1. Question

Case studies that feature financial engineering by way of complex derivatives include Bankers Trust, the Orange County case, and Sachsen Landesbank. In regard to these financial engineering cases, each of the following statements is true EXCEPT which is false?

a) Bankers Trust (BT) proposed an overly complex swap to their clients (P&G and Gibson Greetings) but the swaps experienced colossal losses; the clients sued BT, who never recovered from the ensuing reputational damage

b) Orange County's treasurer (Robert Citron) borrowed through the repo market to purchase inverse floating-rate notes–positions that Citron later said he did not understand–but the combination of excessive leverage and embedded interest-rate risk generated losses that ultimately forced Orange County to file for bankruptcy

c) Sachsen Landesbank set up off-balance-sheet vehicles (guaranteed by Sachsen) that held highly-rated U.S. mortgage-backed securities; the operation was highly profitable, but the 2007-08 subprime crisis wiped out Sachsen's capital

d) If the purpose of the position is designated as hedging (rather than speculation) and if the hedge consists only of some combination(s) of forwards, swaps and/or options–which are the primary building blocks–then the firm can avoid problems suffered by the financial engineering case studies because the firm avoids undue sophistication

Correct

D. FALSE. A hedge does not avoid the assumption of embedded risks that may not be understood; the hedge/speculation intention is important but does not completely warranty the risks of the position. More importantly, complex positions are

combinations of the primary building blocks such that complex hedge positions do not avoid running significant

2. Question

A very small sample of 10 public companies has one target variable (i.e., Dividend) and four features (i.e., Earnings, LargeCap, Retail, and Tech). Both Dividend and Earnings are binary variables where respectively, one (1) indicates the company recently paid a dividend, and its earnings dropped in the previous year. The data frame is displayed below.

Dividend	Earnings	LargeCap	Retail (%)	Tech
1	0	0	80	1
1	0	1	40	1
1	0	1	20	0
1	0	1	60	0
0	1	0	30	1
0	1	0	40	0
0	1	1	40	0
1	1	1	30	0
1	1	1	20	0
1	1	1	20	1

Based on Dividend as the output (aka, target) variable, the base Gini coefficient is 0.420. That's because 1- [(7/10)^2 + (3/10)^2]. What is the information gain if we split (as the root node's feature) the Earnings feature?

- [ ] a) Zero
- [x] b) 0.120
- [ ] c) 0.348

- [ ] d) 0.875

Correct

B. True: 0.120 = 0.420 – 0.300

We need the weighted Gini coefficient for (splitting on) the Earnings feature. The four {Earnings=0} all pay dividends: this branch is pure with a Gini of zero! The Gini of the six {Earnings = 1} branch, where 3 pay dividends and 3 do not, is given by 1 – (3/6)^2 – (3/6)^2 = 0.50. The weighted Gini is, therefore, 0*4/10 + 0.50*6/10 = 0.30. The information gain is 0.120 because splitting on the Earnings feature reduces from the base Gini of 0.420 to 0.300.

3. Question

About swaps, each of the following is true **EXCEPT** which is false?

- a) At any given time during the life of a bilateral OTC swap, at least one of the counterparties incurs both market and credit risk
- b) A difference between the typical interest rate swap and currency swap is whether the principal (aka, notional principal) is exchanged
- c) Both overnight indexed swaps (OIS) and volatility swaps need to determine a realized (aka, actual) financial variable at the end of a period or tenor
- **d) A commercial bank funded by short-term floating-rate deposits that extends long-term fixed-rate loans can hedge market risk by entering a swap where it is the floating-rate payer and fixed-rate receiver**

Correct
D. False. This is the opposite of a hedge! The bank hedges with a swap where it is the floating-rate receiver and fixed-rate payer
In regard to (A), (B), and (C), each is TRUE.

4. Question

A large international bank uses EWMA for their risk system, with a decay factor of 0.92. On day T the forecast volatility for two variables, X&Y, are identical at 1.25% and the current correlation forecast is 15.0%. If on day T the realized returns for X & Y are 0.50% and -0.50% respectively, which of the following is closest to the new correlation?

