.

Output Crop	Average Yield (Bu)	Total Production (Bu)	Acres	Cash Receipts
Corn	97	15,035	155	$39,842.75
Soybeans	48.7	3,650	75	22,082.50
Wheat	62	1,550	25	5,657.50
Total			255	$67,582.75

2.

Program			Comment
Lbl	A		
0	STO	42	Total farm acres - Initialize
	STO	43	Total farm cash receipts - Initialize
10	STO	01	Acres input register number
17	STO	02	Yield input register number
24	STO	03	Price input register number

```
30 STO 04          Average yield output register number
33 STO 05          Total production output register number
36 STO 06          Acres output register number
39 STO 07          Cash receipts output register number
 3 STO 08          Set inside loop counter
   STO 09          Set outside loop counter
Lbl B              Ouside loop label
 0 STO Ind 06      Initialize acres register
   STO Ind 05      Initialize total production register
Lbl C              Inside loop label
RCL Ind 01
Sum Ind 06
Sum 42             Sum acres
RCL Ind 01 x
RCL Ind 02
= Sum Ind 05       Sum production
Op 21  Op 22       Increment counter registers
Dsz 8 C            Inside loop address
RCL Ind 05 ÷
RCL Ind 06
= STO Ind 04       Calculate Average Yield
RCL Ind 05 x
RCL Ind 03
= STO Ind 07
Sum 43             Sum cash receipts
Op 23  Op 24
Op 25  Op 26
Op 27              Increment counter register
 2 STO 08          Reset inside loop counter
Dsz 9 B            Outside loop address
R/S                Stop
Lbl D              Label to recall output to display
30 STO 00          Initialize output counter
14 STO 09          Set loop counter
Lbl Cos            Loop label
```

RCL Ind 00	Recall output
R/S	Stop
Op 20	Increment counter register
Dsz 9 Cos	Loop address
R/S	Stop

3. 125 program steps

5-11 FLAGS

1. A flag is a two way switch controlled from elsewhere in the program which can transfer execution to another segment or allow the program to continue with the next instruction.

2. Commands

   - To set flag -- St flg y where y is the flag number 1-6. Flags 6-9 have a special purpose.

   - To make the transfer after a flag has been set -- If flg y, n or xxx where y is the flag number and n is a label or xxx is a program location.

5-12 SUBROUTINE

1. SBR n or xxx where transfer is made to label n or program location xxx.

2. Defined -- A portion of a program written separate from the main program that can be called many times during execution of the main program.

3. Transfer command from main program [SBR] n or xxx.

4. Return command back to main program [INV] [SBR] -- RETURN

5-13 SUBROUTINE EXAMPLE

1. Problem -- A person has three loans from a financial institution. Calculate the annual payments on each loan assuming an amortized loan.

2. Calculation --

$$A = \frac{r}{1 - \left(\frac{1}{1+r}\right)^n}$$

Where:

A = Annual payment per $1 per loan

r = Annual interest rate expressed as a percent

n = number of annual payments

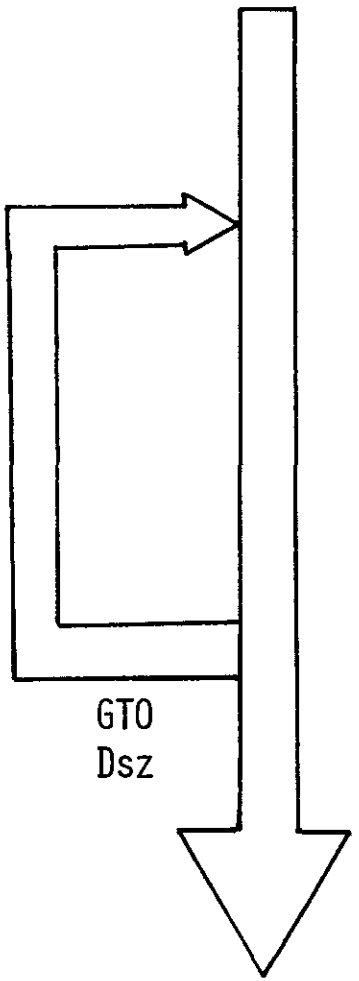
3. Data and data register assignment

Loan	Data	Data Register	Comment
1	100,000	15	Outstanding balance
	8	16	Interest rate
	15	17	Years to repay
2	25,000	18	Outstanding balance
	15	19	Interest rate
	7	20	Year to repay
3	10,000	21	Outstanding balance
	7	22	Interest rate
	5	23	Years to repay

