21. An investor paid $95 for a bond with face value $100 maturing in six months. On which day will the bond value pass $97, provided the interest rate remains constant?

22. Consider the coupon bond in Example 4.20. For any \( t \in [0,1) \), find a formula for \( V(t) \). Use a graphing calculator to sketch \( V(t) \) for \( 0 \leq t < 1 \). Estimate the day on which \( V(t) \) will be $95 for the first time. Finally, sketch the entire graph of the price of the coupon bond as a function of time, for all \( t \in [0,5] \).

23. A bond with face value 100 and annual coupons of $8 maturing after 3 years is trading at par. Find the implied continuous compounding rate.

24. The cash prices of 6-month and 1-year Treasury bills are 94.0 and 89.0. A 1.5-year bond that will pay coupons of $4 every 6 months currently sells for $94.84. A 2-year bond that will pay coupons of $5 every 6 months currently sells for $97.12. Use the bootstrap method to calculate the 6-month, 1-year, 1.5-year, and 2-year zero rates.

25. Suppose zero interest rates with continuous compounding are given by

<table>
<thead>
<tr>
<th>Maturity (years)</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rate (% per annum)</td>
<td>2.0</td>
<td>3.0</td>
<td>3.7</td>
<td>4.2</td>
<td>4.6</td>
</tr>
</tbody>
</table>

(a) Calculate forward interest rates for the second through fifth year.

(b) Value an FRA where you will pay 5% for the third year on $1 million.

26. Portfolio A consists of a 1-year zero-coupon bond with a face value of $2,000 and a 10-year zero-coupon bond with a face value of $6,000. Portfolio B consists of a 5.95-year zero-coupon bond with a face value of $5,000. The current yield on all bonds is 10% per annum.

(a) Show that both portfolios have the same duration.

(b) Show that the percentage changes in the values of the two portfolios for a 0.1% per annum increase in yields are the same.

(c) What are the percentage changes in the values of the two portfolios for a 5% per annum increase in yields?