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Programmable TI 58/59

Electrical Engineering

Quick Reference Guide

CONTENTS

CALCULATING NOTES

Low Battery Indication

If the display flashes erratically, fades out, gives incorrect results or is inconsistent in any way, recharge the battery. Calculator operation can be resumed after several minutes of recharging.

Algebraic Hierarchy

Operations and functions are performed automatically in following order.

1. Math Functions (x^2, cos, etc.)
2. Exponentiation (y^x) and Roots ($\sqrt[x]{y}$)
3. Multiplication, Division
4. Addition, Subtraction
5. Equals

Order applies to each set of parentheses. You can use up to 8 pending operations and 9 open parentheses, except where noted.

Flashing Display

A display flashing off and on indicates that an invalid key sequence has taken place or that the limits of the display have been exceeded. See Appendix B in *Personal Programming* for possible causes.

CONVERSIONS

Angle Formats

[2nd] [D.MS] — DEGREES, MINUTES, SECONDS TO DECIMAL DEGREES — Converts an angle measured in degrees, minutes and seconds to its decimal degrees equivalent. [INV] [2nd] [D.MS] reverses this conversion. Also used for time conversions. **Operates on display value only.** Submit 2 digits each for minutes and seconds. Entry and display format is DD.MMSSsss where DD is degrees, MM is minutes, SS is whole seconds and sss is fractional seconds.

Polar to Rectangular

R [x:t] Θ [2nd] [P-R] → y; [x:t] → x

Rectangular to Polar

x [x:t] y [INV] [2nd] [P-R] → Θ; [x:t] R

Only 4 pending operations are available for other uses when using D.MS or Polar/Rectangular conversions.

Angular Conversions

FROM \ TO	Degrees	Radians	Grads
Degrees		$\times \frac{\pi}{180}$	$\div 0.9$
Radians	$\times \frac{180}{\pi}$		$\times \frac{200}{\pi}$
Grads	$\times 0.9$	$\times \frac{\pi}{200}$	

STATISTICS

Initialize: [2nd] [Pgm] 1 [SBR] [CLR]

Data Entry: x_i [x:t] y_i [2nd] [Σ+]

Data Entry Removal: x_i [x:t] y_i [INV] [2nd] [Σ+]

Trendline Data Entry: x_1 [x:t], y_1 [2nd] [Σ+], y_2 [2nd] [Σ+], etc.

Trendline Point Removal: [x:t] [−] 1 [=] [x:t] y_i [INV] [2nd] [Σ+]

Calculations	Key Sequence
Mean of y-array	[2nd] [x̄]
then x-array	[x:t]
Standard Deviation	
(N − 1 Weighting) of y-array	[INV] [2nd] [x̄]
then x-array	[x:t]
(N Weighting) of y-array	[INV] [2nd] [Op] 11 [√x]
then x-array	[x:t] [√x]
Variance	
(N Weighting) of y-array	[2nd] [Op] 11
then x-array	[x:t]
(N − 1 Weighting) of y-array	[2nd] [x̄] [x²]
then x-array	[x:t] [x²]
Y-Intercept	[2nd] [Op] 12
Slope after y-intercept	[x:t]
Correlation Coefficient	[2nd] [Op] 13
y' for new x	[2nd] [Op] 14
x' for new y	[2nd] [Op] 15

SPECIAL CONTROL OPERATIONS

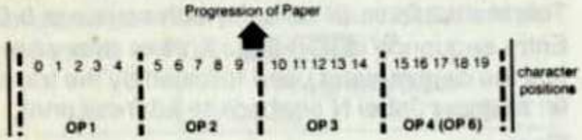
Each special control operation is called by pressing [2nd] [Op] nn where nn is the 2-digit code assigned to each operation (short form addressing can be used here). These operations use up to 4 pending operations and 1 subroutine level.

Code nn	Function
00*	Initialize print register.
01*	Alphanumerics for far left quarter of print column.
02*	Alphanumerics for inside left quarter of print column.
03*	Alphanumerics for inside right quarter of print column.
04*	Alphanumerics for far right quarter of print column.
05*	Print the contents of the print register.
06*	Print last 4 characters of OP 04 with current display.
07*	Plot ✳ in column 0-19 as specified by the display.
08*	List the labels currently used in program memory.
09	Bring specified library program into program memory.
10	Apply signum function to display register value.
11	Calculate variances.
12	Calculate slope and intercept.
13	Calculate correlation coefficient.
14	Calculate new y prime (y') for an x in the display.
15	Calculate new x prime (x') for a y in the display.
16	Display current partition of memory storage area.
17	Repartition memory storage area.
18	If no error condition exists in a program, set flag 7.
19	If an error condition exists in a program, set flag 7.
20-29	Increment a data register 0-9 by 1.
30-39	Decrement a data register 0-9 by 1.

*Designed specifically for use with optional PC-100A Print Cradle

ALPHANUMERIC PRINT CODES

The first seven control operations allow you to create and print out alphanumeric messages. Twenty characters can be printed on each line. They are assembled and stored in groups of 5 characters at a time as shown below.



