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### Study Manual



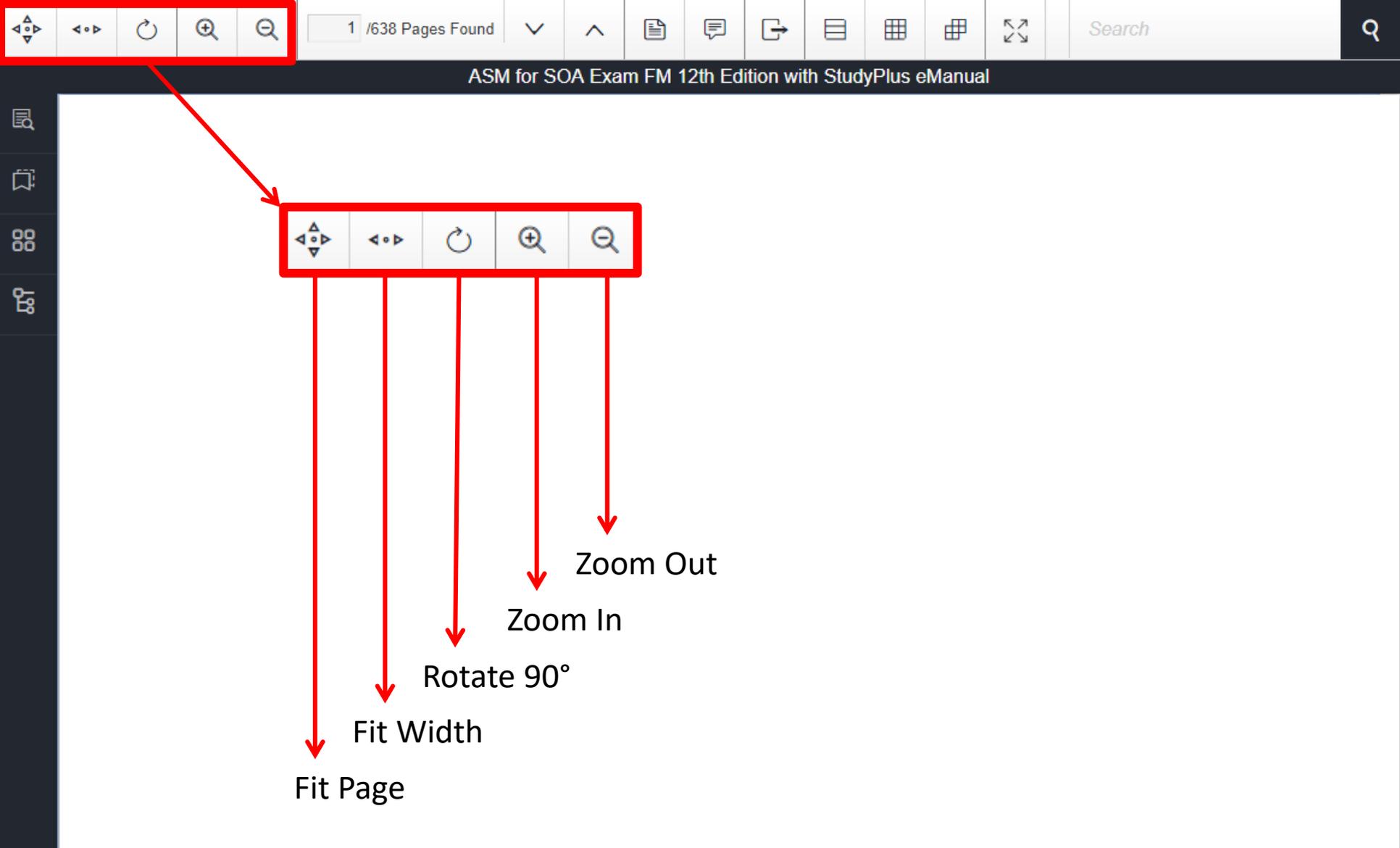
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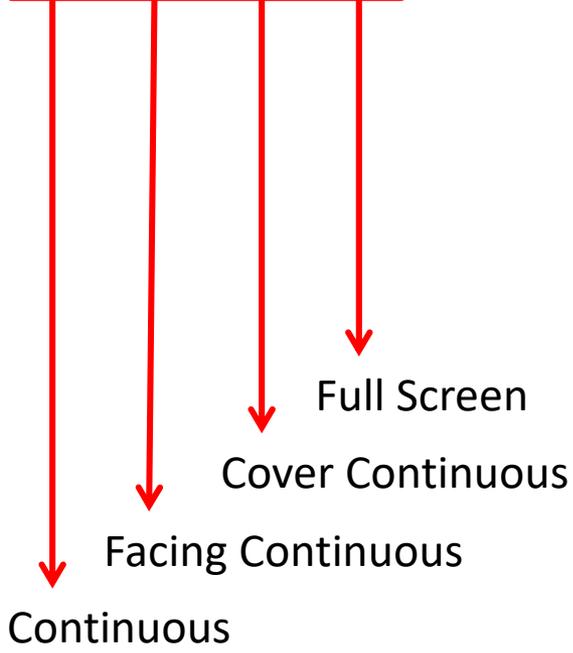


