Course 2

Calculator advice

Introduction

It wasn't very long ago that the square root key was the most advanced function of the only calculator approved by the SOA/CAS for use during an actuarial exam. Now students are faced with a variety of actuarially approved calculators. The official SOA/CAS calculator is the battery-powered or solar-powered Texas Instruments (TI) BA-35 model calculator. However, the SOA and the CAS also allow the following TI calculators: BA II Plus, TI-30X, TI-30Xa or TI-30 XII (IIS solar or IIB battery).

Students may use more than one of the approved calculators during the exam, but the memory of the BA II Plus and the TI 30X II (IIS solar or IIB battery) must be cleared before the exam. The student is responsible for the calculator to be in good working order during the exam, so it is a good idea to have a back-up calculator on hand in case the primary calculator malfunctions or its battery dies during the exam.

Students often wonder which of the approved calculators is best for an actuarial exam. Let's explore the advantages and disadvantages of the approved calculators before we make our recommendation.

The TI-30X Series

These calculators are primarily scientific, not financial calculators. While they are able to perform advanced mathematical, statistical and scientific functions, they do not have time value of money functions. However, the TI-30X series have useful mathematical features that the BA-35 and the BA II Plus lack.

For example, the TI-30X II (S or B) is able to control order of operation calculations with parentheses, scroll through previous entries, and look at most recently calculated stored answers. It has 5 memory variables and a two-line display, the first of which is the entry line and the second of which is the results line.

Many students find the TI-30X calculators very easy to use for complicated calculations. We do not recommend this as the only calculator for the actuarial exams, but it would be a good choice as a back-up calculator. Or, it could be the primary calculator with the BA-35 as the backup calculator for time value of money calculations.

The BA-35

The BA-35 is a straightforward financial calculator that is relatively easy to master. It is also fairly inexpensive. It comes preprogrammed with financial and accounting functions, including time value of money and compound interest functions. It can perform annuity calculations, compute amortization balances, and it can convert annual percentage rates to effective interest rates. The solar version of the BA-35 has the added benefit of eliminating any concern about the batteries dying during the exam.

The BA-35 Quick Reference Guide and Complete Guidebook are both downloadable from http://education.ti.com/us/product/tech/ba35s/guide/ba35sguideus.html.

The BA II Plus

The BA II Plus is a more sophisticated financial calculator that many students find more difficult to master. It can solve time value of money calculations involving annuities and loans, and it can generate amortization schedules. The BA II Plus can perform cash flow analysis involving up to 24 non-level, evenly-spaced cash flows, and it can compute the net present value or the internal rate of return. It can also calculate book values and depreciation amounts for the straight line, declining balance, and sum of the years digits method.

The BA II Plus Quick Reference Guide, which includes examples and tips, is available from TI at http://education.ti.com/us/product/tech/baii/guide/baiiguideqgus.html. A BA II Plus tutorial is also available at http://education.ti.com/us/global/freebaiiptutorials.html.

Our recommendation

We recommend the BA-35 in conjunction with one of the TI-30X calculators for the actuarial exams. If a student would only like to use one calculator during the exam, we recommend the BA-35.

The BA-35, if used correctly, is able to answer any question on the Course 2 exam. The BA II Plus, if a student knows how to use it, is a somewhat more sophisticated calculator that might be able to answer an occasional question more quickly than the BA-35. Some students prefer to use a calculator from the TI-30X series as their primary exam calculator with either the BA-35 or the BA II Plus as the back-up calculator for time value of money calculations.

In our opinion, the slight advantage of the BA II Plus over the BA-35 in its ability to perform complicated functions a little more quickly does not offset the many hours it will take a student to become comfortable with the BA II Plus. The SOA/CAS is interested in testing a student's knowledge of the Course 2 learning objectives, not proficiency with a specific calculator. A student who has a deep understanding of the core exam topics should be able to pass the exam regardless of which calculator is used.

The calculator tips in the BPP Course 2 study program are tailored to the BA-35, since it is the more commonly used calculator. We personally prefer the BA-35 since it is easier to learn and more straightforward to use. The BA II Plus is a great calculator, but it takes longer to learn. The BA II Plus is also less intuitive as it involves frequent use of the 2^{nd} function key to access its powerful operations. We advise students to focus on learning Course 2 concepts and formulas rather than spending too much time learning to use a specific calculator.

If a student still prefers the BA II Plus over the BA-35, the student should learn to use it for Course 2 type questions by working the multitude of questions from our study program. It may take a little longer at first, but once you work enough problems, you will know it well enough to use during the actual exam.

