The University of Hong Kong

FACULTY OF ENGINEERING
DEPARTMENT OF COMPUTER SCIENCE

COMP 7802 Introduction to financial computing

Date: December 14, 2019 (9am) - December 15, 2019 (9am)
Online 24-hours open-book exam

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.

You shall write your answer with any text editor (e.g. MS Word) installed in your computer. If necessary, you may scan your hand-written text or graphics and incorporate them into your document file before submission.

Write your University No. at the beginning of your answer script. Then write the brand and model of the calculator that you use.

Answer ALL questions.

Put all your work in a single file in either PDF, MS Word or ZIP (of JPG images) formats.

You must submit your work to Moodle before December 15, 2019 (9am).

1. [25 points] Consider a simplified version of 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

a to h. [15 points] Find the values of *a* through *h*.

For *e* through *h*, show the expressions, if any, for arriving at your answers.

a	b	c	d	e	f	g	h
1 point	1 point	1 point	1 point	3 points	3 points	3 points	2 points

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

i. **[5 points]** Now assume that both the "Investment Period" and the "Payout Period" are both 24 months, the (simple annual market) rate of interest accrual is 3% throughout the periods and "Payout Amount" is $10,000. Use the Excel *PV* function

PV(rate, nper, pmt, [fv], [type])

Rate Required. The interest rate per period.

Nper Required. The total number of payment periods in an annuity.

Pmt Required. The payment made each period and cannot change over the life of the annuity.

Fv Optional. The future value, or a cash balance you want to attain after the last payment is made.

Type Optional. The number 0 (at the end of the period) or 1 (at the beginning of the period) and indicates when payments are due.

to estimate the remaining balance on the first payout date.

j. **[5 points]** Use the same assumptions as in (i) and in terms of the answer of (i), estimate the "Payment Amount" using the Excel *PMT* function

`PMT(rate, nper, pv, [fv], [type])`

Rate Required. The interest rate for the loan.

Nper Required. The total number of payments for the loan.

Pv Required. The present value, or the total amount that a series of future payments is worth now; also known as the principal.

Fv Optional. The future value, or a cash balance you want to attain after the last payment is made. If fv is omitted, it is assumed to be 0 (zero), i.e., the future value of a loan is 0.

Type Optional. The number 0 (at the end of the period) or 1 (at the beginning of the period) and indicates when payments are due.

Please use "[i]" to represent your answer to (i) in your expression.

2. [20 points]

On 16 October 2014

GBP LIBOR   3 months   1%

GBP FRA   3x6 months   1.1%

Assume that year basis is 365, days to spot is 2.

September 2014								October 2014								November 2014								December 2014						
Su	Mo	Tu	We	Th	Fr	Sa		Su	Mo	Tu	We	Th	Fr	Sa		Su	Mo	Tu	We	Th	Fr	Sa		Su	Mo	Tu	We	Th	Fr	Sa
	1	2	3	4	5	6					1	2	3	4								1			1	2	3	4	5	6
7	8	9	10	11	12	13		5	6	7	8	9	10	11		2	3	4	5	6	7	8		7	8	9	10	11	12	13
14	15	16	17	18	19	20		12	13	14	15	16	17	18		9	10	11	12	13	14	15		14	15	16	17	18	19	20
21	22	23	24	25	26	27		19	20	21	22	23	24	25		16	17	18	19	20	21	22		21	22	23	24	25	26	27
28	29	30						26	27	28	29	30	31			23	24	25	26	27	28	29		28	29	30	31			
																30													

January 2015								February 2015								March 2015								April 2015						
Su	Mo	Tu	We	Th	Fr	Sa		Su	Mo	Tu	We	Th	Fr	Sa		Su	Mo	Tu	We	Th	Fr	Sa		Su	Mo	Tu	We	Th	Fr	Sa
				1	2	3		1	2	3	4	5	6	7		1	2	3	4	5	6	7					1	2	3	4
4	5	6	7	8	9	10		8	9	10	11	12	13	14		8	9	10	11	12	13	14		5	6	7	8	9	10	11
11	12	13	14	15	16	17		15	16	17	18	19	20	21		15	16	17	18	19	20	21		12	13	14	15	16	17	18
18	19	20	21	22	23	24		22	23	24	25	26	27	28		22	23	24	25	26	27	28		19	20	21	22	23	24	25
25	26	27	28	29	30	31										29	30	31						26	27	28	29	30		

a.   **[3 points]** What is the start date and maturity date of the 3-month LIBOR? What is the settlement date of the FRA?

b.   **[1 point]** Suppose Company A would like to transact a spot fixed rate borrowing of GBP 1Million for 6 months using the given LIBOR and FRA. An officer from Company A execute the following transactions:

On 16 October 2014,

Borrow GBP 1Million for 3 month @1%

Buy 1 Million FRA 3x6 month @1.1%

Show the cashflow (including the date) before the settlement date of the FRA.

c.   **[3 points]** Suppose that 2 business days before the settlement date of the FRA, the GBP LIBOR for the FRA period is 2%. Calculate the cashflow (including date) of the FRA settlement. Clearly show your expression to obtain the answer.

d.   **[6 points]** Continue from *b* and *c*, the officer of Company A knows that there should not be any net cashflow after the company obtained the loan and before the company pays off the loan at the end of the six-month. Show the transactions the officer must execute so that this is true. Clearly indicate the dates when the transactions are initiated and the detail (that is, before netting) cashflows (include dates).

e. **[7 points]** Does the officer achieve a fix rate borrowing for 6 months? If yes, what is the fix rate? Otherwise, correct the mistake and calculate the fix rate.