Each printed character is represented by a two-digit, row-column address code according to the following table:

	0	1	2	3	4	5	6	7
0		0	1	2	3	4	5	6
1	7	8	9	A	B	C	D	E
2	-	F	G	H	I	J	K	L
3	M	N	O	P	Q	R	S	T
4	.	U	V	W	X	Y	Z	+
5	×	*	√	π	e	(	)	,
6	↑	%	⇕	/	=	'	×	$\bar{x}$
7	²	?	÷	!	Ⅱ	^	Π	Σ

For instance, A is code 13 and + is code 47

PROGRAMMING NOTES

Labels

Any key on the keyboard can be used as a label except 2nd, LRN, Ins, Del, SST, BST, Ind and the numbers 0-9.

DSZ

This instruction can be used with registers 0-9. Entry sequence is 2nd Dsz **X, N** or **nnn** where X is the data register used followed by the transfer address (label N or absolute address nnn).

Flags

Ten flags are available (0-9). Entry sequence for setting, resetting or testing flags is the flag instruction, flag number, then transfer address (testing only).

MEMORY PARTITIONING

Memory area is partitioned in sets of 10 registers where each register can hold a data value or 8 program instructions. To check placement of current partition, press 2nd Op **16.** To repartition, enter number of sets (N) of 10 data registers needed and press 2nd Op **17.**

N	Program/Data TI-58	Program/Data TI-59
N < 0 = N		
0	479/00	959/00
1	399/09	879/09
2	319/19	799/19
3	**239/29***	719/29
4	159/39	639/39
5	079/49	559/49
6	000/59	**479/59***
7	Flashing	399/69
8	Flashing	319/79
9	Flashing	239/89
10	Flashing	159/99
N > 10	Flashing	159/99

*Partition when calculator is turned on.

PROGRAM KEY CODES

Key Code	Key	Key Code	Key	Key Code	Key
00	0	39	cos	72*	STO Ind
↓	↓	40	Ind	73*	RCL Ind
09	9	42	STO	74*	SUM Ind
10	E'	43	RCL	75	−
11	A	44	SUM	76	Lbl
12	B	45	y^x	77	x≥t
13	C	47	CMs	78	Σ+
14	D	48	Exc	79	$\bar{x}$
15	E	49	Prd	80	Grad
16	A'	50	|x|	81	RST
17	B'	52	EE	83*	GTO Ind
18	C'	53	(	84*	Op Ind
19	D'	54	)	85	+
20	CLR	55	÷	86	St flg
22	INV	57	Eng	87	If flg
23	lnx	58	Fix	88	D.MS
24	CE	59	Int	89	π
25	CLR	60	Deg	90	List
27	INV	61	GTO	91	R/S
28	log	62*	Pgm Ind	92*	INV SBR
29	CP	63*	Exc Ind	93	.
30	tan	64*	Prd Ind	94	+/−
32	x:t	65	×	95	=
33	x^2	66	Pause	96	Write
34	$\sqrt{x}$	67	x=t	97	Dsz
35	1/x	68	Nop	98	Adv
36	Pgm	69	Op	99	Prt
37	P→R	70	Rad		
38	sin	71	SBR		

*Merged codes

RECORDING MAGNETIC CARDS (TI-59 Only)

Display When Write Pressed, Card Entered	Calculator Response
1, 2, 3, 4	Writes a card side with this number from the bank of this number (program and/or data) and records current partition on card.
−1, −2, −3, −4	Writes and protects card side with this number from the bank with this number. Also records current partition on card.
Any other number	Card is passed but not recorded. Rightmost two integer digits of display are flashed.

If the display is flashing any value when trying to read or record a card, the card is passed but not read or recorded and the rightmost two integers in the display are flashed.

The calculator should be in standard display format when reading or recording cards.

Only the integer portion of the display is recognized, i.e., 1.234 = 1.

READING MAGNETIC CARDS
(TI-59 Only)

Display When Card Entered	Calculator Response
0	Reads information into bank number listed on card if current partition matches that on card. If partition incorrect, card is passed, but not read — display flashes card side passed.
1, 2, 3, 4	Expects card with this side number to be read — displays that side number. If another side is entered or if partition is incorrect, card is passed but not read — display flashes card side passed.
−1, −2, −3, −4	Forces side to be read into this bank number regardless of the partition or the number on the card. A protected program cannot be forced into any bank or alternate partition.
Any other number	Card is passed but not read — rightmost two integers in display flash.

LIBRARY USER INSTRUCTIONS

The remainder of this booklet contains the User Instructions for each program of the library.

REMOVING AND INSTALLING MODULES. The library module can easily be removed or replaced with another. It is a good idea to leave the module in place in the calculator except when replacing it with another module. Be sure to follow these instructions when you need to remove or replace a module.

CAUTION

Be sure to touch some metal object before handling a module to prevent possible damage by static electricity.

1. Turn the calculator OFF. Loading or unloading the module with the calculator ON may cause the keyboard or display to lock out. Also, shorting the contacts can damage the module or calculator.
2. Slide out the small panel covering the module compartment at the bottom of the back of the calculator.
3. Remove the module. You may turn the calculator over and let the module fall out into your hand.
4. Insert the module, notched end first with the labeled side up into the compartment. The module should slip into place effortlessly.
5. Replace the cover panel, securing the module against the contacts.

MODULE CHECK

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
	Library Module Check			
A1	Select Program		[2nd] [Pgm] 01	
A2	Run Module Check		[SBR] [2nd] [R/S]	11.[1]
	Initialize Linear Regression			
B1	Select Program		[2nd] [Pgm] 01	
B2	Initialize Linear Regression		[SBR] [CLR]	0.

