JÖNKÖPING UNIVERSITY

Försättsblad till tentamen
Cover sheet for Examination.

15961681

Anonymkod *Anonymous code*	Kurskod *Course code*	Provkod *Test code*
K O G - N K N	F S O R 2 3	1 3 0 1

Kursnamn *Course name*

Derivatives Securities

Tentamensdatum *Examination date* År / *Year* Månad / *Month* Dag / *Day*	Antal lösblad *No. of loose sheets*	Kontrollräkning gjord av inlämnade lösblad *Control count of given loose sheets made*	Signatur/ *Signature*
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Fylls i av TENTAMENSVAKT/ ***To be filled in by the INVIGILATOR***

Kontroll av legitimation/ *Control of Identification* ☒	Härmed intygas att kontroller utförts/ *The checks have been carried out*
Kontroll av inlämnade lösblad/ *Control of given loose sheets* ☒	Signatur/ *Signature*
Inlämningstid/ *Time submitted* 17:02	.....
Antal lösblad/ *No. of loose sheets* 10	

Endast Högskolans anteckningar/ ***For official use only***

Totalt antal poäng/ *Total Exam Score* 93 | Betyg på tentamen/ *Exam Grade* A

Kommentarer (lärare)/ *Comments (teacher)*

Signatur (lärare)/ *Signature (teacher)*

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15961681

DERIVATIVE SECURITIES
FSOR23
WRITTEN EXAMINATION (1301)
2022-06-03, 14-19

AGOSTINO MANDUCHI

- Number of pages: Six. Verify that you have received the entire document.
- This examination consists of five tasks. The Pass mark is 60% of the total; 80% is required for Distinction.
- Please write your answers on one side of the paper only, and write your name and personal registration number separately on each sheet.

Code: KOG- NKN

One calculator of an approved type, one dictionary and one standard (A4) sheet, of paper with formulae and/or notes on either one or both sides of it, prepared before the exam, are permitted.

Completed tasks (Cross the box corresponding to each question answered):

Task/Question	1	2	3	4	5	Total
Task/Question answered						
Maximum points	20	20	20	20	20	100
Total score	15	18	20	20	20	

Teacher: Agostino Manduchi

The teacher can be reached by phone at a number available from the invigilators, only in case of urgent questions and with the consent of an invigilator; avoid abuses.

Examination regulations for students at Jönköping University

The 14th of October 2020

These instructions are based on President's decision § 755, 2018, "Regulations and guidelines for first-, second-, and third-cycle education at Jönköping University". Regulations on disruptive behaviour and cheating are found in the policy documents of the Disciplinary and Expulsion Committee. To guarantee the student's legal rights, Sweden's legislation on discrimination must be observed. The invigilator's role is to guarantee that the examination takes place in an ordered and legally secure manner. The invigilator's instructions must be followed. Cheating or disruptive behaviour during an exam are disciplinary offences that will be reported to the Disciplinary and Expulsion Committee. A disciplinary offence may lead to short- or long-term suspension from the university. The exams are scheduled on the basis of set start times. It is the same times for all days, starting at 9 a.m. and 2 p.m.

1. **Preparations.**

1.1. Register for each exam no later than ten days beforehand. If you fail to register or register late, you will not be allowed to write the exam in question.

1.2. Since hypersensitivity/allergy is relatively common, you are not allowed to bring food/snacks that contain nuts/peanuts or to wear perfume.

1.3. Be sure you know the correct time and place.

1.4. Be sure you know what aids are permitted. Ensure that your aids, if any, are "clean", with no forbidden notes or loose pages. Tabs and bookmarks without any text or marking other than chapter headings or equivalent are permitted.

1.5. Bring a valid photo ID, e.g. your driving licence or passport. Without such ID, you will not be allowed to write the exam. The JU card, if marked "Identity Card" and showing your full civic registration number, may be used as an ID document at exams.

1.6. You may bring refreshments.

1.7. Prior to a digital exam, it is always each student's responsibility to ensure that his/her JU user account will be active at the time of the exam. This is also necessary if you need to borrow a computer. If there are any problems, please contact IT Helpdesk.