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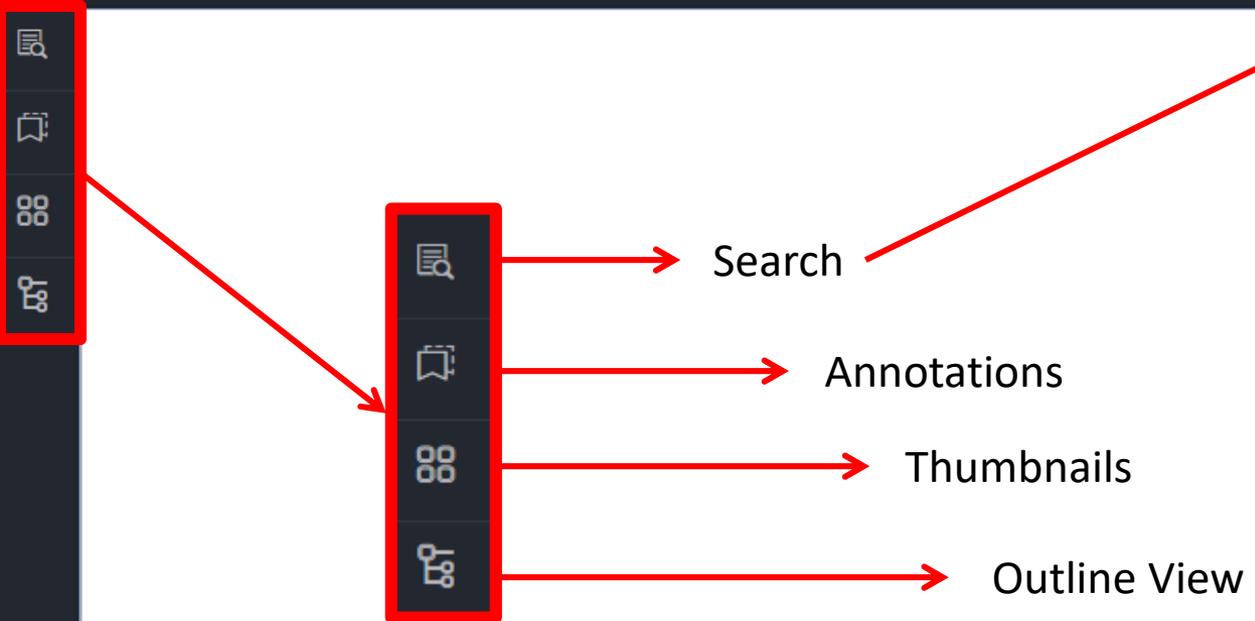
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Along the left-hand side of the new e-reader are pop-out options we will now explore. These are: Search, which is also available in the upper-right corner of the reader, Annotations, Thumbnails and finally Outline view. Let's take a closer look at these.

## ASM for SOA Exam FM 12th Edition with StudyPlus eManual



## Full Document Search X

Conclusion   whole Word Only case Sensitive

Our conclusion is that to get a rate of growth that

Conclusion: When the accumulation function is  $a(t)$ 

same conclusion as before: when a bond sells at a

this conclusion either by following the logic of the swap arrangement

## SECTION 11. Interest Rate Swaps

You can come to this **conclusion** either by following the logic of the swap arrangement or by doing a simple bit of math, using  $F$  as the fixed amount of interest and  $V$  as the variable amount of interest. While this may be pretty obvious, you should confirm that a swap contract accomplishes what it is supposed to for Company A.

You should know the definitions of various terms associated with interest rate swaps, such as the swap rate, the notional amount, the swap term, etc. The last two pages of the Study Note (Section 10) contain a convenient glossary of terms.

Please note that most loans that we will deal with involve paying only interest during the term of the loan, with a final payment of the original loan amount, or principal, at the end of the term.

**Example of a Swap Contract**

Let's take an example of a swap contract. (This is Example 1 in the Study Note.) We will cover this example in some detail, to make sure that you thoroughly understand it.

Your company is the Jordan Corp., which has just borrowed 500,000 for two years at a variable interest rate. Jordan Corp. will make two interest payments to the lender, the first at the end of one year and the second at the end of two years. At the end of two years, it will also repay 500,000 to the lender.

Under the terms of the loan agreement, the variable interest rate is based on an index (say, LIBOR or the prime interest rate) plus the spread. The first interest payment will be based on the index as of the date of the loan, so the amount of this payment is known in advance. But the second interest payment will be based on the index in effect at the beginning of the second year, so the amount of this payment is not known in advance. (Of course, when we say "based on the index", we mean that the loan interest rate is equal to the index plus the spread.)

As the actuary of Jordan Corp., you want to replace the adjustable interest rates by fixed interest rates that are known in advance. So you decide to seek a counterparty with whom to enter into an interest rate swap on the same date as the loan is made.<sup>2</sup>

Let's say that the counterparty is B Corp. and that both counterparties agree that the fixed interest rates will be based on specified spot rates. Say that these spot rates are  $r_1 = 5\%$  and  $r_2 = 6\%$ . Jordan Corp. agrees to pay interest on the 500,000 to B Corp. for two years, based on these spot rates.

It's clear that the interest to be paid by Jordan Corp. to B Corp. at the end of the first year will be  $(500,000)(.05)$ . Now, think about the following question for a moment: What interest rate should be used to determine how much interest Jordan Corp. will pay B Corp. at the end of the second year?

The answer is "whatever the effective interest rate is for the second year, i.e., for the period from time 1 to time 2." Does this sound familiar?

It should. This is the one-year forward rate, deferred one year, or  $f_{1,2}$ . We can determine this rate from the one-year and two-year spot rates:

$$f_{1,2} = \frac{(1 + r_2)^2}{(1 + r_1)} - 1 = \frac{1.06^2}{1.05} - 1 = 7.010\% \quad (\text{to 3 decimals})$$

So Jordan Corp. will pay  $(500,000)(.07010)$  to B Corp. at the end of the second year.

To sum up, Jordan Corp. will pay to its swap counterparty:

Starting with Search, you can click the icon to expand the pop-out search and enter your term, you will see a list of found search items.

**Annotations** X

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# 1

## Interest Rates and Discount Rates

**§ 1a. Basic Concepts**

**§ 1a(i) Accumulation Function and Effective Rate of Interest**

Imagine a fund growing at interest. It would be very convenient to have a function representing the amount in the fund at any time  $t$ . The function  $a(t)$  is defined as the accumulated value (AV) of the fund at time  $t$  of an initial investment of \$1.00 at time 0.  $a(t)$  is called the "accumulation function."

Consider the following accumulation functions. Can you think of any real-life situations where you might encounter them?

(1)

(2)

(3)

(4)

(5)

(6)

(1) This is the accumulation function for money put in a piggy bank or under the mattress. It might also represent "a friendly loan from my father-in-law" or a checking account where you get no interest.