NOTE: 1. The number 11. indicates the Electrical Engineering Library.

PHASE LOCKED LOOP

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
1	Select program		[2nd] [Pgm] 02	
2	Initialize		[SBR] [CLR]	0.
3	Enter loop gain[1,5]	G	[A]	G
4	Enter C for PLL filter in farads	C	[C]	C
5	Enter integer divisor[2] (omit this step for passive PLL filter)	N	[2nd] [A']	N
6	Enter remaining PLL parameters as required[5]			
	a. Natural frequency in radians/second	ω_n	[B]	ω_n
	b. Damping factor	ζ	[D]	ζ
	c. R_1 in ohms	R_1	[2nd] [B']	R_1
	d. R_2 in ohms	R_2	[2nd] [C']	R_2
7	Compute desired PLL (active filter) parameters			
	a. Natural frequency in radians/second		[E] [B]	ω_n
	b. Damping factor		[E] [D]	ζ
	c. R_1 in ohms		[E] [2nd] [B']	R_1
	d. R_2 in ohms		[E] [2nd] [C']	R_2
8	Compute desired PLL (passive filter) parameters			
	a. Natural frequency in radians/second		[2nd] [E'] [B]	ω_n
	b. Damping factor		[2nd] [E'] [D]	ζ
	c. R_1 in ohms[3]		[2nd] [E'] [2nd] [B']	R_1
	d. R_2 in ohms[3]		[2nd] [E'] [2nd] [C']	R_2
9	Compute loop-noise bandwidth in hertz[4]		[2nd] [D']	B

NOTES:

1. The dimension for the loop gain is 1/second since $G = K_p K_v$ where K_p = phase detector gain in volts/radian and K_v = VCO gain in radians/second volt.
2. Input must be an integer ≥ 1. Enter 1 for N when working with basic PLL design ($f_{in} = f_{out}$).
3. Flashing 9's in the display indicates that the input quantities G, ω_n, or ζ need to be modified so that

$$0 < \frac{2\zeta\omega_n G - \omega_n^2}{G^2} < 1.$$

   This insures that the resistances will be greater than zero.
4. Loop-noise bandwidth is one-sided.
5. Inputs must be greater than zero.

$S \rightleftarrows Y$ PARAMETER CONVERSIONS

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
1	Select program		[2nd] [Pgm] 03	
2	Initialize[1]		[SBR] [CLR]	0.
3	Enter polar form of S (or Y) matrix[2]			
	a. Magnitude S_{11} (or Y_{11})	$\|S_{11}(Y_{11})\|$	[x⇄t]	0.
	b. Angle S_{11} (or Y_{11})	$\angle S_{11}(Y_{11})$	[A]	Real S_{11} (or Y_{11})
	c. Magnitude S_{12} (or Y_{12})	$\|S_{12}(Y_{12})\|$	[x⇄t]	Imag S_{11} (or Y_{11})
	d. Angle S_{12} (or Y_{12})	$\angle S_{12}(Y_{12})$	[B]	Real S_{12} (or Y_{12})
	e. Magnitude S_{21} (or Y_{21})	$\|S_{21}(Y_{21})\|$	[x⇄t]	Imag S_{12} (or Y_{12})
	f. Angle S_{21} (or Y_{21})	$\angle S_{21}(Y_{21})$	[C]	Real S_{21} (or Y_{21})
	g. Magnitude S_{22} (or Y_{22})	$\|S_{22}(Y_{22})\|$	[x⇄t]	Imag S_{21} (or Y_{21})
	h. Angle S_{22} (or Y_{22})	$\angle S_{22}(Y_{22})$	[D]	Real S_{22} (or Y_{22})
	i. Display imag S_{22} (or Y_{22}), optional		[x⇄t]	Imag S_{22} (or Y_{22})
4	Enter real characteristic impedance in ohms[3] and press one of the following	Z_0		Z_0
	Convert S → Y		[E]	0.
	Convert Y → S		[2nd] [E']	0.
5.	Display conversion results			
	a. Magnitude Y_{11} (or S_{11})		[2nd] [A']	$\|Y_{11}(S_{11})\|^\dagger$
	b. Angle Y_{11} (or S_{11})[4]		[x⇄t]	$\angle Y_{11}(S_{11})^\dagger$
	c. Magnitude Y_{12} (or S_{12})		[2nd] [B']	$\|Y_{12}(S_{12})\|^\dagger$
	d. Angle Y_{12} (or S_{12})		[x⇄t]	$\angle Y_{12}(S_{12})^\dagger$
	e. Magnitude Y_{21} (or S_{21})		[2nd] [C']	$\|Y_{21}(S_{21})\|^\dagger$
	f. Angle Y_{21} (or S_{21})		[x⇄t]	$\angle Y_{21}(S_{21})^\dagger$
	g. Magnitude Y_{22} (or S_{22})		[2nd] [D']	$\|Y_{22}(S_{22})\|^\dagger$
	h. Angle Y_{22} (or S_{22})		[x⇄t]	$\angle Y_{22}(S_{22})^\dagger$

NOTES:
1. Default value for Z_0 set at 50 ohms.
2. Angle input is in degrees.
3. Enter 0 if default value of 50 ohms or last-entered value for Z_0 is desired.
4. Angle output θ is in degrees where $-90^\circ \leq \theta < 270^\circ$.

