1. (10 pts). A 30-year zero coupon bond has a yield of 3 percent, with annual compounding. What is the convexity of this bond?

2. (20 pts) Pension funds pay lifetime annuities to recipients. If a firm expects to remain in business indefinitely, its pension obligation will resemble a perpetuity. Suppose, therefore, that you are managing a pension fund with obligations to make perpetual payments of $2 million per year to beneficiaries. The yield to maturity on all bonds is 4%.
   a. What is the present value of these obligations?
   b. If the fund wants to fully fund and immunize these obligations using two STRIPS maturing in 5 and 30 years, how much of each of STRIP (in market value) will they want to hold?

3. (20 pts). Mark enters into a 10 year plain vanilla interest rate swap contract on October 31, 2018 to pay fixed and receive 3 month LIBOR. Suppose that the fixed rate at the inception of the swap contract was 2.30225 percent. The notional underlying was $100,000,000. Suppose that October 31, 2019 is a date when payments for one quarter are to be swapped with the floating rate based on the 3 month LIBOR rate on that day. Does Mark make or receive a payment? How much?

4. (20 pts) The CDS spread on Risky Corp is 200 basis points, payable in each of the five years of the contract.
   a. What annual payment does a buyer of credit protection have to pay to insure $1 million of Risky Corp bonds?
   b. In the event of default, the recovery rate is zero. If investors are risk neutral, what is the probability of default per year over the next five years?

5. (30 pts) Using Bloomberg, please download end-of-month monthly data on the S&P500 Total Return Index (Mnemonic: SPXT Index) and the Barclay US Treasury Total Return Index (Mnemonic: LUATTRUU Index) from January 1988 to October 2019, inclusive. As a check, you should have 382 observations for each series, starting with 257.47 for stocks and 395.04 for bonds.
   a. Suppose that you had a portfolio of $1,000,000 in January 1988. You decide to allocate 60 percent to stocks and 40 percent to bonds, but you fix your investment and do no rebalancing.
      i. What is the total value of your portfolio in October 2019?
      ii. What is the average monthly return (not annualized, here or for the rest of this question)?
      iii. What is the standard deviation of monthly returns?
      iv. What is the Monthly Sharpe ratio of the portfolio, assuming a riskfree rate of 0.3% per month?
      v. In October 2019, what is your portfolio allocation to stocks?
   b. Now suppose that you had a portfolio of $1,000,000 in January 1988. Again you decide to allocate 60 percent to stock and 40 percent to bonds, but you rebalance to retain this ratio every month.
      i. What is the total value of your portfolio in October 2019?
      ii. What is the average monthly return?
      iii. What is the standard deviation of monthly returns?
      iv. What is the Monthly Sharpe ratio of the portfolio, assuming a riskfree rate of 0.3% per month?