



Chennai Mathematical Institute  
Financial Modelling Using Python  
Final Exam, 2023

Name:

Roll Number:

Total Number Pages used:

List of the questions you have answered:

Note:

- Filling up the above fields are mandatory
- Please write Roll Number in every pages
- Use of scientific calculator is allowed
- You have to tick the right answer in the question paper and submit

Answer any 7 questions from Section A.

5 marks for correct answer and -1 marks for wrong answer. Good to have explanations but not mandatory.

Section A

✓ Q1:

The price of a six-month, INR 25.00 strike, European put option on a stock is INR 3.00. The stock price is INR 26.00. A dividend of INR 1.00 is expected in three months. The continuously compounded risk-free rate for all maturities is 5% per year. Which of the following is closest to the value of a European call option on the same underlying stock with a strike price of INR 25.00 and a time to maturity of six months?

- A. INR 1.63
- B. INR 2.40
- ✓ C. INR 3.63
- D. INR 4.62
- E. None of the above

The idea is that you need to compute the present value of everything so the time is varying for Dividend and option.

Q2:

A trader in the arbitrage unit of a multinational bank finds that an asset is trading at USD 1,000, the price of a 1-year futures contract on that asset is USD 1,020, and the price of a 2-year futures contract is USD 1,045. Assume that there are no cash flows from the asset for 2 years. If the term structure of interest rates is flat at 2% per year, which of the following is an appropriate arbitrage strategy?

- A. Short 1-year futures and long 2-year futures
- B. Short 2-year futures and long 1-year futures
- C. Short 1-year futures and long the underlying asset funded by borrowing for 1 year
- D. Short 2-year futures and long the underlying asset funded by borrowing for 2 years
- E. None of the above

Q3:

A 15-month futures contract on an equity index is currently trading at USD 3,759.52. The underlying index is currently valued at USD 3,625 and has a continuously-compounded dividend yield of 2% per year. The continuously compounded risk-free rate is 5% per year. Assuming no transactions costs, what is the potential arbitrage profit per contract and the appropriate strategy?

- A. USD 4; buy the futures contract and sell the underlying.
- B. USD 189; buy the futures contract and sell the underlying.
- ☒ C. USD 4; sell the futures contract and buy the underlying.
- D. USD 189; sell the futures contract and buy the underlying.
- E. None of the above

Q4:

If the current market price of a stock is USD 60, which of the following options on the stock has the highest gamma?

- A. Call option expiring in 5 days with strike price of USD 30
- ☒ B. Call option expiring in 5 days with strike price of USD 60
- ☒ C. Call option expiring in 30 days with strike price of USD 60
- D. Put option expiring in 30 days with strike price of USD 30
- E. None of the above

Q5:

An asset manager at an insurance company is considering making a fixed income investment and holding it for 2 years. The manager is comparing two bond issues that have equal yield to maturity at origination. One is a semi-annual coupon bond paying 7%, maturing in 2 years, and priced at USD 101.86. The other is a zero-coupon bond, also maturing in 2 years, and priced at USD 88.85. The manager is uncertain about the outlook for interest rates over the next two years but will incorporate the forecast of the company's economist when making the investment decision. Assuming no default risk, tax implications, or liquidity constraints, which of the following statements is correct?

- A. The manager should be indifferent between the bonds if the interest rate is expected to rise since both bonds have the same yield and cash flows.
- B. The manager should prefer the zero-coupon bond if the interest rate is expected to rise in the future.
- C. The manager should prefer the zero-coupon bond if the expected average interest rate over the next 2 years is less than 6%.
- ☒ D. The manager should prefer the coupon bond if the expected average interest rate over the next 2 years is less than 6%.
- E. None of the above

Q6:

Suppose the S&P 500 Index has an expected annual return of 7.2% and volatility of 8.2%. Suppose the Andromeda Fund has an expected annual return of 6.8% and volatility of 7.0% and is benchmarked against the S&P 500 Index. If the risk-free rate is 2.2% per year, what is the beta of the Andromeda Fund according to the CAPM?

use capm formula



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- ☒ A. 0.92
- B. 0.95
- C. 1.13
- D. 1.23
- E. None of the above

Q7:

