

The University of Hong Kong
FACULTY OF ENGINEERING
DEPARTMENT OF COMPUTER SCIENCE

COMP 7802 Introduction to financial computing

Date: December 9, 2017

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] Loan

- a. [5 points] On 13 Dec 2016, a customer entered into a loan of \$100,000 with a bank. The annual interest rate is 5%. The repayment schedule is P on 13 Dec 2017, $2P$ on 13 Dec 2018 and $3P$ on 13 Dec 2019. Calculate P . Assume ACT/365 for year basis.
- [4 points] Show the equation for calculating P .
 - [1 point] Calculate P .
- b. [10 points] On 13 Dec 2016, a customer entered into a loan of \$100,000 with a bank. The repayment schedule is \$55,000 on 13 Dec 2017 and \$55,000 on 13 Dec 2018. Estimate the annual interest rate r . Again, assume ACT/365 for year basis.
- [4 points] Show the equation for calculating r .
 - [6 points] Calculate r .

2. [15 points] Arbitrage

Given the following market rates:

3 months Rates	5.05% - 5.10%
6 months Rates	4.95% - 5.00%
FRA 3x6 months	4.95% - 5.00%

Is there any opportunity for arbitrage?

If **yes**, clearly indicate the transactions and the respective times you have to execute. You may use a notional of \$1,000,000 for illustration. If you transact an FRA, you should also show the notional. Show a diagram of the cashflows (individual cashflows instead of netted should be shown).

If **no**, clearly explain why.

3. [15 points] An FRA market maker sells a EUR 100 million 3v6 FRA at a rate of 7.52%. He is exposed to the risk that interest rates will have risen by the FRA settlement date in three months' time.

Date (spot)	21 December
3v6 FRA rate	7.52%
March futures price	92.50
Current 3M spot rate	6.85%

The dealer needs to calculate a hedge ratio. Assume 30/360, that is, 90/360 for 3 months.

- a. [4 points] If interest rate for the FRA period rises by 1 bp (basis point), calculate the loss to the dealer, discounting back to the spot day-.
- b. [2 points] Should the dealer buy or sell future contracts to hedge the FRA?
- c. [4 points] Given the following specification for the Three Month Euro (Euribor) Future

Notional	€1,000,000
Tick Size	0.5 bp

Calculate the hedge ratio. Show your expression.

- d. [5 points] Market data after 3 months

Date (spot)	21 March
March futures settlement	92.38
3M spot rate	7.625%

Calculate the P/L (Profit and Loss).

4. [5 points] True or False

- a. If economic activity is expected to accelerate in the future, the yield curve tends to become flatter.
- b. Wide spread quotes indicates an instrument has a high liquidity risk.
- c. Investing in commercial paper usually has a higher return than treasury notes.
- d. At inception, the theoretical NPV of an IRS is zero.
- e. You have to pay a non-refundable premium for entering into a futures contract.

5. [15 points] Near market closing on a given day T, below information is observed for stock and European stock option of Company ABC.

Current Stock price = \$76.5 per share

Option Strike = \$75

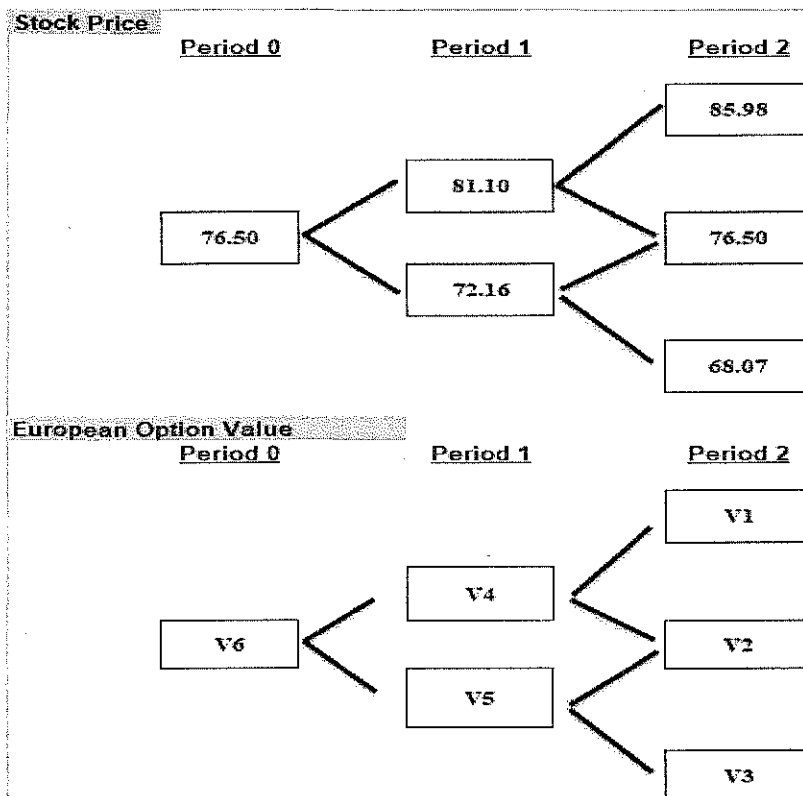
Option time to expiry = 90 days

Day / year convention = ACT/360

Annualized Volatility = 16.52%

Continuous compounding risk-free interest rate = 0.68% per annum

The Investor would like to use 2 periods binomial option pricing model (Cox, Ross & Rubinstein) to calculate the theoretical put and call option price of the above option. In his spreadsheet model, the following tree diagram is shown.



a) [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 (round the calculated results to the nearest 6 decimal points)

- b) [7 points] Please use the tree diagram shown above with given stock prices projection to calculate the European call option theoretical price. You are required to calculate the value of V1 to V6, then indicate the theoretical price of European call option clearly.

