UNIVERSITY EXAMINATIONS

UNIVERSITEITSEKSAMENS

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INVESTMENTS: DERIVATIVES

Duration 2 Hours

40 Marks

EXAMINERS
FIRST MS E BOTHA
SECOND DR RH MYNHARDT
EXTERNAL MR JS DE BEER (PRETORIA - UP)

Use of a non-programmable pocket calculator is permissible

This paper consists of 23 pages, including the standard normal distribution table (p 13), formula sheet (pp14-16), seven sheets of paper for rough work (pp 17-23) and the instructions for completing a mark-reading sheet Please answer all 40 questions on the mark-reading sheet

Indicate your student number and the correct unique number on the mark-reading sheet

Unique number **482279**

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NOTE: PLEASE COMPLETE THE ATTENDANCE REGISTER ON THE BACK PAGE, TEAR IT OFF AND HAND IT TO THE INVIGILATOR

1 An individual, who enters into a forward contract to buy the ALSI index, will face the risk that __________

1 the market will fall
2 the market will rise
3 the market volatility will fall
4 the market volatility will rise

2 Identify the correct statement from the following alternatives

1 With exchange-traded contracts, financial institutions often act as market makers for commonly traded instruments
2 Contingent claims are contracts in which the payoff will occur if a specific event takes place
3 Call options grant the holder the opportunity to buy the underlying security at a price above the current market price
4 Futures contracts can be traded on the exchange-traded and over-the-counter

3 Indicate the correct statement with regards to interest rate parity

1 If the foreign interest rate is greater than the spot interest rate, the foreign currency is trading at a discount
2 If the foreign interest rate is less than the spot interest rate, the foreign currency is trading at a discount
3 If the spot interest rate is greater than the foreign interest rate, the foreign currency is trading at a discount
4 If the spot interest rate is equal to the foreign interest rate , the foreign currency is trading at a premium

4 The following information is available for a security

- Current price = R250
- Risk-free rate = 5 5%

A dealer offers you a forward contract for delivery in three months on the security at a price of R275 What action would you take today to earn an arbitrage profit?

1 Sell the forward contract, borrow money and buy the stock
2 Buy the forward contract, borrow money and buy the stock
3 Buy the forward contract, sell the stock and invest the proceeds
4 Sell the forward contract, sell the stock and invest the proceeds

5 Obama Ltd is a US-based company that exports goods to Japan Obama Ltd will receive a payment in Yen on a shipment of goods in three months They want to hedge their exposure to a decline in Yen within the next three months

The following information are available

	US	Japan
Interest rate	2 1%	5 2%

The current spot rate is $0 555 and the interest rates will remain fixed for the next six months

Indicate what position Obama Ltd must take in the market in order to hedge against the currency risk Obama Ltd should _________

1 enter into a contract to buy Yen forward
2 enter into a contract to buy US dollars forwards
3 enter into a contract to sell Yen forward
4 not enter into a forward contract as there is no arbitrage profit

Use the following information to answer questions 6 and 7

6 Andy Muller, a corporate treasurer needs to hedge the interest rate risk on a future transaction of his company The risk is associated with the rate on 180-day Euribor in 30 days The term structure of Euribor is given as follows

30-day Euribor	4 25%
210-day Euribor	6 00%

Calculate the FRA expiring in 30-days on the 180-days Euribor

1 3 13%
2 6 22%
3 6 27%
4 21 02%

7 Andy Muller took a long position in the FRA, now 20 days later the interest rates are as follows

10-day Euribor	4 00%
190-day Euribor	5 84%

The market value of the FRA for a €15 million notional principal is closest to

1 -€1,096,250
2 -€25,500
3 €206,960
4 €940,000

8 A Treasury bill with a face value of $20,000 has 215 days to maturity and a discount yield of 1 88% if the discount yield decreases to 1 75% the price of the treasury will________

1. increase
2. decrease
3. remain unchanged

9 Mpofu construction considers taking a forward contract on the ALSI index The index is currently at 2775, with a continuously compounded dividend yield of 1 35% and a discreet compounded interest rate of 5 27%

Calculate the price of the 2-year forward contract on the ALSI index

1 2994
2 3001
3 3034
4 3075

10 A security is priced at $2,500 today The forward contract on this security is currently priced at $2,775 and expires in two years The annual interest rate is 7 50%

Calculate the value of the off-market forward contract today, and indicate who makes the payment?