- a) 12.5%
- b) 13.4%
- c) 15.0%
- d) 16.2%

Correct
B. 13.4%
Recall the EWMA equations for variance and covariance:

$$\sigma_{T+1}^2 = \lambda\sigma_T^2 + (1-\lambda)r_T^2$$

$$cov_{T+1}^{\square} = \lambda cov_T^{\square} + (1-\lambda)r_{X,T}^{\square}r_{Y,T}^{\square}$$

So, the covariance forecast for day T is 0.15*0.0125*0.0125 = 2.34e-5
We need to update the variance estimates for X & Y & cov(X,Y):
Variance(X)=0.92*(0.0125^2)+(0.08)*(0.005^2)=0.00014575, Std(X)=1.21%
Variance(Y)=0.92*(0.0125^2)+(0.08)*(-0.005^2)=0.00014575, Std(Y)=1.21%
Cov(X,Y)=0.92*(2.34e-5)*0.08*(0.005)*(-0.005)=1.956e-5
Corr(X,Y)=Cov(X,Y)/(Std(X)*Std(Y))= 13.4%

- 12.5% is the answer if we use yesterday's volatilities in the correlation equation
- 15.0% is the incumbent correlation
- 16.2% is the value if use 0.5% instead of 0.05% for the return on Y

5. Question

According to GARP, each of the following was a causal factor in the 2007-2009 global financial crisis (GFC) **EXCEPT** which is not a causal factor?

- a) Low interest rates
- b) The originate-to-distribute (OTD) business model and securitization, especially CDOs
- c) An unexpected spike in prepayments due to an acceleration in repeat refinancing
- d) Dubious lending practices and risky mortgage loan products (e.g., NINJA) and loan features (e.g., teaser rates)

Correct

C. FALSE: Refinancing enabled borrowers to avoid higher interest rates (as the reset rate) after their initial, teaser rates; the PROBLEM was that home price declines halted the refinance practice that fueled much of the subprime borrowing. In this way, prepayments were not really a cause.

In regard to (A), (B) and (D), each is TRUE. Although there were several causes (some disputed), according to GARP's Chapter 10, causal factors included:

- Low interest rates (note the dual role in terms of housing demand and investor supply): "Growth in housing demand and concomitant mortgage financing was fueled (in part) by the low-interest-rate environment that existed in the early 2000s. This demand helped drive substantial increases in housing prices. Low interest rates also spurred investors, including institutional investors, to look for investments that offered yield enhancement. They found this yield in subprime mortgages, which typically carry premiums of up to 300-basis points over the rates charged to prime borrowers." — Source: 2020 FRM Part I: Foundations of Risk Management, 10th Edition

- The shift toward banks' **originate-to-distribute (OTD) business model** which enabled a moral hazard by discouraging careful scrutiny of borrower creditworthiness.
- **Risky mortgage loan products**, in particular, teaser rates; e.g., 2/28 adjustable-rate mortgages. (But also interest-only teaser periods and other "innovations" like NINJA loans).

6. Question

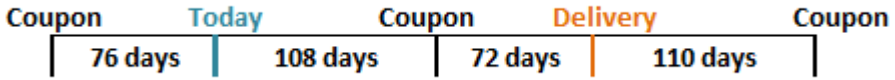
A hedge fund's big data algorithm can predict the market's direction on five out of eight days (62.5%). Each day's prediction is either a success (e.g., market goes up and algo predicts up) or a failure (e.g., market goes down but algo predicts up). If we dubiously assume the predictions are independent, the binomial distribution fits a series of daily predictions over, say, a week or a month. Over two months, the probability of each day's predication being successful, p, equals 5/8 or 62.5% and the number of days, n, equals 60. We observe that n*p = 60*62.5% = 37.5 and n*(1-p) = 60*37.5% = 22.5, and both of these values (i.e., 37.5 and 22.5) are greater than 10; this satisfies a conventional test that says we can use the normal to approximate the binomial. For example, if p were only 1.0%, then n*p = 6, but 6 is less than 10, and such a binomial is deemed to be too skewed to be approximated by the normal distribution. But ours passes the test so we will approximate with the normal distribution. If we do rely on the normal distribution to approximate this binomial where p = 5/8 and n = 60, what is the probability that the algo makes a correct prediction on only half the days or worse; i.e., where X is the number of successful predictions and we approximate with the normal distribution, what is the Pr(X <= 30)?

- [x] a) 2.2750%
- [ ] b) 8.3500%
- [ ] c) 11.090%
- [ ] d) 14.6667%

Correct
A. True: 2.2750%
The variance = n*p*(1-p) and the standard deviation = sqrt[n*p*(1-p)]; in this case, the standard deviation = sqrt[60*(5/8)*(3/8)] = 3.750. Where Z = (30 – 60*5/8)/3.750 = -2.0, the Pr(Z < -2.0) = 2.2750%

7. Question

Suppose that it is known that a bond will be delivered in 180 days under the terms of a futures contract. The timing of coupon payments is shown below. The last coupon on the bond was paid 76 days ago, and the next coupon will be paid in 108 days. The coupon after the next one will be paid in 290 days (i.e., 110 days after delivery). Here is the timeline:



Assume that the risk-free interest rate for all maturities is 5.0% with continuous compounding and that the delivered bond pays a coupon of 9.0% semi-annually with a current quoted (clean) price of USD 124.80 and a conversion factor of 1.300.

