**Birla Institute of Technology & Science, Pilani**
**Pilani Campus – Rajasthan**

**Mid-Semester Exam – FIN F414**
**Financial Risk Analytics & Management**
**Session – 2023-24 (I)**
**Closed Book**

**Maximum Marks**: 105 **Dated**: 10/Oct./2023
**Time Duration**: 90 Minutes (**Max**)

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**Instructions**:

- Do not forget to write your Name and ID number on the answer sheet
- You need to write the answers in the separate answer booklet provided to you and submit to the invigilator before leaving the examination room. Failing to do so will result in zero marks in this evaluative component
- **To get the full score, you need to show all the steps required to arrive at the final answer with proper interpretation**
- Calculator is allowed

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**Q1:** **[30 Marks]**

McLemore Industries has a zero-coupon bond issue that matures in two years with a face value of $75,000. The current value of the company's assets is $46,000, and the standard deviation of the return on assets is 60 percent per year.

a. Assume the risk-free rate is 5 percent per year, compounded continuously. What is the value of a risk-free bond with the same face value and maturity as the company's bond?
b. What price would the bondholders have to pay for a put option on the firm's assets with a strike price equal to the face value of the debt?
c. Using the answers from (a) and (b), what is the value of the firm's debt?
d. From an examination of the value of the assets of McLemore Industries, and the fact that the debt must be repaid in two years, it seems likely that the company will default on its debt. Management has approached bondholders and proposed a plan whereby the company would repay the same face value of debt, but the repayment would not occur for five years. What is the value of the debt under the proposed plan? Explain why this occurs.

**[Hint:** Consider total asset as current stock price, face value of bond as strike price, value of equity as call option; total assets= equity + debt; value of the risky bond=value of the risk free bond-put option of the firm's equity]

**Q2:** **[10+10+10+6+6+4+4=50 Marks]**

**i.** Suppose that a stock price has an expected return of 16% per annum and a volatility of 30% per annum. When the stock price at the end of a certain day is $50, calculate the following:

a. The expected stock price at the end of the next day.
b. The standard deviation of the stock price at the end of the next day.
**c.** The 95% confidence limits for the stock price at the end of the next day.

ii. If $S$ follows the geometric Brownian motion, what is the process followed by (a) y = 2S, (b) $y=S^2$, (c) $y=e^S$, and (d) $y=e^{r(T-t)}/S$. In each case express the coefficients of dt and dz in terms of $y$ rather than S.

iii. Describe the various dimensions of market liquidity. Why is liquidity considered as a precondition for the stability of financial markets? Why is liquidity considered as an increasing function of stock returns? Explain with suitable examples and proper reasoning.

iv. A stock price is currently 50. Its expected return and volatility are 12% and 30%, respectively. What is the probability that the stock price will be greater than 80 in two years? (Hint $S_T > 80$ when $\ln S_T > \ln 80$.)

v. Show that the Black–Scholes–Merton formulas for call and put options satisfy put–call parity.

vi. The market price of a European call is $3.00 and its price given by Black-Scholes-Merton model with a volatility of 30% is $3.50. The price given by this Black-Scholes-Merton model for a European put option with the same strike price and time to maturity is $1.00. What should the market price of the put option be? Explain the reasons for your answer.

vii. "The Black–Scholes–Merton model is used by traders as an interpolation tool." Discuss this view.

**Q3:** **[25 Marks]**

A financial institution has just sold 1,000 seven-month European call options on the Japanese yen. Suppose that the spot exchange rate is 0.80 cent per yen, the exercise price is 0.81 cent per yen, the risk-free interest rate in the United States is 8% per annum, the risk-free interest rate in Japan is 5% per annum, and the volatility of the yen is 15% per annum. Calculate the delta, gamma, vega, theta, and rho of the financial institution's position. Interpret each number.