1	-$81 40	Short pays the amount upfront to the long
2	-$81 40	Long pays the amount upfront to the short
3	$98 70	Short pays the amount upfront to the long
4	$98 70	Long pays the amount upfront to the short

11 Calculate the price of a 240-day forward contract on an 9% US Treasury bond with a spot price of $2,250 and face value of $1,000 The bond has just paid a coupon and will make another coupon payment in 180 days The annual risk-free rate is 4 5%

1 $1,305
2 $2,271
3 $2,304
4 $2,450

TURN OVER

Use the following information to answer questions 12 and 13

Poppie Moloi, a speculator, has purchased an April Eurodollar futures contract at a price of 96 14

12 Calculate the price of the April Eurodollar futures contract, with each contract based on $1 million notional principal

1 $961,400
2 $987,133
3 $1,000,000

13 Indicate what would happen to the futures price if the interest rate were to decrease to 2 55% a month later The futures price will ________

1 decrease
2 increase
3 remain the same

Use the following information to answer questions 14 and 15

Mr N Nyoka is a trader for a large commodity company He has been asked to look into the possibility of investing in gold futures Mr Nyoka has gathered the following information The current price of gold is $1,221 and the risk-free interest rate is 10 5% Assume the net cost of carry for gold is zero

14 Calculate the price of the gold futures contract that expires in 270 days?

1 $998 04
2 $1,177 64
3 $1,314 59
4 $1,349 21

15 If the futures contract were priced at $1,185, what arbitrage transaction could be executed?

1 Take a long futures position and sell short the gold
2 Take a long futures position and buy the gold
3 Take a short futures position and buy the gold
4 Take a short futures position and sell short the gold

16 Jacque Gutto, an investor wants to invest in the stock index A futures contract on the index expires in three months and the futures price is 1,500 Calculate the current value of the stock index if the reinvested dividends over the life of the futures is 8 25 and the risk-free interest rate is 7 5%

1 1,536
2 1,491
3 1,473
4 1,465

17 Consider a futures contract expiring in 85 days on the euro The spot exchange rate is $1 22 The foreign interest rate is 4 00% and the domestic ris-free rate is 5 93% Calculate the appropriate futures price

1 1 0043
2 1 2148
3 1 2252
4 1 2426

18 An increase in the strike price of option prices will

1 increase call and put prices
2 decrease call and put prices
3 increase call prices and decrease put prices
4 decrease call prices and increase put prices

19 You are investigating buying the stock and buying the put option to hedge against your risk exposure Currently the underlying stock is priced at $75 50 The put option with an exercise price of $75 50 is priced at $7 70 and the call option on the same underlying at $8 25 Calculate the payoff and indicate what strategy you will use

1	$13	covered call
2	$75.50	covered call
3	$13	protective put
4	$75 50	protective put

20 Consider a stock index option that expires in 65 days The stock index is currently at 1155 25 and makes no cash payments during the life of the option Assume that the stock index has a multiplier of 1 The risk-free rate is 5 6% Calculate the lower and upper bounds for European-style call options on the above stock index with an exercise price of 1250

	Lower bound	*Upper bound*
1	$94 75	1155 25
2	$0	1155 25
3	$82 68	1250 00
4	$0	1237 93

Use the following information to answer question 21 to 23

Current stock price	$70
Risk-free rate	9 5%

Consider a two-period binomial model were the stock price can go up or down by 10%

21 Calculate the price of the European call option expiring in two periods with an exercise price of $72

1 $10
2 $11
3 $12
4 $13

22 Calculate the price of the American put option expiring in two periods with an exercise price of $64

1 $0 0039
2 $0 0046
3 $0 0228
4 $0 1667

23 Calculate the current value of the fiduciary call if the strike price is currently $68 and the call option is $7 50 and 120 days to expiration

1 $ 9 50
2 $58 50
3 $66 00
4 $73 50

Question 24 to 25: Consider the following information on put and call options on a stock

Call price, c_0	$6 60
Put price, p_0	$7 70
Exercise price, X	$85
Days to expiration	127
Current stock price, S_0	$82 34
Risk-free rate, r	5%

24 Calculate the price of the synthetic put option

1 $2 66
2 $5 37
3 $7 70
4 $7 83

25 Identify the possible arbitrage transaction based on the mispricing

1 no arbitrage, options are perfectly priced
2 short put, long call, long bond, short stock
3 long put; short call, short bond, long stock
4 long put, long call, short bond, short stock

Questions 26 and 27 Consider an asset that trades at \$110 today Call and put options on this asset are available at an exercise price of \$100. The options expire in 125 days, and the volatility is 0 33 The continuously compounded risk-free rate is 4 2%

26 Calculate the d_1 and d_2 using the Black-Scholes-Merton model

1	-0 32	-0 52
2	0 66	0 47
3	0 75	0 68
4	0 82	0 63

27. Calculate the values of European call options using the Black-Scholes-Merton model

1 \$1 41
2 \$10 00
3 \$14 89
4 \$26 27

28 Consider a two-period binomial model in which the stock currently trades at \$70 The stock price can go up 15% or down 15% each period The risk-free rate is 5% A put option on this stock expiring in two periods has an exercise price of \$75 Calculate the number of units of the underlying stock that would be needed at time 0 in the binomial tree in order to construct a risk-free hedge Use 10,000 puts

1 long position in 3,931 shares of the underlying stock
2 short position in 3,931 shares of the underlying stock
3 long position in 4,125 shares of the underlying stock
4 short position in 4,125 shares of the underlying stock