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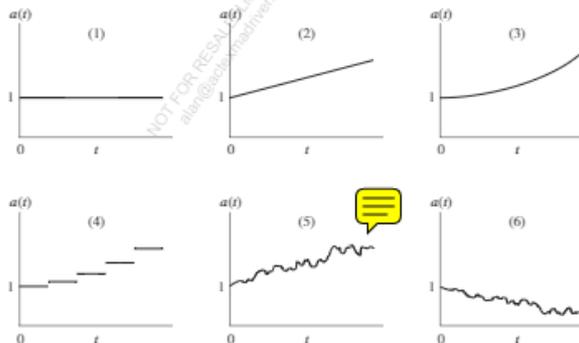
## Interest Rates and Discount Rates

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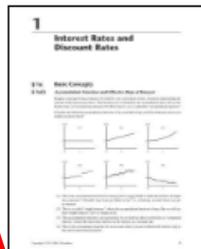
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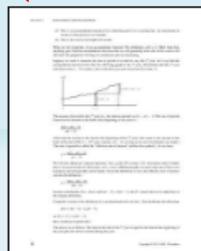
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## Thumbnails X



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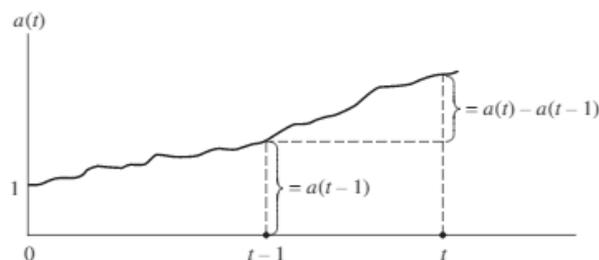
19

## SECTION 1. Interest Rates and Discount Rates

- (5) This is an accumulation function for a fund that grows at a varying rate. An investment in stocks is often given as an example.
- (6) This is the stock you bought last month.

What are the properties of an accumulation function? By definition,  $a(0) \equiv 1$ . Other than that, anything goes. But the accumulation functions that we will generally deal with in this course will also have the properties of being (1) continuous and (2) increasing.

Suppose we want to measure the rate of growth of a fund in, say, the  $t^{\text{th}}$  year. Let's say that the accumulation function looks like the following graph in the  $t^{\text{th}}$  year. (Remember that the  $t^{\text{th}}$  year runs from time  $(t - 1)$  to time  $t$ , just as the first year runs from time 0 to time 1.)



The *amount* of growth in the  $t^{\text{th}}$  year (i.e., the interest earned) is  $a(t) - a(t - 1)$ . The *rate* of growth (based on the amount in the fund at the beginning of the year) is:

$$\frac{a(t) - a(t - 1)}{a(t - 1)}$$

(Note that the amount in the fund at the beginning of the  $t^{\text{th}}$  year is the same as the amount in the fund at the end of the  $(t - 1)^{\text{st}}$  year, namely,  $a(t - 1)$ , as long as no new investments are made.) This rate of growth is called the “effective rate of interest” and has the symbol  $i_t$ . So we have:

$$i_t = \frac{a(t) - a(t - 1)}{a(t - 1)}$$

We will also define an “amount function.”  $A(t)$ , as the AV at time  $t$  of  $k$  invested at time 0 (rather

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## OutlineView X

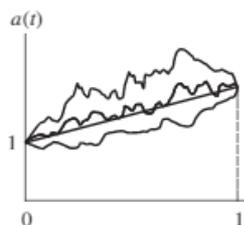
- Introduction
- PART I Financial Mathematics
  - Section 1 Interest Rates and Discount Rates
    - §1a. Basic Concepts
    - §1b. Why Do We Need a Force of Interest?
    - §1c. Defining the Force of Interest
    - §1d. Finding the Fund in Terms of the Force of Interest
    - §1e. The Simplest Case: A Constant Force of Interest
    - §1f. Power Series
    - §1g. The Variable Force of Interest Trap
    - §1h. Equivalent Rates
  - Section 2 Practical Applications
    - §2a. Equations of Value, Time Value of Money, and Time Diagrams
    - §2b. Unknown Time and Unknown Interest Rate
  - Section 3 Annuities
  - Section 4 Complex Annuities
  - Section 5 Comparing Investments
  - Section 6 Loans
  - Section 7 Bonds
    - §7a. Bonds and Other Investments

## §1c. Defining the Force of Interest

## § 1b. Why Do We Need a Force of Interest?

Let's begin with an easy concept that you already understand from Section 1a(i): The effective rate of interest is simply the amount of interest earned during a period divided by the amount invested at the beginning of that period.

Consider the following four funds:



The four curves going from time 0 to time 1 show how each of the funds grows during the first year. As you can see, in this example the amount in the fund is the same at the beginning and the end of the year for all four funds. But they certainly grow quite differently at any moment of time during the year.

**Question:** What can you say about the effective rate of interest for the four funds in this year?

**Answer:** The effective rate of interest is *the same* for all four funds. You can see that the amount of interest earned in the year is the same for all of the funds (i.e., the increase in each fund over the year is the same). Also, the investment at time 0 for each fund is the same. So by definition, the effective rate of interest is the same for all four.

This shows that the effective rate of interest is all we need to know if we are only interested in how much interest is earned on a fund over the entire year, but gives us absolutely no information about how the fund grows at any moment during the year. In theoretical work, and in practical applications of the theory, we may need to know the rate of growth of a fund at *any moment of time*. That's what the force of interest is.

**Please Note!** For now, we are considering the general case, where the rate of growth varies with time. In the special case where the rate of growth is constant at every moment (which is the assumption

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#### § 1a(i) Accumulation Function and Effective Rate of Interest

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§1c. Defining the Force of Interest

§ 1b

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**Question:** What can you say about the effective rate of interest for the four funds in this year?

**Answer:** The effective rate of interest is *the same* for all four funds. You can see that the amount of interest earned in the year is the same for all of the funds (i.e., the increase in each fund over the year is the same). Also, the investment returns of each fund in the year are the same. So, the effective rate of interest is the same for all four funds.

