The Wonderful World Of An Advanced Scientific Calculator

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Abstract

For the solution of many engineering problems, the various capabilities of an advanced scientific calculator are introduced and discussed through the use of examples. The computations include numerical integration, finding the roots of a transcendental function, solution of simultaneous algebraic equations, basic statistical analyses, and the graphing of mathematical functions. Many other types of analyses and computations can be performed on an advanced scientific calculator. The number of numerical digits retained can be up to 12, and the range of numerical values can be between positive and negative $10^{-999}$ and $10^{999}$.

Introduction

The electronic hand calculator was first introduced to the scientific community in the early 1970. The first generation calculator was primarily for hand calculation and the evaluation of basic mathematical functions such as the logarithmic, the trigonometric, the exponential, the factorial, and a few others. No programming was possible for repeated calculation. However, in comparison to the traditional slide rule, the hand calculator was a great leap forward with respect to numerical computation. It provided much better precision than a slide rule, it shortened the time required to obtain a result, and it automatically placed the decimal point in the result.

The advanced scientific calculator available nowadays is just a little larger in its physical size than the original one, however, it is considered more powerful in handling the data than the main-frame computers of the sixties and the seventies. It can carry the number of numerical digits to 12, and the range of numerical values can be between positive and negative $10^{-999}$ and $10^{999}$. Many of the commonly used programs are stored in the memory of the calculator, so that they can be accessed and executed with simple key stroke sequence. The random access memory is sufficiently large to enter and store comparatively sophisticated user programs. Many advanced scientific calculators can also accept and process a complex number, which is a number consists of a real part and an imaginary part.

A desk-top or a lap-top micro-computer installed with appropriate software in its hard drive perhaps is more powerful than a scientific calculator. However, at a cost-ratio of more than 10 to 1, a personal computer is clearly out of reach of many students. In addition, from the point of view of portability, bulkiness, and carrying weight, a scientific calculator is much easier to bring with a person than a personal computer. Finally, under many situations and at many locations, such as attending a class or taking a test, a calculator would be the logical choice of the majority of people.

The discussions covered in this study is through the use of the TI-85 scientific calculator. The topics are listed in the following:

1. Numerical integration
2. Root finding
3. Basic statistical analysis
4. Function graphing
5. Solution of simultaneous algebraic equations

1. Numerical Integration of Definite Integral

Some mathematical integrations, whether definite integral or indefinite integral, are unassailable by any of the familiar methods introduced in calculus. These integrals cannot be expressed in terms of elementary mathematical functions. To obtain numerical results, the method of numerical integration has been developed [1]. Integration can be interpreted as a mathematical method for finding the surface area between the function and the coordinate axis. Instead of finding the exact area, the technique of numerical integration is to determine the approximate value of the area. To approximate this area, the following formula or rules are usually in use: (a) rectangular formula, (b) trapezoidal rule, and (c) the Simpson's rule. The introduction of the following two examples is to show the use of TI-85 calculator for solving problems that require numerical integration:

Example 1: The acceleration of a particle is defined by the relation $a=25 - 3x^2$, where $a$ is the acceleration expressed in $\text{in/s}^2$, and $x$ is the displacement expressed in...
inches. The particle starts with no initial velocity at the position x=0. Determine the time at x=4.00 inches [2].

Solution: Using \( v \) to represent the velocity in in/s, then since
\[
a = v \frac{dv}{dx} = 25 - 3x^2
\]
we have
\[
v = \sqrt{2(25x + \Phi x^3)}
\]
(1)

Also, since
\[
v = \frac{dx}{dt} = \frac{\sqrt{2(25x + \Phi x^3)}}{x}
\]
then
\[
t = \frac{1}{\sqrt{2}} \int \frac{dx}{\sqrt{25x + \Phi x^3}}
\]
(2)

To obtain a numerical relationship between the position \( x \) and the time \( t \), Equation (2) requires the use of numerical integration. Using the TI-85 calculator, the procedure is given in the following:

2nd CALC \( \text{fnInt}(1 \& (2 \times (25 \times x - \text{VAR}^3)), x, \text{VAR}, 0, 1) \) ENTER

The result is 0.283988540628

To run the same calculation for a different upper limit, such as 2, press 2nd \( \text{ENTER} \) to display the original computational procedure, move the cursor to the top of 1, key in 2, then press the ENTER key. The numerical result will be on display in less than 30 seconds. This procedure can be repeated as many times as necessary, as long as there is no new computational sequence introduced.

