Problems 1 through 6: Use the Rates Spreadsheet posted on the website to answer questions 1 through 6. Be sure to read the instructions for the Rates Spreadsheet before using it.

1. Use the Yield worksheet to answer the following questions.
   a) Adjust the spot rates so that they increase each year by 0.5%, starting at 6.0%. What is the shape of the yield curve?
   b) Adjust the spot rates so that they decrease each year by 0.5%, starting at 10.0%. What is the shape of the yield curve?
   c) Adjust the spot rates so that they increase from 8.0% in year 1 to 11.0% in year 4. Then, decrease the rates by 1.5% each year, starting with 9.5% in year 5. What is the shape of the yield curve?

2. Use the Forward worksheet to answer the following questions.
   a) Adjust the yields so that they increase each year by 0.5%, starting at 5.0%. What is the pattern of forward rates through time?
   b) What pattern of forward rates gives a humped yield curve? To answer this, adjust the yields in order to get a humped yield curve.
   c) What pattern of forward rates results in a yield curve that starts at 10% and decreases to 6.5% in the last year?
   d) Why would a yield curve's slope tend to become flatter through time? For example, try making a fairly steep downward sloping yield curve and see what forward rates are necessary for this.

3. Use the Price and Duration worksheet to answer the following questions.
   a) How does the price graph as a function of the coupon rate change as the yield to maturity increases? This price graph is the blue graph in the upper right-hand corner).
   b) How does the price graph as a function of the maturity change as the yield to maturity increases? This price graph is the red graph in the lower right-hand corner).
   c) How does the price of the bond change as the yield to maturity increases? This price graph is the green graph in the lower left-hand corner).
   d) How does the price graph as a function of the coupon rate change as the maturity increases? This price graph is the blue graph in the upper right-hand corner). Does the answer depend on whether the bond is selling for a premium or a discount?
   e) How does the price graph as a function of the yield to maturity change as the maturity increases? This price graph is the green graph in the lower left-hand corner). Does the answer depend on whether the bond is selling for a premium or a discount?
   f) How does the price of the bond change as the maturity increases? This price graph is the red graph in the lower right-hand corner). Does the answer depend on whether the bond is selling for a premium or a discount?
   g) How does the price graph as a function of the maturity change as the coupon rate increases? This price graph is the red graph in the lower right-hand corner)
   h) How does the price graph as a function of the yield to maturity change as the coupon rate increases? This price graph is the green graph in the lower left-hand corner)
   i) How does the price of the bond change as the coupon rate increases? This price graph is the blue graph in the upper right-hand corner).

4. Use the Price and Duration worksheet to answer the following questions.
   a) How does the duration graph as a function of the coupon rate change as the yield to maturity increases? This price graph is the blue graph in the upper right-hand corner).
   b) How does the duration graph as a function of the maturity change as the yield to maturity increases? This price graph is the red graph in the lower right-hand corner).
   c) How does the duration of the bond change as the yield to maturity increases? This price graph is the green graph in the lower left-hand corner).
   d) How does the duration graph as a function of the coupon rate change as the maturity increases? This price graph is the blue graph in the upper right-hand corner). Does the answer depend on whether the bond is selling for a premium or a discount?
   e) How does the duration graph as a function of the yield to maturity change as the maturity increases? This price graph is the green graph in the lower left-hand corner). Does the answer depend on whether the bond is selling for a premium or a discount?
f) How does the duration of the bond change as the maturity increases? This price graph is the red graph in the lower right-hand corner. Does the answer depend on whether the bond is selling for a premium or a discount?
g) How does the duration graph as a function of the maturity change as the coupon rate increases? This price graph is the red graph in the lower right-hand corner.
h) How does the duration graph as a function of the yield to maturity change as the coupon rate increases? This price graph is the red graph in the lower left-hand corner.
i) How does the duration of the bond change as the coupon rate increases? This price graph is the blue graph in the upper right-hand corner.

5. Use the Convexity worksheet to answer the following questions. The 'Price %' graph is best for considering convexity.
a) How does the convexity change as the coupon rate increases?
b) How does the convexity change as the maturity increases? Does this depend on the coupon rate?
c) How does the convexity change as the yield to maturity increases? Does this depend on the coupon rate?
d) What is the relationship between convexity and the duration curve? Hint, notice how the convexity change given a change in yields is related to the duration curve.

6. Use the Convexity worksheet to answer the following questions. The 'Price %' graph is best for considering convexity.
a) How does the convexity change as the coupon rate increases?
b) How does the convexity change as the maturity increases? Does this depend on the coupon rate?
c) How does the convexity change as the yield to maturity increases? Does this depend on the coupon rate?
d) What is the relationship between convexity and the duration curve? Hint, notice how the convexity change given a change in yields is related to the duration curve.

7. Suppose that a fund manager faces the following problem: Lifo Insurance Enterprises (LIE) has promised to provide a 20-year annuity that pays $5,000 per year. It has promised the prevailing rate of return of 6.50% (i.e., yields for all maturities are currently 6.50%). For its service, the purchaser of the annuity has paid the company a $500 origination fee (this is LIE’s profit) on top of the $55,092.54 payment for the present value of the annuity. The company can invest in the following fixed income securities: a 5-year zero coupon bond and a 30-year 9% coupon bond (with annual coupon payments). The face value of each bond is $1,000.
a) How many of each bond should the fund manager purchase in order to immunize LIE’s interest rate risk? Hint: first find the duration of each bond and the liability.
b) Suppose that rates decrease to 6%. Find the new investments in the two bonds that immunize the LIE’s interest rate risk and show that the portfolio is (approximately) self-financing.
c) Now suppose that rates remained at 6.50% for an entire year. After this year has passed, show how the fund manager must rebalance the portfolio in order to have a portfolio that is immunized against future interest rate changes. Show that the portfolio is self-financing.

8. Suppose that a fund manager faces the following problem: Jason’s Equity Research Corp (JERC) has promised to provide a 20-year annuity that pays $10,000 per year. It has promised the prevailing rate of return of 7.00% (i.e., yields for all maturities are currently 7.00%). For its service, the purchaser of the annuity has paid the company a $500 origination fee (this is JERC’s profit). This $500 should not enter into your calculations. The company can invest in the following fixed income securities: a level perpetuity that pays $100 per year forever, and a 6-year 8% coupon bond (with annual coupon payments). The face value of the coupon bond is $1,000.
a) How many of each asset should the fund manager purchase in order to immunize JERC’s interest rate risk?
b) Suppose that rates decrease to 6.90% (one day after creating the immunized portfolio). Find the new investments in the two bonds that immunize JERC’s interest rate risk and show that the portfolio is (approximately) self-financing.
c) Now suppose that rates remained at 7.00% for an entire year. After this year has passed, show how the fund manager must rebalance the portfolio in order to have a portfolio that is immunized against future interest rate changes. Show that the portfolio is self-financing.