4. Press B -- RCL 40, RCL 41, RCL 42

PROGRAM EXECUTION FLOW

LOOPING



LOOPING WITH CONDITION TRANSFER

1. Dsz = DECREMENT, SKIP ON ZERO

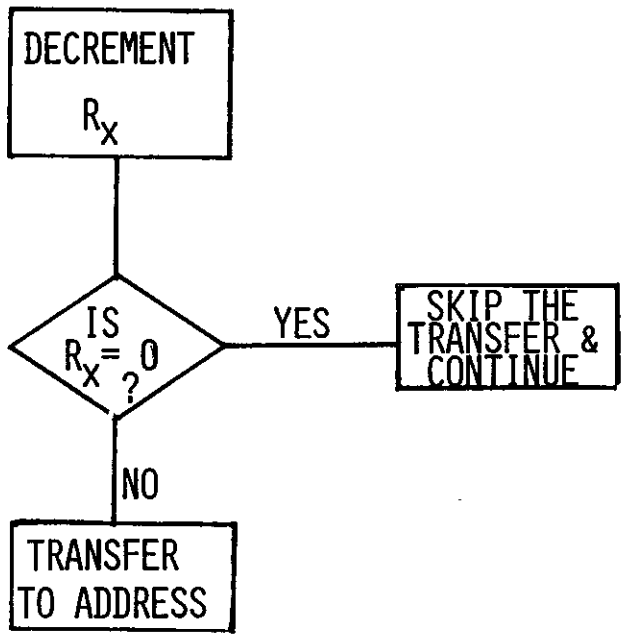
2. STATEMENT -- Dsz X, N OR NNN

   WHEN X = DATA REGISTER 0-9

   N = LABEL

   NNN = PROGRAM LOCATION

3. FLOW DIAGRAM



LOOP EXAMPLE

SUM THE NUMBER 1 TO 5

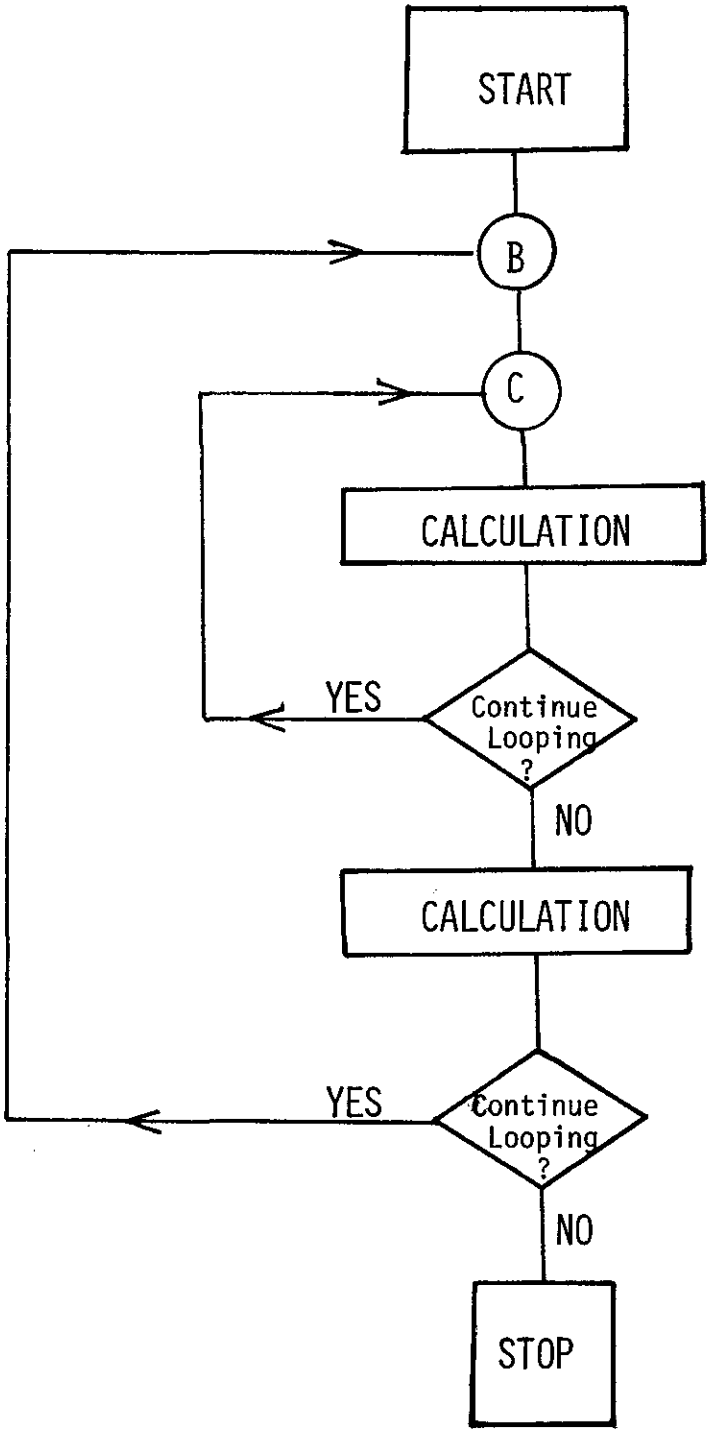
```
LBL A
5 STO 00
0 STO 02
R/S
LBL B
RCL 00
SUM 02
PAUSE
DSZ 0 B
RCL 02
R/S
```

LOOP USING OPERATION CODES

1. INCREMENT -- Op 20-29
   - *Op 2 N
2. DECREMENT -- Op 30-39
   - *Op 3 N
3. EXAMPLE -- ADD THE NUMBERS 1 THROUGH 10
   - STORE 10 IN REGISTER 00
   - PROGRAM

```
Lbl A
1 STO 02
0 STO 21
Lbl B
RCL 02  SUM 21
Op 22
Dsz 0 B
RCL 21
R/S
```

FLOW DIAGRAM OF CONCEPTUAL NESTED LOOP



INDIRECT INSTRUCTIONS

LOOP USING INDIRECT COMMAND TO RECALL DATA

(PROBLEM)

FIELD	ACRES	YIELD PER ACRE	PRICE PER UNIT	CASH RECEIPTS
1	32	90 BU.	$ 3.10	$ 8,928
2	10	40 BU.	3.80	1,520
3	58	85 BU.	1.20	5,916
4	72	12 CWT	22.00	19,008
5	43	20 TON	33.00	28,380
			TOTAL CASH RECEIPTS	$63,752

LOOP USING INDIRECT COMMAND TO STORE DATA

STORE DATA

5 STO 00

15000 STO 01

PROGRAM

LBL A

RCL 00 STO 02

0 STO 10

LBL B

RCL 02 SUM 10

Dsz 2 B

20 STO 03

LBL C

RCL 00 ÷ RCL 10 x RCL 01 = STO IND 03

1 SUM 03

Dsz 0C

R/S

ANSWERS

RCL 20, 21, ETC.