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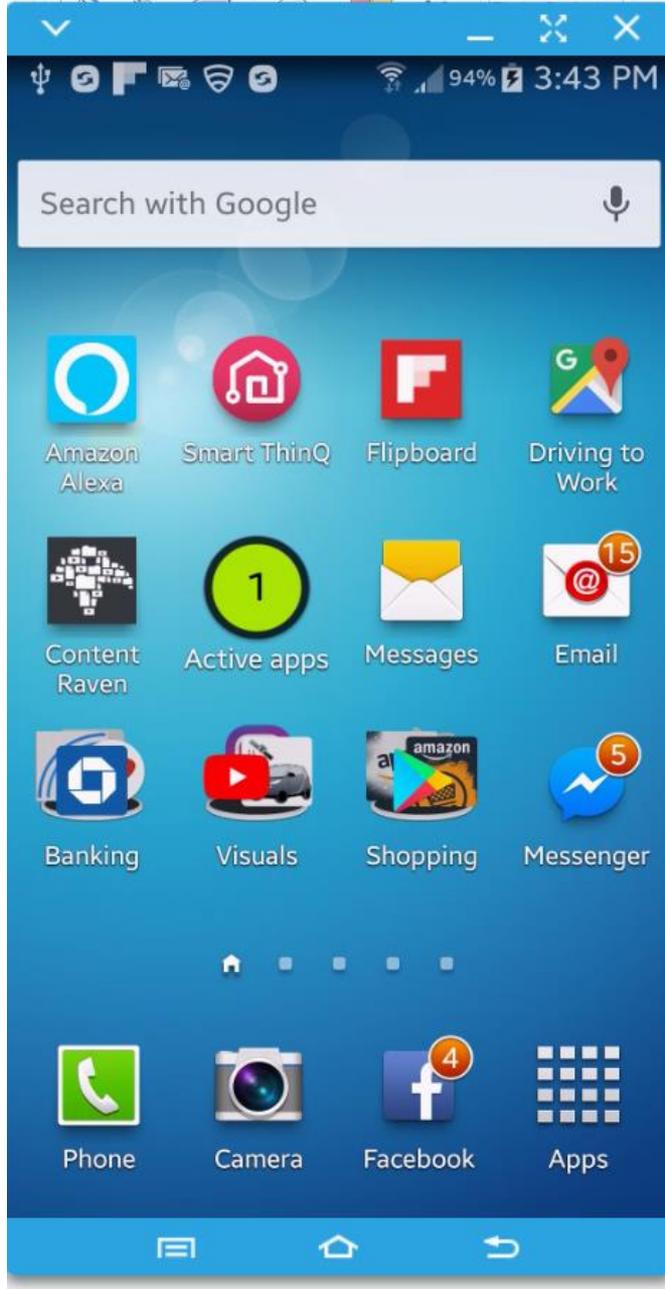
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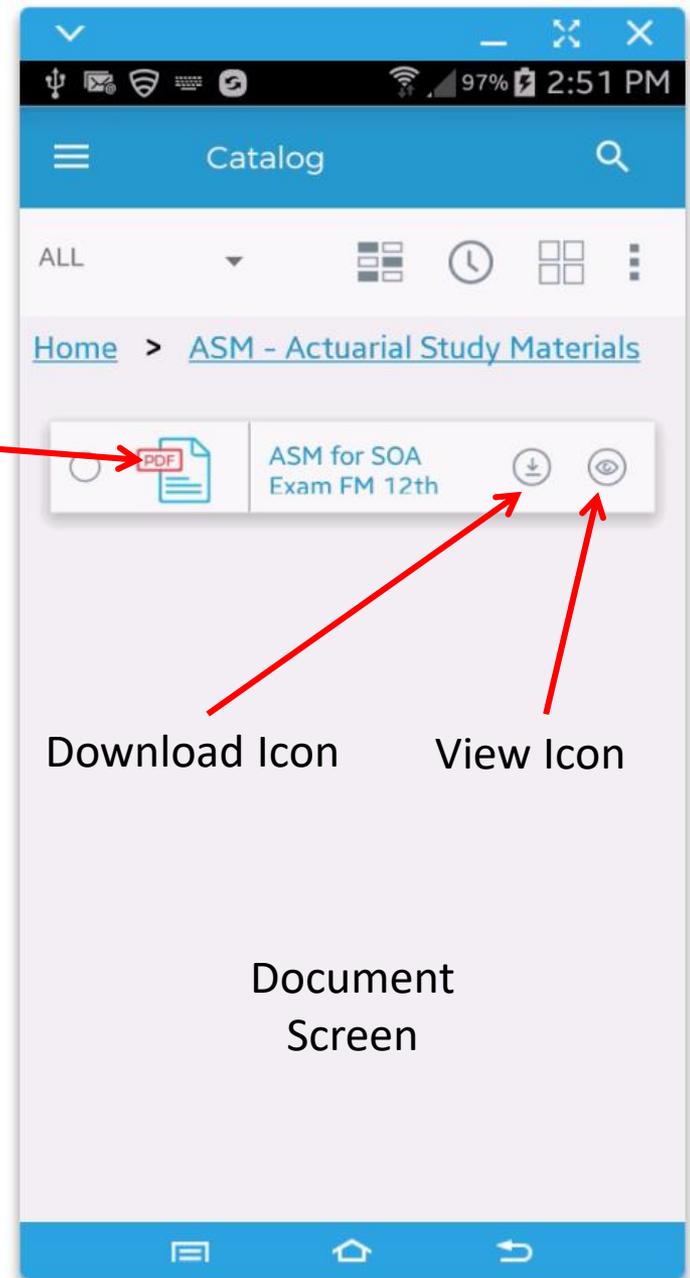
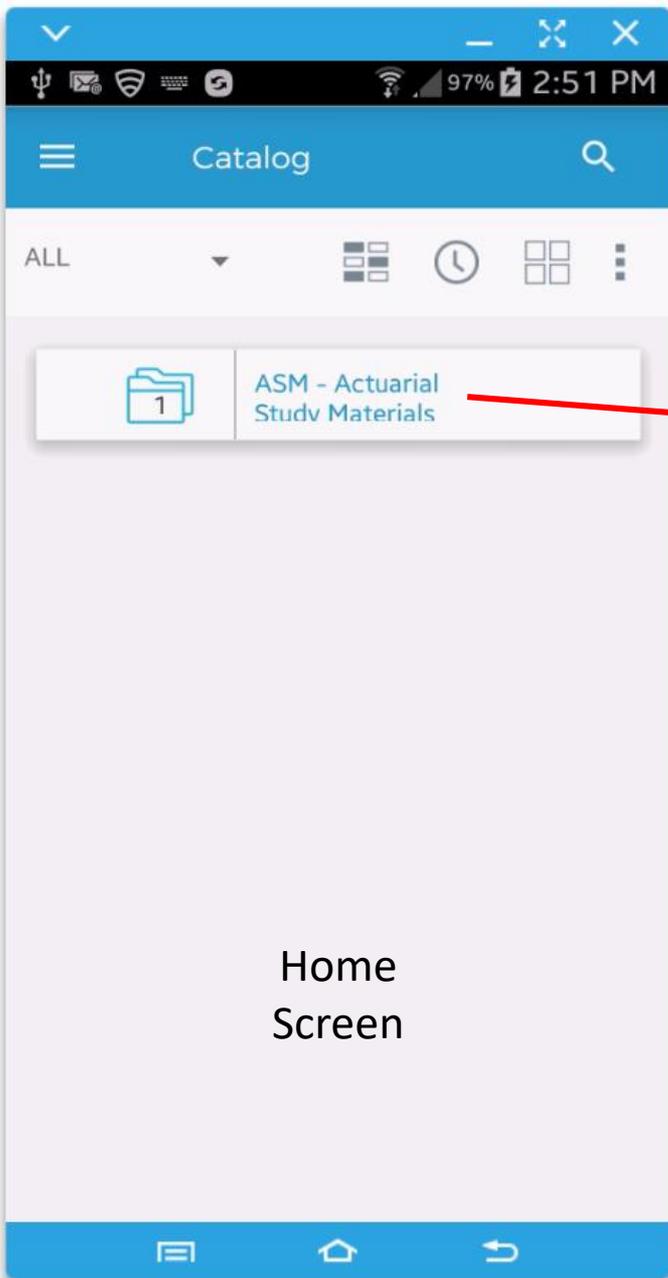
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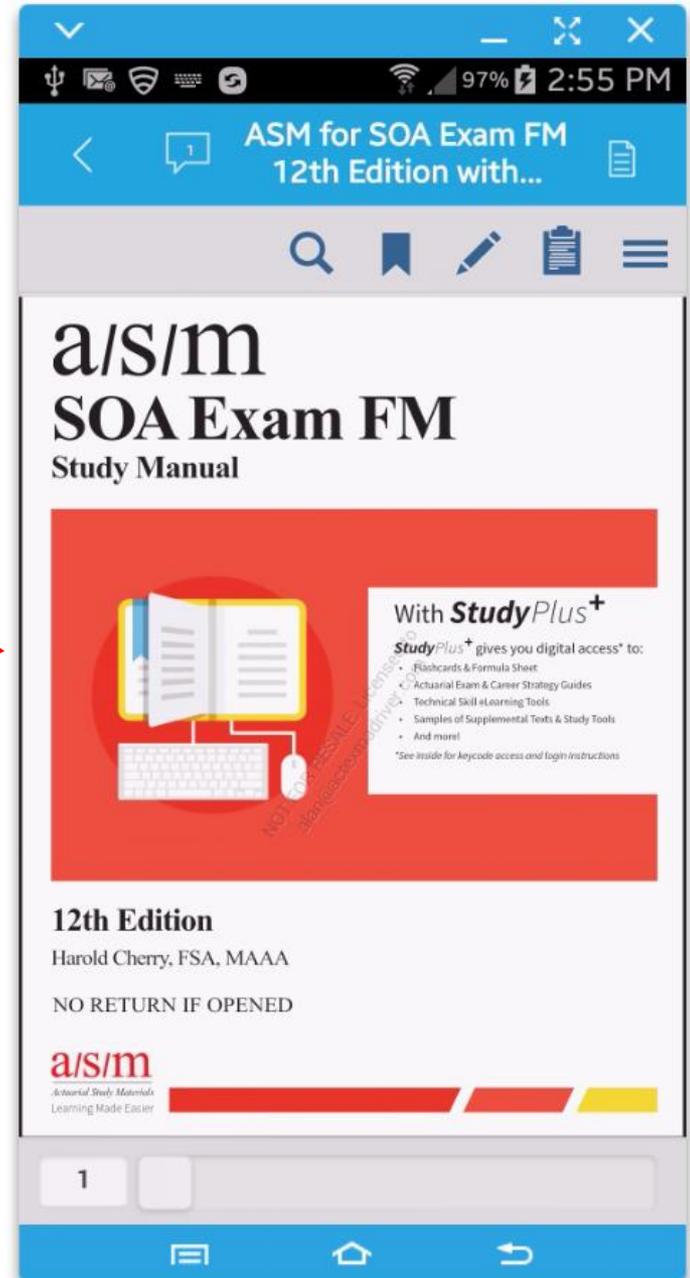
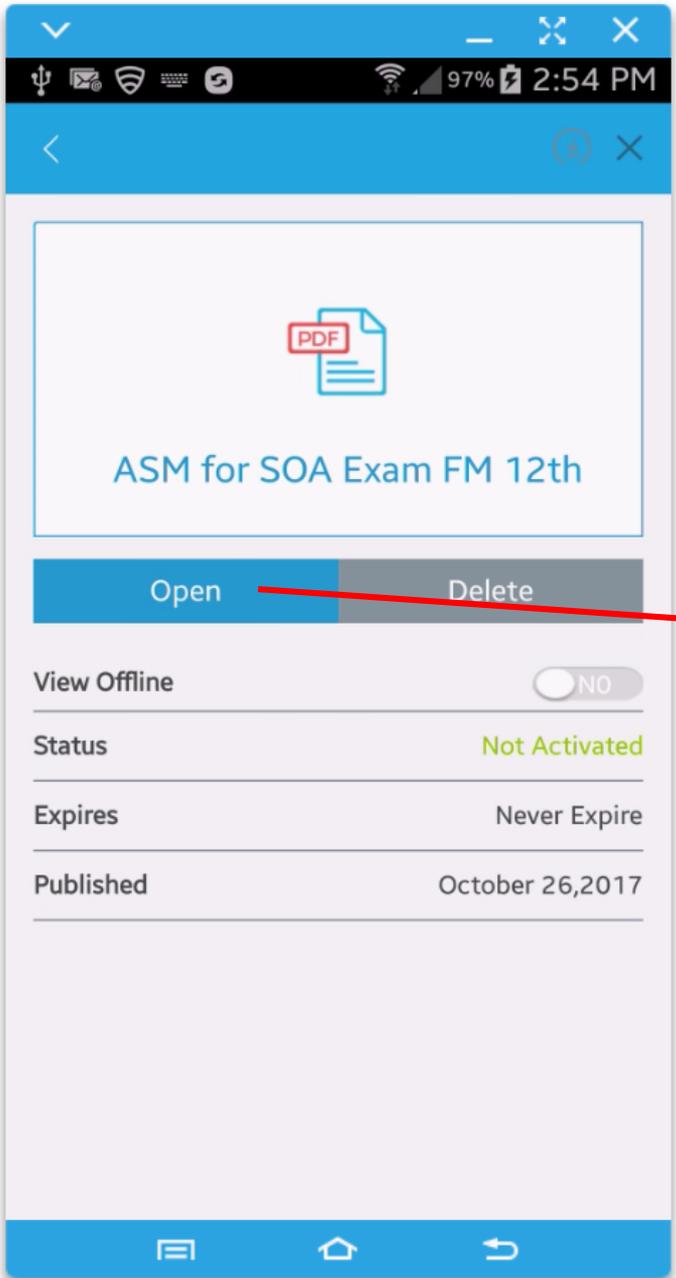