2. **During admission.**

2.1. Arrive at the latest 20 minutes before the exam starts. The door is locked at exactly the specified time.

2.2. Before entering, tick off your name on the registration list at the entrance. If you are not on the list, you will not be allowed to write the exam.

2.3. Those who arrive for the second admission, 30 minutes after the start, must be present outside the door so that the invigilator can verify their identity.

2.4. Anyone arriving more than 30 minutes late will not be allowed to sit the exam. No excuses are accepted.

2.5. Leave any outerwear and bags in their designated places.

2.6. Seat yourself in the indicated place. Only permitted aids, ID and refreshments are allowed at the desk.

2.7. All electronic equipment (mobile phones, smart watches, MP3 players, etc.) are to be switched off and kept with the outerwear and bags. Do not bring anything to the exam that you do not wish to leave unsupervised. Any sound coming from a mobile phone during an examination will be reported as both disruptive behaviour and attempted cheating. o If you consider that you have legitimate reasons to have your mobile switched on during the exam, notify the invigilator of this before the exam begins. Only exceptional reasons are accepted. The switched-on mobile (silent ringtone) is to be kept by the invigilator. If you accept a call, you must immediately stop the examination and hand in your paper.

3. **Start.**

3.1. When the invigilator locks the door and announces the start of the exam, you must immediately sit down and stay silent.

3.2. Check that you receive the correct exam paper from the invigilator and that the paper is complete. In Inspera check that you see the correct exam.

3.3. If you are registered to write two exams, you receive both papers at the beginning of the exam session. However, the individual finish times must be respected. In Inspera both exams will be visible.

4. **During the examination.**

4.1. No student may leave the exam room during the first half an hour.

4.2. There must be no communication whatsoever between the students.
4.2.1. Any communication between the candidates must go through an invigilator.

4.3. There must be no disruptive behaviour. If you feel that you are being disrupted, please inform the invigilator.

4.4. When the invigilator is performing the ID check, have your ID readily to hand.
4.4.1. If you do not have an ID that the invigilator can accept, you will be turned away from the exam.
4.4.2. If you are not on the registration list, you will be turned away from the exam.
4.4.3. When the invigilator comes to check your ID, your name must have been entered on the first page of the exam paper.

4.5. The invigilator may, at any time and without special reason, check what is on your desk. The invigilator may also leaf through permitted books to check that they do not contain forbidden notes and look inside pencil cases, sweet bags and the like.

4.6. The only writing papers that are allowed are the ones with a colored corner, provided by the invigilators during the exam.

4.7. If you visit the toilet, both name and time must be noted on the toilet list. Only one student may visit the toilet at any one time.

4.8. If you leave the room for any reason other than visiting the toilet, you are considered to have stopped the exam and may not continue writing.

5. **End.**

5.1. The invigilator lets the students know when 30 and 10 minutes of writing time remains.

5.2. When the invigilator announces that the time is up, you must stop writing immediately.

5.3. Ensure that you have written your name and civic registration number on each piece of paper that you hand in. In case you have not done this when the time is up, you must continue filling in your name and civic registration number in the presence of an invigilator.

5.4. When you hand in your paper, you must show your ID.

5.5. Even if no questions have been answered, the pre-personalised page must be handed in.

5.6. The number of submitted loose pages are counted by the invigilator and noted on the pre- personalised page.

5.7. Check that the invigilator ticks off your name correctly and notes the correct number of submitted pages.

5.8. Unless otherwise specified, you may take the exam paper with you once you have handed in your answers. You are not allowed to take the writing papers with a colored corner with you from the exam venue.

5.9. In a digital exam, you and the invigilator are to jointly note the time of submission on the attendance list.

6. **Special educational support.**

6.1. If you have been granted special educational support owing to disability and wish to have an alternative exam arrangement, register this with the examination coordinator in the case management system no later than ten days beforehand and, for information, with the responsible teacher. You must also register for the exam as usual.

6.2. A student with special educational support who writes a paper exam, but is entitled to use a computer, must write the entire exam either on paper or on computer.