† These values are printed if printer is connected.

COMPLEX ARITHMETIC

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
1	Select program.		[2nd] [Pgm] 04	
	If rectangular form:			
2a	Enter real part of X	a	[A]	a
2b	Enter imaginary part of X	b	[A]	b
	(2a and 2b must be performed in sequence) OR			
	If polar form:			
2c	Enter modulus of X	r_1	[A]	r_1
2d	Enter argument of X in degrees	θ_1	[A]	θ_1
2e	Convert polar to rectangular		[SBR] [2nd] [P→R]	0.
	(2c, 2d, and 2e must be performed in sequence)			
	If rectangular form:			
3a	Enter real part of Y	c	[2nd] [A']	c
3b	Enter imaginary part of Y	d	[2nd] [A']	d
	(3a and 3b must be performed in sequence) OR			
	If polar form:			
3c	Enter modulus of Y	r_2	[2nd] [A']	r_2
3d	Enter argument of Y in degrees	θ_2	[2nd] [A']	θ_2
3e	Convert polar to rectangular		[SBR] [2nd] [P→R]	0.
	(3c, 3d, and 3e must be performed in sequence)			
	Perform either Step 4, 5, 6, 7, 8, 9, or 10.			
4	Calculate X + Y		[B] [x⪰t]	real part imaginary part
5	Calculate X − Y		[2nd] [B'] [x⪰t]	real part imaginary part
6	Calculate X × Y		[C] [x⪰t]	real part imaginary part
7	Calculate X ÷ Y		[2nd] [C'] [x⪰t]	real part imaginary part
8	Calculate Y^x		[D] [x⪰t]	real part imaginary part
9	Calculate $\log_y X$		[2nd] [D'] [x⪰t]	real part imaginary part
10	Calculate $\sqrt[x]{Y}$		[E] [x⪰t]	real part imaginary part
	After a calculation, the result becomes the new X.			
11	To swap X and Y		[2nd] [E']	0.

COMPLEX FUNCTIONS

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
1	Select program.		[2nd] [Pgm] 05	
	If rectangular form:			
2a	Enter real part of X	a	[A]	a
2b	Enter imaginary part of X	b	[A]	b
	(2a and 2b must be performed in sequence)			
	OR			
	If polar form:			
2c	Enter modulus of X	r	[A]	r
2d	Enter argument of X in degrees	θ	[A]	θ
2e	Convert polar to rectangular		[SBR] [2nd] [P→R]	0.
	(2c, 2d, and 2e must be performed in sequence)			
3	Calculate polar form of X, if desired		[B] [x⇄t]	r θ
4	Calculate rectangular form of X, if desired		[2nd] [D'] [x⇄t]	a b

	Perform either Step 5, 6, 7, 8, or 9			
5	Calculate X^2		[C] [x⇄t]	real part imaginary part
6	Calculate $\sqrt{X}$		[D] [x⇄t]	real part imaginary part
7	Calculate 1/X		[E] [x⇄t]	real part imaginary part
8	Calculate ln X		[2nd] [A'] [x⇄t]	real part imaginary part
9	Calculate e^X		[2nd] [B'] [x⇄t]	real part imaginary part
	After a calculation, the result becomes the new X.			

COMPLEX TRIGONOMETRIC FUNCTIONS

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
1	Select program.		[2nd] [Pgm] 06	
	If rectangular form:			
2a	Enter real part of X	a	[A]	a
2b	Enter imaginary part of X	b	[A]	b
	(2a and 2b must be performed in sequence)			
	OR			
	If polar form:			
2c	Enter modulus of X	r	[A]	r
2d	Enter argument of X in degrees	θ	[A]	θ
2e	Convert polar to rectangular		[SBR] [2nd] [P→R]	0.
	(2c, 2d, and 2e must be performed in sequence)			
	Perform either Step 3, 4, 5, 6, 7, or 8			
3	Calculate sin X		[B] [x⇄t]	real part imaginary part
4	Calculate cos X		[C] [x⇄t]	real part imaginary part
5	Calculate tan X		[D] [x⇄t]	real part imaginary part
6	Calculate $\sin^{-1}$ X		[2nd] [B'] [x⇄t]	real part imaginary part
7	Calculate $\cos^{-1}$ X		[2nd] [C'] [x⇄t]	real part imaginary part
8	Calculate $\tan^{-1}$ X		[2nd] [D'] [x⇄t]	real part imaginary part

NOTES: 1. After a calculation, the result becomes the new X.

2. X is expressed in radians. Program leaves calculator in radian mode.

dB, Np, P, V, I RATIO CONVERSIONS

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
1	Select program.		[2nd] [Pgm] 07	
2	Initialize		[SBR] [CLR]	0.
3	Input any one of the following:			
	Power ratio[1]	P_2/P_1	[A]	P_2/P_1
	Voltage or Current ratio[1]	V_2/V_1 or I_2/I_1	[B]	V_2/V_1 or I_2/I_1
	Nepers	Np	[C]	Np
	Decibels	dB	[D]	dB
4	Calculate any of the following:			
	Power ratio		[E] [A]	P_2/P_1
	Voltage and Current ratio		[E] [B]	$V_2/V_1 = I_2/I_1$
	Nepers[2]		[E] [C]	Np
	Decibels[2]		[E] [D]	dB

Notes: 1. P_2/P_1, V_2/V_1, I_2/I_1 must be greater than zero.
2. Negative values denote an Np or dB loss.