☒ Assume that a random variable follows a normal distribution with a mean of 40 and a standard deviation of 14. What is the probability that X does not lie between 12 and 61? **easy**

- A. 4.56%
- B. 6.18%
- ☒ C. 8.96%
- D. 18.15%
- E. None of the above

Q8:

☒ Portfolio A has an expected return of 8%, volatility of 20%, and beta of 0.4. Assume that the market has an expected return of 10% and volatility of 25%. Also, assume a risk-free rate of 5%. What is Jensen's alpha for portfolio A? **Use formula from PDF**

- A. 0.5%
- ☒ B. 1.0%
- C. 10.0%
- D. 15.0%
- E. None of the above

Q9:

☒ An analyst is evaluating the performance of a portfolio of equities that is benchmarked to the INFTY Index. The analyst collects the information about the portfolio and the benchmark index, shown below:

Expected return on the portfolio	8.7%
Volatility of returns on the portfolio	12.0%
Expected return on the NIFTY	4.0%
Volatility of returns on the NIFTY	8.7%
Risk free rate of return	2%
Beta of the portfolio relative to NIFTY	1.4

What is the Sharpe ratio for this portfolio? **use formula**

- A. 0.036
- B. 0.047
- C. 0.389
- ☒ D. 0.558
- E. None of the above

Answer any 4 questions from Section B. Total Marks  $4 \times 5$

Section B

✓ Q10: **ayush**

A financial instrument pays  $C$  dollars per year for  $n$  years. The investor interested in the instrument expects the cash flows to be reinvested at an annual rate of  $r$  and is asking for a yield of  $y$ . What should this instrument be selling for in order to be attractive to this investor?

✓ Q11: **meethu**

Explain the reason for correct option in Q4 and why other options are not correct.

✓ Q12: **write all three**

Explain the "Liquidity Premium Theory". Show that it explains all 3 facts of term structure of interest rates.

✓ Q13:

Par Value: 1000

Coupon Rate: 7.5%

Can be called after 2 years at 1005

The interest trees as follows: -

		7.50%	1075
	7.20%		
7%		7.10%	1075
	6.80%		
		6.75%	1075

Calculate bond price, call price and callable bond price.

✓ Q14:

Explain the following: - **GPT**

- A. Option Adjusted Spread
- B. Credit Spread
- C. Duration
- D. In-the-money
- E. At-the-money

✓ Q15: **Use formula from PDF**

An analyst is analyzing the historical performance of two commodity funds and tracking some Index as benchmark. The analyst collated the data on the monthly returns and decided to use the information ratio (IR) to assess which fund achieved higher returns more efficiently and presented the findings.



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	Fund 1	Fund 2	Benchmark Returns
Average monthly return	1.488%	1.468%	1.415%
Average excess return	0.073%	0.053%	0.000%
Standard deviation of returns	0.294%	0.237%	0.238%
Tracking error	0.344%	0.341%	0.000%

What is the information ratio for each fund, and what conclusion can be drawn and why?

- A. IR for Fund I = 0.212, IR for Fund II = 0.155; Fund II performed better as it has a lower IR.
- ✓ B. IR for Fund I = 0.212, IR for Fund II = 0.155; Fund I performed better as it has a higher IR.
- C. IR for Fund I = 0.248, IR for Fund II = 0.224; Fund I performed better as it has a higher IR.
- D. IR for Fund I = 0.248, IR for Fund II = 0.224; Fund II performed better as it has a lower IR.

Higher IR = Better risk-adjusted performance.

Answer all questions from Section C.

Section C

✓ Q16: Total Marks 5

Suppose that the time to expiration is 4 months, the strike price is \$95, the call premium is \$6, the put premium is \$3, the current stock price is \$94, and the continuously compounded annual interest rate is 10%. How to earn a riskless arbitrage profit?  $C - P > S - Ke^{-rT}$

✓ Q17: Total Marks 5

Explain the following:

There are two identical options except for their strike prices. The difference in their prices cannot be greater than the difference in their strike prices.