3. [5 points] For 3-month HIBOR Futures Contract,

Contract Size	HK$5,000,000
Minimum Fluctuation	one (1) basis point

a. **[2 points]** What is the value of a Minimum Fluctuation?

b. **[2 points]** Suppose you buy a contract at a price of 98.25 and sell it at a price of 98.20. What is your P&L?

c. **[1 point]** Today is 14 December 2019, when is next Settlement Day for a 3-month HIBOR Futures Contract?

4. [17 points] Below are the current market data for stock option of Company ABC.

Today = T

Current Stock price on T ($) : **58.25**

Continous compounding risk free rate : 1.81% per annum

Day Count Convention: Act / 360

Stock Option Style = European

Stock option conversion ratio: 1 option = 1 share

Option Reference	Call/Put	Time to Expiry	Strike	Price
1	Call	30 days	57.5	1.36
2	Call	30 days	60.0	0.41
3	Call	30 days	62.5	0.10
4	Put	30 days	57.5	1.22
5	Put	30 days	60.0	2.90
6	Put	30 days	62.5	5.03

For calculation, please show you calculation expression with result in 2 decimal points accuracy.

a) **[6 points]** Please compute the time value of Option #1 and #4?

b) **[7 points]** Investor buys 1 unit each for Option #2 and #5, what is this option strategy? Please compute the stock price ranges at which the investor will make profit?

c) **[4 points]** Referring to Option #3 and #6, please identify any mispricing based on put-call parity theory? Please state which option(s) is/are overpriced or underpriced by comparing the actual and theoretical option price?

5. [33 points] Below information is the current market data available for stock and stock option of Company XYZ.

Current Stock price = $6.13 per share
Option Strike = $5.5
Option time to expiry = 90 days
Stock Option Style = European
Day count convention = ACT/360
Annualized Volatility = 22%
Continuous compounding risk-free interest rate = 1.85% per annum

The Investor would like to use 2 periods binomial option pricing model (Cox, Ross & Rubinstein) to calculate the European Put option theoretical price of the above option. In his spreadsheet model, the following tree diagram is shown.
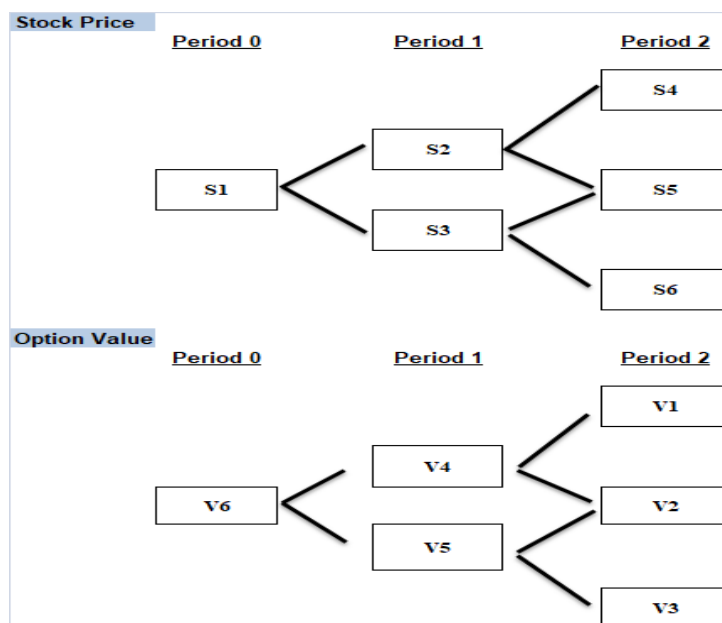
a) **[2 points]** Please advise the Moneyness of the Put Option with justification?

b) **[5 points]** Please calculate below intermediary parameters of binomial option pricing model.

- 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 with result in 6 decimal points accuracy.

c) **[7 points]** Based on the investor spreadsheet, the Share Value computation result is given as follows:

S1 = 6.13,
S2 = 6.63, S3 = 5.67,
S4 = 7.16, S5 = 6.13, S6 = 5.25

Please compute the option value of V1 to V6, then indicate the theoretical price of European put option clearly. *Show the calculation expression with result in 6 decimal points accuracy.*

d) Investor expects that "the decrease of stock annualized volatility to 10% will impact the binomial model intermediary parameters and stock value projection result, hence impact the option intrinsic value projection. As a result, the put option price will be cheaper after projected option intrinsic value discounting." Based on his expectation statement, assuming all other factors remained unchanged, please answer below questions.

d1) **[6 points]** Please indicate clearly which intermediary parameter(s) of binomial option pricing model will be impacted and re-calculate the impacted parameter(s) value?

Please show the calculation expression of each intermediary parameters with result in 6 decimal points accuracy.

d2) **[6 points]** Please indicate clearly which option value (V1 to V6) in the binomial pricing model spreadsheet tree diagram are (i) option intrinsic value projection and (ii) projected option intrinsic value discounting?

d3) **[7 points]** With the above-mentioned new stock volatility, please recalculate the European Put Option theoretical price? The new Share Values are given in below:

S1 = 6.13,

S2 = 6.35, S3 = 5.92,

S4 = 6.58, S5 = 6.13, S6 = 5.71

END OF PAPER