

NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF COMMERCE

DEPARTMENT OF FINANCE

MASTER OF SCIENCE IN FINANCIAL ENGINEERING

DERIVATIVES PRICING & APPLICATIONS [CFI 5105]

FINAL EXAMINATIONS NOVEMBER 2016

3 HOURS

INSTRUCTIONS TO CANDIDATES

1. Answer **ALL** questions in **SECTION A** and **ANY THREE** in **SECTION B**
 2. Read questions carefully and address all parts of the question
 3. Questions may be written in any order.
 4. Show all workings.
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INFORMATION FOR CANDIDATES

- 1) The paper contains FIVE (5) questions.
- 2) The paper consists of EIGHT (5) printed pages including cover page.
- 3) Each question carry 25 marks each.

Section A

Bankers Trust-Gibson Greetings

On April 19, 1994, Gibson Greetings, Inc., a manufacturer of seasonal greeting cards, wrapping paper, and related products, with headquarters in Cincinnati, Ohio, filed its quarterly financial statement with the SEC. The company stated that it had taken a \$16.7 million charge resulting from losses on two swap transactions with BT Securities Corporation, a subsidiary of Bankers Trust New York Corporation (BT), which is now part of Deutsche Bank.¹³ The announcement stated that this loss was in addition to a \$3 million charge announced earlier related to the same swap transactions. The announcement also stated that cumulative losses from the two swap transactions could potentially reach \$27.5 million. Gibson's announcement and the resulting legal and regulatory events involving Gibson's swap counterparty, BT, attracted considerable attention in the financial press and among participants in the financial markets. These newsworthy events included a lawsuit filed by Gibson against BT that was settled out of court in November 1994, with Gibson paying BT only \$6.2 million out of \$20.7 million owed under the terms of its swap agreements with BT.¹⁴ In addition to this private lawsuit, three government regulatory actions resulted from the Gibson-BT dispute. In December 1994, the Federal Reserve Bank of New York (NY Fed) entered into a written agreement with BT regarding the future conduct of BT's "leveraged derivatives transactions." That same month, the Commodity Futures Trading Commission (CFTC) and the Securities and Exchange Commission entered and settled simultaneous actions against BT in which BT paid a civil penalty of \$10 million to the United States Treasury. Although the BT-Gibson dispute revolved around two swap contracts, BT and Gibson had engaged in 27 previous transactions. The two contracts in dispute represented the cumulative position resulting from the earlier transactions. The relationship between BT and Gibson began innocently enough with simple plain vanilla fixed-for-floating interest rate swaps. Over time, the transactions evolved to more complex, customized structures. The dispute between Gibson and BT centered around the duties of the two parties in determining the value of these complex structures. Gibson claimed that BT

breached its fiduciary duty as Gibson's financial adviser by dispensing advice that advantaged BT at Gibson's expense. BT claimed that their relationship with Gibson was purely arm's length, without any fiduciary or advisory role. Characterizing the nature of the relationship between BT and Gibson was an important element of the dispute.

Gibson entered into its first interest rate swaps with BT on November 12, 1991. These plain vanilla interest rate swaps were, according to Gibson, intended to "reduce its interest costs" related to a \$50 million fixed-rate (9.33%) borrowing completed in May 1991. Attracted to the low short-term rates at the time, Gibson transformed its fixed obligation into a floating obligation by entering into two fixed-for-floating interest rate swaps on this date, each with a notional amount of \$30 million. By transmuted its fixed-rate expense into a floating-rate expense, the swaps allowed Gibson to offset a portion of its fixed interest expense on its borrowing during 1992 and 1993. In each of those years, Gibson would have received a net payment equal to 1.21% of \$30 million from BT. Based on expectations about LIBOR at the initiation of the swap agreements; Gibson's overall interest rate expense during 1994 through 1996 was expected to rise above its initial fixed-rate obligation. Of course, this is reasonable, since when all the swap payments were taken together, the swaps initially had zero value. *Ex ante*, Gibson had only succeeded in shifting its anticipated interest expense from one period to another. However, if future interest rates were to be below the rates initially expected to prevail, then Gibson would have profited from the swap (Gibson would have received a value of fixed payments higher than the value of the floating payments made). Further, if future rates were to be low enough relative to expectations, then Gibson's interest-rate expense could be lower during this period as well. Achieving this reduction in interest rate expense was dependent on winning what was, in effect, a bet on the future direction of rates. Gibson did not hold these swaps to term, but, after amending the contracts in January 1992, terminated them on July 7, 1992, receiving a payment from BT of \$260,000, representing the value of the swaps at that time. This payment reflected that Gibson had profited under its swaps because of falling interest rates during the first half of 1992. On October 1, 1992, Gibson entered into another swap with BT called a "ratio swap."