SPECIFIC INSTRUCTIONS CONCERNING THE PRESENT TEST

1. Unless otherwise specified, if a question is split into multiple parts, all parts are equally weighted.

2. The answers must always be justified by suitable logical arguments and calculations.

3. The answers must be clear and well-structured. Multiple answers to the same question and generic arguments, effectively requiring the examiner to identify the relevant answer, will be penalised.

4. Unless otherwise indicated, the interest rates and rates of return are understood as yearly rates, with continuous capitalisation.

5. *If necessary*, the cumulative distribution of the standardised normal distribution can be approximated by using

$$F(x) = \frac{1}{1 + e^{-1.749x}}.$$

The "reverse" formula

$$x = -\frac{1}{1.749} \log\left(\frac{1}{\widehat{F}} - 1\right)$$

can also be used to approximate the value of x such that $F(x) = \widehat{F}$, for a given $\widehat{F}$ between 0 and 1.

QUESTION 1 (20 POINTS).

Consider the prices for *coupon-paying* bonds with face value equal to SEK 100 and maturity in one year reported in Table 1.

	Coupon Rate	Price
Bond A	2%	101.6628
Bond B	4%	105.5995

TABLE 1.

Two coupon payments are due on each bond, one in six months and one in one year from today. The coupon rates are expressed as yearly rates, with a capitalisation period of six months, in accordance with the standard convention used in bond markets. Thus, the holder of a bond who pays a coupon rate of interest of c% will receive a SEK $100 \times \frac{c}{2}$ payment in six months, and a SEK $100 \times (1 + \frac{c}{2})$ payment in one year.

1.1. How can the given bonds be used to construct a portfolio that pays out SEK 100 in six months from today? What is today's price of this portfolio?

1.2. How can the given bonds be used to construct a portfolio that pays out SEK 100 in one year from today? What is today's price of this portfolio?

1.3. What are the arbitrage-free values of the spot rates of interest $r_{0,6}$ and $r_{0,12}$ - expressed as yearly rates in continuous capitalisation, as per our standard convention?

1.4. What would be the lowest arbitrage-free value of the spot rate of interest $r_{0,12}$ if the prices of the bonds were those reported in Table 2, and thus featured bid/ask spreads?

	Coupon Rate	Bid Price	Ask Price
Bond A	2%	101.5928	101.7328
Bond B	4%	105.5395	105.6595

TABLE 2.

$\Delta_A + 50 - \frac{\sigma_A}{2} = 100$ $\qquad$ $\frac{\Delta_A}{2} + 50 = 100$

QUESTION 2 (20 POINTS).

2.1. Consider a forward contract under which a firm is due to receive Canadian Dollars (CAD) 5 000 in exchange for South African Rands (ZAR), in one year from today. The risk-free interest rates on the Canadian Dollar and the South African Rand are respectively equal to 1% and to 4.25%. The current spot exchange rate is ZAR 12.29 per CAD 1.

The contract is written today, and the level of the forward exchange rate is chosen so as to make today's value of the contract equal to 0. At which level should it be set?

2.2. What would be the value of the contract for the party due to deliver Canadian Dollars, three months before maturity, if the interest rates on the CAD and the ZAR on that date were respectively equal to 0.75% and to 4%, and the spot exchange rate were equal to ZAR 12.17 per CAD 1?

QUESTION 3 (20 POINTS).

The options in the present Question are written on a ("underlying") stock that is currently traded at SEK 54 and that will pay no dividends during the next two months. The risk-free rate of interest is equal to 1%.

3.1. Consider a portfolio that comprises:

(i) A long position in an European put option with exercise price equal to SEK 55 and time to maturity equal to two months.

(ii) A long position in one share of the underlying stock, to be kept in place for two months.

(iii) A sum of SEK $e^{-0.01\times\frac{2}{12}} \times 55$ borrowed at the risk-free rate of interest, which we must repay in two months.

Provide the payoff table at maturity for this portfolio.

3.2. Provide the payoff diagram at maturity for the portfolio in 3.1.

3.3. Provide today's no-arbitrage value of an European call option with exercise price equal to SEK 55 and time to maturity equal to two months, if the premium of the put option in 3.1 is equal to SEK 2.96.

