SOCIETY OF ACTUARIES

EXAM STAM SHORT-TERM ACTUARIAL MATHEMATICS

EXAM STAM SAMPLE QUESTIONS

Questions 1-307 have been taken from the previous set of Exam C sample questions. Questions no longer relevant to the syllabus have been deleted. Questions 308-326 are based on material newly added.

April 2018 update: Question 303 has been deleted. Corrections were made to several of the new questions, 308-326.

December 2018 update: Corrections were made to questions 322, 323, and 325. Questions 327 and 328 were added.

Some of the questions in this study note are taken from past examinations. The weight of topics in these sample questions is not representative of the weight of topics on the exam. The syllabus indicates the exam weights by topic.

1. DELETED

2. You are given:

(i) The number of claims has a Poisson distribution.

(ii) Claim sizes have a Pareto distribution with parameters $\theta = 0.5$ and $\alpha = 6$

(iii) The number of claims and claim sizes are independent.

(iv) The observed pure premium should be within 2% of the expected pure premium 90% of the time.

Calculate the expected number of claims needed for full credibility.

(A) Less than 7,000

(B) At least 7,000, but less than 10,000

(C) At least 10,000, but less than 13,000

(D) At least 13,000, but less than 16,000

(E) At least 16,000

3. DELETED

4. You are given:

(i) Losses follow a single-parameter Pareto distribution with density function:

$$f(x) = \frac{\alpha}{x^{\alpha+1}}, \quad x > 1, \quad 0 < \alpha < \infty$$

(ii) A random sample of size five produced three losses with values 3, 6 and 14, and two losses exceeding 25.

Calculate the maximum likelihood estimate of α .

(A) 0.25

(B) 0.30

(C) 0.34

(D) 0.38

(E) 0.42

5. You are given:

(i) The annual number of claims for a policyholder has a binomial distribution with probability function:

$$p(x \mid q) = \binom{2}{x} q^x (1-q)^{2-x}, \quad x = 0,1,2$$

(ii) The prior distribution is:

$$\pi(q) = 4q^3, \quad 0 < q < 1$$

This policyholder had one claim in each of Years 1 and 2.

Calculate the Bayesian estimate of the number of claims in Year 3.

(A) Less than 1.1

(B) At least 1.1, but less than 1.3

(C) At least 1.3, but less than 1.5

(D) At least 1.5, but less than 1.7

(E) At least 1.7

6. DELETED

7. DELETED

8. You are given:

(i) Claim counts follow a Poisson distribution with mean θ.

(ii) Claim sizes follow an exponential distribution with mean 10θ.

(iii) Claim counts and claim sizes are independent, given θ.

(iv) The prior distribution has probability density function:

$$\pi(\theta) = \frac{5}{\theta^6}, \quad \theta > 1$$

Calculate Bühlmann's k for aggregate losses.

(A) Less than 1

(B) At least 1, but less than 2

(C) At least 2, but less than 3

(D) At least 3, but less than 4

(E) At least 4

9. DELETED

10. DELETED

11. You are given:

(i) Losses on a company's insurance policies follow a Pareto distribution with probability density function:

$$f(x \mid \theta) = \frac{\theta}{(x+\theta)^2}, \quad 0 < x < \infty$$

(ii) For half of the company's policies $\theta = 1$, while for the other half $\theta = 3$.

For a randomly selected policy, losses in Year 1 were 5.

Calculate the posterior probability that losses for this policy in Year 2 will exceed 8.

(A) 0.11

(B) 0.15

(C) 0.19

(D) 0.21

(E) 0.27

12. You are given total claims for two policyholders:

	Year			
Policyholder	1	2	3	4
X	730	800	650	700
Y	655	650	625	750

Using the nonparametric empirical Bayes method, calculate the Bühlmann credibility premium for Policyholder Y.

(A) 655

(B) 670

(C) 687

(D) 703

(E) 719

13. A particular line of business has three types of claim. The historical probability and the number of claims for each type in the current year are:

Type	Historical Probability	Number of Claims in Current Year
X	0.2744	112
Y	0.3512	180
Z	0.3744	138

You test the null hypothesis that the probability of each type of claim in the current year is the same as the historical probability.

Calculate the chi-square goodness-of-fit test statistic.

(A) Less than 9

(B) At least 9, but less than 10

(C) At least 10, but less than 11

(D) At least 11, but less than 12

(E) At least 12

14. The information associated with the maximum likelihood estimator of a parameter θ is $4n$, where n is the number of observations.

Calculate the asymptotic variance of the maximum likelihood estimator of 2θ.

(A) $1/(2n)$

(B) $1/n$

(C) $4/n$

(D) $8n$

(E) $16n$

15. You are given:

(i) The probability that an insured will have at least one loss during any year is p.

(ii) The prior distribution for p is uniform on $[0, 0.5]$.

(iii) An insured is observed for 8 years and has at least one loss every year.

Calculate the posterior probability that the insured will have at least one loss during Year 9.

(A) 0.450

(B) 0.475

(C) 0.500

(D) 0.550

(E) 0.625

16. DELETED

17. DELETED

18. You are given:

(i) Two risks have the following severity distributions:

Amount of Claim	Probability of Claim Amount for Risk 1	Probability of Claim Amount for Risk 2
250	0.5	0.7
2,500	0.3	0.2
60,000	0.2	0.1

(ii) Risk 1 is twice as likely to be observed as Risk 2.

A claim of 250 is observed.

Calculate the Bühlmann credibility estimate of the second claim amount from the same risk.

(A) Less than 10,200

(B) At least 10,200, but less than 10,400

(C) At least 10,400, but less than 10,600

(D) At least 10,600, but less than 10,800

(E) At least 10,800

19. DELETED

20. DELETED

21. You are given:

(i) The number of claims incurred in a month by any insured has a Poisson distribution with mean λ.