Table 1 shows the numerical relationship between \( x \) and \( t \):

<table>
<thead>
<tr>
<th>( x )</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>( t )</td>
<td>0.2839</td>
<td>0.4068</td>
<td>0.5109</td>
<td>0.6180</td>
<td>0.8291</td>
</tr>
</tbody>
</table>

Example 2: For the conduction of heat in solid materials, it is necessary to evaluate a mathematical function called the gamma function. The following integral defines the gamma function [3]:

\[
\Gamma(n) = \int_0^\infty x^{n-1} e^{-x} \, dx
\]
(3)

If \( n \) is an integer, then \( \Gamma(n) = (n - 1)! \) where \( \Gamma(n) \) is the factorial function.

To obtain a numerical value of the gamma function, it is necessary to apply the technique of numerical integration. In the procedure shown below for a scientific calculator, the numerical integration is performed within a program, so that the complete procedure is stored in the memory of the calculator. The program can be recalled and executed whenever necessary, and it is not affected by the introduction of another computational procedure.

PRGM EDIT Name= GAMMA ENTER
: 5 \( \text{STO}\to \) N ENTER
: ALPHA ALPHA FX = ALPHA x- \( \text{VAR} \) \(^x\) (ALPHA N - 1) x 2nd \( \text{e}^x \) (-) \( \text{VAR} \)\( \text{ENTER} \)
: 2nd CALC \( \text{fnInt}(\text{ALPHA ALPHA FX \( \text{ALPHA} \), \( \text{VAR} \), 0, 50 \) \( \text{ENTER} \)
: \text{EXIT EXIT PRGM NAMES GAMMA ENTER}

This computation uses an upper limit of 50. The numerical result is 24, which is the factorial of 4.

Normally an upper limit of between 50 and 100 should provide a sufficiently accurate result. Table 2 shows some of the other computations for different values of \( n \).

<table>
<thead>
<tr>
<th>( n )</th>
<th>2</th>
<th>2.5</th>
<th>3</th>
<th>3.5</th>
<th>4</th>
<th>4.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \Gamma(n) )</td>
<td>1.0000</td>
<td>1.3293</td>
<td>2.0000</td>
<td>3.3234</td>
<td>6.0000</td>
<td>11.631</td>
</tr>
<tr>
<td>( n )</td>
<td>5</td>
<td>5.5</td>
<td>6</td>
<td>6.5</td>
<td>7</td>
<td>7.5</td>
</tr>
<tr>
<td>( \Gamma(n) )</td>
<td>24.000</td>
<td>52.343</td>
<td>120.00</td>
<td>287.89</td>
<td>720.00</td>
<td>1871.3</td>
</tr>
</tbody>
</table>

Note: The upper limit is 50 in all computations.

2. Finding the Roots of Transcendental Functions

A transcendental function is a mathematical function that consists of the combination of algebraic functions, exponential functions, logarithmic functions, and trigonometric functions. Many engineering problems require the determination of the roots of such a function. Traditional algebraic methods cannot be used to locate the roots. A numerical method called the interval-halving or the Newton-Raphson method is usually applied for such a purpose [4]. On the TI-85 calculator, this is effectively solved through a program identified as the SOLVER. On the basis of the SOLVER program, the first step is to key in the mathematical equation containing two or more unknown variables with the associated parameters. The next step is to specify the numerical values of all variables and parameters, with the exception of one variable that is to be determined. An option is available
to enter the estimated range of the root. The last step is to solve for the value of the unknown variable. The following two examples demonstrate the usage of the SOLVER program.

Example 3: When a mechanical system such as a pendulum vibrates in a viscous medium such as air or water, the following equation specifies the governing mathematical relationship for the motion [5]:

$$x(t) = Ae^{-k\omega t} \cos(\sqrt{1 - k^2} \omega t)$$ (4)

Where A, k, and $\omega$ are parameters, t is the independent variable time, and x is the dependent variable displacement.

To determine the values of time where the displacement is x=0.5, with A=0.75, k=0.15, and $\omega$=2$\pi$, the procedure shown below is developed for the TI-85 scientific calculator.

