The University of Hong Kong

FACULTY OF ENGINEERING
DEPARTMENT OF COMPUTER SCIENCE

COMP 7802 Introduction to financial computing

Date: December 10, 2016   Time: 2:30pm–4:30pm

Time allowed   :   2 hours
Student I.D.   :   _____

Only approved calculators as announced by the Examinations Secretary can be used in this examination. It is candidates' responsibility to ensure that their calculator operates satisfactorily, and candidates must record the name and type of the calculator used on the front page of the examination script.

**Brand and type
of calculator**   :   _____

Candidates are permitted to bring to the examination one piece of A4-sized paper with printed or written notes on both sides.

Answer ALL questions.

1. [15 points] Recall Assignment #1. The *Payout Period* and *Investment Period* are *Months* instead of *Years*. Note that interest should still be accrued throughout the investment and payout period, that is, the month beginning at the last payment date and ending at the first payout date should accrue interest.

Given an investment product:						
1. Buyer will pay a certain fixed premium (to be calculated) at the end of each month (modified following) for a number of months (to be input).						
2. The premium paid will earn interest (derived from the discount factors given). Interest should still be earned from the last payment date to the first payout date.						
3. Starting the next month after the last payment, buyer will start receiving a fixed amount (to be input) at the end of each month (modified following) for a number of years (to be input).						
Note: 1. Interest (again derived from the discount factors) will continue to be earned for the remaining balance throughout the payout periods.						
2. The final balance should be as close to zero as possible.						

Date	March 8, 2007	Fixed				
Payout Amount	$10,000			Last Payment Date	b	
Payout Period	2	Months		Payment Amount	e	
Investment Period	2	Months				
				Final Balance	h	

Payment Date	Payment Amount	Accrued Amount	Payout Date	Payout Amount	Remaining Balance
a	e	e	c	10,000.00	g
b	e	f	d	10,000.00	h

Discount Factors:

Date	Discount Factor			Date	Discount Factor	
March 8, 2007	1	Thu		June 1, 2007	0.9983504	Fri
March 29, 2007	0.99960354	Thu		June 2, 2007	0.998330832	Sat
March 30, 2007	0.999583948	Fri		June 3, 2007	0.998311264	Sun
March 31, 2007	0.999564356	Sat		June 4, 2007	0.998291697	Mon
April 1, 2007	0.999544764	Sun		June 28, 2007	0.997858361	Thu
April 2, 2007	0.999525173	Mon		June 29, 2007	0.997839202	Fri
April 25, 2007	0.99907468	Wed		June 30, 2007	0.997820044	Sat
April 26, 2007	0.999055098	Thu		July 1, 2007	0.997800886	Sun
April 27, 2007	0.999035516	Fri		July 2, 2007	0.997781729	Mon
April 28, 2007	0.999015935	Sat		July 3, 2007	0.997762572	Tue
April 29, 2007	0.998996354	Sun		July 26, 2007	0.99732206	Thu
April 30, 2007	0.998976774	Mon		July 27, 2007	0.997302911	Fri
May 1, 2007	0.998957193	Tue		July 28, 2007	0.997283763	Sat
May 2, 2007	0.998937614	Wed		July 29, 2007	0.997264616	Sun
May 29, 2007	0.998409106	Tue		July 30, 2007	0.997245469	Mon
May 30, 2007	0.998389537	Wed		July 31, 2007	0.997226322	Tue
May 31, 2007	0.998369968	Thu		August 1, 2007	0.997207175	Wed

Holidays:

March 21, 2007	April 30, 2007	May 3, 2007	May 4, 2007	July 16, 2007

Question 1 (Cont'd)

Find the values of *a* through *h*.

Hint: *e* through *h* can be evaluated in any order.

a.   **[1 points]**

b.   **[1 points]**

c.   **[1 points]**

d.   **[1 points]**

e.   **[3 points]** (2 decimal points accuracy)

f.   **[3 points]** (2 decimal points accuracy)

g.   **[3 points]** (2 decimal points accuracy)

h.   **[2 points]** (2 decimal points accuracy)

2.   **[12 points]** A dealer has borrowed funds for six months at an interest rate of 10.375% and has lent funds for one month at an interest rate of 9.875%. The amount involved is US$5 million. The dealer now has a five-month forward exposure gap.

To match or cover the exposure created by the "gap" will require the dealer to lend US$5 million for five months, in one-month's time, and hedge the position now with an FRA.