CROP	DATA	DATA REGISTER	FIELD	FACTOR
CORN	35	10	1	ACRES
	75	11	2	ACRES
	45	12	3	ACRES
	115	17	1	YIELD
	85	18	2	YIELD
	103	19	3	YIELD
SOYBEANS	55	13	1	ACRES
	20	14	2	ACRES
	50	20	1	YIELD
	45	21	2	YIELD
WHEAT	15	15	1	ACRES
	10	16	2	ACRES
	60	22	1	YIELD
	65	23	2	YIELD
CORN	2.65	24		PRICE PER BU.
SOYBEANS	6.05	25		PRICE PER BU.
WHEAT	3.65	26		PRICE PER BU.

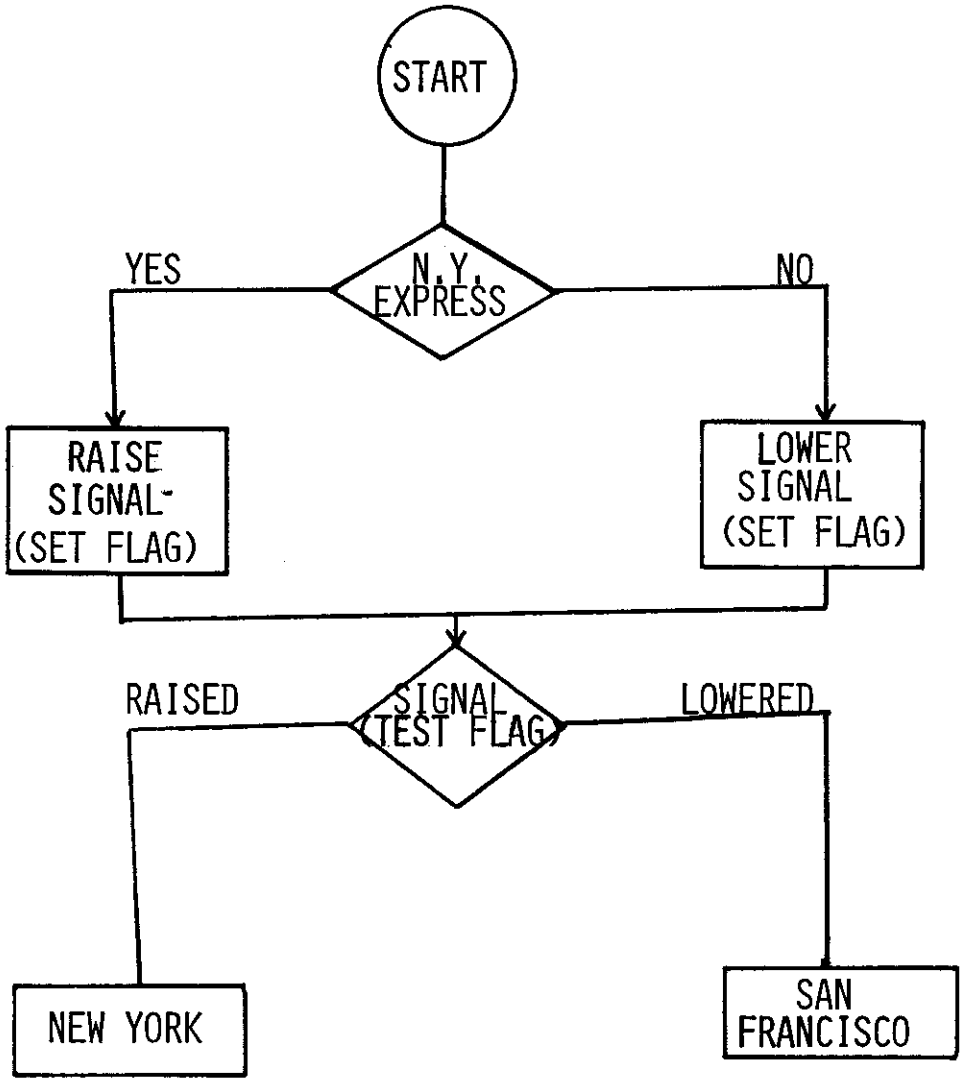
Data

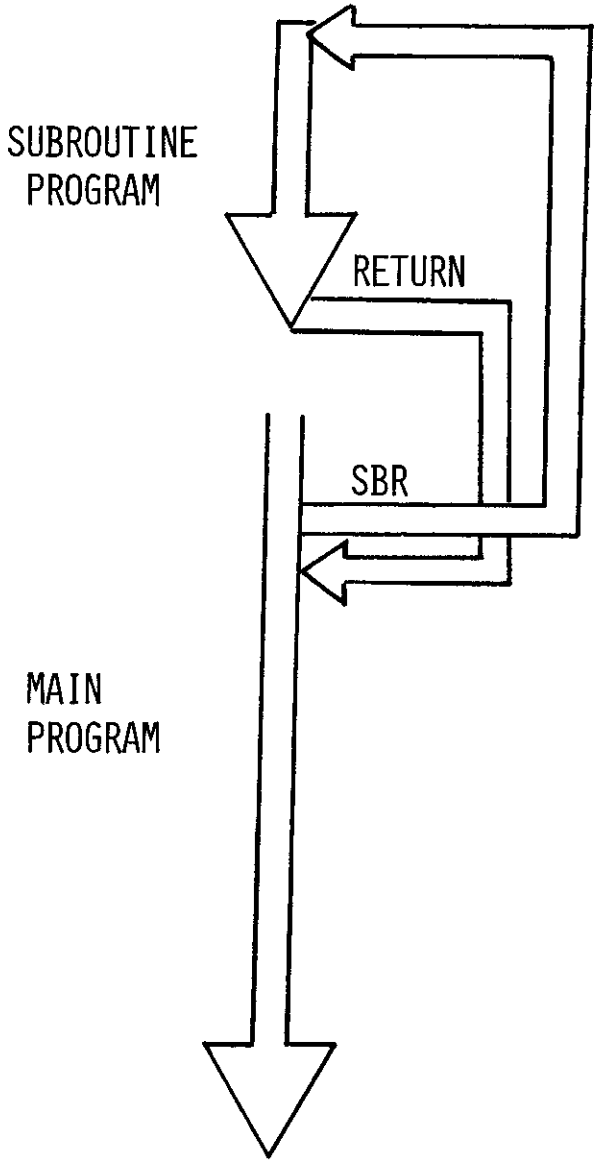
35.	10
75.	11
45.	12
55.	13
20.	14
15.	15
10.	16
115.	17
85.	18
103.	19
50.	20
45.	21
60.	22
65.	23
2.65	24
6.05	25
3.65	26