This swap increased Gibson's exposure to increases in the level of short-term interest rates. Under the new swap, the future net payments to Gibson would become negative more rapidly than under the original swaps, and the difference would become exponentially greater, the greater the rate. This swap was amended three times to shorten the agreement before being terminated on April 21, 1993, with BT making a payment to Gibson of \$978,000. In one of the amendments, the termination date of the swap was shortened by a year in exchange for Gibson entering into another swap. Through March 4, 1994, Gibson entered into several additional swaps with BT. According to Gibson's complaint, the swaps "ultimately involved complex structures highly sensitive to even small movements" in rates. When interest rates spiked upward sharply beginning in February 1994, Gibson had two outstanding swaps with BT, and it was still exposed to interest rate increases. According to Gibson, between February 25 and March 3, 1994, the present value of Gibson's two outstanding swaps fell \$9.5 million for a cumulative loss of \$17.5 million. On March 4, Gibson rolled its existing swaps into two final swaps that became the subject of Gibson's suit. Although the plain vanilla and ratio swap transactions described earlier were not at the center of the Gibson-BT dispute, it is important to understand how these transactions became intertwined with more complex future transactions. It is this process of terminating a swap, or a portion of a swap (a so-called *tear-up agreement*), in consideration for entering into a new or amended swap agreement that ultimately triggered the dispute. Of the 29 transactions between Gibson and BT, many involved the termination of one position in exchange for entering into another position. This process of rolling from one position to another is called *morphing* by some practitioners. It requires agreement between the parties as to the terms that will equate the tear-up value of the existing swap (or swap portion) to the value of the new position (or amendment) received in exchange for the tear-up. The dispute between Gibson and BT centered on the duties of the two parties in determining the value of the positions involved in tear-ups and rollovers. Because of the complexity of the customized deals, valuation relied on model prices—comparable market quotes were not observable as they would be with a plain vanilla transaction. Gibson, and the government, alleged that BT knew that Gibson

relied on BT's information to value swap positions. In addition, Gibson, and the government, alleged that BT misled Gibson about the value of those swap positions. Gibson alleged that BT provided it with valuations that significantly understated the magnitude of Gibson's losses, leaving the company unaware of the actual extent of its losses from the swap transactions. Moreover, Gibson, and the government, alleged that an advisory relationship existed between BT and Gibson. Under this legal theory, BT owed Gibson a duty not to misrepresent valuation information. BT argued that their transactions with Gibson were strictly arm's length deals and that the masters swap agreement did not establish any advisory or fiduciary relationship. BT argued that the tear-up values they quoted were simply that—quotations at which BT stood ready to transact a tear-up. BT was certainly aware of Gibson's reliance on BT's models. A taped conversation of a BT managing director and his supervisor includes the passage: "From the very beginning, [Gibson] just, you know, really put themselves in our hands like 96 percent. . . . And we have known that from day one . . . these guys have done some pretty wild stuff. And you know, they probably did not understand it quite as well as they should. I think that they have a pretty good understanding of it, but not perfect. And that's like perfect for us."15 The SEC alleged that on two occasions BT provided Gibson with valuations that differed by more than 50 percent from the value generated by BT's models and recorded on BT's books.