QUESTION 4 (20 POINTS).

Figure 1 (on page 6) reports the possible paths of the price per share of a given stock over the next six months. The risk-free rate of interest is equal to 0.5% and no dividends are paid on the stock.

4.1. What is the current premium of an European call option with exercise price of SEK 77.5 and maturity in six months from today?

4.2. Suppose that at $t = 3$ months, after finding out that the value of the underlying stock has increased to SEK 87.2466, the holder of the European option in 4.1 wishes to hedge the option by taking a position in the underlying stock, so as to create a portfolio that yields a non-random payoff at $t = 6$ months. Indicate both the sign and the size of the position - namely whether the position should be long or short and the (possibly fractional) number of shares to be used to construct the hedge.

4.3. What is the current premium of an American call option with exercise price of SEK 77.5 and maturity in six months from today?

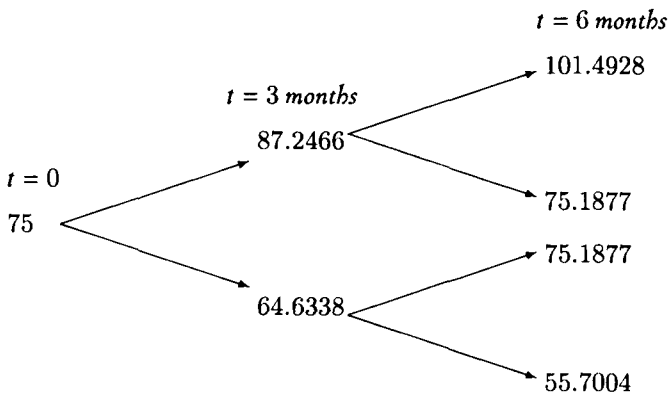

FIGURE I.

QUESTION 5 (20 POINTS).

All options in the present Question are European have maturity in three months. The options are written on a stock that is currently traded at SEK 51 and that will pay no dividends before the options expire.

The standard deviation of the continuous time-rate of return on the stock is equal to 27% and the risk-free rate of interest is equal to 1%.

5.1. Provide the current premium of a binary option which pays out:

$$D_T^1 = \begin{cases} \text{SEK } S_T, & \text{if } S_T \leq 50, \\ \text{SEK } 0, & \text{if } S_T > 50. \end{cases}$$

5.2. Provide the current premium of a binary option which pays out:

$$D_T^2 = \begin{cases} \text{SEK } 50, & \text{if } S_T \leq 50, \\ \text{SEK } 0, & \text{if } S_T > 50. \end{cases}$$

5.3. Provide the current premium of an European put option with exercise price equal to SEK 50.

No writing here

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Question 1

Bond A: $CF_6 = \frac{0,02}{2} \cdot 100 = 1$

$CF_{12} = \frac{0,02}{2} \cdot 100 + 100 = 101$

Bond B: $CF_6 = \frac{0,04}{2} \cdot 100 = 2$

$CF_1 = \frac{0,04}{2} \cdot 100 + 100 = 102$

Question 1.1

a) b) ϕ_a

$CF_6: \Delta_A \cdot 1 + \Delta_B \cdot 2 = 100$

c) d) ϕ_B

$CF_{12}: \Delta_A \cdot 101 + \Delta_B \cdot 102 = 0$

$$\Delta_A = \frac{d \cdot \phi_a - b \cdot \phi_B}{a \cdot d - b \cdot c} = \frac{102 \cdot 100 - 2 \cdot 0}{100 \cdot 102 - 2 \cdot 101} = \frac{10.200}{-100} = -102$$

$\Rightarrow -102 \cdot 101 + \Delta_B \cdot 102 = 0$

$\Rightarrow \Delta_B \cdot 102 = 10302$

$\Rightarrow \Delta_B = 101$

- This portfolio can be created by taking a short positions in 102 bonds of type A & a long position in 101 bonds of type B.