Program List

000	76	LBL
001	11	A
002	00	0
003	42	STO
004	42	42
005	42	STO
006	43	43
007	01	1
008	00	0
009	42	STO
010	01	01
011	01	1
012	07	7
013	42	STO
014	02	02
015	02	2
016	04	4
017	42	STO
018	03	03
019	03	3
020	00	0
021	42	STO
022	04	04
023	03	3
024	03	3
025	42	STO
026	05	05
027	03	3
028	06	6
029	42	STO
030	06	06
031	03	3
032	09	9
033	42	STO
034	07	07
035	03	3
036	42	STO
037	08	08
038	42	STO
039	09	09
040	76	LBL
041	12	B
042	00	0
043	72	ST*
044	06	06
045	72	ST*
046	05	05
047	76	LBL
048	13	C
049	73	RC*
050	01	01
051	74	SM*
052	06	06
053	44	SUM
054	42	42
055	73	RC*
056	01	01
057	65	×
058	[illegible]	RC*
059	[illegible]	[illegible]
060	[illegible]	[illegible]
061	[illegible]	[illegible]
062	[illegible]	03
063	[illegible]	OP
064	21	21
065	69	OP
066	22	22
067	97	DSZ
068	08	08
069	13	C
070	73	RC*
071	05	05
072	55	÷
073	73	RC*
074	06	06
075	95	=
076	72	ST*
077	04	04
078	73	RC*
079	05	05
080	65	×
081	73	RC*
082	03	03
083	95	=
084	72	ST*
085	07	07
086	44	SUM
087	43	43
088	69	OP
089	23	23
090	69	OP
091	24	24
092	69	OP
093	25	25
094	69	OP
095	26	26
096	69	OP
097	27	27
098	02	2
099	42	STO
100	08	08
101	97	DSZ
102	09	09
103	12	B
104	91	R/S
105	76	LBL
106	14	D
107	03	3
108	00	0
109	42	STO
110	00	00
111	01	1
112	04	4
113	42	STO
114	09	09
115	76	LBL
116	39	COS
117	73	RC*
118	00	00
119	91	R/S
120	69	OP
121	20	20
122	97	DSZ
123	09	09
124	39	COS
125	91	R/S

FLAGS


START
N.Y. EXPRESS
YES
NO
RAISE SIGNAL (SET FLAG)
LOWER SIGNAL (SET FLAG)
SIGNAL (TEST FLAG)
RAISED
LOWERED
NEW YORK
SAN FRANCISCO


SUBROUTINE
PROGRAM
RETURN
SBR
MAIN
PROGRAM

```
LBL A
RCL 10 x .01 = STO 00
÷ (1 − (1 ÷ (1 + RCL 00)) Y^X RCL 11 = STO 02
INV SBR
LBL B
RCL 16 STO 10
RCL 17 STO 11
SBR A
RCL 02 x RCL 15 = STO 40
RCL 19 STO 10
RCL 20 STO 11
SBR A
RCL 02 x RCL 18 = STO 41
RCL 22 STO 10
RCL 23 STO 11
SBR A
RCL 02 x RCL 21 = STO 42
R/S
```

LESSON 6 INTERNAL ROUTINES AND LIBRARY MODULES

Objectives

-- To describe the application of internal routines for calculator control operations and calculations

-- To apply internal routines in problem solutions

-- To learn the process for accessing and using solid-state module libraries

6-1 INTERNAL ROUTINES

1. Defined -- A subroutine or calculation sequence contained within the electronic circuitry of the calculator.

2. Types

   - Function keys (ie: y^x, x^2)
   - Special control operations -- See p. V-27 of Personal Programming for a complete list of all Op codes
   - Conversions -- p. V 30-32
   - Statistics -- p. V 32-40

6-2 STATISTICAL MEASURES -- SINGLE VARIABLE

1. Data

Year	U. S. Corn Production (Million Bu.)
75-76	5,829
76-77	6,266
77-78	6,505
78-79	7,268
79-80	7,939
80-81	6,645
81-82	8,201

2. Statistical Measures

x = Yearly corn production

$\bar{x}$ = Mean corn production

σ^2 = Variance in corn production

σ = Standard deviation of corn production

3. Steps to obtain the statistical measures

- Step 1 -- Clear data register 01 to 06
- Step 2 -- Enter data
- Step 3 -- Compute the mean -- 6950
- Step 4 -- Compute the variance -- 665,684
- Step 5 -- Compute the standard deviation -- 815

4. Error correction

- Error in number before pressing $\boxed{\overset{*}{\Sigma+}}$
  Press $\boxed{\text{CE}}$, enter correct number and continue with normal entry.
- Error after pressing $\boxed{\overset{*}{\Sigma+}}$ Key in the incorrect number; press $\boxed{\text{INV}}$ $\boxed{\overset{*}{\Sigma+}}$; and reenter the number with normal entry.

