Dept of Mathematics and Statistics
King Fahd University of Petroleum & Minerals
AS450: Risk Modelling
Dr. Mohammad H. Omar
Major 2 Exam Term 231 FORM 001

Name_____ ID#:_____ Serial #:___

Instructions.

1. Mobile calculators, I-pad, smart watches, or communicable devices **are disallowed**.
   a. Please **do not bring** your cell phones, smart watches, or other electronic devices in the exam.
   b. If you bring these, **switch them off** and put **them** in the corner chair.
   c. The phone **must be switched off** to **avoid any disturbance** during the exam
2. Any student caught with these devices switched on during the exam will be considered under the **cheating rules** of the University
3. If you finish the test earlier and want to leave the room, please do so quietly so not to disturb others taking the test.
   a. **No bathroom break during exam.** You can only leave the room after the exam or use the bathroom before the exam starts.
   b. **No two person** can leave the room at the same time.
   c. **No extra time** will be provided for the time missed outside the classroom.
4. Only materials provided by the instructor can be present on the table during the exam.
5. While every attempt is made to avoid defective questions, sometimes they do occur. In the rare event that you believe a question is defective, the instructor cannot give you any guidance beyond these instructions.
6. Do not spend too much time on any one question. If a question seems too difficult, leave it and go on.
7. Use the blank portions of each page for your work. Extra blank pages can be provided if necessary.
   a. If you use an extra page, indicate **clearly your name and what problem** you are working on.
8. Only **problem-solving** answers supported by work will be considered. Unsupported guesses will not be graded.
9. Use regular scientific calculators or SoA approved calculators only.
   a. But write **important steps** to arrive at the solution of the problem-solving questions.
10. Record your final answers to the multiple-choice questions on the OMR sheet.
    a. Submit the physical OMR page to your proctor
    b. Submit your answers to problem-solving questions to your proctor

The test is 90 minutes, GOOD LUCK, and you may begin now!

Exam date: Thursday Nov 9 2023 6.00pm - 7.30pm. bldg. 63 room 137

Q1. The shape parameter, γ, in a particular Generalized Extreme Value (GEV) distribution is equal to 3. Which of the following provides the **correct type** of distribution and its **key characteristic**?

A) Exponential distribution. Appropriate for modeling extreme values from a heavy-tailed distribution.
B) Gumbel distribution. Tail follows a power law.
C) Frechet-type GEV distribution. Good for modeling extremes of a fat-tailed distribution.
D) Generalized Pareto distribution. Superb for modeling large extreme values of a data distribution.
E) Weibull-type GEV distribution. Tail represents extreme value that (cuts-off)

Q2. The following auto-insurance claims data of size 32 are being prepared to find the extreme values for further analysis with the Generalized Extreme Value distribution. **Note:** read the data by each row.

250.48	274.78	244.5	797.8	213.71	298.6	298.13	362.23	250.57	248.56	297.9
342.31	229.09	228.5	293.87	367.46	153.62	201.67	238.21	256.21	208.59	202.8
236.06	352.49	207.6	202.67	253.63	340.56	192	196.33	259.79	342.58	

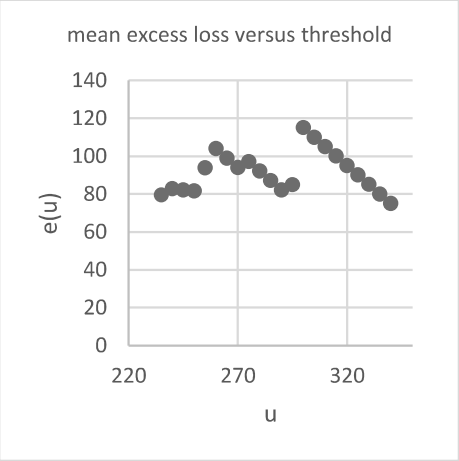
Which of the following **data** will be **used for further analysis** using a block size of 4 (or a threshold of 255) with either the *return period* or the *return level* approach?

A) 797.8, 367.46, 352.49, 342.58 using the *return level* approach
B) 797.8, 362.23, 342.31, 367.46, 256.21, 352.49, 340.56, 342.58 using the *return level* approach
C) 244.5, 213.71, 248.56, 228.5, 153.62, 202.8, 202.67, 192 using the **return period** approach
D) 274.78, 797.8, 298.6, 298.13, 362.23, 297.9, 342.31, 293.87, 367.46, 256.21, 352.49, 340.56, 259.79, 342.58 using the *return level* approach
E) *return period* approach will select less data than the *return level* approach

Q3. Which of the following provides the **key advantage** that the Generalized Pareto (GP) distribution typically has over the Generalized Extreme Value (GEV) distribution when modelling extreme losses?

A) GP distribution uses all the original raw data
B) GP distribution has one more parameter than the GEV distribution
C) GP distribution can be used for modeling maximum losses within each data block
D) GP distribution uses all data in the tail instead of the extreme values within blocks
E) GP distribution is symmetrical in shape

Q4. From an auto-insurance severity, a plot of the mean excess loss, $e(u)$, versus threshold, u, values below is prepared to aid in extreme value analysis with the Generalized Pareto (GP) distribution.



Which of the following is the **primary purpose** of using the above plot?