Which of the following is **nearest** to the quoted futures price?

- [x] a) $95.00
- [ ] b) $98.22
- [ ] c) $123.50
- [ ] d) $125.27

Correct
A. True: $95.00
See this spreadsheet:

Assumptions	
Face	**$100.00**
Current Quoted (Clean) Price	**$124.80**
Coupon	**9.0%**
Interest rate	**5.0%**
Conversion Factor	**1.300**
Delivery (days)	**180**
Last Coupon (-days)	**76**
Next Coupon (+ days)	**108**
Coupon thereafter	**182**

Timeline	
7/1/2023	**Coupon payment**
-76 days	
9/15/2023	**Current time**
108 days	
1/1/2024	**(Next) coupon payment**
72 days	
3/13/2024	**Maturity of futures**
110 days	
7/1/2024	**Coupon payment**

Solution (Hull's Example 6-2)	
Accrued Interest	$1.859
Cash (Dirty, Full) Price	**$126.6587**
PV of next coupon	$4.434
Cash Futures Price	**$125.2760**
Days Accrued @ delivery	72
Days Remain @ delivery	110
Futures price, Quoted, 12% bond	$123.4958
Futures price, Quoted, CTD	**$94.9968**

COC: $F_0=(S_0-I)*EXP(rT)$	
1. COC to calculate Cash forward	
Spot:	**$126.659**
Income:	**$4.434**
Forward cash price:	**$125.276**
2. Then dirty --> clean & standardize	
Subtract AI	**$1.780**
Quoted Price, 12% bond =	**$123.496**
Divide by CF of 1.30	**$94.997**

8. Question

A risk analyst is using the EWMA model to build a daily update of correlation and covariance rates. The two variables are random and are called X and Y. The most recent covariance weight (aka, lambda in the EWMA model) from day n-1 is 0.7. The correlation between X and Y on day N-1 is estimated to be 0.55. X and Y had estimated standard deviations of 0.015 and 0.017 with percentage changes of 3% and 4% respectively on day N-1. The updated covariance between X and Y on day n is **nearest** to which of the following?

- a) 1.48 × 10^(-4)
- b) 4.58 × 10^(-4)
- c) 1.18437
- d) 0.04581

Correct
B. 0.00046
We can find the EWMA using the following formula:
CovN = λ * CovN-1 + (1- λ)* Xn-1 * Yn-1
λ = weight of the most recent covariance on day n−1
X = percentage change for variable X on day n−1
Y = percentage change for variable Y on day n−1
We know that Covxy= ρxy ∗ σx σy
Cov (n-1) = 0.55* 0.015 * 0.017 = 0.00014025
Cov N = 0.7 * 0.00014025 + (1-.7) * 3% * 4% = 0.000458175 = 4.58 *10^(-4)

9. Question

Which of the following is **TRUE** about the SWIFT (Society for Worldwide Interbank Financial Telecommunication) case study?

- [ ] a) The 2015-16 cyber-attack (aka, hack) demonstrated that the SWIFT network was unreliable, and it was subsequently phased out
- [x] b) The 2015-16 cyber-attack (aka, hack) successfully exploited vulnerabilities to achieve the theft of about USD 81.0 million
- [ ] c) The 2015-16 cyber-attack (aka, hack) was an unsuccessful attempt to steal money, and it demonstrated the SWIFT network is essentially impervious to attacks
- [ ] d) The 2015-16 cyber-attack (aka, hack) was a fictitious news account but the negative press nonetheless shook confidence sufficiently in the network that transactions ground to a halt for several weeks

Correct
B. TRUE: The 2015-16 cyber attack (aka, hack) successfully exploited vulnerabilities to achieve the theft of about USD 81.0 million
In regard to (A), (C) and (D), each is FALSE.

10. Question

A credit portfolio contains some number of independent credit-sensitive assets with identical default probabilities; as the defaults are i.i.d., we can use the binomial distribution to characterize the number of defaults. We are told the expected number of defaults is 4.0 with a variance of 3.80. Which is **nearest** to the probability of exactly four defaults; Pr(X = 4 | binomial with mean of 4.0 and variance of 3.80)?

- a) Less than 0.01%
- b) 10.0%
- c) 20.0%
- d) 33.3%

Correct

C. True: 20.0%

The mean of a binomial equals p*n and the variance equals p*(1-p)*n. We are told that p*n = 4.0 and p*(1-p)*n = 3.80. We can substitute the first into the second, and thereby determine the number of credits in the portfolio and the default probability:

If p*(1-p)*n = [p*n]*(1-p) = 3.80, and p*n = 4.0, then [p*n]*(1-p) = 4.0*(1-p) = 3.80, and p = 1 – 3.80/4.0 = 5.0%.