Five banks are quoting FRA rates for 1 v 6 month as follows:

Bank A   10.39 – 34

Bank B   10.40 – 35

Bank C   10.43 – 38

Bank D   10.44 – 39

Bank E   10.41 – 36

Assuming **day to spot is 0** and **interest per month is 1/12 of a year**.

a.   **[4 points]** Calculate the dealer's break-even forward-forward rate of interest, that is, no loss at the end of the sixth-month.

b.   **[2 points]** Identify the best FRA price (from the bank quotes above) at which he should deal to cover the exposure.

c.   **[3 points]** Use FRA notional as US$5 million. Calculate the settlement amount which would be received/paid by the dealer if, at the settlement of his FRA, the LIBOR fix was 10.75%.

d.   **[3 points]** Calculate the total loss at the end of the sixth-month. Assume that the dealer will execute transaction(s) such that there is no net cash flow at the end of the first-month.

3. [8 points] Today is 1 May 2006. Given the following market data of an IRS:

Notional amount:	10 million
Start of swap:	3 May 2006
Maturity of swap:	3 May 2007 (Note that 2004 is a leap year)
Receive (Fixed leg):	? % (semi-annual ACT/365)
Pay (Floating leg):	LIBOR (semi-annual ACT/365)

Zero-coupon discount factors:

3 May 2006:   0.999602858

3 Nov 2006:   0.963202331

3 May 2007   0.930693218

a. **[2 points]** Suppose a company would like to enter the above IRS deal with a counterparty. What is the "ideal" NPV of the IRS on 1 May 2006?

b. **[5 points]** Show the equation for calculating the rate of the fixed leg.

c. **[1 points]** Solve the equation in part (b).

4. [8 points] For a settlement on 9 February 1990 you purchase the following Eurodollar CD at a price of 8.38% (Note: yield definition is comparable with other Eurodollar money market yield)

Issuer:	National Westminster Bank
Date of Issue:	4 November 1989
Maturity:	4 November 1990
Principal Amount:	$100,000.00
Coupon	9.75%

a. **[3 points]** What is the purchase cost, in dollars?

b. **[2 points]** Calculate the interest paid by the CD at maturity.

c. **[3 points]** On 19 February 1990 the CD is sold at 8.50%. How much profit or loss has been made and what is the yield achieved?

5. **[7 points]** Money market dealers in London traditionally quote Eurodollar rates in fractions, to the nearest 1/16% or 1/32%. Given the following rates:

Eurodollars	1 MONTH	
Bank A	8.11/16 – 8.1/2	(i.e., $8\frac{11}{16}\%$ and $8\frac{1}{2}\%$)
Bank B	8.23/32 – 8.9/16	
Bank C	8.21/32 – 8.17/32	
Bank D	8.5/8 – 8.15/32	
Bank E	8.19/32 – 8.7/16	

a. **[2 points]** From which bank would you borrow dollars and what rate of interest would be applied?

b. **[2 points]** With which bank would you deposit money and at what rate of interest?

c. **[3 points]** Quote a two-way rate, both for lending and borrowing, that will encourage a borrower and a lender to deal with you rather than with the other banks.

6. [22 points] On a given day T, the current Stock Index level is 23300 near the market closing. The 3-month European Call and Put option prices quoted for the Stock Index in the market as follows:

Current Index	23300	
Stirke	Call	Put
22800	1,064	444
23000	923	511
23200	800	590
23400	686	675
23600	582	766

The following information is provided for 3-month Stock Index option contract:

- all options are of same expiry date, the remaining time to maturity is 90 days
- day/year convention is ACT/365
- Option price is quoted in index point. 1 index point = $50

a. **[2 points]** Please list out the out-of-money Call Options above and provide justification.

b. **[2 points]** Please list out the in-the-money Put Options above and provide justification.

Question 6 (Cont'd)

c. On T, an Investor observed that the current risk free annual interest rate is 1.5%. He is considering to create the Put-Call Parity Portfolios as follows:

Portfolio A	Long Stock Index Call Option at Strike 22800 + Long zero coupon Bond
Portfolio B	Long Stock Index Put Option at Strike 22800 + Long Stock Index Basket at Index level 23300 (Note: The Stock Index Basket replicates the equivalent stock index portfolio value at the prevailing index level).