6-3 STATISTICAL MEASURES -- TWO VARIABLES

1. Data

Year	U.S. Corn Production (Million Bu.)	U.S. Price Per Bu.
75-76	5,829	2.58
76-77	6,266	2.15
77-78	6,505	2.02
78-79	7,268	2.25
79-80	7,939	2.52
80-81	6,645	3.11
81-82	8,201	2.45

2. Steps to obtain the statistical measures

- Step 1 -- Clear registers 01 to 06 and the t register
- Step 2 -- Enter data in x, y form as follows:

  Enter x value

  Press [x⇆t]

  Enter corresponding y value

  Press *[Σ+]
- Step 3 -- Compute the y mean and the x mean -- $2.44 and 6950
- Step 4 -- Compute the variance for y and x -- $ .11 and 665,684
- Step 5 -- Compute the standard deviation for y and x -- $ .33 and 815

3. Error correction: Original x value, [x⇆t]

   Original y value, [INV], *[Σ+]

   Correct x value, [x⇆t]

   Correct y value, *[Σ+]

6-4 LINEAR REGRESSION -- TWO VARIABLES

Step 1 -- Clear all data registers and the t register

Step 2 -- Enter data using the two variable format -- example of nitrogen fertilizer and corn yields, "Effect of Nitrogen Fertilizer on Corn Yield," Extension Bulletin E-802, Cooperative Extension Service, Michigan State University, Feb. 1979.

Step 3 --Compute the intercept and slope

*[Op] 12 intercept

[x⇆t] slope

$y = 53.89 + .43036\ x$

Step 4 -- Compute the correlation coefficient and the index of determination

*[Op] 13 correlation coefficient R=.95

[x^2] index of determination R^2=.90

Step 5 -- Compute the means, standard deviations and variances for the x and y data

Measure	x	y
$\bar{x}$	60	80
σ^2	1600	330
σ	40	18

Step 6 -- Expect y given x as 200

y = 140

6-5 SOLID-STATE MODULE FEATURES

1. Pre-programmed routines readily accessible using keys *[Pgm] nn where nn is the two-digit number of the program.

2. Module contains up to 5000 program steps or 15-25 magnetic cards.

3. Module is executed directly without using program memory.

4. Read only memory -- Cannot change the program in the module, but can download the program in memory, list, execute and change. Key sequence: *[Pgm] nn *[Op] 09 where nn is the two-digit number of the program.

5. Customized modules can be factory ordered -- i.e.: Iowa State University Agricultural Module.

6. Incorporation of module program as a subroutine in a magnetic card external program.

6-6 MODULE PROGRAM SUBROUTINES

1. Module library programs can be used as part of a user developed program stored in program memory.

2. A module as a subroutine saves programming time and memory storage. (A library module as a subroutine does not enter calculator memory, but operates electronically.)

3. Access instructions in program memory. (Refer to module library manual for the program labels, number and specific access instructions.) In general, the access instructions are:

   a. *[Pgm] mm, N where mm is the module program number and N is the user-defined label in the module program. Execution transfers back to program memory at the end of label N section.

   b. *[Pgm] mm [SBR] N where mm is the module program and N is the common label in the module program. Execution transfers back to program memory at the end of label N section.

INTERNAL ROUTINES

- FUNCTION KEYS
- SPECIAL CONTROL OPERATIONS
- CONVERSIONS
- STATISTICS

STATISTICAL MEASURES -- SINGLE VARIABLE

STEP 1 -- CLEAR DATA REGISTER 01 TO 06

STEP 2 -- ENTER DATA FOLLOWED BY * [Σ+] AFTER EACH NUMBER

5829	7939
6266	6645
6505	8201
7268	

STEP 3 -- COMPUTE THE MEAN -- PRESS * [$\bar{x}$]

STEP 4 -- COMPUTE THE VARIANCE -- PRESS [INV] * [OP] 11

STEP 5 -- COMPUTE THE STANDARD DEVIATION -- PRESS [$\sqrt{x}$]

STATISTICAL MEASURES -- TWO VARIABLES

STEP 1 -- CLEAR DATA REGISTER 01 TO 06 AND THE T REGISTER

STEP 2 -- ENTER DATA x FOLLOWED BY [x⇆T] AND y FOLLOWED BY *[Σ+] AFTER EACH NUMBER

X	Y	X	Y
5829	2.58	7939	2.52
6266	2.15	6645	3.11
6505	2.02	8201	2.45
7268	2.25		

STEP 3 -- COMPUTE THE MEAN

*[$\bar{x}$] y MEAN

[x⇆T] x MEAN

STEP 4 -- COMPUTE THE VARIANCE

[INV] *[Op] 11 VARIANCE OF y VALUES

[x⇆T] VARIANCE OF x VALUES

STEP 5 -- COMPUTE THE STANDARD DEVIATIONS

REPEAT STEP 4 FOLLOWED BY [$\sqrt{x}$]