Whichever calculator you choose, you should be very comfortable with it by the day of the exam so that no time is wasted trying to figure it out during the exam. It could be disastrous for a student to pick up a calculator for the first time a few weeks before the exam with the intention of using it during the exam. The student should learn the material on the same calculator that will be used during the exam to ensure maximum familiarity with it.

BA II Plus examples

We have selected a few questions from the BPP Course 2 study program to illustrate how the BA II Plus calculator is used. For more instructions regarding the use of the BA II Plus calculator, please consult the BA II Plus Complete Guidebook or Quick Reference Guide, both of which are available on the TI website at www.ti.com.

Unit 2, page 32 - Example 2.15

Payments of \$15 are received at times 0, 1, 2, …, 6 years. The annual effective rate of interest is 3%. Find the accumulated value of these payments at time 7.

Solution

Make sure that you have first cleared the financial memories by pressing [2^{nd}] [CLR TVM].

For each problem, we need to check the settings of the BEGIN/END mode, the payment frequency and the compounding frequency.

Since we are working with an annuity-due, we want the calculator to be in the BEGIN mode. To check which mode the calculator is in, press [2^{nd}] [BGN]. If the calculator shows END, then change it to BGN by pressing [2^{nd}] [SET] and [CE/C]. If the calculator shows BGN, press [CE/C]. This setting continues indefinitely until it is changed, even after the calculator has been turned off and back on again.

We also need to make sure that the calculator is set to annual payments and annual compounding. Press [2nd] [P/Y] to see the payment frequency. If *P/Y*= is not set to one, press 1 then [ENTER]. To check the compounding frequency, press the up or down arrow key until *C/Y*= is shown. To leave this mode, press [2nd] [QUIT]. The compounding frequency is automatically changed to match the payment frequency unless the compounding frequency is changed after the payment frequency is changed. This setting continues indefinitely until it is changed, even after the calculator has been turned off and back on again.

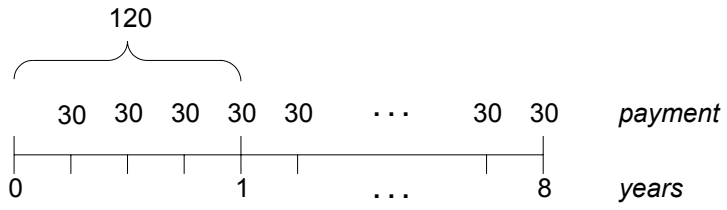
Now we are ready to determine the accumulated value at time 7. Press –15 [PMT], 7 [N], 3 [I/Y] and then [CPT] [FV]. The correct answer of 118.39 should appear.

We see that the BA II Plus requires more keystrokes than the BA-35 to determine the same answer since we have more settings to check with the BA II Plus.

Unit 4, page 40 – Example 4.23

Find the present value of payments of \$30 at the end of each quarter for 8 years. Use a nominal rate of interest of 5% a year, convertible monthly.

Solution



First, clear the financial memories by pressing [2nd] [CLR TVM].

Since we are working with an annuity-immediate, we want the calculator to be in END mode. To check which mode the calculator is in, press [2nd] [BGN]. If the calculator shows END, then press [CE/C]. If the calculator shows BGN, change it to END by pressing [2nd] [SET] and [CE/C].

For this problem, we have 4 payments of \$30 per year but interest is compounded 12 times per year. Press [2nd] [P/Y] to see the payment frequency. If *P/Y*= is not set to 4, press 4 then [ENTER]. To check the compounding frequency, press the up or down arrow key until *C/Y*= is shown. Press 12 then [ENTER]. To leave this mode, press [2nd] [QUIT].

A word of caution is warranted here. If the payment frequency is changed and the mode is exited, the compounding frequency is automatically changed to match the payment frequency. If the compounding frequency is different from the payment frequency, make sure that the compounding frequency is the last setting changed before exiting this mode. If the payment frequency is changed after the compounding frequency, the compounding frequency will be automatically changed to match the payment frequency.

To determine the present value, we need to calculate the number of payments first. There are 32 payments since the payments are made each quarter for 8 years. Each periodic payment is \$30 and the nominal interest rate is 5% per year, convertible monthly. To determine the present value, press 32 [N], 30 [PMT], 5 [I/Y], and then [CPT] [PV]. The correct answer of –786.61 should be displayed.

Since we entered the payments as a positive number, the present value appears as a negative number. Time value of money calculations require both a cash inflow and a cash outflow. Inflows are positive and outflows are negative. It doesn't matter if the payments are entered as a positive or a negative number as long as we're consistent.