c(i) **[2 points]** In Portfolio A, what should be the expected Bond value on T in order to create the Put-Call Parity Portfolios? (Please show the calculation expression with 2 decimal points accuracy)
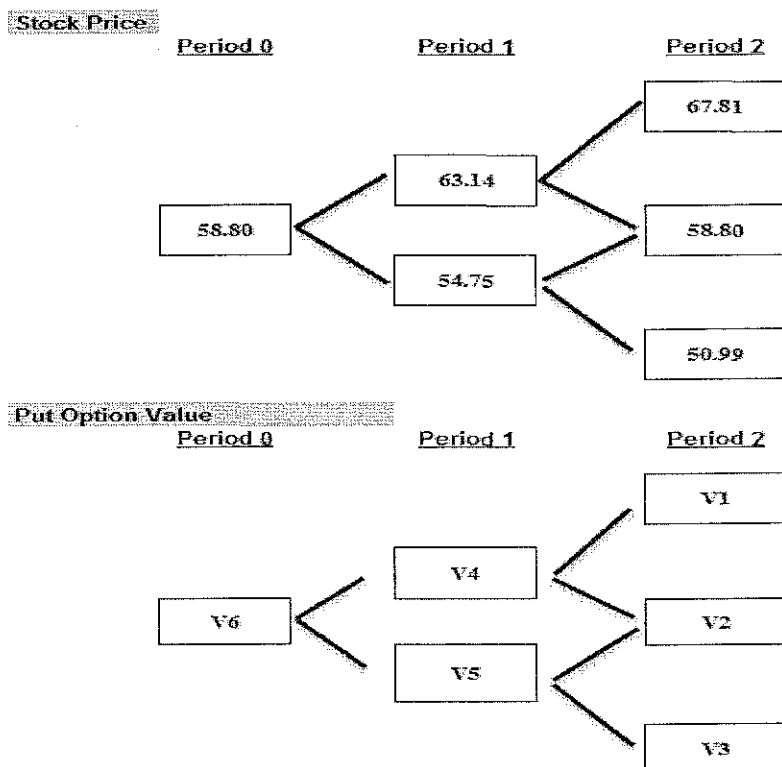
(Hints: 1 index point = $50)

c(ii) **[7 points]** Continued from above, assuming that the Stock Index is closed at 21,000 level at Option expiry date. Investor said that "based on put-call parity relationship, the two portfolio values is expected to be the same at Option expiry". Please prove his statement. (You need to show all the calculation expression for the value of each portfolio and its products breakdown with 2 decimal point accuracy.)

c(iii) **[3 points]** For Option with strike at 22800, with the given Call Option market price above, what should be the Put Option theoretical price (in index point) on T based on Put-Call Parity relationship? (Please show the calculation expression with 2 decimal points accuracy).

c(iv) **[1 point]** Continued from the above, Investor said he felt that Put Option market price is over-valued for given Call Option market price at the strike of 22800. Please validate and justify if his feeling is correct?

Question 6 (Cont'd)

d. On T, Investor is currently holding the Stock Index Basket constructed at 23300 index level (Hint: 1 index point = $50). He is worrying the index might fall below 23300 in 90 days and would like to protect downside risk by means of simple Option strategy with Option at strike 22800 on T.

   d(i) **[1 point]** Please describe and explain how he could protect the downside risk of his Stock Index Basket with simple Option strategy with Option at strike 22800 on T?

   d(ii) **[4 points]** Continued from above, the Stock Index is closed at 21,000 level Index at Option expiry date. Please calculate the net profit or loss (in $) of Stock Index Basket at expiry with your Option Strategy in the above question. You need to show the calculation expression for each product components profit and loss clearly in your calculation with 2 decimal points accuracy before showing the total net profit/loss result.

7.   **[28 points]** A student is constructing the 2 period (or 2-steps) binomial pricing model for a Stock Put option with below information:

    Current Stock price = $58.8
    Option Strike = $60
    Continuous compound risk-free interest rate = 2%
    Option time to maturity = 90 days
    Day / year convention = ACT/360

    a. **[2 points]** Student observed the daily historical volatility is estimated as 1.27%, what is the annualized volatility assuming 252 days in a year.

    b. **[5 points]** Apply the Cox, Ross & Rubinstein binomial pricing model to calculate below intermediary parameters:

- Δt = period interval in each binomial nodes
- DF = discount factor in each binomial nodes
- u = up jump size
- d = down jump size
- p = risk neutral probability of up jump size

Please show the calculation expression of each intermediary parameters and round to 6 decimal point accuracy.

Question 7 (Cont'd)

c.   **[10 points]** The student created below 2 period binomial pricing model spreadsheet. He would like to calculate the theoretical European Put option price. Part of the result is done for stock price valuation. Please compute the Option value from V1 to V6, then deduct the theoretical European Put option price. Show the calculation expression and round to 6 decimal points accuracy.

Stock Price

	Period 0	Period 1	Period 2
			67.81
		63.14	
	58.80		58.80
		54.75	
			50.99

Put Option Value

	Period 0	Period 1	Period 2
			V1
		V4	
	V6		V2
		V5	
			V3

d.   **[10 points]** Using the same spreadsheet format in c) above to compute the theoretical American Put option price. Show the calculation expression and round to 6 decimal point accuracy.

e.   **[1 point]** Which theoretical option price is higher - American or European Put? Please provide justification.

END OF PAPER