- Todays value of the portfolio

$102 \cdot 101,6628 - 101 \cdot 105,5995 = 10369,056 - 10665,5455$

$= -295,9439$ → Price = 295,9439

Question 1.2

CF_6 : $\underset{a)}{\Delta_A} + 2 \cdot \underset{b)}{\Delta_B} = \underset{\phi a}{0}$

CF_{12} : $\Delta_A \cdot \underset{c)}{101} + \Delta_B \cdot \underset{d)}{102} = \underset{\phi b}{100}$

$$\Delta_A = \frac{d \cdot \phi_a - b \cdot \phi_B}{a \cdot d - b \cdot c} = \frac{102 \cdot 0 - 2 \cdot 100}{1 \cdot 102 - 2 \cdot 101} = \frac{-200}{-100} = 2$$

$\Rightarrow 2 \cdot 1 + 2 \cdot \Delta_B = 0 \quad \Rightarrow \underline{\Delta_B = -1}$

· To get this cash-flow take a long position in 2 bonds of type A & a short position in 1 bond of type B.

· Todays price of the portfolio :

$-2 \cdot 101,6628 + 1 \cdot 105,5995 = \underline{-97,7261}$

Price = 97,7261

Question 1.3

$CF_0 \cdot e^{r \cdot T} = CF_T \quad \Rightarrow r = \frac{1}{T} \cdot \ln\left(\frac{CF_0}{CF_T}\right)$

$r_{0,6} = \frac{12}{6} \cdot \ln($

No writing here

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Question 1.3

$\underset{\Phi_A}{101,6628} = \underset{a)\ \Delta_A}{1} \cdot R_6 + \underset{b)\ \Delta_B}{101} \cdot R_{12}$

$\underset{\Phi_B}{105,5995} = 2 \cdot R_6 + \underset{d)\ \Delta_B}{102} \cdot R_{12}$

$\Delta_A = \frac{d \cdot \Phi_A - b \cdot \Phi_B}{a \cdot d - b \cdot c} = \frac{102 \cdot 101,6628 - 101 \cdot 105,5995}{1 \cdot 102 - 101 \cdot 2}$

$= \frac{-295,9439}{-100} = \underline{\underline{2,959438 = R_6}}$

$\Delta_B = \frac{a \cdot \Phi_B - c \cdot \Phi_A}{a \cdot d - b \cdot c} = \frac{1 \cdot 105,5995 - 2 \cdot 101,6628}{-100}$

$= \underline{\underline{0,977261 = R_{12}}}$

$R_6 = e^{-r_{0,6} \cdot \frac{6}{12}} = 2,959438$

$\Rightarrow -r_{0,6} = \ln(2,959438) \cdot 2$

$\Rightarrow r_{0,6} = -2,16599877 1$

$\Rightarrow r_{0,6} \approx \underline{\underline{-216,5998771\ \%}}$

$R_{12} = e^{-r_{0,12} \cdot \frac{12}{12}} = 0,977261$

$\Rightarrow r_{0,12} = 0,023$

$\Rightarrow r_{0,12} \overset{!}{=} \underline{\underline{2,3\ \%}}$

No writing here

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Question 1.4

upper ~~lower~~ bound: $101,5928 = R_6 \cdot 1 + R_{12} \cdot 101$ (a) (b)

$105,5395 = R_6 \cdot 2 + R_{12} \cdot 102$ (c) (d)

~~$R_6 = \frac{105,5395 - 2 \cdot 101,5928}{102 - 101 \cdot 2}$~~ =

$R_{12} = \frac{1 \cdot 105,5395 - 2 \cdot 101,5928}{1 \cdot 102 - 101 \cdot 2} = 0,9764671$

$0,9764671 = e^{-r_{0,12}}$

$\Rightarrow 0,02382046 8 = r_{0,12} = 2,38\%$ upper bound

lower bound R_{12}: $\frac{105,5395 - 2 \cdot 101,7328}{102 - 101 \cdot 2} = \frac{-97,8661}{-97,8661} = 1$

$= 0,9780671$

$R_{12} = e^{-r_{0,12}} = 0,9780671$

$r_{0,12} = 0,0221832 \Rightarrow 2,218\%$ (lower bound)

not quite on target I should have used one bid price and one ask price

2,09%, by using ask & bid B in the answer to 2.2.