Unit 5, page 27 – Question 5.21

A loan of \$15,000 is repaid, using the amortization method, by monthly payments at the end of each month for 8 years. The nominal rate of interest convertible quarterly is 8% a year. Find:

(i) the monthly repayment

(ii) the principal outstanding at the end of the 4^{th} year after the payment has been made

(iii) the interest and principal repaid in the 49^{th} payment.

Solution

Part (i)

First, clear the financial memories by pressing [2^{nd}] [CLR TVM].

Since we are working with an annuity-immediate, we want the calculator to be in END mode. To check which mode the calculator is in, press [2^{nd}] [BGN]. If the calculator shows END, then press [CE/C]. If the calculator shows BGN, change it to END by pressing [2^{nd}] [SET] and [CE/C].

We also need to make sure that the calculator is set to monthly payments and quarterly compounding. Press [2^{nd}] [P/Y] to see the payment frequency. If *P/Y*= is not set to 12, press 12 then [ENTER]. To check the compounding frequency, press the up or down arrow key until *C/Y*= is shown. Press 4 then [ENTER]. To leave this mode, press [2^{nd}] [QUIT].

We have 8 years of monthly payments, so there are 96 total payments. The nominal interest rate is 8% a year, convertible quarterly.

To determine the periodic payment amount, press 96 [N], –15,000 [PV], 8 [I/Y], and then [CPT] [PMT]. The correct answer of 211.65 should be displayed.

Part (ii)

To determine the principal at the end of year 4 after the payment has been made, we first press [2nd] [AMORT]. At the end of year 4, there have been $4x12 = 48$ payments. Press the down arrow key until *P1*= is shown. If *P1* does not equal 1, press 1 [ENTER]. Press the down arrow key until *P2*= is shown, then press 48 [ENTER]. Press the down arrow key to see the balance displayed as *BAL*= $-8,678.32$.

Part (iii)

To determine the interest and principal repaid in the 49th payment, press the up or down arrow key until *P1*= is shown. Then press 49 [ENTER]. Press the down arrow key until *P2*= is shown. Then press 49 [ENTER]. Press the down arrow key again to see that the balance after the 49th payment is shown as *BAL*= –8,524.14. Press the down arrow key to see that the amount of principal in the 49th payment is *PRN*= 154.17. Press the down arrow key again to see the amount of interest in the 49th payment is *INT*= 57.47.

Unit 6, page 22 – Example 6.4 (amended)

An asset that costs \$40,000 has a useful life of 5 years. At the end of the five years, it will be worth \$15,000. Calculate the depreciation charge for the third year and the book value at the end of year 3 using all four methods of depreciation. Assume that the sinking fund earns interest at 6%.

Solution

METHOD 1: Sinking fund method

The sinking fund method isn't a function of the BA II Plus, but we can mimic the pattern of this method using an amortization schedule.

Clear the financial worksheet by pressing [2nd] [CLR TVM]. Make sure that the calculator is set to one payment per year by pressing [2nd] [P/Y]. If *P/Y*= does not equal 1, press 1 then [ENTER]. Exit by pressing [2nd] [QUIT]. The compounding frequency is automatically set to 1 to match the payment frequency.

Since we are working with end of period depreciation charges, we want the calculator to be in END mode. To check which mode the calculator is in, press [2nd] [BGN]. If the calculator shows END, then press [CE/C]. If the calculator shows BGN, change it to END by pressing [2nd] [SET] and [CE/C].

To calculate the sinking fund amortization schedule from 40,000 to 15,000 over 5 years, we need to assume that a sinking fund will be established to pay off a loan of $A - S = 40,000 - 15,000 = 25,000$ over the same period. The sinking fund payments are deposited into the sinking fund. The initial book value of 40,000 less the accumulated sinking fund balance provides us with the book value balance at any point in time.

We enter the value of $A - S = 40{,}000 - 15{,}000 = 25{,}000$ as the future value since this is the amount the sinking fund accumulates to over 5 years. Press –25,000 [FV], 5 [N], 6 [I/Y]. Press [CPT] [PMT] to determine the sinking fund payment of 4,434.91.

To determine the amortization schedule, press [2nd] [AMORT] and use the down arrow key until *P1*= is shown. Press 3 then [ENTER]. Use the down arrow key again until *P2*= is shown. Press 3 then [ENTER]. Use the down arrow key to see the balance displayed as *BAL*= 14,118.98. We must subtract this amount from 40,000 to get the correct balance of $40{,}000.00 - 14{,}118.98 = 25{,}881.02$.

Press the down arrow key again to get the depreciation charge displayed as the amount of principal, *PRN*= 4,983.06.