2nd SOLVER eqn: x-VAR ALPHA = 0.75 x 2nd e^((x (0.15 x 2 x 2nd $\pi$ x ALPHA T) x cos(2nd $\sqrt{(1 - 0.15 x^2) x 2 x 2nd \pi$ x ALPHA T})) ENTER

x = 0.25 ENTER
T = CLEAR (blank)
bound = {0, 0.5}
Move the cursor to the line showing T=, then press SOLVE

The result is 0.18704, with an error of -1E-14.

Next, change the bound to {0.2, 1.0}, then the solution for T is 0.90273, with an error of 0.

For a bound of {1.0,2.0}, the solution is T=1.07651, with an error of 1E-14. These are the three possible solutions for the equation.

In this example, the angular mode for the calculator should be in radians.

Example 4: For an eccentrically loaded, pinned-end column with allowable stress $\sigma_a$, the maximum permissible axial load, p, is the smallest positive root of the transcendental equation given below [6]:

$$f(p) = \frac{p}{A} - \frac{\sigma_a}{1 + \frac{c}{r^2} \sec(\frac{L}{2r} \sqrt{\frac{p}{EA}})}$$ (5)

Where L is the length of the column, A is the cross-sectional area, e is the distance of the load from the axis of the column, c is the distance from the centroidal axis to the extreme fiber on the concave side of the column, r is the radius of gyration of the cross-section in the plane of bending, and E is the Young's modulus of the material.

To find the smallest positive root of Equation (5) for given values of e and L, let A=1.00 in², c=1.00 in, $\sigma_a$=40,000 psi, $E=3\times10^7$ psi, $e=0.300$ in, and L=50.0 in. The following shows the procedure for the TI-85 calculator:

2nd SOLVER eqn: ALPHA ALPHA FP = P ALPHA + ALPH A - 2nd CHAR GREEK MORE MORE $\sigma$ + (1 + ALPHA E x ALPHA C + ALPHA R $r^2$ + cos(ALPHA L + (2 x ALPHA R) x 2nd $\sqrt{(ALPHA P + (3 E E 7 x ALPHA A)))) ENTER
FP=0 ENTER
P=CLEAR (blank) ENTER
A=1 ENTER
$\sigma=40000$ ENTER
E=0.3 ENTER
C=1 ENTER
R=1 ENTER
L=50 ENTER
bound={0.1E99}

Press SOLVE to get the solution for p as 28,235.5 lb. The angular mode for the calculator should be in radians.

To find p for different values of e and L, such as e=0.10 in and L=100.00 in, change the values in the respective line, then press SOLVE. The result is p= 24,132.6 lb.

3. Statistical Analysis

The statistical program in an advanced scientific calculator can be used to perform one-variable or two-variable statistical analyses. It can be used to sort a data set in ascending order, from which the mode, the median, and the range can be determined. Statistical quantities such as the variance, the standard deviation, and the coefficient of correlation can all be extracted. For the regression analysis, in addition to the familiar linear regression method, more sophisticated mathematics such as the logarithmic, the exponential, the power function, the 2nd, the 3rd, and the 4th-order polynomial regression are also available. Two examples are given below. The first example is for a one-variable statistics, while the second is for a two-variable statistics:

Example 5 [7]: The wastewater flow rate into a small wastewater treatment plant varies with the time of day. The following flow rates were measured on an "average" day, beginning at 12:00 midnight (all values in m³/h):

<table>
<thead>
<tr>
<th>Time</th>
<th>Flow Rate (m³/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>000</td>
<td>300</td>
</tr>
<tr>
<td>020</td>
<td>290</td>
</tr>
<tr>
<td>040</td>
<td>250</td>
</tr>
<tr>
<td>060</td>
<td>210</td>
</tr>
<tr>
<td>080</td>
<td>205</td>
</tr>
<tr>
<td>100</td>
<td>285</td>
</tr>
<tr>
<td>120</td>
<td>380</td>
</tr>
<tr>
<td>140</td>
<td>505</td>
</tr>
<tr>
<td>160</td>
<td>490</td>
</tr>
<tr>
<td>180</td>
<td>400</td>
</tr>
<tr>
<td>200</td>
<td>500</td>
</tr>
<tr>
<td>220</td>
<td>420</td>
</tr>
<tr>
<td>240</td>
<td>390</td>
</tr>
<tr>
<td>260</td>
<td>380</td>
</tr>
<tr>
<td>280</td>
<td>425</td>
</tr>
<tr>
<td>300</td>
<td>500</td>
</tr>
<tr>
<td>320</td>
<td>540</td>
</tr>
<tr>
<td>340</td>
<td>500</td>
</tr>
<tr>
<td>360</td>
<td>330</td>
</tr>
</tbody>
</table>

