M.I.T. **Fall 1998**
Sloan School of Management **15.415**

Prof. Denis Gromb

MIDTERM 1

Section B

Wednesday, October 7, 1998

The exam is between **08:10am** and **09:50am**. Books and lecture notes are not allowed. One double-sided sheet of personal notes written reasonably large is allowed. There are 5 independent questions. Do not line up equations without explanation: **No Explanations, No Points** (except for Question 1).

- Please, write your name at the top of **each** page **NOW!**
- Answer each question in the corresponding space
- Keep the package stapled together
- **To avoid chaos and ensure equity among the students:**
  - If you finish before 09:35am, you can hand in your exam and leave the room
  - **If you finish after 09:35am, please STAY SEATED UNTIL YOUR EXAM IS COLLECTED AT YOUR DESK**
  - **Once your exam is collected, please leave the room in silence**

GOOD LUCK!

Question 1 (20 pts)	
Question 2 (20 pts)	
Question 3 (20 pts)	
Question 4 (20 pts)	
Question 5 (20 pts)	
Total (100 pts)	

Question 1 [20 points]

No explanations needed. Circle **one or several** answers per question. You will get credit for a question only if you circle **all** the correct answers.

1. In which of the following account would you prefer to deposit your money for 2 years?

   (a) An account with an 8.1% APR compounded monthly
   (b) An account with an 8.2% APR compounded monthly
   (c) An account with an 8.2% APR compounded every 2 months
   (d) An account with an 8.3% EAR
   (e) An account with an 8.5% EAR

2. Which of the following statements are correct?

   (a) A 5-year US Treasury coupon bond's YTM always exceeds the 5-year spot rate
   (b) Bonds with the same maturity have the same YTM
   (c) Bonds with lower YTMs are better deals
   (d) Bonds with higher YTMs are better deals
   (e) None of the above statements is correct

3. The yield curve is flat at 8%. Suppose you ranked the following US T-bonds by decreasing price as a fraction of par value. That is: 1st the bond with the highest $\frac{\text{Price}}{\text{Par Value}}$ ratio, 2nd a bond with a lower ratio, etc. Which one would come third?

   (a) The 19-year T-bond with annual coupon rate 10% and face value $\$1,000$
   (b) The 20-year STRIP with face value $\$100,000$
   (c) The 5-year T-bond with annual coupon rate 10% and face value $\$1,000$
   (d) The 19-year STRIP with face value $\$10,000$
   (e) The 20-year zero coupon bond with face value $\$1,000$

4. A *puttable bond* (or put bond) provides its holder with the option to sell back (or put) the bond to the issuer at a prespecified date (the expiration date) before maturity at a prespecified price (the put price). One defines the YTM of a put bond as its YTM computed assuming that the option will not be exercised. Similarly, one defines the YTM of a callable bond as its YTM computed assuming that the bond will not be called. Which of the following bonds issued by XYZ Inc. do you expect to have the highest YTM? All bonds have a 10-year maturity and a 12% semi-annual coupon rate.

   (a) A callable bond with face value $\$10,000$ and call price $\$11,000$
   (b) A put bond with expiration date in 5 years, face value $\$1,000$ and put price $\$990$
   (c) A convertible bond with convertibility ratio 5 and face value $\$3,000$
   (d) A straight bond (i.e. with no particular feature) with face value $\$1,000$
   (e) A straight bond with face value $\$10,000$

Question 2 [20 points]

Your firm, LHS Inc., is seeking new cities to install one or several new branches. The expected cash flows generated by opening a branch in Atlanta, Boston and Chicago are given (in millions of dollars) in the following table.

Year	0	1	2	3
Atlanta	-135	50	50	50
Boston	-100	45	45	45
Chicago	-190	50	100	100

The discount rates appropriate for the expected cash flows in years 1, 2 and 3 are 7%, 8% and 7% respectively. LHS Inc. has $\$900M$ available from its various bank accounts, financial securities, etc. Assume frictionless financial markets.

a) If these are independent projects, which investments if any should you undertake?

b) For this question only, assume that LHS Inc. had only $\$150M$ on its accounts, etc. If the projects are independent, which investment or investments would you undertake?

c) If the projects are mutually exclusive, which investment if any should you undertake?

d) If the projects are independent and you apply the simple IRR criterion with a 14% threshold, which investments would you undertake? [Hint: You can but need not compute the projects' IRR].

Question 3 [20 points]

a) You would like to set up the following trust fund for your granddaughter: Starting today, you intend to make 20 equal annual payments of $\$X$ into an account. Starting 25 years from today, your granddaughter can start making 5 equal annual withdrawals of $\$1,000$ each. Suppose that the appropriate discount rate is and will remain 5% per year. How much do you have to pay into the trust fund each year (i.e. what is X)?

b) Consider the same problem except that now you want your granddaughter's first withdrawal to be $\$1,000$ but then to grow every year at a rate of 4%. How much do you have to pay into the trust fund each year (i.e. what is X)?

c) Suppose that inflation is going to be 2% per year for the next 20 years. What is the real discount rate?

d) Suppose again that inflation is going to be 2% per year for the next 20 years. Instead of being constant *in nominal terms*, you would like your 20 payments to be constant *in real terms*. Nevertheless, you would like your granddaughter's 5 withdrawals to be constant at $\$1,000$ *in nominal terms*. What real payments ($\$Y$ in real terms) would you have to make each year?

Question 4 [20 points]

The yield curve is flat at 7%. You are forecasting that you will need to make 25 annual payments of $\$2M$. The next payment is due one year from today.

a) Suppose you wanted to immunize this liability against interest rate risk using a single zero coupon bond. What would its face value and maturity have to be? [Hint: The Macaulay duration of an annuity with maturity T and YTM y is $D = \frac{1+y}{y} - \frac{T}{(1+y)^T - 1}$]

b) Suppose you wanted to immunize this liability against interest rate risk with a portfolio of 5-year and 20-year strips. How much money would you have to invest in each of these STRIPS?

Question 5 [20 points]

Assume that the following US Treasury bonds are traded. There are no arbitrage opportunities.

	Bond A	Bond B
Face value	$\$1,000$	$\$1,000$
Annual coupon rate	5%	10%
Maturity in years	2	2
Price as % of par	94.69	103.65

a) What are the 1-year spot rate, the 2-year spot rate and the forward rate between year 1 and 2?

b) Bond C is a US Treasury bond with a 2-year maturity, 3% coupon rate and face value $\$1,000$. Suppose that you invest $\$12,000$ in bond C. What cash flows will this investment generate one year and two years from today?