No writing here

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Question 2.1

- A firm receives ~~10 000~~ 5000 CAD in exchange for ZAR

$r_{CAD} = 0,01$ $r_{ZAR} = 0,0425$ $S_t = 12,29$

$T = \frac{1}{12}$

$$k = e^{r_H \cdot T} - e^{r_F \cdot T} \cdot S_t \approx e^{0,0425} \cdot e^{-0,01} \cdot 12,29$$

$$= 1,0434\,16056 \cdot 12,16\,771246 = 12,69\,59\,86\,54 = k$$

$\rightarrow 5000 \cdot 12,69\,59\,86\,54 = 63.479,93271$ Should be the value of k

Question 2.2

- 3 month before maturity $\rightarrow T = \frac{3}{12}$
- $r_{CAD} = 0,0075$ $r_{ZAR} = 0,04$ $S_t = 12,17$

$$F_0 = S_t \cdot e^{-r_f \cdot T} - e^{-r_H \cdot T} \cdot k$$

$$\approx 12,17 \cdot e^{-0,0075 \cdot \frac{3}{12}} - 12,69\,59\,86\,54 \cdot e^{-0,04 \cdot \frac{3}{12}}$$

$$= \text{~~2019 1660~~} -$$

$$12,14\,720263 - 12,56\,96\,59\,36 = -0,422\,456\,73$$

$$5000 \cdot (-0,422\,456\,73) = -2\,112,28\,365$$

deliver!

the sign is positive for the party due to CVL at the set forward rate

Question 3

$S_t = 54$ $\quad r = 1\%$

(i) European put $\quad k = 55$ $\quad T = \frac{2}{12}$

(ii) Long in the stock for $T = \frac{2}{12}$

(iii) $PV(55)$

Question 3.1

Put: $\max\{k - S_T, 0\}$

	long put	long share	rf inv.	CF_T
$S_T \leq 55$	$55 - S_T$	S_T	-55	0
$S_T > 55$	0	S_T	-55	$S_T - 55$

Question 3.2

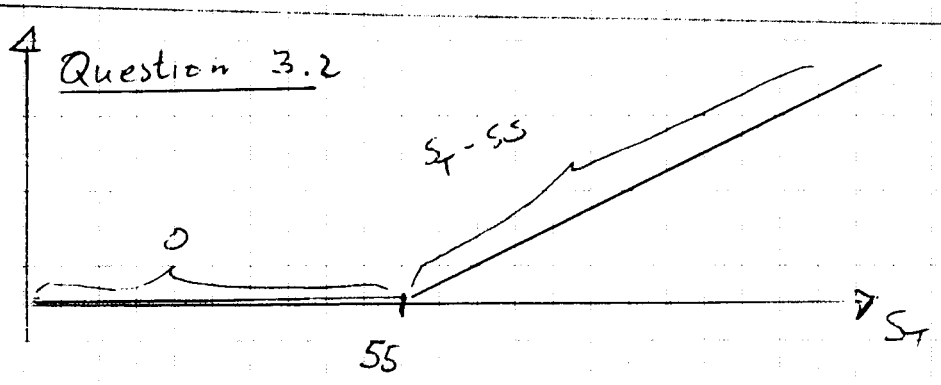
$P_t = 2{,}96$ $\quad$ Call $\rightarrow k = 55$ $\quad T = \frac{2}{12}$

Put-Call-Parity

$\rightarrow C_t + PV(K) = P_t + S_t$

$\rightarrow C_t = P_t + S_t - PV(K)$

$\Rightarrow C_t = 2{,}96 + 54 - 55 \cdot e^{-0{,}01 \cdot \frac{2}{12}} = 2{,}05159032$



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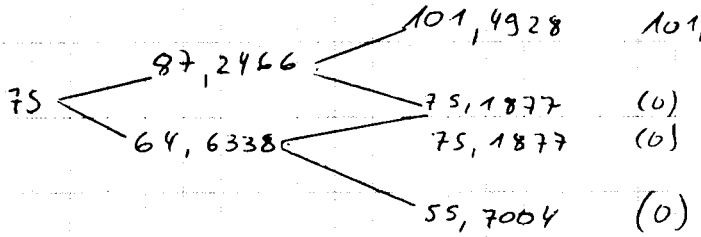
Question 4