- (i) What were the key issues in the BT-Gibson Greetings case? **[10marks]**
- (ii) In what ways would you address the problems in this case? **[15marks]**

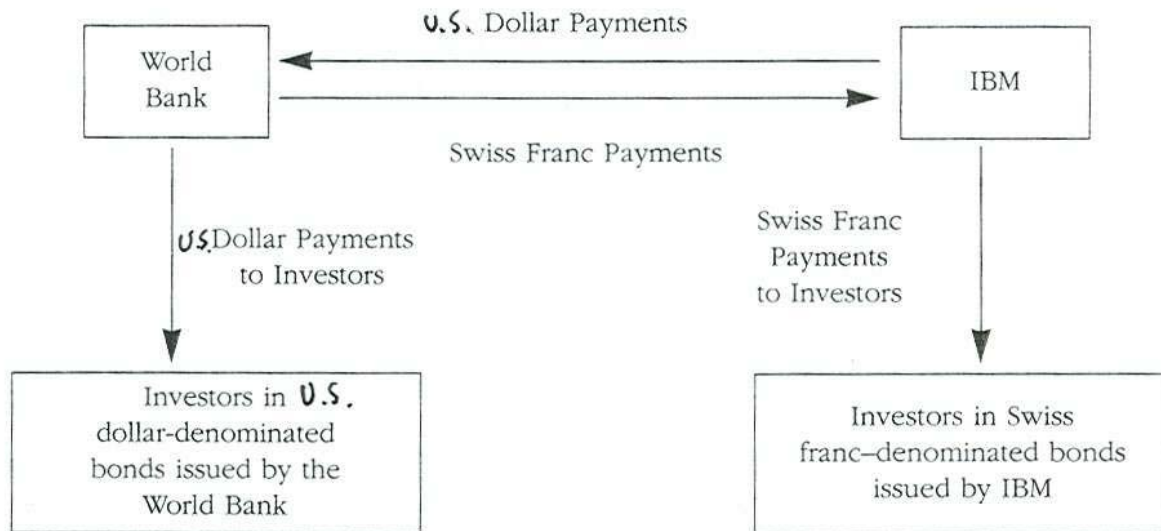
Question 1

- (i) Your company has three investment portfolios. Your company's guideline on single company exposure mandates that credit risk exposure to a single issue within a portfolio be limited. The managers of the three portfolios are reviewing alternative ways of managing issuer-specific risk.

Portfolio/Manager	A	B	C
Portfolio Size	Large	Small	Small
Credit Research Ability	Weak	Strong	Strong
Transaction Cost Efficiency	Efficient	Not Efficient	NotEfficient
Complies with Guideline on Single-Company Exposure	Yes	Yes	No

Explain how the manager of Portfolio C can use credit default swaps (CDS) to manage single issuer risk, while providing a similar cash flow pattern and achieving the original target total return. **[6marks]**

(ii) Figure below shows the basic structure of the World Bank-IBM currency swap.



What could be the motivation of IBM in this transaction?

[8marks]

- (ii) Company A is a AAA-rated firm desiring to issue five-year FRNs. It finds that it can issue FRNs at six-month LIBOR + .125 percent or at three-month LIBOR + .125 percent. Given its asset structure, three-month LIBOR is the preferred index. Company B is an A-rated firm that also desires to issue five-year FRNs. It finds it can issue at six-month LIBOR + 1.0 percent or at three-month LIBOR + .625 percent. Given its asset structure, six-month LIBOR is the preferred index. Assume a notional principal of \$15,000,000.
- Determine the QSD and set up a floating-for-floating rate swap where the swap bank receives .125 percent and the two counterparties share the remaining savings equally. **[6marks]**
 - Determine the value of the swap to Company A. **[5marks]**

Question 2

- (i) Karla Ferris, a fixed income manager at Mangus Capital Management, expects the current positively sloped U.S. Treasury yield curve to shift parallel upward.

Ferris owns two \$1,000,000 corporate bonds maturing on June 15, 1999, one with a variable rate based on 6-month U.S. dollar LIBOR and one with a fixed rate. Both yield 50 basis points over comparable U.S. Treasury market rates, have very similar credit quality, and pay interest semi-annually. Ferris wished to execute a swap to take advantage of her expectation of a yield curve shift and believes that any difference in credit spread between LIBOR and U.S. Treasury market rates will remain constant.

- (a) Describe a six-month U.S. dollar LIBOR-based swap that would allow Ferris to take advantage of her expectation. Discuss, assuming Ferris' expectation is correct, the change in the swap's value and how that change would affect the value of her portfolio.

[3marks]

- (ii) Today is March 1, 2004. The day-count basis is actual/365. You have the following contracts on your FX-book. CONTRACT A: On March 15, 2004, you will sell 1,000,000 EUR at a price F_{1t} dollars per EUR. CONTRACT B: On April 30, 2004, you will buy 1,000,000 EUR at a price F_{2t} dollars per EUR.

