**HOMEWORK 4**

*This homework is due on March 13th. It must be handwritten and handed in at the beginning of the lecture. No late homeworks will be accepted. Please show all your work to receive partial credit.*

**1)** You manage a pension fund that will provide retired workers with lifetime annuities. You determine that the payouts of the fund are essentially going to resemble level perpetuities of $1 million per year. The interest rate is 10%. You plan to fully fund the obligation using 5-year and 20-year maturity zero-coupon bonds. How much market value of each of the zeros will be necessary to fund the plan if you desire an immunized position?

**2) a.** What is the duration of a 5-year 5% annual coupon bond with a par value of $100 if the prevailing continuously compounded interest rate is 6%?

**b.** What is the duration of a 5-year 8% annual coupon bond with a par value of $100 if the prevailing continuously compounded interest rate is 6%? What does this tell you about the relationship between coupon rates and duration? Comment.

**c.** What is the duration of a 5-year 5% annual coupon bond with a par value of $100 if the prevailing continuously compounded interest rate is 9%? What does this tell you about the relationship between interest rates and duration? Comment.

**3)** A bond has four years to maturity, a 10% annual coupon and a par value of $100. The bond pays a continuously compounded interest of 8%.

**a.** What would the actual percentage change in the price of the bond be if the interest rate goes up from 8% to 9%?

**b.** What would be the percentage change in the price of the bond implied by the duration approximation?

**c.** What would be the percentage change in the price of the bond implied by the duration plus convexity approximation?

**d.** Why does adding the convexity term to the approximation improve it?