Questions 29 and 30 A forward contract is priced at 200 European options on the forward contract have an exercise price of 211 and expire in 122 days The discreet risk-free rate is 3 77%, and volatility is 0 45

29 Calculate $N(d_1)$ and $N(d_2)$, using the Merton model

1	0 3669	0 4681
2	0 4681	0 3669
3	0 5319	0 6331
4	0.6331	0 5319

30 Calculate the price of the call and put option on the forward contract using the Black model

1	$0	$16 00
2	$14 21	$0
3	$14 21	$25 08
4	$16 00	$26 88

31 Indicate the correct statement from the following alternatives

1 The payment from a call on a forward contract and a zero-coupon bond differ from the payment of a put on a forward contract and the forward contract
2 The Black model can be used to price European options on interest rates
3 American options on forwards are not equivalent to European options on forwards
4 Cash flows are accommodated for in option pricing models by adding the cash flows to the price

32 A mutual fund entered into an equity swap with an equity dealer The mutual fund agrees to pay the dealer the return on the small-cap index and the dealer will pay a fixed rate of 7 23% (payments made on basis of 182 days in the period and 365 day year) The small-cap index starts off at 1,550 30 and is valued at 1,512 40 six months later The notional principal is $20 million with semi-annual payments Determine the first payment for both the mutual fund and the equity dealer

	Dealer	*Mutual fund*
1	$721,019	-$488,938
2	-$721,019	$488,938
3	$1,446,000	$501,190
4	-$1,446,000	$501,190

Use the following information to answer questions 33 and 34

Consider a two-year interest rate swap with semi-annual payments Assume a notional principal of $50 million

33 Calculate the annualized fixed rate on the swap if the current term structure of LIBOR interest rates is as follows

$L_0(180) = 0\ 0814$ $L_0(540) = 0\ 0788$
$L_0(360) = 0\ 0805$ $L_0(720) = 0\ 0779$

1 3 70%
2 7 39%
3 13 90%
4 27 80%

34 Calculate the market value of the swap 60 days later from the point of view of the party paying the fixed rate and receiving the floating rate, and from the point of view of the party paying the floating rate and receiving the fixed rate, if the term structure 60 days later is as follows

$L_{60}(120) = 0\ 0797$
$L_{60}(300) = 0\ 0753$
$L_{60}(480) = 0\ 0729$
$L_{60}(660) = 0\ 0713$

1	\$40,000	–\$40,000
2	–\$40,000	\$40,000
3	\$400,000	–\$400,000
4	–\$400,000	\$400,000

35 Assume an asset manager enters into a one-year equity swap in which he will receive the return on the Nasdaq 100 Index in return for paying a floating interest rate The swap calls for quarterly payments The Nasdaq 100 is at 1651 72 at the beginning of the swap Ninety days later, the rate $L_{90}(90)$ is 0 0665 Calculate the market value of the swap 100 days from the beginning of the swap if the Nasdaq 100 is at 1695 27, the notional principal of the swap is \$50 million, and the term structure is

$L_{100}(80) = 0.0654$
$L_{100}(170) = 0\ 0558$
$L_{100}(260) = 0\ 0507$

1 –\$1,205,000
2 –\$1,399,456
3 \$1,205,000
4 \$1,399,456

36 A British company enters into a currency swap in which it pays a fixed rate of 4 88 percent in dollars and the counterparty pays a fixed rate of 4 88 percent in pounds The notional principals are £80 million and \$115 million Payments are made semi-annually and on the basis of 30 days per month and 360 days per year. Calculate the semi-annual payments

1	\$325,333	£2,806,000
2	\$2,806,000	£467,667
3	\$2,806,000	£1,952,000
4	\$1,952,000	£2,806,000

37 Indicate the correct statement from the following alternatives

1 The payoffs of an interest rate swaption are like those of an option on a coupon bond
2 Swaptions are not based on specific underlying swaps but have a set exercise and expiration date
3 Swaption is the option to enter into a swap contract and gives the user less flexibility

38 Consider a European receiver swaption that expires in one year and is on a two-year swap that will make semiannual payments The swaption has an exercise rate of 8 6% and the notional principal in $34 million At expiration, the term structure of interest rates is as follows

$L_0(180) = 0\ 0420$
$L_0(360) = 0\ 0474$
$L_0(540) = 0\ 0544$
$L_0(720) = 0\ 0661$

Calculate the cash flow associated with the exercising of the swaption where the holder choose to receive the cash up front

1 $714,000
2 $1,060,800
3 $1,501,250
4 $1,462,000

Questions 39 and 40 A one-year swap with quarterly payments pays a fixed rate and receives a floating rate The term structure at the beginning of swap is