METHOD 2: Declining balance method

The BA II Plus does not directly calculate the declining balance method in the same way that the SOA/CAS does, so an adjustment must be made. Before beginning the depreciation work, we first need to calculate the declining balance percentage that we'll need to input into the calculator later.

From Unit 6 of the Course 2 study program, we remember that the declining balance percentage is calculated by $d = 1 - \left(\frac{S}{A}\right)^{\frac{1}{n}}$.

In this case, we have $d = 1 - \left(\frac{15}{40}\right)^{\frac{1}{5}} = 0.178125$. The adjustment that we need to make to the declining balance percentage for the BA II Plus is to multiply this number by 100*n*. This gives us $100(5)(0.178124) = 89.0620$. Store this number into the first memory by pressing [STO] 1.

To go to the depreciation worksheet, press [2nd] [DEPR]. The current depreciation method is shown. Press [2nd][SET] repeatedly until *DB*= is displayed. Once *DB*= is shown, press [RCL] 1 to recall our declining balance percentage calculation and then press [ENTER].

Use the down arrow key until *LIF*= is shown. Press 5 [ENTER] to enter the asset's lifetime. Press the down arrow key until *MO1*= is shown. Press 1 [ENTER] to indicate that the first year will get a full year of depreciation. Press the down arrow key until *CST*= is shown. Press 40,000 [ENTER] to input the cost of the asset. Press the down arrow key until *SAL*= is shown. Press 15,000 [ENTER] to enter the salvage value of the asset. Press the down arrow key again until *YR*= is shown. Press 3 [ENTER] to input the desired year of depreciation.

Press the down arrow key again until *DEP*= is shown. The depreciation charge of 4,812.77 is displayed. Press the down arrow key until *RBV*= is shown. The remaining book value of 22,206.44 is displayed. To leave the depreciation worksheet, press [2nd] [QUIT].

METHOD 3: Straight line method

To go to the depreciation worksheet, press [2nd] [DEPR]. The current method is shown. If we do not press [2nd] [CLR WORK] to clear the worksheet, the previous values that we entered for the declining balance method are retained in the memory and we won't need to re-enter them. Press [2nd][SET] repeatedly until *SL* is displayed.

Press the down arrow key until *DEP*= is shown. The depreciation charge of 5,000.00 is displayed. Press the down arrow key until *RBV*= is shown. The remaining book value of 25,000 is displayed. To leave the depreciation worksheet, press [2nd] [QUIT].

METHOD 4: Sum of year digits method

To go to the depreciation worksheet, press [2nd] [DEPR]. The current method is shown. If we do not press [2nd] [CLR WORK] to clear the worksheet, the previous values that we entered for the declining balance method are retained in the memory and we won't need to re-enter them. Press [2nd][SET] repeatedly until *SYD* is displayed.

Press the down arrow key until *DEP*= is shown. The depreciation charge of 5,000.00 is displayed. Press the down arrow key until *RBV*= is shown. The remaining book value of 20,000.00 is displayed. To leave the depreciation worksheet, press [2nd] [QUIT].

A nice feature of the BA II Plus is that we can easily go from one depreciation method to the next without re-entering the data.

Unit 19, page 17 – Example 19.5 (amended)

A project requires an initial investment of \$50,000. The project will generate net cash flows of \$15,000 at the end of the first year, \$40,000 at the end of the second year, and \$10,000 at the end of the third year. The project's cost of capital is 13%. Calculate the project's net present value and IRR.

Solution

One of the biggest advantages of using the BA II Plus is being able to determine the IRR and the NPV very quickly when the cash flows are evenly spaced.

To go to the cash flow worksheet, press [CF]. Clear the worksheet by pressing [2^{nd}] [CLR WORK]. The initial cash flow *CF0*= should be displayed. Press –50,000 [ENTER] to input the initial cash flow. Press the down arrow key and press 15,000 [ENTER] to input the first cash flow. Press the down arrow key and press 1 [ENTER] to indicate that this is a single cash flow. Press the down arrow key and press 40,000 [ENTER] to input the second cash flow. Press the down arrow key and press 1 [ENTER] to indicate that this is a single cash flow. Press the down arrow key and press 10,000 [ENTER] to input the third cash flow. Press the down arrow key and press 1 [ENTER] to indicate that this is a single cash flow.

Press the [NPV] key. The interest rate for discounting *I*= should be displayed. Press 13 [ENTER] to input the interest rate. Press the down arrow key and then [CPT]. The net present value of *NPV*= 1,530.71 should be shown.

Press the [IRR] key. Press [CPT] to determine the internal rate of return. The display should indicate *IRR*= 14.833.