SIGNAL DETECTION

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
1	Select program		[2nd] [Pgm] 08	
2	Initialize		[SBR] [CLR]	0.
3	Enter ratio of standard deviations	σ_1/σ_0[1]	[A]	σ_1/σ_0
4	Enter two of the following in any order		[B]	
	a. Signal-to-noise ratio (dB)	SNR	[B]	$\mu/\sigma_0 = 10^{SNR/20}$
	b. Probability of declaring a signal present when none exists	P(FA)[2]	[C]	P(FA)
	c. Probability of detecting a signal	P(D)[2]	[D]	P(D)
5	Calculate the remaining variable			
	SNR		[E] [B]	SNR
	P(FA)		[E] [C]	P(FA)
	P(D)		[E] [D]	P(D)

NOTES: 1. σ_1/σ_0 must be >0.
2. Probabilities must be >0 and <1.

ROOTS OF A POLYNOMIAL

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
1	Select program		[2nd] [Pgm] 09	
2	Initialize		[SBR] [CLR]	0.
3	Repartition (TI-58 only)	6	[2nd] [Op] 17	0.59
4	Enter degree of polynomial	n^1	[A]	n
5	Enter coefficient of x^n, repeat until all coefficients have been entered.	a_i^2 ⋮ a_{n+1}	[R/S]	(n−1) ⋮ −1.
6	Enter allowable error	ϵ	[B]	ϵ
7	Enter control digit	CTRL[3]	[E]	CTRL
8	Enter initial estimate of u, then enter initial estimate of v in display	u v	[x⇄t]	v
9	Calculate first two roots		[2nd] [C'][4]	Degree[5,†]
10	Calculate discriminant of quadratic factor		[R/S]	Disc.[6,†]
11	Calculate 1st root		[R/S]	Root 1[6,†]
12	Calculate 2nd root		[R/S]	Root 2[6,†]
13	Execute exit logic		[R/S]	2.[7]
14	Reduce degree of polynomial by 2 by dividing P(x) by $x^2 - ux - v$		[D]	1.
15	Calculate next pair[8] of roots		[C][9]	Degree[5,†]
16	Repeat steps 10 through 15 until all roots have been found			

NOTES:

1. $2 \leq n \leq 21$
2. All coefficients must be entered in sequence starting with the coefficient of x^n. Missing terms have coefficients = 0.
3. CTRL = 1: PRINT successive values of Δu and Δv and final values of u and v.
   CTRL = 0: Suppress output of Δu and Δv and final values of u and v.
   CTRL = −1: DISPLAY (FLASHING) successive values of Δu and Δv (use [R/S] to clear flashing and proceed with calculations of next Δu and Δv and final values of u and v, and degree of polynomial).
   CTRL = 1 or −1 is recommended if user is uncertain of convergence.
4. [2nd] [C'] is used to calculate a pair of roots when the user desires to specify initial estimates of u and v.
5. See Note 3 describing output which may occur prior to display of Degree = n.
6. If discriminant <0, the following root calculations give the imaginary and real parts, respectively, of the complex conjugate roots. If discriminant ≥ 0, the following roots are both real.
7. Exit logic performs initialization of flags.
8. If reduced polynomial is of first degree, only one root exists.
9. [C] is used to calculate roots using previously calculated values of u and v.

† These values are printed if printer is connected.

CHAINED MULTIPLICATION OF POLYNOMIALS

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
1	Select program		[2nd] [Pgm] 10	
2a	Printer used		[D]	
2b	Printer not used		[2nd] [D']	
3a	TI-59 used[1]		[E]	
3b	TI-58 used[1]		[2nd] [E']	
4	Initialize		[A]	0.[2]
5	Enter the coefficients of P_1 starting with a_0. Repeat for all coefficients.		[R/S]	1.[2]
6	Prepare to multiply		[B]	0.[2]
7	Enter the coefficients of P_2 starting with a_0. Repeat for all coefficients.[3,4]		[R/S]	1.[2]
8a	Output product with printer[5]		[C]	$a_0, a_1, \cdots$ are printed
8b	1. Output product without printer[5]		[C]	No. of coefficients in product
	2. Display a_0 (Repeat for $a_1, a_2, \cdots, a_n$)		[R/S]	$a_0, a_1, \cdots, a_n$
9	Exit the program[6]		[2nd] [A']	479.59 or 239.29

NOTES:

1. A TI-59 will be partitioned 239.89, for products of up to 40th degree.
   A TI-58 will be partitioned 0.59, for products of up to 25th degree.
2. The number in the display shows the power of x for the coefficient to be entered. If this power of x is missing in the polynomial, a 0 must be entered as its coefficient.
3. Wait until the next power of x is displayed (when actual multiplication is completed).
4. If another polynomial is to be multiplied, repeat steps 6 and 7.
5. Intermediate products may be output.
6. [2nd] [A'] must be used to return to standard partitioning and to reset flags.