$L_0(90) = 0\ 0373$
$L_0(180) = 0\ 0429$
$L_0(270) = 0\ 0453$
$L_0(360) = 0\ 0533$

In order to mitigate the credit risk of the parties engaged in the swap, the swap will be marked to market in 90 days Suppose it is now 90 days later and the swap is being marked to market The new term structure is

$L_{90}(90) = 0\ 0552$
$L_{90}(180) = 0\ 0607$
$L_{90}(270) = 0\ 0667$

39 Calculate the market value of the swap per $1 notional principal and indicate who would make the payment

1 Fixed pays floating party $0 0173
2 Floating pays fixed party $0 0173
3 Fixed pays floating party $0 0192
4 Floating pays fixed party $0 0192

40 Calculate the new fixed rate on the swap at which the swap would proceed after the marked to market

1 1 59%
2 1 66%
3 5 21%
4 6 64%

[40]

Cumulative Probabilities for a Standard Normal Distribution

P(X ≤ x) = N(x) for x ≥ 0 or 1 – N(– x) for x < 0

x	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.00	0 5000	0 5040	0 5080	0 5120	0 5160	0 5199	0 5239	0 5279	0 5319	0 5359
0.10	0 5398	0 5438	0 5478	0 5517	0 5557	0 5596	0 5636	0 5675	0 5714	0 5753
0.20	0 5793	0 5832	0 5871	0 5910	0 5948	0 5987	0 6026	0 6064	0 6103	0 6141
0.30	0 6179	0 6217	0 6255	0 6293	0 6331	0 6368	0 6406	0 6443	0 6480	0 6517
0.40	0 6554	0 6591	0 6628	0 6664	0 6700	0 6736	0 6772	0 6808	0 6844	0 6879
0.50	0 6915	0 6950	0 6985	0 7019	0 7054	0 7088	0 7123	0.7157	0 7190	0.7224
0.60	0 7257	0 7291	0 7324	0 7357	0 7389	0 7422	0 7454	0 7486	0 7517	0 7549
0.70	0 7580	0 7611	0 7642	0 7673	0 7704	0 7734	0 7764	0 7794	0 7823	0 7852
0.80	0.7881	0 7910	0 7939	0 7967	0 7995	0 8023	0 8051	0 8078	0 8106	0 8133
0.90	0 8159	0 8186	0 8212	0 8238	0 8264	0 8289	0 8315	0 8340	0 8365	0.8389
1.00	0 8413	0 8438	0 8461	0 8485	0 8508	0 8531	0 8554	0 8577	0 8599	0.8621
1.10	0 8643	0 8665	0 8686	0 8708	0 8729	0 8749	0 8770	0 8790	0 8810	0 8830
1.20	0 8849	0 8869	0 8888	0 8907	0 8925	0 8944	0 8962	0 8980	0 8997	0 9015
1.30	0 9032	0 9049	0 9066	0 9082	0 9099	0 9115	0 9131	0 9147	0 9162	0 9177
1.40	0 9192	0 9207	0 9222	0 9236	0 9251	0 9265	0 9279	0 9292	0 9306	0 9319
1.50	0 9332	0 9345	0 9357	0 9370	0 9382	0 9394	0 9406	0 9418	0 9429	0 9441
1.60	0 9452	0 9463	0 9474	0 9484	0 9495	0 9505	0 9515	0 9525	0 9535	0 9545
1.70	0 9554	0 9564	0 9573	0 9582	0 9591	0 9599	0 9608	0 9616	0 9625	0 9633
1.80	0 9641	0 9649	0 9656	0 9664	0 9671	0 9678	0 9686	0 9693	0 9699	0 9706
1.90	0 9713	0 9719	0 9726	0 9732	0 9738	0 9744	0 9750	0 9756	0 9761	0.9767
2.00	0 9772	0 9778	0 9783	0 9788	0 9793	0 9798	0 9803	0 9808	0 9812	0 9817
2.10	0 9821	0 9826	0 9830	0 9834	0 9838	0 9842	0 9846	0 9850	0 9854	0 9857
2.20	0 9861	0 9864	0 9868	0 9871	0 9875	0 9878	0 9881	0 9884	0 9887	0 9890
2.30	0 9893	0 9896	0 9898	0 9901	0 9904	0 9906	0 9909	0 9911	0.9913	0 9916
2.40	0 9918	0 9920	0.9922	0.9925	0 9927	0 9929	0 9931	0 9932	0 9934	0 9936
2.50	0 9938	0 9940	0 9941	0 9943	0 9945	0 9946	0 9948	0 9949	0 9951	0 9952
2.60	0 9953	0 9955	0 9956	0 9957	0 9959	0 9960	0 9961	0 9962	0 9963	0 9964
2.70	0 9965	0 9966	0 9967	0 9968	0 9969	0 9970	0 9971	0 9972	0.9973	0 9974
2.80	0 9974	0 9975	0 9976	0 9977	0 9977	0 9978	0 9979	0 9979	0 9980	0 9981
2.90	0 9981	0 9982	0 9982	0 9983	0 9984	0 9984	0 9985	0 9985	0 9986	0 9986
3.00	0 9987	0 9987	0 9987	0 9988	0 9988	0 9989	0 9989	0 9989	0 9990	0 9990