Therefore, since n*p = 4.0, n =4/0.050 = 80.

The Pr(X = 4) = BINOM.DIST(4, 80 trials, 0.050, false) = 20.043%.

11. Question

At the request of his boss at a large commercial bank, Jason is using the bank's internal model to perform a valuation of a freshly constructed pass-through mortgage-backed security (MBS) pool. The pool contains about 500 mortgages with a principal value of $400 billion; all of the mortgages originated within the last 30 days. The pool's weighted average coupon (WAC) is 7.50%. Jason is going to assume a PSA rate of 140%. This multiplies by 1.40 the baseline 100% PSA rate that starts at 0.20% CPR each month for 30 months, then levels at 6.0% CPR. Each of the following is true EXCEPT which is false?

- a) The pass-through security will pay investors a coupon rate less than 7.50%
- b) The pool factor declines over time due to both scheduled and unscheduled prepayments
- **c) An increase in the assumption for the PSA rate (e.g., 140% to 170%) implies an increase in present value of this pool**
- d) The single month mortality (SMM) rate excludes scheduled prepayments, and after three years, it will be about 0.7285%

Correct

C. False. Instead, an increase in the PSA rate models an increase in unscheduled prepayments, which DECREASES the value of the MBS pool.

In regard to (A), (B), and (D), each is TRUE. Specifically,

- The pass-through security will pay investors a coupon rate less than 7.50%
- The pool factor declines over time due to both scheduled and unscheduled prepayments

- The single month mortality (SMM) rate excludes scheduled prepayments, and after three years, it will be about 0.7285%

12. Question

Scott, a risk manager at a small deep-value strategy, is trying to ensure his company is using a coherent risk benchmark. The deep value strategy can be volatile, and thus, Scott wants to see how his capital at risk would adjust if the portfolio had the same holdings but in a smaller proportion to increase its allocation to the risk-free asset. Which principal of a coherent benchmark is reflected in the below scenario?

Portfolio	$20,000,000	$20,000,000
Risk-free Allocation	1.0%	11.0%
Risky Allocation	$ 19,800,000	$ 17,800,000
Volatility	24.49%	24.49%
Capital at Risk	$ 4,850,000	$ 4,360,101
Risk free Capital	$ 200,000	$ 2,200,000
Net Capital at Risk	$ 4,650,000	$ 2,160,101

- [x] a) Translation Invariance
- [ ] b) Homogeneity
- [ ] c) Subadditivity
- [ ] d) Monotonicity

Correct

A. Translation Invariance

- **Regarding A,** translation invariance says the addition of (n) reduces the additional cash required by (n). Put more simply, adding cash reduces the risk. For the above example, the increase in the risk-free allocation reduced the risky allocation. The capital at risk was then reduced by the risk-free allocation.
- **Regarding B,** homogeneity refers to the property that multiplying the portfolio size by a constant results in a proportional change in the risk measure.
- **Regarding C,** subadditivity states that the sum of two or more portfolios is less than or equal to the sum of their individual risk measures. Adding more assets or asset classes (like commodities) to the portfolio should result in an overall risk measure that is less than or equal to the sum of the individual risk measures.
- **Regarding D, monotonicity implies that if one portfolio has a larger or equal risk than another, then it should also have a larger or equal risk measure.** It ensures that adding more assets or increasing allocations to existing assets doesn't increase the risk measure.

13. Question

Barbara is a certified FRM who previously generated income statement and profit projections over a five-year horizon in response to her client's request. Subsequent to the coronavirus outbreak, her client asks Barbara to generate revised financial projections (income statement and balance sheet) and provide the best single point estimate of future revenue, profit, and equity. Barbara utilizes Monte Carlo simulation. Although her client has asked for a single point estimate of these future financial metrics, Barbara perceives that the virus (and the consequential responses) render economic predictions extremely difficult and necessarily laced with great uncertainty. Which of the following is probably her **BEST** approach to the problem?

- a) She can comply by simply selecting the most probable future outcome; the Code has generally nothing to say about this technical task
- **b) She can comply but she should qualify her findings to avoid overstating the accuracy of her projections; for example, she can plot a future distribution**
- c) She should work hard to generate the most precise estimate possible; for example, "sales will go down by 10.85%" is more useful than "sales will go down by 10%"
- d) She should avoid the temptation to offer any revised future estimates in the face of several "unknown unknowns" because some future values cannot be estimated with sufficient accuracy

Correct

B. TRUE: She can comply, but she should qualify her findings to avoid overstating the accuracy of her projections; for example, she can plot a future distribution

According to (4.) Fundamental Responsibilities, GARP Members (**emphasis ours**):