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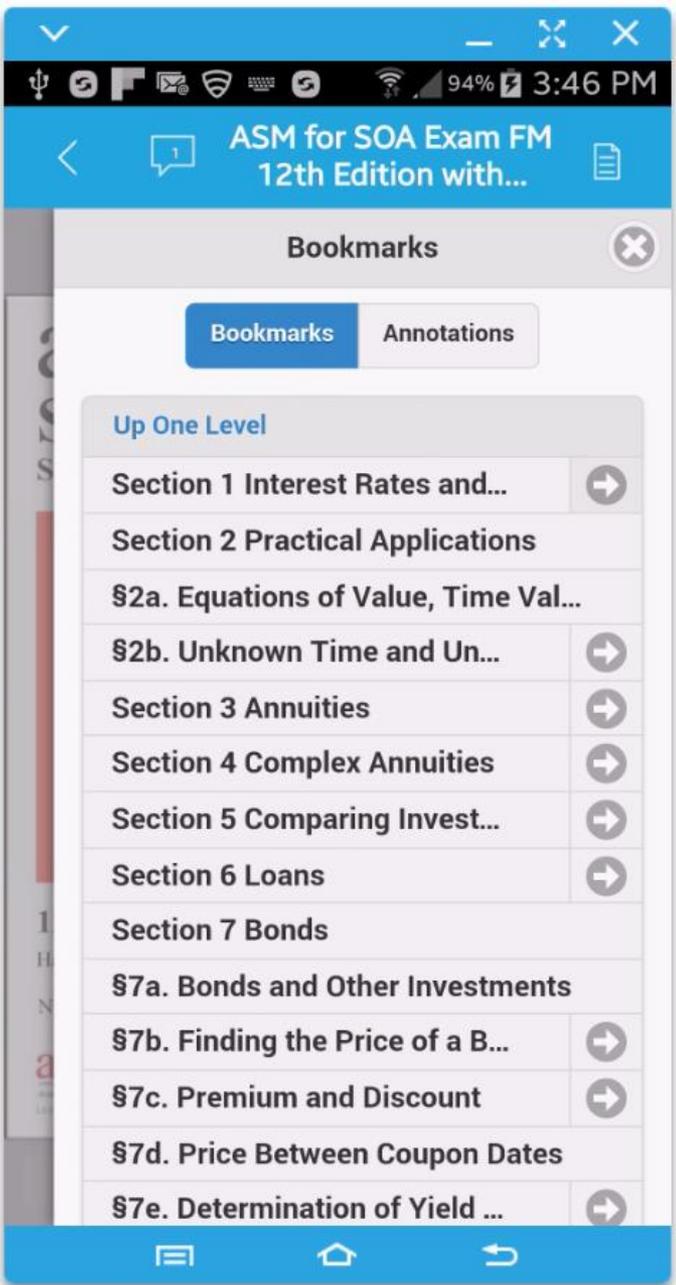
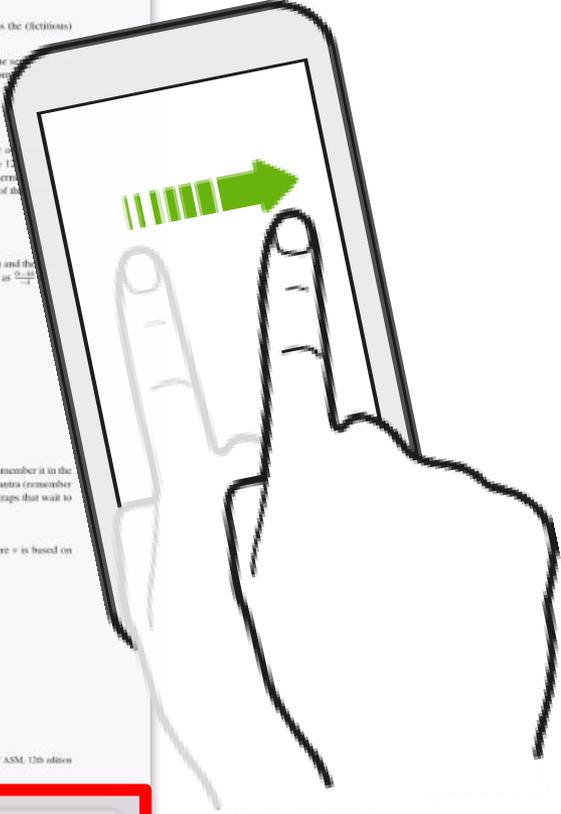
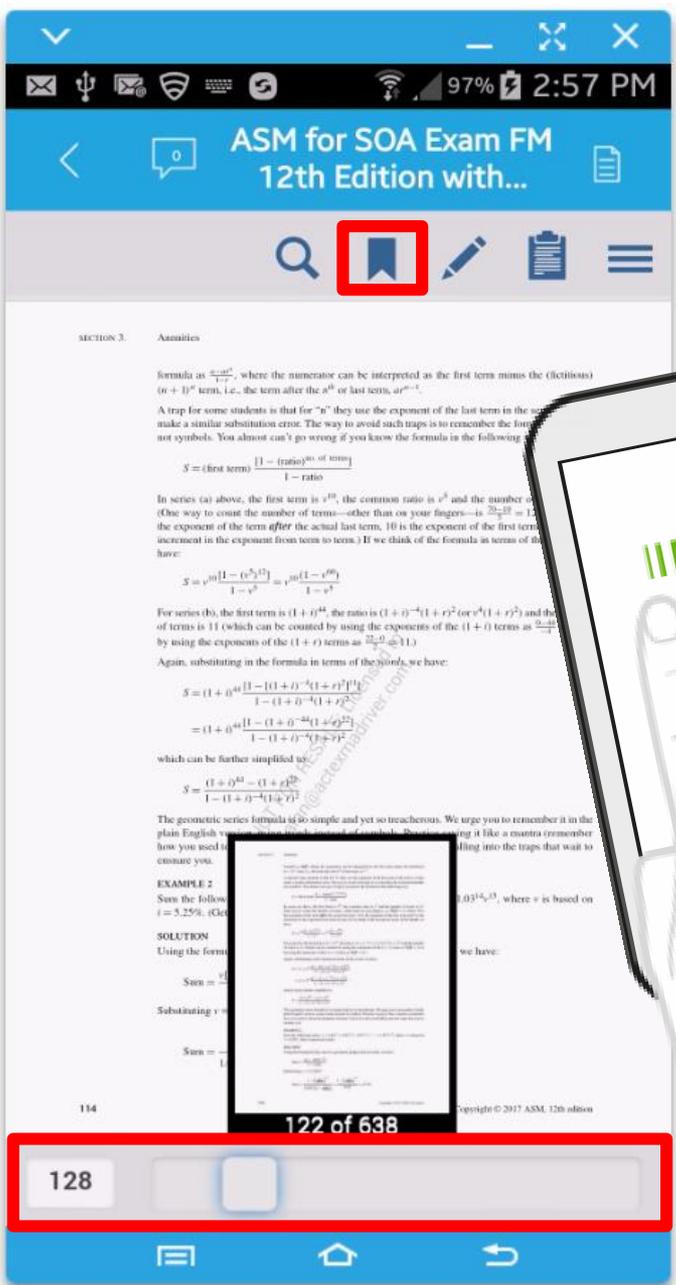
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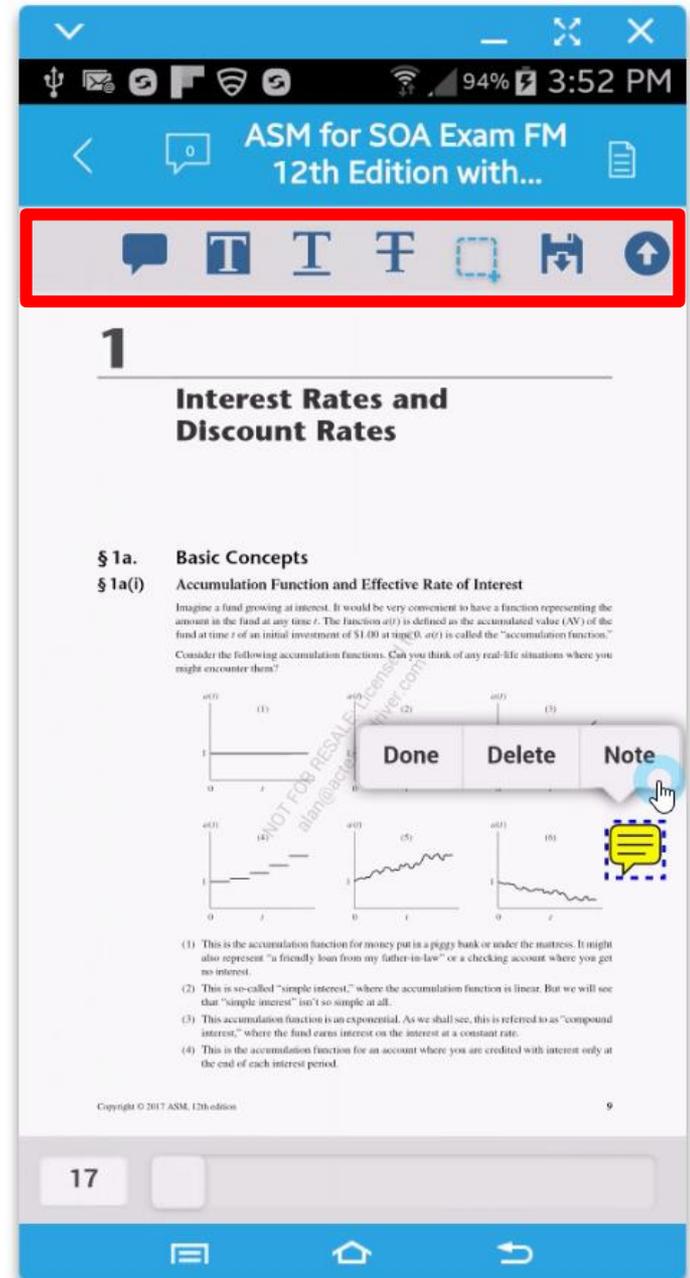
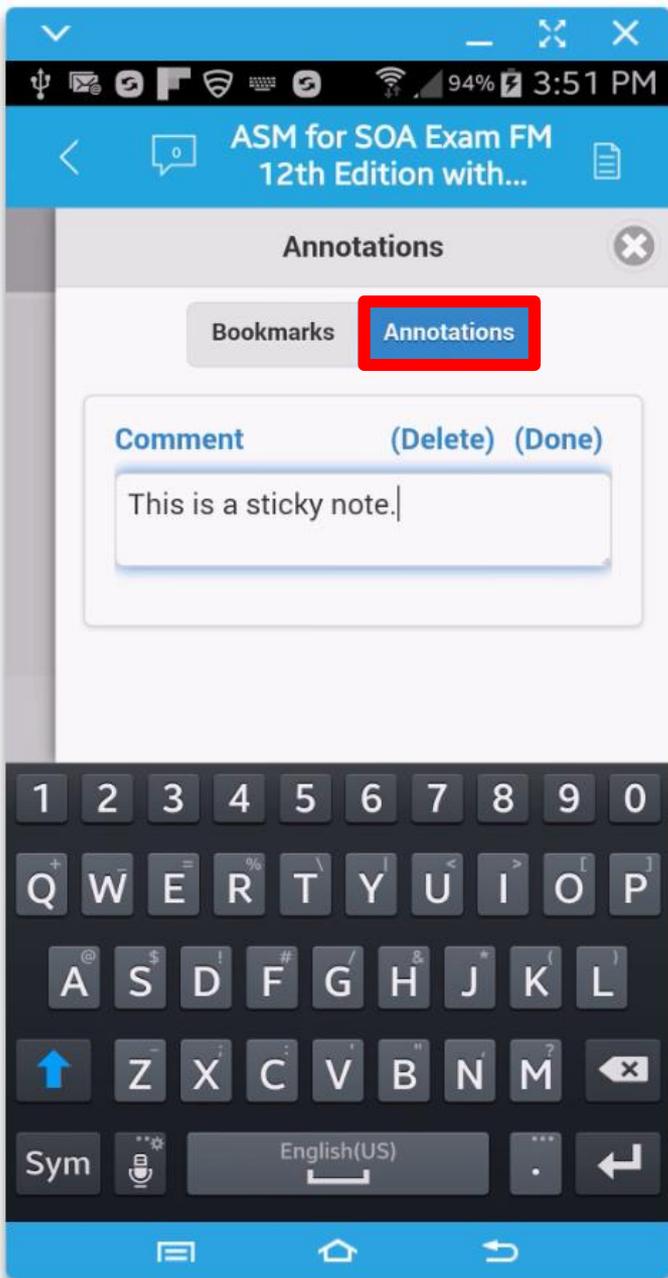