STEP 1 -- CLEAR ALL DATA REGISTERS AND THE T REGISTER

STEP 2 -- ENTER DATA USING THE TWO-VARIABLE FORMAT

X	Y	X	Y
0	45	80	93
20	63	100	96
40	77	120	98
60	86		

STEP 3 -- COMPUTE THE INTERCEPT AND SLOPE

* [OP] 12 INTERCEPT

[X⇆T] SLOPE

STEP 4 -- COMPUTE THE CORRELATION COEFFICIENT AND THE INDEX OF DETERMINATION

* [OP] 13 CORRELATION COEFFICIENT R

[X^2] INDEX OF DETERMINATION R^2

STEP 5 -- COMPUTE THE MEANS, STANDARD DEVIATION AND VARIANCES FOR THE X AND Y DATA USING THE TWO-VARIABLE FORMAT

STEP 6 -- EXPECTED Y GIVEN X

X

* [OP] 14 EXPECTED Y

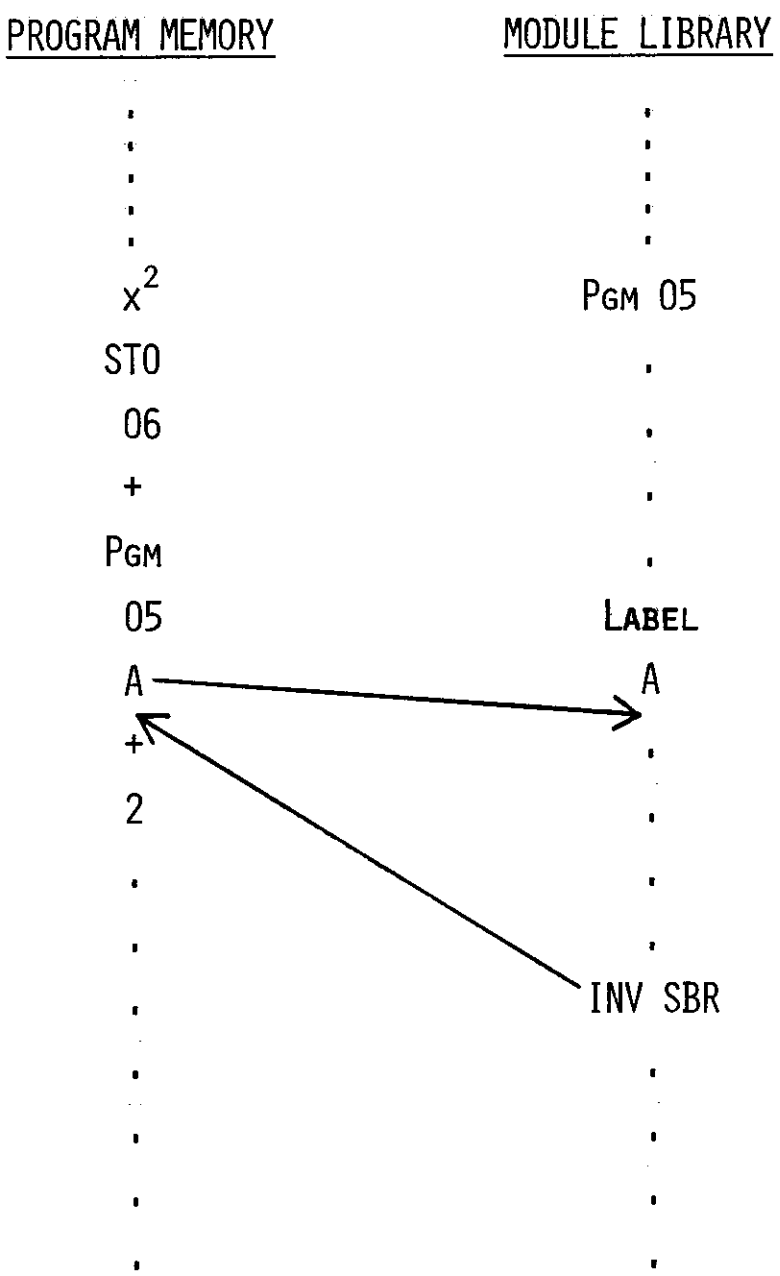
EXAMPLE PROGRAM -- COMPOUND INTEREST

ENTER	PRESS	DISPLAY	COMMENTS
	* PGM 18	0	SELECT PROGRAM
	* E′	0	INITIALIZE
1000	C	1000.00	PRESENT VALUE
8	A	8.00	YEARS
6	B	6.00	INTEREST
0	D	1593.85	FUTURE VALUE

DOWNLOAD PROGRAM

* PGM 18		SELECT PROGRAM
* OP 09		DOWNLOAD PROGRAM
RST		RESTORE
LRN		PROGRAM STEPS

MODULE PROGRAM SUBROUTINES



LESSON 7. USING THE PRINTER

Objectives

-- To understand the function of special control operations with the printer

-- To learn how to write programs to print alphanumeric characters

-- To be able to use the printer for plotting data graphically

7-1 CONTROL OPERATIONS FOR PRINTING

Op Codes	Function
00	Initialize print register
01	5 alphanumeric codes for print column
02	5 alphanumeric codes for print column
03	5 alphanumeric codes for print column
04	5 alphanumeric codes for print column
05	Print contents of print register
06	Print last 4 characters of Op 04 with current display value
07	Plot a * in column 0-19 as specified by the display
08	List labels currently used in program memory

7-2 CHARACTER POSITIONS

- Twenty characters can be printed on a line of paper output or a display value plus 4 alphanumeric characters

- The characters can be letters, numbers or symbols
- The 20 characters are divided into 4 groups with 5 alphanumeric characters per group. The four groups are positioned with an Op code as follows:

  Op 01 Left 5 characters

  Op 02 Inside left 5 characters

  Op 03 Inside right 5 characters

  Op 04 Right 5 characters

7-3 ALPHANUMERIC PRINTING ADDRESS CODE

- Each character is represented by a two digit code based on the row column position.
- Examples

Code	Character
00	Blank
01	0
13	A
47	+

7-4 ALPHANUMERIC PRINT EXAMPLE

1. Code alphanumeric messages
2. Write the program to print messages
3. Print the messages
   a. Clear fix-decimal, engineering notation and scientific notation

b. Clear the display register

c. Move code to display

d. Execute the Op 05 print command

4. Continue with program execution

7-5 SPECIAL PURPOSE CONTROL PRINT

- Print the value currently in the display plus
- Print the far right 4 characters on the same line
- Example