$r = 0{,}5\ \%$

Question 4.1

- European call $\rightarrow$ $k = 77{,}5$ $\quad T = \frac{6}{12}$ $\quad$ call: $\max\{S_t - k, 0\}$



$101{,}4928 - 77{,}5 = 23{,}9928$

$u = \frac{S_u}{S} = \frac{87{,}2466}{75} = 1{,}163288$ $\quad d = \frac{S_d}{S} = \frac{64{,}6338}{75} = 0{,}861784$

$$q = \frac{e^{r \cdot T} - d}{u - d} \approx \frac{e^{0{,}005 \cdot \frac{3}{12}} - 0{,}861784}{1{,}163288 - 0{,}861784} = 0{,}462570325$$

$$C_t = [0{,}462570325^2 \cdot 23{,}9928 + 0] \cdot e^{-0{,}005 \cdot \frac{6}{12}} = 5{,}120950075$$

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Question 4.2

- In 3 month
- $S_t = 87,2466$
- hedge by taking a position in the underlying

→ Intuitively: we should take a short position in the stock, since the value of the call increases as S_t increases & the short decreases as S_t increases.

$101,4928 - 75,1877 = 26,3051$

$\Rightarrow -26,3051 \cdot \Delta = 23,9928$

$\Rightarrow \Delta = -0,9120\,96839$

→ we should take a short position of ≈ 0,912 shares of the underlying asset.

Question 4.3

- The premium is $5,12095075$

↳ This is the same result as in Question 4.1

⇒ This is because we never execute an american call written on a non-dividend paying stock before maturity.

No writing here

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Question 5

$T = \frac{3}{12}$, $S_t = 51$, $\sigma = 0{,}27$, $r = 0{,}01$

Question 5.1

$D_T^1 = N(-d_1) \cdot S_t \cdot e^{-r \cdot (T-t)}$ $\quad D_T^2 =$

$$d_1 = \frac{\ln\left(\frac{S_t}{K}\right) + \left(r + \frac{\sigma^2}{2}\right) \cdot (T-t)}{\sigma \cdot \sqrt{T-t}}$$

$$\hat{=} \frac{\ln\left(\frac{51}{50}\right) + \left(0{,}01 + \frac{0{,}27^2}{2}\right) \cdot \left(\frac{3}{12}\right)}{0{,}27 \cdot \sqrt{\frac{3}{12}}} = \frac{1102 + (0{,}04645) \cdot 0{,}25}{0{,}135}$$

$= 0{,}12327 = d_1$

$d_2 = d_1 - \sigma \cdot \sqrt{T-t}$ $\hat{=}$ $0{,}12327 - 0{,}27 \cdot \sqrt{\frac{3}{12}}$ $\approx 0{,}12327 - 0{,}135$

$= 0{,}10977 = d_2$

$N(-d_1) = \frac{1}{1 + e^{-1{,}749 \cdot (-0{,}12327)}} = 0{,}3996$

$N(-d_2) = \frac{1}{1 + e^{-1{,}7479 \cdot (-0{,}10977)}} = 0{,}4574$

$D_T^1 = 0{,}3996 \cdot 51 \cdot e^{-0{,}01 \cdot \frac{3}{12}} = 20{,}3287$

Question 5.2

$D_T^2 = N(-d_2) \cdot e^{-r \cdot (T-t)} \cdot k = 0{,}4574 \cdot e^{-0{,}01 \cdot \frac{3}{12}} \cdot 50 = 22{,}813$

No writing here

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Question 5.3

$$P_t = N(-d_2) \cdot e^{-r \cdot (T-t)} \cdot k - N(-d_1) \cdot S_t$$

$$\hat{=} 0{,}4574 \cdot e^{-0{,}01 \cdot \frac{3}{12}} \cdot 50 - 0{,}3996 \cdot 51 = \underline{2{,}4333}$$

→ It is basically the same as $D_T^2 - D_T^1$

$\hat{=}$ 22,813 − 20,3287 = 2,4843