PRICING AND VALUATION OF FORWARD CONTRACTS

Discrete interest (r)

$$(1+r)^T$$

Continuous interest (r^c)

$$e^{r^cT}$$

Conversion ($r \leftrightarrow r^c$)

$$r^c = \ln(1+r)$$

$$r = e^{r^c} - 1$$

Discount interest

$$\text{Amount}\left[1 - r(d/360)\right]$$

Add-on interest

$$\text{Amount}\left[1 + r(d/360)\right]$$

Forward rate agreement (FRA)

Price/rate

$$FRA_{rate} = \left[\frac{1+L_0\left(\frac{h+m}{360}\right)}{1+L_0\left(\frac{h}{360}\right)} - 1\right]\left(\frac{360}{m}\right)$$

Value

$$V_g = \left[\frac{1}{1+L_g\left(\frac{h-g}{360}\right)}\right] - \left[\frac{1+FRA_{rate}\left(\frac{m}{360}\right)}{1+L_g\left(\frac{h+m-g}{360}\right)}\right]$$

Payoff

$$FRA_{payoff} = NP\left[\frac{\left(U_{rate} - FRA_{rate}\right)\left(\frac{U_{days}}{360}\right)}{1+U_{rate}\left(\frac{U_{days}}{360}\right)}\right]$$

Forward contract – no cash flows

Price

$$F_T = S_0(1+r)^T$$

Value

$$V_0 = S_0 - \frac{F_T}{(1+r)^T} \qquad V_t = S_t - \frac{F_T}{(1+r)^{T-t}}$$

Forward contract – equity

Price and value – discrete compounding

$$F_T = \left[S_0 - PV(D)\right](1+r)^T$$

$$V_t = S_t - PV(D) - \left[\frac{F_T}{(1+r)^{T-t}}\right]$$

Price and value – continuous compounding

$$F_T = S_0 e^{(r^c - \delta^c)T}$$

$$V_t = S_t e^{-\delta(T-t)} - F_T e^{-r(T-t)}$$

Forward contract – fixed income

Price and value

$$F_T = \left[B_0 - PV(C)\right](1+r)^T$$

$$V_t = B_t - PV(C) - \left[\frac{F_T}{(1+r)^{T-t}}\right]$$

Forward contract – currency

Price and value – discrete compounding

$$F_T = S_0\left[\frac{(1+r_d)^{d/365}}{(1+r_f)^{d/365}}\right]$$

$$V_t = \left[\frac{S_t}{(1+r_f)^{T-t}}\right] - \left[\frac{F_T}{(1+r_d)^{T-t}}\right]$$

Price and value – continuous compounding

$$F_T = S_0 e^{(r_d^c - r_f^c)(d/365)}$$

$$V_t = S_t e^{-r_f^c(T-t)} - F_T e^{-r_d^c(T-t)}$$

Interest rate parity (IRP)

$$(1+r_d)^{d/365} = (1+r_f)^{d/365}\left(\frac{F}{S}\right)$$

PRICING OF FUTURES CONTRACTS

Futures price – no cost or benefit

$$f_0(T) = S_0(1+r)^T$$

Futures price – net cost or benefit

$$f_0(T) = S_0(1+r)^T + FV(CB)$$

Futures price – stock

$$f_0(T) = S_0(1+r)^T - FV(D)$$

Futures price – stock index

$$f_0(T) = S_0 e^{(r^c - \delta^c)T}$$

Futures price – Treasury bill

$$f_0(T) = \frac{B_0(1+r)^T - FV(C)}{\text{Conversion Factor}}$$

Futures price – currency

Discrete compounding

$$f_o(T) = S_0\left[\frac{(1+r_d)^{d/365}}{(1+r_f)^{d/365}}\right]$$

Continuous compounding

$$f_0(T) = S_0 e^{(r_d^c - r_f^c)(d/365)}$$

PRICING AND VALUATION OF SWAPS

Net fixed payment

$$NFP = (\text{swap rate} - \text{LIBOR})\left(\frac{\text{days}}{360}\right)NP$$

Swap fixed rate

$$C = \left(\frac{1 - Z_4}{Z_1 + Z_2 + Z_3 + Z_4}\right)$$

Discount rate

$$Z_{day} = \frac{1}{1 + \left(R_{day} \times \frac{\text{days}}{360}\right)}$$

Market value of interest rate swap

$$MV_{IRS} = V_{\text{floating-rate bond}} - V_{\text{fixed-rate bond}}$$

Market value of currency swap

$$MV_{CS} = V_{\text{domestic bond}} - V_{\text{foreign bond}}$$

Return on equity

$$\text{Return} = \left(\frac{\text{Ending value}}{\text{Beginning value}}\right)$$