Determine: (a) the mean, (b) the median, (c) the mode, (d) the variance, (e) the sample standard deviation, and (f) the population standard deviation.
The following shows the procedure for TI-85:

```
STAT EDIT xlist Name= xStat ENTER
   ylist Name= yStat ENTER
x1= 300 ENTER
y1= 1 ENTER
x2= 290 ENTER
y2= 1 ENTER
etc.
x24= 330 ENTER
y24= 1 ENTER

SORTX gives the following sorted data:
205 210 250 285 290 300 330 350 380 380
390 400 400 420 425 440 450 490 500
500 505 505 540

Since this is a one-variable statistics, the values of y remain unchanged, and are all equal to 1.

From the sorted data, it can be seen that the smallest value is 205, and the largest value is 540. The middle two values are both 400. The mode is found to be 500 with a frequency of 3. The range is calculated as (540 - 205)=330. and the median is 400, which is the average of the middle two values.

To perform the one-variable statistical analysis, continue with the following procedure:

STAT CALC xlist Name= xStat ENTER
   ylist Name= yStat ENTER
1-VAR

The display shows the following quantities:

x= 390 Sx= 96.03 σx= 94.01 n= 24

Hence the mean value is 390 m³/h. The sample standard deviation is 96. The population standard deviation is 94. The variance is 94.01²=8837.9.

**Example 6:** The boiling temperature of water is related to the pressure as shown in Table 3 [8]. Perform the regression analysis based on the following mathematical functions: (a) linear, (b) logarithmic, (c) exponential, (d) power, and (e) 4th order polynomial.

The following shows the procedure on the calculator:

```
STAT EDIT xlist Name= PRESSURE ENTER
   ylist Name= TEMP ENTER
x1= 10.00 ENTER
y1= 193.19 ENTER
x2= 14.70 ENTER
y2= 211.99 ENTER
x3= 20.00 ENTER
y3= 227.96 ENTER
etc.
x10= 90.00 ENTER
y10= 320.31 ENTER

EXIT CALC xlist Name= PRESSURE ENTER
   ylist Name= TEMP ENTER

For the linear regression, press LINER to get the following results:

a=195.372 This is the y-intercept
b=1.5195 This is the slope
corr=0.9752 This is the coefficient of correlation.

The equation of the line is therefore

\[ TEMP = 195.372 + 1.5195*\text{PRESSURE} \]  
(6)

For the logarithmic function regression, press CALC LNR to get the following results:

a=55.58232, b=58.101241, and corr=0.9985.

Hence the equation is given by the following:

\[ TEMP = 55.58232 + 58.101241*\text{ln[PRESSURE]} \]  
(7)

For the exponential function regression, press CALC EXPR to get the following results:

a=199.710, b=1.005904, and corr=0.9583.

The equation is given by the following:

\[ TEMP = 199.710*1.005904^{\text{PRESSURE}} \]  
(8)

For the power function regression, press CALC PWRR to get the following results:

<table>
<thead>
<tr>
<th>P (psi)</th>
<th>10.00</th>
<th>14.70</th>
<th>20.00</th>
<th>30.00</th>
<th>40.00</th>
<th>50.00</th>
<th>60.00</th>
<th>70.00</th>
<th>80.00</th>
<th>90.00</th>
<th>100.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>T (F)</td>
<td>193.19</td>
<td>211.99</td>
<td>227.96</td>
<td>250.34</td>
<td>267.26</td>
<td>281.03</td>
<td>292.73</td>
<td>302.96</td>
<td>312.07</td>
<td>320.31</td>
<td>327.86</td>
</tr>
</tbody>
</table>

Table 3. Boiling Temperature of Water as Function of Pressure
a = 114.40615, b = 0.2293850, and corr = 0.9999.