✓ Q18: Total Marks 5

Assume you are assigned the task of evaluating the stock of TCS. To evaluate the stock, you calculate required return using the CAPM. You can assume that the price of TCS is fairly valued. The following information is available:

- Expected Annual Nifty return is 12%
- beta of TCS is 0.65
- Risk free rate 5.3% (SBI's FD rate)
- The annualised volatility of market return is 15%

Answer the following questions:

- a) Using CAPM, calculate the annual expected return of TCS
- b) If the current market price of Rs 3500/- per share, then what will be the expected price of TCS stock after one year.
- c) Find the annualised volatility of the return of TCS **how?**
- d) Assuming TCS return follows Gaussian distribution, what is the probability that after one year the TCS price will be less than Rs. 3500/-?



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Reference Table: Let  $Z$  be a standard normal random variable.

$z$	$P(Z < z)$	$z$	$P(Z < z)$	$z$	$P(Z < z)$	$z$	$P(Z < z)$	$z$	$P(Z < z)$	$z$	$P(Z < z)$
-3	0.0013	-2.50	0.0062	-2.00	0.0228	-1.50	0.0668	-1.00	0.1587	-0.50	0.3085
-2.99	0.0014	-2.49	0.0064	-1.99	0.0233	-1.49	0.0681	-0.99	0.1611	-0.49	0.3121
-2.98	0.0014	-2.48	0.0066	-1.98	0.0239	-1.48	0.0694	-0.98	0.1635	-0.48	0.3156
-2.97	0.0015	-2.47	0.0068	-1.97	0.0244	-1.47	0.0708	-0.97	0.1660	-0.47	0.3192
-2.96	0.0015	-2.46	0.0069	-1.96	0.0250	-1.46	0.0721	-0.96	0.1685	-0.46	0.3228
-2.95	0.0016	-2.45	0.0071	-1.95	0.0256	-1.45	0.0735	-0.95	0.1711	-0.45	0.3264
-2.94	0.0016	-2.44	0.0073	-1.94	0.0262	-1.44	0.0749	-0.94	0.1736	-0.44	0.3300
-2.93	0.0017	-2.43	0.0075	-1.93	0.0268	-1.43	0.0764	-0.93	0.1762	-0.43	0.3336
-2.92	0.0018	-2.42	0.0078	-1.92	0.0274	-1.42	0.0778	-0.92	0.1788	-0.42	0.3372
-2.91	0.0018	-2.41	0.0080	-1.91	0.0281	-1.41	0.0793	-0.91	0.1814	-0.41	0.3409
-2.9	0.0019	-2.40	0.0082	-1.90	0.0287	-1.40	0.0808	-0.90	0.1841	-0.40	0.3446
-2.89	0.0019	-2.39	0.0084	-1.89	0.0294	-1.39	0.0823	-0.89	0.1867	-0.39	0.3483
-2.88	0.0020	-2.38	0.0087	-1.88	0.0301	-1.38	0.0838	-0.88	0.1894	-0.38	0.3520
-2.87	0.0021	-2.37	0.0089	-1.87	0.0307	-1.37	0.0853	-0.87	0.1922	-0.37	0.3557
-2.86	0.0021	-2.36	0.0091	-1.86	0.0314	-1.36	0.0869	-0.86	0.1949	-0.36	0.3594
-2.85	0.0022	-2.35	0.0094	-1.85	0.0322	-1.35	0.0885	-0.85	0.1977	-0.35	0.3632
-2.84	0.0023	-2.34	0.0096	-1.84	0.0329	-1.34	0.0901	-0.84	0.2005	-0.34	0.3669
-2.83	0.0023	-2.33	0.0099	-1.83	0.0336	-1.33	0.0918	-0.83	0.2033	-0.33	0.3707