Yield on equity

$$\text{Yield} = \left(\frac{\text{Ending value}}{\text{Beginning value}}\right) - 1$$

Payment on equity position

$$PMT = \text{Yield} \times NP$$

Market value of equity swap

$$MV_{ES} = NP(\text{Return}_X - \text{Return}_Y)$$

Swaption payoffs

$$\text{Payoff}_{\text{Swaption-payer}} = (SFR - X)\left(\frac{\text{days}}{360}\right)NP$$

$$\text{Payoff}_{\text{Swaption-receiver}} = (X - SFR)\left(\frac{\text{days}}{360}\right)NP$$

PRICING OF OPTION CONTRACTS

Intrinsic values

$$c = \max\left[0;(S-X)\right]$$
$$p = \max\left[0;(X-S)\right]$$

Bounds – European options

No cash flows – upper and lower

$$\left[S - X(1+r)^{-t}\right] \le c \le S$$
$$\left[X(1+r)^{-t} - S\right] \le p \le X(1+r)^{-t}$$

Cash flows – lower bounds

$$c \ge \left[S - PV(CF)\right] - PV(X)$$
$$p \ge PV(X) - \left[S - PV(X)\right]$$

Bounds – American options

$$\left[S - X(1+r)^{-t}\right] \le C \le S$$
$$(X-S) \le P \le X$$

Put-call parity – European options

No cash flows

$$S + p = c + X(1+r)^{-t}$$

Cash flows

$$\left[S - PV(CF)\right] + p = c + PV(X)$$

Futures contracts

$$F_T(1+r)^{-t} + p = c + X(1+r)^{-t}$$

Put-call parity – American options

$$S - X \le C - P \le S - X(1+r)^{-t}$$

Binomial model

$$p = \frac{(1+r)-d}{u-d}$$

$$f = \frac{\left[(p)(f^{+}) + (1-p)(f^{-})\right]}{(1+r)}$$

$$f = \frac{\left[(p)^2(f^{++}) + 2(p)(1-p)(f^{+-}) + (1-p)^2(f^{--})\right]}{(1+r)^2}$$

Black-Scholes Merton model

Black-Scholes model

$$d_1 = \frac{\ln(S/X) + \left[r^c + (\sigma^2/2)\right]T}{\sigma\sqrt{T}}$$
$$d_2 = d_1 - \sigma\sqrt{T}$$

$$c = SN(d_1) - Xe^{-r^cT}N(d_2)$$
$$p = Xe^{-r^cT}N(-d_2) - SN(-d_1)$$

Merton's model

$$d_1 = \frac{\ln(S/X) + \left[(r^c - \delta) + (\sigma^2/2)\right]T}{\sigma\sqrt{T}}$$
$$d_2 = d_1 - \sigma\sqrt{T}$$

$$c = Se^{-\delta T}N(d_1) - Xe^{-r^cT}N(d_2)$$
$$p = Xe^{-r^cT}N(-d_2) - Se^{-\delta T}N(-d_1)$$

[$r^c = r_d^c$ and $\delta = r_f^c$ when pricing currency options]

Black's model

$$d_1 = \frac{\ln(F/X) + (\sigma^2/2)T}{\sigma\sqrt{T}}$$
$$d_2 = d_1 - \sigma\sqrt{T}$$

$$c = e^{-r^cT}\left[FN(d_1) - XN(d_2)\right]$$
$$p = e^{-r^cT}\left[XN(-d_2) - FN(-d_1)\right]$$

Delta

$$\text{Delta} = \frac{f_1 - f_0}{S_1 - S_0} = N(d_1)$$

Interest rate options

$$IR_{call} = NP(U_{rate} - X_{rate})\left(\frac{d}{360}\right)$$
$$IR_{put} = NP(X_{rate} - U_{rate})\left(\frac{d}{360}\right)$$

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UNIVERSITY OF SOUTH AFRICA UNISA university of south africa UNIVERSITEIT VAN SUID-AFRIKA

EXAMINATION MARK READING SHEET — EKSAMEN-MERKLEESBLAD

PART 1 (GENERAL/ALGEMEEN) DEEL 1

STUDY UNIT e g PSY100-X
STUDIE EENHEID bv PSY100-X
(1)

INITIALS AND SURNAME
VOORLETTERS EN VAN (3)

PAPER NUMBER
VRAESTELNOMMER (2)

DATE OF EXAMINATION
DATUM VAN EKSAMEN (4)

EXAMINATION CENTRE (E G PRETORIA)
EKSAMENSENTRUM (BV PRETORIA) (5)

STUDENT NUMBER
STUDENTENOMMER (6)

0	0	0	0	0	0	0	0
1	1	1	1	1	1	1	1
2	2	2	2	2	2	2	2
3	3	3	3	3	3	3	3
4	4	4	4	4	4	4	4
5	5	5	5	5	5	5	5
6	6	6	6	6	6	6	6
7	7	7	7	7	7	7	7
8	8	8	8	8	8	8	8
9	9	9	9	9	9	9	9