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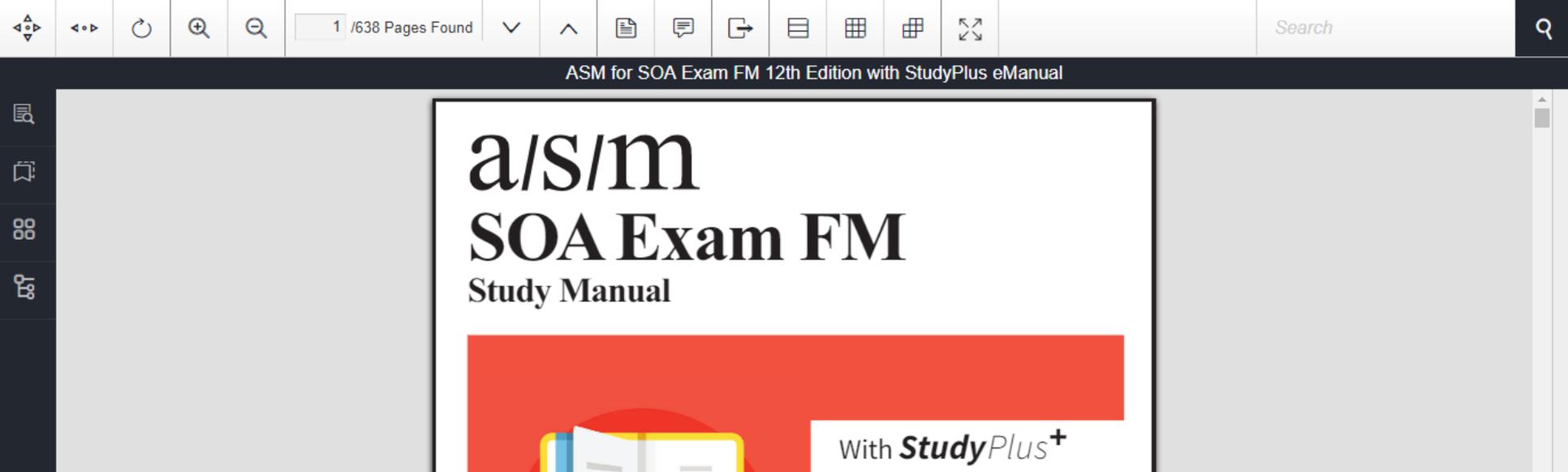
Now you're at the document and you can open it by clicking the open button or you can delete it by clicking the delete button... but don't do that, click OPEN and voila! There's your content.



You can navigate by swiping your finger to change pages in either direction or you can click on the slider at the bottom of the screen and look for pages using the thumbnail viewer. You can also click the bookmarks icon, which looks like a ribbon in the menu bar and select just like you can in the online viewer. Also note the Annotations button here.



You can create a sticky note to place on your content.  
And you'll notice that the highlight, underline and strikethrough here too.



## Digital Content eReader Features Overview

Thank you for taking a few moments to learn more about the features of our Digital Content eReader.

Please refer to the frequently asked questions for more information on a wide number of topics.

Thank you for being our customer. We really appreciate your business!