| $x$ | .00 | .01 | .02 | .03 | .04 | .05 | .06 | .07 | .08 | .09 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | 0.5000 | 0.5040 | 0.5080 | 0.5120 | 0.5160 | 0.5199 | 0.5239 | 0.5279 | 0.5319 | 0.5359 |
| 0.1 | 0.5398 | 0.5438 | 0.5478 | 0.5517 | 0.5557 | 0.5596 | 0.5636 | 0.5675 | 0.5714 | 0.5753 |
| 0.2 | 0.5793 | 0.5832 | 0.5871 | 0.5910 | 0.5948 | 0.5987 | 0.6026 | 0.6064 | 0.6103 | 0.6141 |
| 0.3 | 0.6179 | 0.6217 | 0.6255 | 0.6293 | 0.6331 | 0.6368 | 0.6406 | 0.6443 | 0.6480 | 0.6517 |
| 0.4 | 0.6554 | 0.6591 | 0.6628 | 0.6664 | 0.6700 | 0.6736 | 0.6772 | 0.6808 | 0.6844 | 0.6879 |
| 0.5 | 0.6915 | 0.6950 | 0.6985 | 0.7019 | 0.7054 | 0.7088 | 0.7123 | 0.7157 | 0.7190 | 0.7224 |
| 0.6 | 0.7257 | 0.7291 | 0.7324 | 0.7357 | 0.7389 | 0.7422 | 0.7454 | 0.7486 | 0.7517 | 0.7549 |
| 0.7 | 0.7580 | 0.7611 | 0.7642 | 0.7673 | 0.7704 | 0.7734 | 0.7764 | 0.7794 | 0.7823 | 0.7852 |
| 0.8 | 0.7881 | 0.7910 | 0.7939 | 0.7967 | 0.7995 | 0.8023 | 0.8051 | 0.8078 | 0.8106 | 0.8133 |
| 0.9 | 0.8159 | 0.8186 | 0.8212 | 0.8238 | 0.8264 | 0.8289 | 0.8315 | 0.8340 | 0.8365 | 0.8389 |
| 1.0 | 0.8413 | 0.8438 | 0.8461 | 0.8485 | 0.8508 | 0.8531 | 0.8554 | 0.8577 | 0.8599 | 0.8621 |
| 1.1 | 0.8643 | 0.8665 | 0.8686 | 0.8708 | 0.8729 | 0.8749 | 0.8770 | 0.8790 | 0.8810 | 0.8830 |
| 1.2 | 0.8849 | 0.8869 | 0.8888 | 0.8907 | 0.8925 | 0.8944 | 0.8962 | 0.8980 | 0.8997 | 0.9015 |
| 1.3 | 0.9032 | 0.9049 | 0.9066 | 0.9082 | 0.9099 | 0.9115 | 0.9131 | 0.9147 | 0.9162 | 0.9177 |
| 1.4 | 0.9192 | 0.9207 | 0.9222 | 0.9236 | 0.9251 | 0.9265 | 0.9279 | 0.9292 | 0.9306 | 0.9319 |
| 1.5 | 0.9332 | 0.9345 | 0.9357 | 0.9370 | 0.9382 | 0.9394 | 0.9406 | 0.9418 | 0.9429 | 0.9441 |
| 1.6 | 0.9452 | 0.9463 | 0.9474 | 0.9484 | 0.9495 | 0.9505 | 0.9515 | 0.9525 | 0.9535 | 0.9545 |
| 1.7 | 0.9554 | 0.9564 | 0.9573 | 0.9582 | 0.9591 | 0.9599 | 0.9608 | 0.9616 | 0.9625 | 0.9633 |
| 1.8 | 0.9641 | 0.9649 | 0.9656 | 0.9664 | 0.9671 | 0.9678 | 0.9686 | 0.9693 | 0.9699 | 0.9706 |
| 1.9 | 0.9713 | 0.9719 | 0.9726 | 0.9732 | 0.9738 | 0.9744 | 0.9750 | 0.9756 | 0.9761 | 0.9767 |
| 2.0 | 0.9772 | 0.9778 | 0.9783 | 0.9788 | 0.9793 | 0.9798 | 0.9803 | 0.9808 | 0.9812 | 0.9817 |
| 2.1 | 0.9821 | 0.9826 | 0.9830 | 0.9834 | 0.9838 | 0.9842 | 0.9846 | 0.9850 | 0.9854 | 0.9857 |
| 2.2 | 0.9861 | 0.9864 | 0.9868 | 0.9871 | 0.9875 | 0.9878 | 0.9881 | 0.9884 | 0.9887 | 0.9890 |
| 2.3 | 0.9893 | 0.9896 | 0.9898 | 0.9901 | 0.9904 | 0.9906 | 0.9909 | 0.9911 | 0.9913 | 0.9916 |
| 2.4 | 0.9918 | 0.9920 | 0.9922 | 0.9925 | 0.9927 | 0.9929 | 0.9931 | 0.9932 | 0.9934 | 0.9936 |
| 2.5 | 0.9938 | 0.9940 | 0.9941 | 0.9943 | 0.9945 | 0.9946 | 0.9948 | 0.9949 | 0.9951 | 0.9952 |
| 2.6 | 0.9953 | 0.9955 | 0.9956 | 0.9957 | 0.9959 | 0.9960 | 0.9961 | 0.9962 | 0.9963 | 0.9964 |
| 2.7 | 0.9965 | 0.9966 | 0.9967 | 0.9968 | 0.9969 | 0.9970 | 0.9971 | 0.9972 | 0.9973 | 0.9974 |
| 2.8 | 0.9974 | 0.9975 | 0.9976 | 0.9977 | 0.9977 | 0.9978 | 0.9979 | 0.9979 | 0.9980 | 0.9981 |
| 2.9 | 0.9981 | 0.9982 | 0.9982 | 0.9983 | 0.9984 | 0.9984 | 0.9985 | 0.9985 | 0.9986 | 0.9986 |
| 3.0 | 0.9986 | 0.9987 | 0.9987 | 0.9988 | 0.9988 | 0.9989 | 0.9989 | 0.9989 | 0.9990 | 0.9990 |

| *Greek letter* | *Call option* | *Put option* |
|---|---|---|
| Delta | $e^{-qT}N(d_1)$ | $e^{-qT}[N(d_1)-1]$ |
| Gamma | $\frac{N'(d_1)e^{-qT}}{S_0\sigma\sqrt{T}}$ | $\frac{N'(d_1)e^{-qT}}{S_0\sigma\sqrt{T}}$ |
| Theta | $-S_0N'(d_1)\sigma e^{-qT}/(2\sqrt{T}) + qS_0N(d_1)e^{-qT} - rKe^{-rT}N(d_2)$ | $-S_0N'(d_1)\sigma e^{-qT}/(2\sqrt{T}) - qS_0N(-d_1)e^{-qT} + rKe^{-rT}N(-d_2)$ |
| Vega | $S_0\sqrt{T}N'(d_1)e^{-qT}$ | $S_0\sqrt{T}N'(d_1)e^{-qT}$ |
| Rho | $KTe^{-rT}N(d_2)$ | $-KTe^{-rT}N(-d_2)$ |