(7)

UNIQUE PAPER NO
UNIEKE VRAESTEL NR (8)

0	0	0	0	0	0
1	1	1	1	1	1
2	2	2	2	2	2
3	3	3	3	3	3
4	4	4	4	4	4
5	5	5	5	5	5
6	6	6	6	6	6
7	7	7	7	7	7
8	8	8	8	8	8
9	9	9	9	9	9

(9)

For use by examination invigilator
Vir gebruik deur eksamenopsiener

IMPORTANT

1 USE ONLY AN HB PENCIL TO COMPLETE THIS SHEET
2 MARK LIKE THIS
3 CHECK THAT YOUR INITIALS AND SURNAME HAS BEEN FILLED IN CORRECTLY
4 ENTER YOUR STUDENT NUMBER FROM LEFT TO RIGHT
5 CHECK THAT YOUR STUDENT NUMBER HAS BEEN FILLED IN CORRECTLY
6 CHECK THAT THE UNIQUE NUMBER HAS BEEN FILLED IN CORRECTLY
7 CHECK THAT ONLY ONE ANSWER PER QUESTION HAS BEEN MARKED
8 DO NOT FOLD

BELANGRIK

1 GEBRUIK SLEGS N HB POTLOOD OM HIERDIE BLAD TE VOLTOOI
2 MERK AS VOLG
3 KONTROLEER DAT U VOORLETTERS EN VAN REG INGEVUL IS
4 VUL U STUDENTENOMMER VAN LINKS NA REGS IN
5 KONTROLEER DAT U DIE KORREKTE STUDENTENOMMER VERSTREK HET
6 KONTROLEER DAT DIE UNIEKE NOMMER REG INGEVUL IS
7 MAAK SEKER DAT NET EEN ALTERNATIEF PER VRAAG GEMERK IS
8 MOENIE VOU NIE

PART 2 (ANSWERS/ANTWOORDE) DEEL 2

(10)