- (a) Construct *one* synthetic equivalent of each contract. **[4marks]**

(b) Suppose the spot EUR/USD is 1.1500/1.1505. The USD interest rates for loan under 1 year equal 2.25/2.27, and the German equivalents equal 2.35/2.36.

Calculate the F_{it} numerically. **[4marks]**

- (c) Suppose the forward points for F_{1t} that we observe in the markets is equal to 10/20. How can an arbitrage portfolio be formed? **[3marks]**

(iii) Suppose a trader would like to buy a t_1 -maturity bond at time t_0 . The trader also wants this bond to be *liquid*. Unfortunately, he discovers that the only bond that is liquid is an *on-the-run* Treasury with a longer maturity of t_2 . All other bonds are *off-the-run*. How can the trader create the liquid short-term bond synthetically assuming that all bonds are of discount type and that, contrary to reality, forward loans are liquid? **[4marks]**

(iv) You are given the following information:

3-m Libor 3.2% 92 days

3 × 6 FRA 3.3%–3.4% 90 days

6 × 9 FRA 3.6%–3.7% 90 days

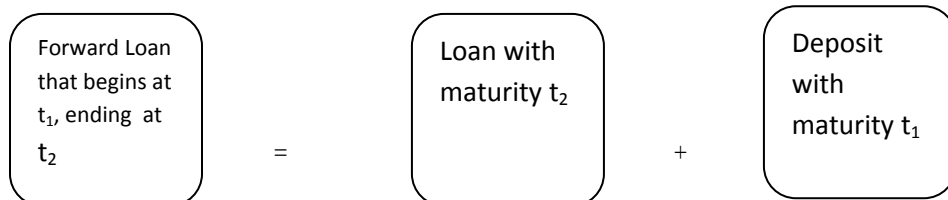
9 × 12 FRA 3.8%–3.9% 90 days

(a) Show how to construct a synthetic 9-month loan with fixed rate beginning with a 3-month loan. Plot the cash flow diagram. **[4marks]**

(b) What is the fixed 9-month borrowing cost? **[3marks]**

Question 3

(i) Consider a bank that has a *maturity mismatch* at time t_0 . The bank has borrowed t_1 -maturity funds from Euromarkets and lent them at maturity t_2 . Clearly, the bank has to roll over the short-term loan that becomes due at time t_1 with a new loan covering the period $[t_1, t_2]$. This new loan carries an (unknown) interest rate L_{t_1} and creates a mismatch risk. Use the following contractual equation below to address the banks problem. **[4marks]**



- (ii) The treasurer of a small bank has borrowed funds for 3 months at an interest rate of 6.73% and has lent funds for 6 months at 7.87%. The total amount is USD38 million. To cover his exposure created by the mismatch of maturities, the dealer needs to borrow another USD38 million for months, in 3 months' time, and hedge the position now with a FRA. The market has the following quotes from three dealers:

BANK A 3 × 6 6.92–83

BANK B 3 × 6 6.87–78

BANK C 3 × 6 6.89–80

(a) What is (are) the exposure(s) of this treasurer? Represent the result on cash flow diagrams. **[3marks]**

(b) Calculate this treasurer's break-even forward rate of interest, assuming no other costs. **[3marks]**

(c) What is the best FRA rate offered to this treasurer? **[2marks]**

(d) Calculate the settlement amount that would be received (paid) by the treasurer if, on the settlement date, the Libor fixing was 6.09%. **[2marks]**

- (iii) You are hired by a financial company in New Zealand and you have instant access to markets. You would like to lock in a 3-month borrowing cost in NZ\$ for your client. You consider a NZ\$ 1 × 4 FRA. But you find that it is overpriced as the market is thin. So you turn to Aussie. A\$ FRAs are very liquid. It turns out that the A\$ and NZ\$ forwards are also easily available. In particular, you obtain the following data from Reuters:

A\$/NZ\$ Spot the: 1.17/18

1-m forward: 1.18/22

3-m forward: 1.19/23

4-m forward: 1.28/32

A\$ FRA's 1 × 4 8.97

(a) Show how you can create a 1 × 4 NZ\$ from these data. **[4marks]**

(b) Show the cash flows.