The equation is given by the following:

\[
\text{TEMP} = 114.40615 \times [\text{PRESSURE}]^{0.2293850}
\]  \hspace{1cm} (9)

For the fourth-order polynomial regression, press CALC MORE P4REG to get the coefficients of the polynomial as, from the highest to the lowest,

-4.293E-6, 0.0010911, -0.107328, 5.903121, 144.4158

Figure 1 presents a graphical comparison of the regression analyses performed in this study. The power function regression, with a correlation coefficient of 0.9999, provides the best approximation. The fourth-order polynomial regression, as expected, gives nearly as good an approximation as the power function.

4. Function Graphing

The graphical presentation of a mathematical function can enhance the understanding of the function. The graphing capability of the advanced scientific calculator can be utilized for such a purpose to great advantage. The following two examples illustrate the application of graphing in solving engineering and mathematical problems.

Example 7. In the isentropic compressible flow of a fluid through a Laval nozzle (a duct with varying cross-sectional area), the relationship between area and Mach number is given by the following equation [9]:

\[
\frac{A}{A^*} = \frac{1}{M} \left[ 1 + \frac{(k - 1)/2}{(k + 1)/2} \right]^{(k+1)/(k-1)}
\]  \hspace{1cm} (10)

Where \(A\) and \(A^*\) are areas, \(M\) is the Mach number, and \(k\) is the specific heat ratio. For the flow of air, with \(k=1.4\), show the graphical relationship between \(A/A^*\) and \(M\).

The following graphing procedure is for the TI-85 calculator:

GRAPH RANGE  xMin = -4 ENTER  
xMax = 4 ENTER  
xScl = 1 ENTER  
yMin = -4 ENTER  
yMax = 4 ENTER  
yScl = 1 ENTER  
y(x) = (select from the menu)  
y1 = 1 + x-VAR x((1 + ((1.4 - 1) / 2) x x-VAR x^2) + ((1.4 + 1) / 2)) \left( ((1.4 + 1) + (2 x (1.4 - 1))) \right)

ENTER EXIT TRACE

Figure 2 shows the resulting graph. Since the Mach number is always positive, the lower-left part of the graph is physically not applicable.

Figure 1. Comparison of Regression Analysis

Figure 2. Area Ratio Versus Mach Number
Example 8. Two functions are given in polar coordinate as follows. Show the graphs of these functions.

\[ r_1 = 2 + 2 \sin(3\theta) \quad r_2 = 0.3 \theta \quad (11) \]

The following is the procedure on TI-85:

2nd MODE Radian PolarC Pol

These steps select the angular mode in radian, the coordinate in polar, and the function mode in polar.

GRAPH RANGE θMin=0 θMax= 4x2nd π xMin=-5 xMax=5 xScl=1 yMin=-5 yMax=5 yScl=1 r(θ)= (select from the menu) r1= 2 + 2 x SIN (3 x θ ) ENTER r2= 0.3 x θ ENTER EXIT ZOOM MORE ZSQR

The resulting graph is shown in Figure 3.

![Figure 3. Polar Graphs of r1 (Full Line) and r2 (Dash Line)](image)

5. Solution of Simultaneous Equations

Many engineering problems require the solution of a set of simultaneous algebraic equations. When the numbers of equation exceed three, the hand solution for the unknown quantities becomes cumbersome and time-consuming. Even when the systematic method of matrix technique is applied, the accuracy of the results still may not be desirable. Using the TI-85 calculator, the procedure is simple, the precision can be up to 12 digits, and the maximum number of equations can be up to 30.

Example 9. Figure 4 shows an alternating current network. \( E_1 \) and \( E_2 \) are the power sources, \( X_L \) is the reactance of the inductor, \( X_C \) is the reactance of the capacitor, and \( R \) is the resistance of the resistor. With \( j=\sqrt{-1} \) representing the imaginary part of a number, the impedance of each electrical element is: \( Z_L = 2j \, (\Omega) \), \( Z_R = 4 \, (\Omega) \), and \( Z_C = -1j \, (\Omega) \). [10].