1	[1] [2] [3] [4] [5]	36	[1] [2] [3] [4] [5]	71	[1] [2] [3] [4] [5]	106	[1] [2] [3] [4] [5]
2	[1] [2] [3] [4] [5]	37	[1] [2] [3] [4] [5]	72	[1] [2] [3] [4] [5]	107	[1] [2] [3] [4] [5]
3	[1] [2] [3] [4] [5]	38	[1] [2] [3] [4] [5]	73	[1] [2] [3] [4] [5]	108	[1] [2] [3] [4] [5]
4	[1] [2] [3] [4] [5]	39	[1] [2] [3] [4] [5]	74	[1] [2] [3] [4] [5]	109	[1] [2] [3] [4] [5]
5	[1] [2] [3] [4] [5]	40	[1] [2] [3] [4] [5]	75	[1] [2] [3] [4] [5]	110	[1] [2] [3] [4] [5]
6	[1] [2] [3] [4] [5]	41	[1] [2] [3] [4] [5]	76	[1] [2] [3] [4] [5]	111	[1] [2] [3] [4] [5]
7	[1] [2] [3] [4] [5]	42	[1] [2] [3] [4] [5]	77	[1] [2] [3] [4] [5]	112	[1] [2] [3] [4] [5]
8	[1] [2] [3] [4] [5]	43	[1] [2] [3] [4] [5]	78	[1] [2] [3] [4] [5]	113	[1] [2] [3] [4] [5]
9	[1] [2] [3] [4] [5]	44	[1] [2] [3] [4] [5]	79	[1] [2] [3] [4] [5]	114	[1] [2] [3] [4] [5]
10	[1] [2] [3] [4] [5]	45	[1] [2] [3] [4] [5]	80	[1] [2] [3] [4] [5]	115	[1] [2] [3] [4] [5]
11	[1] [2] [3] [4] [5]	46	[1] [2] [3] [4] [5]	81	[1] [2] [3] [4] [5]	116	[1] [2] [3] [4] [5]
12	[1] [2] [3] [4] [5]	47	[1] [2] [3] [4] [5]	82	[1] [2] [3] [4] [5]	117	[1] [2] [3] [4] [5]
13	[1] [2] [3] [4] [5]	48	[1] [2] [3] [4] [5]	83	[1] [2] [3] [4] [5]	118	[1] [2] [3] [4] [5]
14	[1] [2] [3] [4] [5]	49	[1] [2] [3] [4] [5]	84	[1] [2] [3] [4] [5]	119	[1] [2] [3] [4] [5]
15	[1] [2] [3] [4] [5]	50	[1] [2] [3] [4] [5]	85	[1] [2] [3] [4] [5]	120	[1] [2] [3] [4] [5]
16	[1] [2] [3] [4] [5]	51	[1] [2] [3] [4] [5]	86	[1] [2] [3] [4] [5]	121	[1] [2] [3] [4] [5]
17	[1] [2] [3] [4] [5]	52	[1] [2] [3] [4] [5]	87	[1] [2] [3] [4] [5]	122	[1] [2] [3] [4] [5]
18	[1] [2] [3] [4] [5]	53	[1] [2] [3] [4] [5]	88	[1] [2] [3] [4] [5]	123	[1] [2] [3] [4] [5]
19	[1] [2] [3] [4] [5]	54	[1] [2] [3] [4] [5]	89	[1] [2] [3] [4] [5]	124	[1] [2] [3] [4] [5]
20	[1] [2] [3] [4] [5]	55	[1] [2] [3] [4] [5]	90	[1] [2] [3] [4] [5]	125	[1] [2] [3] [4] [5]
21	[1] [2] [3] [4] [5]	56	[1] [2] [3] [4] [5]	91	[1] [2] [3] [4] [5]	126	[1] [2] [3] [4] [5]
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23	[1] [2] [3] [4] [5]	58	[1] [2] [3] [4] [5]	93	[1] [2] [3] [4] [5]	128	[1] [2] [3] [4] [5]
24	[1] [2] [3] [4] [5]	59	[1] [2] [3] [4] [5]	94	[1] [2] [3] [4] [5]	129	[1] [2] [3] [4] [5]
25	[1] [2] [3] [4] [5]	60	[1] [2] [3] [4] [5]	95	[1] [2] [3] [4] [5]	130	[1] [2] [3] [4] [5]
26	[1] [2] [3] [4] [5]	61	[1] [2] [3] [4] [5]	96	[1] [2] [3] [4] [5]	131	[1] [2] [3] [4] [5]
27	[1] [2] [3] [4] [5]	62	[1] [2] [3] [4] [5]	97	[1] [2] [3] [4] [5]	132	[1] [2] [3] [4] [5]
28	[1] [2] [3] [4] [5]	63	[1] [2] [3] [4] [5]	98	[1] [2] [3] [4] [5]	133	[1] [2] [3] [4] [5]
29	[1] [2] [3] [4] [5]	64	[1] [2] [3] [4] [5]	99	[1] [2] [3] [4] [5]	134	[1] [2] [3] [4] [5]
30	[1] [2] [3] [4] [5]	65	[1] [2] [3] [4] [5]	100	[1] [2] [3] [4] [5]	135	[1] [2] [3] [4] [5]
31	[1] [2] [3] [4] [5]	66	[1] [2] [3] [4] [5]	101	[1] [2] [3] [4] [5]	136	[1] [2] [3] [4] [5]
32	[1] [2] [3] [4] [5]	67	[1] [2] [3] [4] [5]	102	[1] [2] [3] [4] [5]	137	[1] [2] [3] [4] [5]
33	[1] [2] [3] [4] [5]	68	[1] [2] [3] [4] [5]	103	[1] [2] [3] [4] [5]	138	[1] [2] [3] [4] [5]
34	[1] [2] [3] [4] [5]	69	[1] [2] [3] [4] [5]	104	[1] [2] [3] [4] [5]	139	[1] [2] [3] [4] [5]
35	[1] [2] [3] [4] [5]	70	[1] [2] [3] [4] [5]	105	[1] [2] [3] [4] [5]	140	[1] [2] [3] [4] [5]

MARK READING SHEET INSTRUCTIONS

Your mark reading sheet is marked by computer and should therefore be filled in thoroughly and correctly

USE ONLY AN HB PENCIL TO COMPLETE YOUR MARK READING SHEET

PLEASE DO NOT FOLD OR DAMAGE YOUR MARK READING SHEET

Consult the illustration of a mark reading sheet on the reverse of this page and follow the instructions step by step when working on your sheet

Instruction numbers ❶ to ❿ refer to spaces on your mark reading sheet which you should fill in as follows

❶ Write your paper code in these eight squares, for instance

P	S	Y	1	0	0	-	X

❷ The paper number pertains only to first-level courses consisting of two papers

WRITE | 0 | 1 | for the first paper and | 0 | 2 | for the second If only one paper, then leave blank

❸ Fill in your initials and surname

❹ Fill in the date of the examination

❺ Fill in the name of the examination centre

❻ WRITE the digits of your student number HORIZONTALLY (from left to right) Begin by filling in the first digit of your student number in the first square on the left, then fill in the other digits, each one in a separate square

❼ In each vertical column mark the digit that corresponds to the digit in your student number as follows [-]

❽ WRITE your unique paper number HORIZONTALLY
NB Your unique paper number appears at the top of your examination paper and consists only of digits (e g 403326)

❾ In each vertical column mark the digit that corresponds to the digit number in your unique paper number as follows [-]

❿ Question numbers 1 to 140 indicate corresponding question numbers in your examination paper The five spaces with digits 1 to 5 next to each question number indicate an alternative answer to each question The spaces of which the number correspond to the answer you have chosen for each question and should be marked as follows [-]

♦ For official use by the invigilator Do not fill in any information here