[2marks]

(c) What are the risks of your position compared to a direct 1 × 4 NZ\$ FRA? [3marks]

(d) Do you think there must be arbitrage relationships between the FRA markets and currency forwards? Explain.

[5marks].

Question 4

- (i) Northwestern Bell Telephone (NWB) is a subsidiary of U.S. West, one of the Baby Bell telephone companies. On May 2, 1990, it extinguished \$42.7 million of several debt issues with coupons ranging from 4.875 to 9.5 percent having maturities of 8 to 26 years. To extinguish this debt, NWB issued a new security paying 7.75 percent maturing in May 2030. Morgan Stanley & Company assisted in this transaction. Morgan Stanley purchased \$42.675 million of NWB's debt for about \$34.5 million through open market and privately negotiated transactions. NWB gave to Morgan Stanley a cash payment of \$408,000 and \$42.883 million face value of its new issued 7.75 bonds due in 2030 in exchange for the \$42.675 million of NWB bonds that Morgan Stanley had acquired in the open market. Figure 8.8 shows the transactions involved. In these transactions, Morgan did not act as the agent of NWB. If Morgan had acted as NWB's agent, buying the old bonds for NWB's account, the difference between the basis and the market value of each bond would have been treated as taxable income to NWB. At the time of the transaction, the tax law allowed for a tax-free exchange if the principal amount of the new issue was about the same as the principal amount retired. Because the transaction was structured as an exchange, NWB avoided any unfortunate tax implications.

Explain the financial mechanics used by NWB in this case.

[5marks]

(ii) Sonatrach is the state-owned hydrocarbon producer of Algeria. In late 1989, Sonatrach was faced with financial difficulty in meeting payments to a banking syndicate on its borrowings through a floating-rate note (FRN). Sonatrach was paying LIBOR plus a large spread of several full percentage points. To resolve this financial embarrassment, Chase Manhattan Bank helped Sonatrach retire its existing FRNs by issuing a series of inverse oil-indexed bonds. The new debt structure substantially reduced the cash flows due from Sonatrach in each period, thereby reducing the likelihood of financial difficulty. The Sonatrach transaction was organized as follows. First, Sonatrach issued new FRNs paying LIBOR plus 100 basis points to a group of syndicate banks. Second, Sonatrach wrote two-year call options on oil with a striking price of \$23 to Chase. Third, Chase wrote seven-year calls on oil with a striking price of \$22 to the syndicate banks. Fourth, Chase wrote seven-year puts on oil with a striking price of \$16 to the syndicate banks. Fifth, the banks extinguished the previously existing FRNs, accepting the new FRN from Sonatrach and the calls and puts from Chase as a substitute.

- a. Describe the strategy employed by Sonatrach. **[4marks]**
- b. Present the above transactions diagrammatically and deduce Sonatrach effective cost of financing. **[4marks]**

(iii) Consider two interest rate swaps to pay fixed and receive floating. The two swaps require the same payments each semi-annual period, but one swap has a tenor of 5 years, while the second has a tenor of 10 years. Assume that you buy the 10-year swap and sell the 5-year swap. What kind of instrument do these transactions create? Explain. **[3marks]**

(iv) Nifty is at 3200. Mr. XYZ expects very little movement in Nifty. He sells 2 ATM Nifty Call Options with a strike price of Rs. 3200 at a premium of Rs. 97.90 each, buys 1 ITM Nifty Call Option with a strike price of Rs. 3100 at a

premium of Rs. 141.55 and buys 1 OTM Nifty Call Option with a strike price of Rs. 3300 at a premium of Rs. 64.

- a. What is the motivation of the investor in this transaction? **[3marks]**
- b. Identify primary and secondary positions, what are their respective roles?
[2marks]

- c. Mr. XYZ buys a Nifty Call with a Strike price Rs. 4100 at a premium of Rs. 170.45 and he sells a Nifty Call option with a strike price Rs. 4400 at a premium of Rs. 35.40. The net debit here is Rs. 135.05 which is also his maximum loss. Explain the motivation of this trading strategy clearly identifying the primary and secondary positions. Use pay off table to deduce the payoff chart. **[5marks]**