-2.82	0.0024	-2.32	0.0102	-1.82	0.0344	-1.32	0.0934	-0.82	0.2061	-0.32	0.3745
-2.81	0.0025	-2.31	0.0104	-1.81	0.0351	-1.31	0.0951	-0.81	0.2090	-0.31	0.3783
-2.8	0.0026	-2.30	0.0107	-1.80	0.0359	-1.30	0.0968	-0.80	0.2119	-0.30	0.3821
-2.79	0.0026	-2.29	0.0110	-1.79	0.0367	-1.29	0.0985	-0.79	0.2148	-0.29	0.3859
-2.78	0.0027	-2.28	0.0113	-1.78	0.0375	-1.28	0.1003	-0.78	0.2177	-0.28	0.3897
-2.77	0.0028	-2.27	0.0116	-1.77	0.0384	-1.27	0.1020	-0.77	0.2206	-0.27	0.3936
-2.76	0.0029	-2.26	0.0119	-1.76	0.0392	-1.26	0.1038	-0.76	0.2236	-0.26	0.3974
-2.75	0.0030	-2.25	0.0122	-1.75	0.0401	-1.25	0.1056	-0.75	0.2266	-0.25	0.4013
-2.74	0.0031	-2.24	0.0125	-1.74	0.0409	-1.24	0.1075	-0.74	0.2296	-0.24	0.4052
-2.73	0.0032	-2.23	0.0129	-1.73	0.0418	-1.23	0.1093	-0.73	0.2327	-0.23	0.4090
-2.72	0.0033	-2.22	0.0132	-1.72	0.0427	-1.22	0.1112	-0.72	0.2358	-0.22	0.4129
-2.71	0.0034	-2.21	0.0136	-1.71	0.0436	-1.21	0.1131	-0.71	0.2389	-0.21	0.4168
-2.7	0.0035	-2.20	0.0139	-1.70	0.0446	-1.20	0.1151	-0.70	0.2420	-0.20	0.4207
-2.69	0.0036	-2.19	0.0143	-1.69	0.0455	-1.19	0.1170	-0.69	0.2451	-0.19	0.4247
-2.68	0.0037	-2.18	0.0146	-1.68	0.0465	-1.18	0.1190	-0.68	0.2483	-0.18	0.4286
-2.67	0.0038	-2.17	0.0150	-1.67	0.0475	-1.17	0.1210	-0.67	0.2514	-0.17	0.4325
-2.66	0.0039	-2.16	0.0154	-1.66	0.0485	-1.16	0.1230	-0.66	0.2546	-0.16	0.4364
-2.65	0.0040	-2.15	0.0158	-1.65	0.0495	-1.15	0.1251	-0.65	0.2578	-0.15	0.4404
-2.64	0.0041	-2.14	0.0162	-1.64	0.0505	-1.14	0.1271	-0.64	0.2611	-0.14	0.4443
-2.63	0.0043	-2.13	0.0166	-1.63	0.0516	-1.13	0.1292	-0.63	0.2643	-0.13	0.4483
-2.62	0.0044	-2.12	0.0170	-1.62	0.0526	-1.12	0.1314	-0.62	0.2676	-0.12	0.4522
-2.61	0.0045	-2.11	0.0174	-1.61	0.0537	-1.11	0.1335	-0.61	0.2709	-0.11	0.4562
-2.6	0.0047	-2.10	0.0179	-1.60	0.0548	-1.10	0.1357	-0.60	0.2743	-0.10	0.4602
-2.59	0.0048	-2.09	0.0183	-1.59	0.0559	-1.09	0.1379	-0.59	0.2776	-0.09	0.4641
-2.58	0.0049	-2.08	0.0188	-1.58	0.0571	-1.08	0.1401	-0.58	0.2810	-0.08	0.4681
-2.57	0.0051	-2.07	0.0192	-1.57	0.0582	-1.07	0.1423	-0.57	0.2843	-0.07	0.4721
-2.56	0.0052	-2.06	0.0197	-1.56	0.0594	-1.06	0.1446	-0.56	0.2877	-0.06	0.4761
-2.55	0.0054	-2.05	0.0202	-1.55	0.0606	-1.05	0.1469	-0.55	0.2912	-0.05	0.4801
-2.54	0.0055	-2.04	0.0207	-1.54	0.0618	-1.04	0.1492	-0.54	0.2946	-0.04	0.4840
-2.53	0.0057	-2.03	0.0212	-1.53	0.0630	-1.03	0.1515	-0.53	0.2981	-0.03	0.4880
-2.52	0.0059	-2.02	0.0217	-1.52	0.0643	-1.02	0.1539	-0.52	0.3015	-0.02	0.4920
-2.51	0.0060	-2.01	0.0222	-1.51	0.0655	-1.01	0.1562	-0.51	0.3050	-0.01	0.4960