Strathmore
UNIVERSITY

STRATHMORE INSTITUTE OF MATHEMATICAL SCIENCES
BACHELOR OF BUSINESS SCIENCE IN FINANCIAL ENGINEERING
END OF SEMESTER EXAMINATION
BSF 4238 FINANCIAL INNOVATION AND STRUCTURED FINANCE

DATE: 2ND DECEMBER 2022 Time: 2 Hours

Instructions
1. This examination consists of **FIVE** questions.
2. Answer **Question ONE (COMPULSORY)** and any other **TWO** questions.

QUESTION ONE (30 MARKS)

1. Consider two assets whose prices $S_{1,t}$ and $S_{2,t}$ at time $t \in [0,T]$ that follow geometric Brownian dynamics as follows:

$$dS_{1,t} = rS_{1,t}dt + S_{1,t}\sigma_1 dW_{1,t}$$

$$dS_{2,t} = rS_{2,t}dt + S_{2,t}\sigma_2 dW_{2,t}$$

where $W_{1,t}, t \in [0,T]$, and $W_{2,t}, t \in [0,T]$ are two standard Brownian motions with correlation $\rho \in [-1, 1]$ under a risk-neutral probability measure Q^* , with $dW_{1,t} \bullet dW_{2,t} = \rho dt$.

   a) Determine the risk-neutral valuation formula for a Twin-win note written on the 2 underlying assets that pays a coupon of 5% of the principal of X USD when the $S_{1,t} > k_1$ and $S_{2,t} < k_2$. (6 Marks)
   b) Determine the risk-neutral valuation formula for a Chooser Option written on the first underlying asset. (4 Marks)

2. Modelling of derivatives and structured products payoffs and price trajectories is an involving processes in which the analysts can apply a variety of mathematical and

computation techniques and financial models with a variety of assumptions and trade-offs. Discuss the 3 main purposes of structure products modelling (6 Marks)

3. Outline the differences between the following swap contracts a) Credit Default Swap b) Variance Swap (4 Marks)
4. Majority of financial innovations involve different ways of bundling or unbundling more basic instruments such as bonds, equities, commodities and currencies. Discuss 2 possible source drivers of financial innovation and a type of product that resulted from such innovation (4 marks)
5. An analyst evaluates two European call options with different strike prices and time-to-maturity and summarizes their details as follows:

Pricing Date	05/01/2022			10/01/2022		
Underlying	S&P 500			S		
Price						
Maturity	1 Year			6 Months		
Direction	Long	**Delta**	0.9918	Long	**Delta**	0.9912
Option Type	Call	**Gamma**	0.0022	Call	**Gamma**	0.0013
Contract Size	100	**Vega**	1.1296	150	**Vega**	1.4339
Spot	100	**Theta**	-4.3554	110	**Theta**	-5.023
Volatility (%)	--	**Rho**	19.697	--	**Rho**	20.8761
Interest Rate (%)	--	**Vanna**	-0.2585	--	**Vanna**	-0.1704
Dividend Yield (%)	0.0	**Charm**	0.0913	0.0	**Charm**	0.0971

Determine the volatility rate and interest rate used in the evaluation of these European Call options on S&P 500 Index at pricing dates 05/01/2022 and 10/01/2022 respectively (6 Marks)

QUESTION TWO (20 MARKS)

1. In a conference on "*The Role of the Financial Engineers in Financial Deepening and Market Vibrance*", you are invited to highlight the benefits of securitization of assets. Explain 5 such benefits to be yielded for the African Financial Markets. (10 marks)
2. Explain the following approaches in deploying hedging strategies (4 Marks)
   a) Model-dependent Hedging
   b) Margin Hedging

3. Differentiate between the following types of arbitrage (6 marks)

    a) Spatial Arbitrage

    b) Statistical arbitrage

    c) Strategical arbitrage

QUESTION THREE (20 MARKS)

1. Provide a Pseudo-algorithm in R programming language for pricing an arithmetic Asian option under CIR stochastic volatility using monte carlo simulation (6 marks)
2. Examine 2 advantages of pricing derivatives and structured products under the influence of jumps and stochastic dynamics (4 marks)
3. A parity condition is a no-arbitrage condition representing an equilibrium state under which investors cannot obtain a risk-less profit. Show the parity conditions present in forward contracts and option contracts (4 Marks)
4. An analyst considers a 2 period binomial lattice model. The first 3 nodes of the call option's nodes were as follows 25.5, 5.3, 28.3. You are required to Determine the options payoffs at nodes N4, N5, N6 given that for the call at node N7 is 54 payoff. (6 marks)

QUESTION FOUR (20 MARKS)

1. Differentiate the following types of exotic options and structured products as used in hedging and speculation in forex, currency, equity and energy markets (12 marks)

    i) Ladder
    ii) Forward Start Option
    iii) Boston Option
    iv) Parisian Option
    v) Quanto Option
    vi) Shark Fin
    vii) Power Option
    viii) Rainbow Option

ix) Trend Option

x) Window Barrier Option

xi) Himalaya

xii) Wedding Cake

2. Covid-19 outbreak has resulted in unprecedented disruptions in operations, supply and demand shocks. Many businesses across sectors in Kenya have been disrupted and affected particularly in Hospitality, Tourism, Education, Sporting etc. Such a "black swan and its contagion" in the economy can bring about challenges in designing, pricing and writing of structured products. Discuss 4 of such challenges (8 Marks)

QUESTION FIVE (20 MARKS)

1. Explain the following terms as applied in the context of option pricing models in financial engineering (6 Marks)

   i) Risk-neutral probability

   ii) Real-world probability

   iii) Payoff condition

   iv) Calibration

   v) Back-testing

   vi) Martingale

2. Differentiate between cash-flow based securitization and synthetic securitization (4 marks).

3. Explain the securitization process of a non-performing loan portfolio, clearly describing the roles of the SPV, Originator, Servicers, Credit Enhancer, Trustee, Underwriters with relevant processes diagrams (10 Marks).

----------All the Best ----------