Printer line 43852 INC

7-6 PLOTTING DATA

1. Control operation Op 07 plots a * for current display value in character position 0-19 on the printer paper.

2. Example program using plotting for the program on p. 156, Programmable Calculators -- Business Application.

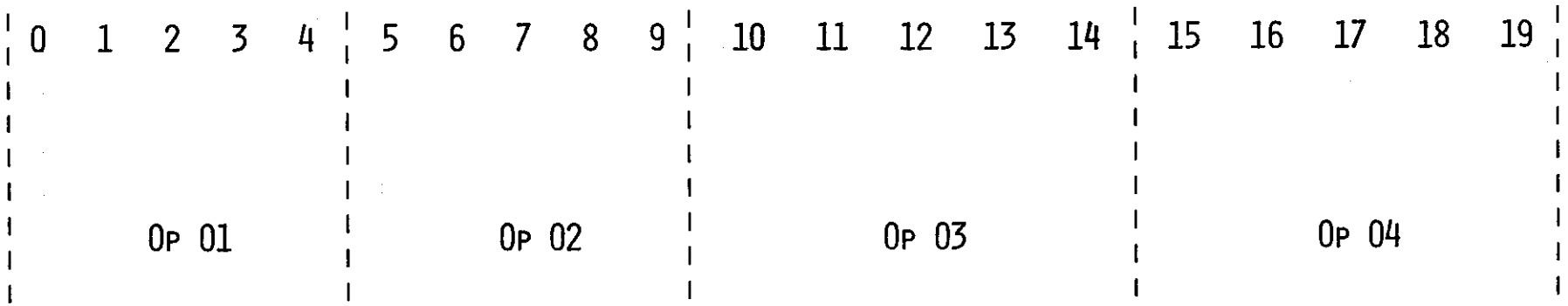
3. Data -- Net Farm Income

Year	Grain Farm	Dairy Farm
73	$45,124	$41,982
74	31,465	30,628
75	24,972	21,676
76	10,020	28,395
77	10,434	24,904
78	16,523	52,418
79	34,336	59,027
80	37,949	53,513

CONTROL OPERATIONS FOR PRINTING

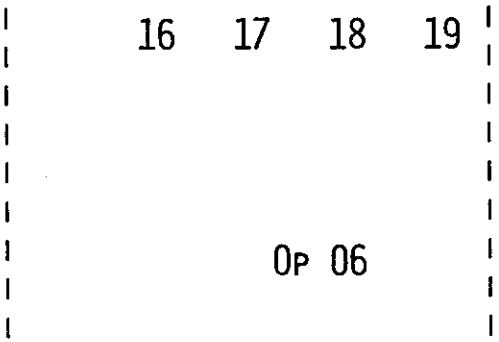
* OP	00-06	ALPHANUMERIC PRINTING
* OP	07	PLOTTING DATA
* OP	08	LIST PROGRAM LABELS USED

CHARACTER POSITIONS



OR

(DISPLAY NUMBER)



ALPHANUMERIC PRINTING ADDRESS CODE

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PROGRAM

CLR	*OP	00
37 32 37 13 27	*OP	01
00 24 31 15 32	*OP	02
30 17 00 00 00	*OP	03
*OP	05	

COMMENT

CLEARS PRINT REGISTER

STORE "TOTAL" IN PRINT REGISTER

STORE "(B) INCO" IN PRINT REGISTER

STORE "ME (B)(B)(B)" IN PRINT REGISTER

PRINT COMPLETE TITLE ON PAPER

SPECIAL PURPOSE CONTROL PRINT

PROGRAM	EXECUTION
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Op 04	
RCL 30	
Op 06	
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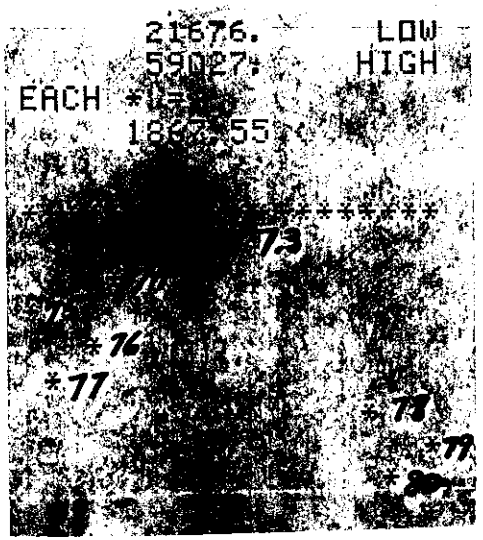
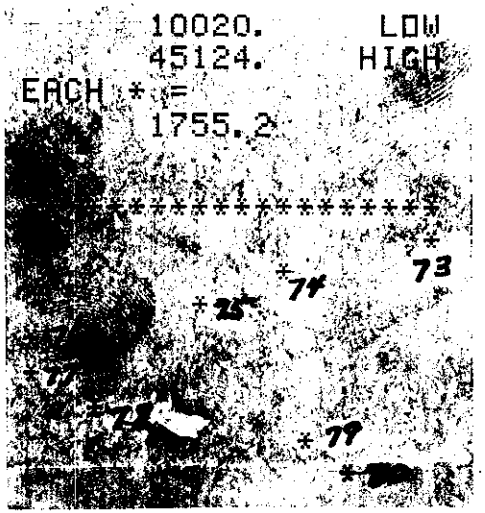
PLOTTING DATA

NET FARM INCOME
DAIRY FARMS



NET FARM INCOME
GRAIN FARMS



LESSON 8. APPLICATION PROGRAMS

Objectives

-- To become aware of sources of library programs for the programmable calculator.

-- To practice operating programs prepared for the TI/59 programmable calculator

8-1 SOLID STATE SOFTWARE MODULES

Numerous modules can be purchased from TI retail outlets for TI programmable calculators on different topics. Each module contains 15-25 programs in a professional area.

8-2 PPX-59 PROFESSIONAL PROGRAM EXCHANGE

PPX
P.O. Box 53
Lubbock, TX 79408

A membership subscription to the PPX-59 software catalog containing a list of programs written by various users in many professional areas and a bimonthly newsletter. A subscriber can order programs for $4 per program.