REACTANCE CHART

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
1	Select program		[2nd] [Pgm] 11	
2	Initialize		[SBR] [CLR]	0
3	Enter any two of the following:[1]			
	a. Applied frequency or	f	[A]	f
	Resonant frequency in hertz	f_0	[2nd] [A′]	f_0
	b. Inductance in henrys	L	[B]	L
	c. Inductive reactance in ohms	X_L	[2nd] [B′]	X_L
	d. Capacitance in farads	C	[C]	C
	e. Capacitive reactance in ohms	X_C	[2nd] [C′]	X_C
4	Compute remaining quantity in the frequency equation[1]			
	a. Applied frequency or		[E] [A]	f
	Resonant frequency in hertz		[E] [2nd] [A′]	f_0
	b. Inductance in henrys		[E] [B]	L
	c. Inductive reactance in ohms		[E] [2nd] [B′]	X_L
	d. Capacitance in farads		[E] [C]	C
	e. Capacitive reactance in ohms		[E] [2nd] [C′]	X_C

NOTES: 1. Use computation chart as a guide.

SERIES/PARALLEL IMPEDANCE CONVERSIONS

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
1	Select program		[2nd] [Pgm] 12	
2	Initialize		[SBR] [CLR]	
	Do either Step 3 or Step 4			
3	Enter the following in any order			
	a. Series resistance in ohms	R_S	[A]	R_S
	b. Series reactance in ohms	X_S	[B]	X_S
	Compute the following in any order			
	c. Parallel resistance in ohms		[E] [C]	R_P
	d. Parallel reactance in ohms		[E] [D]	X_P
4	Enter the following in any order			
	a. Parallel resistance in ohms	R_P	[C]	R_P
	b. Parallel reactance in ohms	X_P	[D]	X_P
	Compute the following in any order			
	c. Series resistance in ohms		[E] [A]	R_S
	d. Series reactance in ohms		[E] [B]	X_S

ACTIVE LP, HP, BP FILTERS

STEP	PROCEDURE		ENTER	PRESS	DISPLAY
1	Select program			[2nd] [Pgm] 13	
2	Initialize			[SBR] [CLR]	0.
3	Enter the following as needed:				
	a. peaking factor (LP, HP)[1]		α	[A]	α†
	b. passpand voltage gain (LP, HP) or midband voltage gain (BP) in dB[2]		A	[B]	A†
	c. cutoff frequency (LP, HP) or center frequency (BP) in hertz[1]		F	[C]	F†
	d. 3-dB bandwidth (BP) in hertz[1]		B	[D]	B†
	e. C_1 for (BP, LP) in farads[1]		C_1	[2nd] [A']	C_1†
	f. C_2 for (BP, HP) in farads[1]		C_2	[2nd] [B']	C_2†
4	Compute component values:				
	a. Bandpass[3,5]	R_1 in ohms		[2nd] [C']	R_1†
		R_2 in ohms		[R/S]	R_2†
		R_3 in ohms		[R/S]	R_3†
	b. Lowpass[4,5]	C in farads		[2nd] [D']	C†
		R_2 in ohms		[R/S]	R_2†
		R_1 in ohms		[R/S]	R_1†
		R_3 in ohms		[R/S]	R_3†
	c. Highpass[4]	C in farads		[2nd] [E']	C†
		R_1 in ohms		[R/S]	R_1†
		R_2 in ohms		[R/S]	R_2†

NOTES:

1. Input value must be greater than zero.
2. Because operational amplifiers are non-ideal, A should be chosen to insure H_0 is less than 10 when α is about 0.1. H_0 may be increased if α is also increased. A maximum H_0 of 100 is acceptable with $\alpha = 1$ for an operational amplifier with an open-loop gain of at least 80 dB.
3. If $Q \leq (H_0/2)^{1/2}$, program execution stops with a flashing nines display. To insure that all resistances are greater than zero, either $Q = F/B$, or H_0 should be adjusted so that $Q > (H_0/2)^{1/2}$. See steps 3b, 3c, and 3d.
4. A 12-dB per octave roll-off exists in the lowpass, highpass cases.
5. The value of R_1 calculated includes source resistance, i.e., actual R_1 = Calculated R_1 − Source R.

† These values are printed if printer is connected.

PASSIVE LOWPASS FILTERS

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
1	Select program		[2nd] [Pgm] 14	
2	Initialize		[SBR] [CLR]	0.
3	Enter the following in any order:			
	a. Order of the filter[1]	n	[A]	n
	b. Allowable ripple in dB[3]	ϵ	[B]	ϵ
	c. Termination resistance in ohms[2]	R	[C]	R
	d. Cutoff frequency in hertz[2]	f_c	[D]	f_c
4	Compute and display component values. C is in farads. L is in henrys.		[2nd] [E']	"1."[4,5]
				C_1
	OR		[R/S]	"2."
				L_2
			[R/S]	"3."
				C_3
				⋮
5	Compute and print component values.		[E]	1.[4,6,†]
				C_1[†]
				2.[†]
				L_2[†]
				3.[†]
				C_3[†]
				⋮

NOTES:
1. Input must be an integer ≥ 1.
2. Input > 0.
3. Input ≥ 0. For Butterworth, enter 0.
4. If $\epsilon < 0$, display will flash.
5. " " indicates that the component number is displayed for about 2.5 seconds.
6. Last filter component value remains in the display.

[†] These values are printed only.