Please show the calculation expression and round to 6 decimal points accuracy

- c) [3 points] The current call option market price on T is the same as the option theoretical price computed in b) above, please determine the following on T:

- Intrinsic value of the call option
- Time value of the call option
- Moneyness of the call option

Please show the calculation expression and round to 6 decimal points accuracy.

6. [20 marks] Below are the current market price observation for Company ABC on a given day T.

Current Stock price on T (\$) 76.5
Continuous compounding risk free rate (p.a.) 0.68%

Charateristic	Call Option	Put Option
Price(\$)	3.20	1.78
Strike(\$)	75	75
Time to expiry	90 days	90 days
day count basis	ACT/360	ACT/360
Option Style	European	European

The Investor said that *"the arbitrage opportunity exists based on the above option price quotation in the market"*. He would like to consult your advice on the appropriate investment strategy to exploit the optimal arbitrage profit in the market based on Put-Call Parity theory.
(Please show the calculation expression with 2 decimal points accuracy in this question.)

- a) [2 points] Please apply the Put-Call Parity theory to prove that the statement advised by Investor is correct.
- b) [9 points] Based on Put-Call Parity Theory, the Investor is considering to use the following products with 1 unit each to exploit the arbitrage opportunity per observed market data, namely (i) bond at price of PV(X) on T, (ii) stock, (iii) call option and (iv) put option. He said his expectation is *"all the arbitrage profit should be locked up on T and no additional profit or loss at option expiry date regardless the stock price at expiry is above or below the option strike."*
- i) [4 points] Please advise the Investor the appropriate buy / sell action of each product on T which will meet the expectation required by the investor.

ii) [5 points] Then, please list out the cost of investment of each product and calculate the arbitrage profit locked up on T. (Please indicate +ve and -ve sign as cash-inflow and cash-outflow respectively)

c) [9 points] Based on your advice given in b above, please explain what you will do to settle the products involved at option expiry date in each scenario below in order to validate that there will have "no additional profit or loss at option expiry date regardless the stock price at expiry is above or below the option strike:

i) stock price = \$70 at option expiry

ii) stock price = \$75 at option expiry

iii) stock price = \$80 at option expiry

In your solution, you are required to provide (i) each option value at expiry, (ii) each option exercise status at expiry and (iii) the respective product delivery actions to be taken at option expiry.

7. [15 marks] The Investor is working on the spreadsheet to estimate the stock price volatility.

Below is the sequence of closing prices of the stock of Company ABC for the preceding month-end shown in the spreadsheet. However, the calculation is only partially completed.

Month	Observed Price (S_t)	X_t	$(x_t - \bar{x})^2$
0	58.35		
1	61.45	0.051764	0.000859
2	62.25	0.012935	0.000091
3	66.00	0.058496	0.001299
4	62.55	-0.053689	0.005799
5	63.15	0.009547	0.000167
6	64.25	0.017269	0.000027
7	67.90	0.055254	0.001075
8	72.85	0.070366	0.002295
9	78.40	0.073421	0.002597
10	76.00	-0.031091	0.002868
11	76.55	0.007211	0.000233
12	76.40	-0.001961	0.000596

where:

S_t = observed stock price at time period t

$X_t = \text{LN}(S_t / S_{t-1})$

$\bar{x} = \text{Average}(X_t) = (\sum X_t) / n$

n = no. of months over the year

- a) [3 points] Using the above data, please help him to complete the annual volatility calculation. *Please show the calculation expression with 6 decimal points accuracy and express volatility result in percent with 2 decimal points.*
- b) [12 points] At the end of month-9, Investor executed the 1 unit of long straddle option strategy at the following option market prices of Company ABC

Current Stock price on T (\$) **76.5**
 Continuous compounding risk free rate (p.a.) **0.68%**

Charateristic	Call Option	Put Option
Price(\$)	3.40	1.78
Strike(\$)	75	75
Time to expiry	3 months	3 months
Option Style	European	European

Please show the calculation expression with 2 decimal points accuracy in this question.

- i) [2 points] Please explain the long straddle option strategy in terms of (i) the option combination and (ii) the expectation in this strategy deployment.
- ii) [4 points] Please calculate the following of 1 unit long straddle option strategy taken by the Investor at option expiry date.
- potential maximum loss
 - potential maximum gain
 - breakeven point (stock price) when the stock price goes up
 - breakeven point (stock price) when the stock price goes down
- iii) [6 points] After 3 months, the option expired. Please calculate the profit or loss of this 1 unit long straddle option strategy at expiry in the following 2 scenarios:
- the option expired and settled at month-12 stock closing price
 - the option expired and settled at stock price of \$100 per share