Cost: $20 annual membership fee payable to PPX-59

8-3 TELCAL

Bulletin Office
Michigan State University
P.O. Box 231
East Lansing, MI 48824

Cost: $30 for a first-time subscriber and $10 annual renewal payable to Michigan State University.

Contents: A notebook with TI/59 programs in agriculture and forestry related areas.

8-4 PROGRAMS APPLIED TO AGRICULTURAL DECISIONS

Publications Distribution
Iowa State University
Ames, IA 50011

Cost: $30 or $1 per program payable to Iowa State University

Contents: A notebook with TI/59 programs in agriculture

8-5 AGRICULTURAL MODULE

ISU Research Foundation
315 Beardshear Hall
Iowa State University
Ames, IA 50011

Cost: $50 payable to ISU Research Foundation

Contents: Agricultural module and manual with 16 programs for the TI/58 and 59.

8-6 NRAES-5 CALCULATOR PROGRAMS FOR EXTENSION

Northeast Regional Agricultural
Engineering Service
Riley-Robb Hall
Cornell University
Ithaca, NY 14853

Cost: $20 payable to NRAES

Contents: A notebook with TI/59 programs in agriculture

8-7 TI/59 PROGRAMMABLE CALCULATOR NOTEBOOK

Extension Agricultural Economics
Waters Hall
Kansas State University
Manhattan, KS 66506

Cost: $30 for a 3 year subscription payable to Kansas State University

Contents: A notebook with TI/59 programs in agriculture

8-8 HP-41C PROGRAMMABLE CALCULATOR PROGRAMS

Department of Agricultural Economics
Oregon State University
Corvallis, OR 97331

Contents: Several programs in agriculture for the HP-41C

8-9 TI/59 CALCULATOR PROGRAMS

Department of Agricultural Economics
Washington State University
Pullman, WA 99164

Contents: Several programs in agriculture for the TI/59

8-10 TI/59 CALCULATOR PROGRAMS

Department of Agricultural Economics
Texas A&M University
College Station, TX 77843

Contents: Several programs in agriculture for the TI/59

8-11 FOREST PROGRAMS FOR PROGRAMMABLE CALCULATORS E-1601

Bulletin Office
Michigan State University
P. O. Box 231
East Lansing, MI 48824

Cost: $1.10 payable to Michigan State University

Contents: A catalog listing of forestry programs for programmable calculators from various authors.

MSU INTERNATIONAL DEVELOPMENT PAPERS

		Price
IDP No. 1	Carl K. Eicher and Doyle C. Baker, "Research on Agricultural Development in Sub-Saharan Africa: A Critical Survey," 1982, (346 pp.).	$8.00
IDP No. 2	Eric W. Crawford, "A Simulation Study of Constraints on Traditional Farming Systems in Northern Nigeria," 1982, (136 pp.).	$5.00
IDP No. 3	M. P. Collinson, "Farming Systems Research in Eastern Africa: The Experience of CIMMYT and Some National Agricultural Research Services, 1976-81," 1982, (67 pp.).	$4.00
IDP No. 4	Vincent Barrett, Gregory Lassiter, David Wilcock, Doyle Baker, and Eric Crawford, "Animal Traction in Eastern Upper Volta: A Technical, Economic, and Institutional Analysis," 1982, (132 pp.).	$5.00
IDP No. 5	John Strauss, "Socio-Economic Determinants of Food Consumption and Production in Rural Sierra Leone: Application of an Agricultural Household Model with Several Commodities," 1983, (91 pp.).	$5.00

MSU INTERNATIONAL DEVELOPMENT WORKING PAPERS

WP No. 1	Daniel Galt, Alvaro Diaz, Mario Contreras, Frank Peairs, Joshua Posner, and Franklin Rosales, "Farming Systems Research (FSR) in Honduras, 1977-81: A Case Study," 1982, (48 pp.).	$0.00
WP No. 2	Edouard K. Tapsoba, "Credit Agricole et Credit Informel dans la Region Orientale de Haute-Volta: Analyse Economique, Performance Institutionnelle et Implications en Matiere de Politique de Developpement Agricole," 1982, (125 pp.).	$0.00
WP No. 3	W. P. Strassman, "Employment and Construction: Multi-Country Estimates of Costs and Substitution Elasticities for Small Dwellings," 1982, (48 pp.).	$0.00
WP No. 4	Donald C. Mead, "Sub-Contracting in Rural Areas of Thailand," 1982, (52 pp.).	$0.00
WP No. 5	Michael T. Weber, James Pease, Warren Vincent, Eric W. Crawford, and Thomas Stilwell, "Microcomputers and Programmable Calculators for Agricultural Research in Developing Countries," 1983, (113 pp.).	$5.00
WP No. 6	Thomas C. Stilwell, "Periodicals for Microcomputers: An Annotated Bibliography," 1983, (70 pp.).	$4.00
WP No. 7	W. Paul Strassman, "Employment and Housing in Lima Peru," 1983, (96 pp.).	$0.00
WP No. 8	Carl K. Eicher, "Faire Face a la Crise Alimentarie de l'Afrique," 1983, (29 pp.).	$0.00
WP No. 9	Thomas C. Stilwell, "Software Directories for Micro-Computers: An Annotated Bibliography," 1983 (14 pp.).	$3.00
WP No. 10	Ralph E. Hepp, "Instructional Aids for Teaching How to Use the TI-59 Programmable Calculator," 1983, (133 pp.).	$5.00

Copies may be obtained from: MSU International Development Papers, Department of Agricultural Economics, Agriculture Hall, Michigan State University, East Lansing, Michigan, 48824-1039, U.S.A. All orders must be prepaid in United States currency. Please do not send cash. Make checks or money orders payable to Michigan State University. There is a 10% discount on all orders of 10 or more copies. Individuals and institutions in the Third World may receive single copies free of charge.