CONVOLUTION

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
1	Initialize		[RST]	
2	Select learn mode.		[LRN]	
3	Use A' as the label for x(t) subroutine.		[2nd] [Lbl] [2nd] [A']	
4	Enter x(t) as a series of keystrokes. Assume t is in the display. Do not use [=] or [CLR] or any used registers.			
5	End subroutine with [INV] [SBR]		[INV] [SBR]	
6	Use B' as the label for h(t) subroutine.		[2nd] [Lbl] [2nd] [B']	
7	Enter h(t) as in steps 4 and 5			
8	Exit learn mode		[LRN]	
9	Select program 15		[2nd] [Pgm] 15	
10	Enter number of panels in each Δt	n_0	[A]	n_0
11	Number of values of y(t) desired	N	[B]	N
12	Enter increment Δt	Δt	[C]	Δt
13	Execute without printer		[2nd] [E']	t_1 (flashing) $y(t_1)$
	Repeat until N values have been displayed		[R/S]	t_2 (flashing) $y(t_2)$
14	Execute with printer		[E]	$t_1, y(t_1)$ through $t_N, y(t_N)$ are printed
15	If additional values of y(t) are desired without printer[1]		[2nd] [D']	t_{N+1} (flashing) $y(t_{N+1})$
16	If additional values of y(t) are desired with printer[1]		[D]	$t_{N+1}, y(t_{N+1})$ are printed

NOTES: 1. Step 15 or 16 may be repeated as many times as desired.

ROOT LOCUS CALCULATIONS

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
1	Select program		[2nd] [Pgm] 16	
2	Initialize		[SBR] [CLR]	0.
3	Repartition (TI-58 only)	6	[2nd] [Op] 17	0.59
4	Enter number of poles	n^2	[2nd] [A']	n
5	Enter real part of 1st pole	$Re(p_1)$	[A]	1.
6	Enter imag. part of 1st pole	$Im(p_1)$	[R/S]	1.
7	Repeat steps 5 and 6 until n poles have been entered. Steps 5 and 6 must be performed in sequence.	$Re(p_i)$ $Im(p_i)$	[A] [R/S]	i i
8	Enter number of zeros	$m^{1,2}$	[2nd] [B']	m
9	Enter real part of 1st zero	$Re(z_1)$	[A]	1.
10	Enter imag. part of 1st zero	$Im(z_1)$	[R/S]	1.
11	Repeat steps 9 and 10 until m zeros have been entered. Steps 9 and 10 must be performed in sequence	$Re(z_i)$ $Im(z_i)$	[A] [R/S]	i i
12	Calculate asymptote intersection point		[C]	σ_0†
13	Calculate asymptote angles		[R/S]	ψ_i†
14	Repeat step 13 until (n–m) angles have been calculated.			
15	Calculate departure angles from poles. Repeat for J=1,n.	J	[D]	J† ϕ_J†
16	Calculate arrival angles at zeros. Repeat for K=1,m	K	[E]	K† θ_K†

NOTES: 1. If $m > (n-1)$, error condition will result at execution time.

2. $n \leq 13$, $m \leq 12$

† These values are printed if printer is connected.

DISCRETE FOURIER TRANSFORM

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
1	Select program		[2nd] [Pgm] 17	
2	Initialize		[SBR] [CLR]	0.
3	Repartition (6 TI-58, 10 TI-59)	6 or 10	[2nd] [Op] 17	0.59 or 159.99
	For DFT			
4	Enter sample number ($0 \leq n \leq N-1$)[1]	n	[A]	$n^{\dagger}$
5	Enter sample value[1]	f(n)	[B]	$f(n)^{\dagger}$
6	Repeat steps 4 and 5 until all data is entered[1]			
7	Enter total number of samples and compute DFT[4]	N^2	[E]	
	sample number			$n^{\dagger}$
	real part of transform			$F_{re}(n)^{\dagger}$
	imaginary part of transform			$F_{im}(n)^{\dagger}$
	magnitude of transform[3]			$\|F(n)\|^{\dagger}$
	magnitude of transform in dB			$20 \log \|F(n)\|^{\dagger}$
	phase of transform in degrees			$\angle F(n)^{\dagger}$
	This six-part sequence is repeated for all values of n.			
	For IDFT			
8	Enter sample number ($0 \leq n \leq N-1$)[1]	n	[A]	$n^{\dagger}$
9a	Enter magnitude of transform at n[1]	$\|F(n)\|$	[C]	$\|F(n)\|^{\dagger}$
9b	Enter phase in deg of transform at n[1]	$\angle F(n)$	[D]	$\angle F(n)^{\dagger}$
10	Repeat steps 8 and 9 until all data is entered[1]			
11	Enter total number of samples and compute IDFT	N^2	[2nd] [E']	
	sample number			$n^{\dagger}$
	time value at n			$f(n)^{\dagger}$
	This two-part sequence is repeated for all values of n.			

NOTES:

1. Steps 4, 5, and 6 or 8, 9, and 10 can be omitted if data is entered directly into registers. Step 2 clears memories, so zero values don't need to be entered.
2. For DFT, $N \leq 88$ for TI-59; $N \leq 48$ for TI-58.
   For IDFT, $N \leq 32$ for TI-59; $N \leq 16$ for TI-58.
3. When magnitude approaches zero, the value of the phase angle can be ignored as the phase becomes indeterminate. If magnitude = 0, the indeterminate state is indicated by flashing nines for magnitude in dB and 45. for phase in degrees.
4. Because DFT's for real time series have magnitudes and phases which are symmetric and antisymmetric respectively, about the sample point corresponding to Int(N/2), program execution may be terminated using [RST] after data from point Int(N/2) has been printed.