A) to estimate parameters of the Generalized Extreme Value distribution
B) to determine whether observations are in the middle of the distribution
C) to determine whether the generalized Pareto distribution or the generalized extreme value distribution is most appropriate for modelling extreme losses
D) to find a suitable threshold to define extreme loss observations
E) to estimate the parameters of the Generalized Pareto distribution

Q5. A particular rating agency has four ratings for companies: A, B, C and D. Ratings A to C are for firms that are *solvent*, while a rating of D means that firm has *defaulted* on its payments. The **one-year** migration rates are shown below:

		Year-end Rating			
		A	B	C	D
Initial	A	0.80	0.10	0.07	0.03
Rating	B	0.05	0.70	0.15	0.12
	C	0.02	0.08	0.65	0.25

Estimate the **probability** that a firm currently rated B will have defaulted ***within* two** years.

A) 0.015
B) 0.100
C) 0.170
D) 0.209
E) 0.243

Q6. Altman's Z is defined as: $Z = 1.2X_1 + 1.4X_2 + 3.3X_3 + 0.6X_4 + 1.0X_5$, where:

- X_1 = the ratio of working capital to total assets,
- X_2 = the ratio of retained earnings to total assets,
- X_3 = the ratio of earnings before interest and taxes to total assets,
- X_4 = the ratio of the market value of equity to the book value of total liabilities, and
- X_5 = the ratio of sales to total assets.

A firm has X_i values (i =1, 2, … , 5) as follows:

$$X_1 = 0.3, \quad X_2 = 0.2, \quad X_3 = 0.1, \quad X_4 = 1.3, \quad \text{and } X_5 = 1.35.$$

Calculate Altman's Z **statistic** and **comment** on the result.

A) Altman's Z statistic is 3.10. This means the firm is 'safe'.
B) Altman's Z statistic is 2.89. This means the firm is 'safe'.
C) Altman's Z statistic is 2.47. This means the firm is 'not safe'.
D) Altman's Z statistic is 1.75. This means the firm is 'safe'.
E) Altman's Z statistic is 1.75. This means the firm is 'not safe'.

Q7. Which one of the following interest rate simulation models is **designed to address** serious practical and economic issue of **negative** interest rates?

A) Hull-White model
B) Vasicek model
C) Cox-Ingersoll-Ross model
D) Merton model
E) Ho-Lee model

Q8. The price of a particular government bond, which has an outstanding term of exactly two years, is $108 per $100 nominal. This bond has an annual coupon of 6%, and a coupon has just been paid. The price of another government bond, which has an outstanding term of exactly one year, is $102 per $100 nominal. This bond has an annual coupon of 4% and again, a coupon has just been paid. Calculate the **two- year spot rate** in this government bond market.

A) 0.010021
B) 0.018668
C) 0.019418
D) 0.025011
E) 0.036806

Q9. A particular firm has a total asset value of $20 000 000. The expected rate of growth of this asset value is 6% per annum, whilst its volatility is 10% per annum. The firm's total borrowing consists of a fixed repayment of $16 000 000 that must be made in exactly one year's time. Calculate the probability that the firm will be **insolvent** at this point.

A) 0.00271
B) 0.01481
C) 0.01898
D) 0.02650
E) 0.02960

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DEPARTMENT OF MATHEMATICS AND STATISTICS
AS 450: Risk Modelling - Semester 231,
Major 2 Exam Thursday Nov 9, 2023 (6:00 pm - 7:30 pm)

Your instructor's name: Dr. Mohammad H. Omar

Name:_____ ID#:_____ Serial#:_____

Part 1 (2 marks each). Please mark the correct answer to each of the questions by completely darkening the oval of your choice with a dark pen or pencil.

MULTIPLE CHOICE:	A	B	C	D	E
Q1	O	O	O	O	O
Q2	O	O	O	O	O
Q3	O	O	O	O	O
Q4	O	O	O	O	O
Q5	O	O	O	O	O

MULTIPLE CHOICE:	A	B	C	D	E
Q6	O	O	O	O	O
Q7	O	O	O	O	O
Q8	O	O	O	O	O
Q9	O	O	O	O	O

Score ___/25

Code: 001

Q10. (**3 marks**) Consider the R output below on Severity of claims in an automobile collision loss data. Please answer the accompanying questions.

```
fevd(x = Severity, data = AutoCollision, threshold = 255, type = "GP",
    time.units = "279/year")

[1] "Estimation Method used: MLE"

 Negative Log-Likelihood Value:  76.9732

 Estimated parameters:
     scale      shape
69.6700412  0.2489922

 Standard Error Estimates:
     scale      shape
26.6510784  0.2840261

 Estimated parameter covariance matrix.
           scale       shape
scale 710.279979 -4.05880347
shape  -4.058803  0.08067084

 AIC = 157.9464
 BIC = 159.2245
```

a. What **type** of Extreme value distribution is reported by the *R* data analysis above?

[ ].

b. Is the shape parameter significantly different from zero?

[ ].

c. Do you suggest refining the analysis using a model with lesser parameters?

[Yes/No].

Q11. (**4*1 = 4 marks**) Consider five bonds with terms of one to five years, each paying annual interest payments or coupons of 5% with the next coupons all being due one year from now. The gross redemption yields for these bonds and the corresponding continuously compounded spot rates of interest are given below:

Term (t)	1	2	3	4	5
Gross redemption yield (r_t)	5.40%	5.45%	5.55%	5.55%	5.80%
Spot Interest Rate (s_t)	5.259%	5.308%	5.407%	5.407%	5.667%

Calculate the following continuously compounded **one-year forward rates** of interest for the maturities of one to five years. **Note:** f_t is the rate in the interval between t -1 and t.

f_1 =	f_3 =	f_4 =	f_5 =