Applying the Kirchhoff's voltage law around each closed loop, the following two equations are obtained:

\[
(4 + 2j)I_1 - 4I_2 = 2 \, (V) \quad (a) \\
-4I_1 + (4 - j)I_2 = -6 \, (V) \quad (b)
\]

To solve for \( I_1 \) and \( I_2 \), the procedure is as follows:

2nd SIMULT Number= 2 ENTER
a1,1 = (4, 2) ENTER a1,2 = (-4, 0) ENTER
b1 = (2, 0) ENTER a2,1 = (-4, 0) ENTER
a2,2 = (4, -1) ENTER b2 = (-6, 0) ENTER

The results are as follows:

\( I_1 = -2 + 3j \, (A) = (3.606, 123.6°) \, (A) \)
\( I_2 = -4 + 2j \, (A) = (4.472, 153.49°) \, (A) \)

Example 10. A furnace is in the shape of a rectangular parallelepiped, as shown in Figure 5. The interior surfaces of the furnace, comprising a complete enclosure, exchange radiant energy. The furnace is 5 m high, 10 m wide, and 20 m long. The floor of the furnace, \( A_1 \), acts as a black active surface maintained at \( T_1=200 \, °C \), the back wall (5 m by 20 m) acts as a gray active plane, \( A_2 \), maintained at \( T_2=400 \, °C \), with emissivity \( e_2=0.4 \). The two 5 m by 10 m ends act, together, as a single adiabatic surface \( A_3 \), and the remaining 10 m by 20 m ceiling together with the 5 m by 20 m front wall act as a second single adiabatic surface, \( A_4 \). Find the heat flow at each of the two active surfaces, \( A_1 \) and \( A_2 \), and the equilibrium temperature of the two adiabatic surfaces, \( A_3 \) and \( A_4 \) [11].

With the given geometry, temperatures, and surface properties, the various shape factors can be determined, and the heat transfer equations in terms of the radiosities \( J \) are set up as follows:

![Figure 4. Alternating Current Network](image)
mathematical functions can be used by high school students to enhance their mathematical study, while its advanced programming features can be used by college students and the professional people to solve many problems. Furthermore, to expand the scientific applications of the calculator, it can be interfaced with a desk-top computer to utilize additional memory, to interchange data, and to print out the results.

References


Figure 5. Rectangular Parallelepiped Furnace

\[ J_1 = 2838 \quad (a) \]
\[ -0.5010J_1 + 2.5000J_2 - 0.2520J_3 - 0.7470J_4 = 11632 \quad (b) \]
\[ -0.3160J_1 - 0.1680J_2 + 0.9680J_3 - 0.4840J_4 = 0 \quad (c) \]
\[ -0.4500J_1 - 0.1660J_2 - 0.1610J_3 + 0.7770J_4 = 0 \quad (d) \]

The procedure for the calculator is shown below:

2nd SIMULT Number= 4 ENTER
a1,1 = 1 ENTER
a1,2 = 0 ENTER
a1,3 = 0 ENTER
a1,4 = 0 ENTER
b1 = 2838 ENTER
a2,1 = (-) 0.5010 ENTER
a2,2 = 2.500 ENTER
a2,3 = (-) 0.2520 ENTER
a2,4 = (-) 0.7470 ENTER
b2 = 11632 ENTER
a3,1 = (-) 0.3160 ENTER
a3,2 = (-) 0.1680 ENTER
a3,3 = 0.9680 ENTER
a3,4 = (-) 0.4840 ENTER
b3 = 0 ENTER
a4,1 = (-) 0.4500 ENTER
a4,2 = (-) 0.1660 ENTER
a4,3 = (-) 0.1610 ENTER
a4,4 = 0.7770 ENTER
b4 = 0 SOLVE

The results are: \(J_1= 2838 \text{ W/m}^2, J_2= 6811 \text{ W/m}^2, J_3= 4081 \text{ W/m}^2, J_4= 3944 \text{ W/m}^2\). From these values of the radioisotropy, the heat flows at the two active surfaces can be calculated as \(q_1=-321.3 \text{ kW} \) and \(q_2=321.3 \text{ kW}\). The equilibrium temperatures of the two adiabatic surfaces are \(T_3=245 \text{ °C} \) and \(T_4=241 \text{ °C} \), respectively.

Summary

An advanced scientific calculator is a very powerful computing device. It is compact in volume, it is light weight, it contains a large number of built-in programs, and its cost is relatively low compared to a desk-top or lap-top computer. Due to its easy portability, it can be used not only in the office but also in the field. Its basic
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