† These values are printed if a printer is connected. The output values are displayed only briefly. Therefore, for most applications a printer will be desirable.

SMITH CHART CALCULATIONS

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
1	Select program		[2nd] [Pgm] 18	
2	Initialize		[SBR] [CLR]	0.
3	Enter complex characteristic impedance. Omit for $Z_0 = 50 + 0_j$ ohms[1]	$Re(Z_0)$ $Im(Z_0)$	[2nd] [A'] [R/S]	$Re(Z_0)^\dagger$ $Im(Z_0)^\dagger$
4	Enter termination impedance Z_L in ohms. If admittance given, see step 10.	$Re(Z_L)$ $Im(Z_L)$	[2nd] [B'] [R/S]	$Re(Z_L)$ $Re(P_L)^*$ $Im(P_L)^\dagger$
5	Enter attenuation in dB. Omit for a = 0.[1]	a	[A]	$a^\dagger$
6	Enter distance X in wavelengths from termination	X	[C]	$X^\dagger$
7	Compute input impedance Z_i		[E]	$Re(Z_i)^*$ $Im(Z_i)^\dagger$
8	Display magnitude of P_i[2]		[D]	$\|P_i\|^\dagger$
	Display angle of P_i		[R/S]	$\angle P_i^\dagger$
9	Enter magnitude of P and calculate VSWR[3]	|P|	[B]	$\sigma^\dagger$
10	Perform Y⇌Z conversions	Re(Y) Im(Y)	[2nd] [C'] [R/S]	Re(Y) $Re(Z)^*$ $Im(Z)^\dagger$
		Re(Z) Im(Z)	[2nd] [C'] [R/S]	Re(Z) $Re(Y)^*$ $Im(Y)^\dagger$

NOTES:

1. Values for Z_O and a are set at $50 + 0_j$ and 0, respectively, if they are not entered.
2. This calcualtion is performed during execution of input impedance at step 7. Thus step 8 must immediately follow step 7 (Display of P_i is optional).
3. If $|P_i|$ is desired for VSWR, enter $|P_i|$ using [D] in step 8. If $|P_L|$ is desired for VSWR, enter $|P_L|$ by pressing [RCL] 10 after execution of step 7.

† These displayed values are printed if printer is connected.

* These values are printed only.

NETWORK ANALYSIS

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
1a	Repartition	9	[2nd] [Op] 17	239.89
1b	Initialize		[2nd] [CMs] [RST]	239.89
2a	Prepare to load input card[1]		[2nd] [CP] [CLR]	0
2b	Load input card			1.
3a	Enter order of NAM[2]	n	[A]	n†
3b	Enter starting frequency in hertz	f	[R/S]	f†
3c	Enter frequency increment in hertz	Δf	[R/S]	Δf†
4	Initialize for component input		[2nd] [E']	INPUT* VALUE* FM.TO*
	Enter, in any order, values and nodal data for both passive and active components			
	Step 5a, b, c, or d must be followed by Step 6.[3]			
5a	Enter resistor value in ohms OR	R	[B]	R†
5b	Enter inductor value in henrys OR	L	[C]	L†
5c	Enter capacitor value in farads OR	C	[D]	C†
5d	Enter source value in mhos	g_m	[2nd] [A']	g_m†
6	Enter nodal data, From node.To node	Fm.To	[R/S]	Fm.To* Component No.†
	Repeat Steps 5 and 6 until all components are entered[5]			
7a	Prepare to load Construct NAM card[1]		[2nd] [CP] [CLR]	0
7b	Load Construct NAM card			1.
	If NAM order = 5, go to step 9			
8a	Enter learn mode		[GTO] [E] [LRN]	031 06
8b	If NAM order = 4	5	[LRN]	1.
8c	If NAM order = 3 or 2	3	[LRN]	1.
9	Perform network analysis[4] (A linear sweep continues until user termination in step 10)		[E]	Frequency* Magnitude (dB)* Phase (deg)* ⋮
10	Terminate linear sweep and repartition	9	[R/S] [RST] [2nd] [Op] 17	239.89

NOTES:

1. Reference: *Personal Programming*, pg. VII-5.
2. n, order of NAM, corresponds to the total number of nodes (excluding ground node zero) and must meet the constraint $(2 \leq n \leq 5)$.
3. To edit a miskeyed entry in steps 5 and 6, enter component no., press [E] and repeat these steps.
4. When NAM order = 2, a "?" is printed with frequency during linear sweep. This is a normal occurrence resulting from a two-node network being handled internally in three nodes during matrix reduction. When desired sweep is completed, execute step 10 and press [CE] to stop flashing.
5. For easy updating, record contents of bank 4 (reference – *Personal Programming*, pg. VII-1) when steps 5 and 6 are completed. Enter 4 in the display, press [2nd] [Write]. Load Input Card, Side 2. A "4" will appear in the display.

† These displayed values are printed.

* These values are printed only.

NOTES