(ii) The claim frequencies of different insureds are independent.

(iii) The prior distribution is gamma with probability density function:

$$f(\lambda) = \frac{(100\lambda)^6 e^{-100\lambda}}{120\lambda}$$

(iv)

Month	Number of Insureds	Number of Claims
1	100	6
2	150	8
3	200	11
4	300	?

Calculate the Bühlmann-Straub credibility estimate of the number of claims in Month 4.

(A) 16.7

(B) 16.9

(C) 17.3

(D) 17.6

(E) 18.0

22. You fit a Pareto distribution to a sample of 200 claim amounts and use the likelihood ratio test to test the hypothesis that $\alpha = 1.5$ and $\theta = 7.8$.

You are given:

(i) The maximum likelihood estimates are $\hat{\alpha} = 1.4$ and $\hat{\theta} = 7.6$.

(ii) The natural logarithm of the likelihood function evaluated at the maximum likelihood estimates is −817.92.

(iii) $\sum \ln(x_i + 7.8) = 607.64$

Determine the result of the test.

(A) Reject at the 0.005 significance level.

(B) Reject at the 0.010 significance level, but not at the 0.005 level.

(C) Reject at the 0.025 significance level, but not at the 0.010 level.

(D) Reject at the 0.050 significance level, but not at the 0.025 level.

(E) Do not reject at the 0.050 significance level.

23. For a sample of 15 losses, you are given:

(i)

Interval	Observed Number of Losses
(0, 2]	5
(2, 5]	5
$(5, \infty)$	5

(ii) Losses follow the uniform distribution on $(0, \theta)$.

Estimate θ by minimizing the function $\sum_{j=1}^{3} \frac{(E_j - O_j)^2}{O_j}$, where E_j is the expected number of losses in the jth interval and O_j is the observed number of losses in the jth interval.

(A) 6.0

(B) 6.4

(C) 6.8

(D) 7.2

(E) 7.6

24. You are given:

(i) The probability that an insured will have exactly one claim is θ.

(ii) The prior distribution of θ has probability density function:

$$\pi(\theta) = \frac{3}{2}\sqrt{\theta}, \quad 0 < \theta < 1$$

A randomly chosen insured is observed to have exactly one claim.

Calculate the posterior probability that θ is greater than 0.60.

(A) 0.54

(B) 0.58

(C) 0.63

(D) 0.67

(E) 0.72

25. The distribution of accidents for 84 randomly selected policies is as follows:

Number of Accidents	Number of Policies
0	32
1	26
2	12
3	7
4	4
5	2
6	1
Total	84

Which of the following models best represents these data?

(A) Negative binomial

(B) Discrete uniform

(C) Poisson

(D) Binomial

(E) Either Poisson or Binomial

26. You are given:

(i) Low-hazard risks have an exponential claim size distribution with mean θ.

(ii) Medium-hazard risks have an exponential claim size distribution with mean 2θ.

(iii) High-hazard risks have an exponential claim size distribution with mean 3θ.

(iv) No claims from low-hazard risks are observed.

(v) Three claims from medium-hazard risks are observed, of sizes 1, 2 and 3.

(vi) One claim from a high-hazard risk is observed, of size 15.

Calculate the maximum likelihood estimate of θ.

(A) 1

(B) 2

(C) 3

(D) 4

(E) 5

27. You are given:

(i) X_{partial} = pure premium calculated from partially credible data

(ii) $\mu = E[X_{\text{partial}}]$

(iii) Fluctuations are limited to $\pm k\mu$ of the mean with probability P

(iv) Z = credibility factor

Determine which of the following is equal to P.

(A) $\Pr[\mu - k\mu \le X_{\text{partial}} \le \mu + k\mu]$

(B) $\Pr[\mathrm{Z}\mu - k \le ZX_{\text{partial}} \le Z\mu + k]$

(C) $\Pr[\mathrm{Z}\mu - \mu \le ZX_{\text{partial}} \le Z\mu + \mu]$

(D) $\Pr[1 - k \le ZX_{\text{partial}} + (1-Z)\mu \le 1 + k]$

(E) $\Pr[\mu - k\mu \le ZX_{\text{partial}} + (1-Z)\mu \le \mu + k\mu]$

28. You are given:

Claim Size (X)	Number of Claims
(0, 25]	25
(25, 50]	28
(50, 100]	15
(100, 200]	6

Assume a uniform distribution of claim sizes within each interval.

Estimate $E(X^2) - E[(X \wedge 150)^2]$.

(A) Less than 200

(B) At least 200, but less than 300

(C) At least 300, but less than 400

(D) At least 400, but less than 500

(E) At least 500

29. You are given:

(i) Each risk has at most one claim each year.

(ii)

Type of Risk	Prior Probability	Annual Claim Probability
I	0.7	0.1
II	0.2	0.2
III	0.1	0.4

One randomly chosen risk has three claims during Years 1-6.

Calculate the posterior probability of a claim for this risk in Year 7.

(A) 0.22

(B) 0.28

(C) 0.33

(D) 0.40

(E) 0.46

30. DELETED

31. DELETED

32. You are given:

(i) The number of claims made by an individual insured in a year has a Poisson distribution with mean λ.

(ii) The prior distribution for λ is gamma with parameters $\alpha = 1$ and $\theta = 1.2$.

Three claims are observed in Year 1, and no claims are observed in Year 2.

Using Bühlmann credibility, estimate the number of claims in Year 3.

(A) 1.35

(B) 1.36

(C) 1.40

(D) 1.41

(E) 1.43

33. DELETED

34. The number of claims follows a negative binomial distribution with parameters β and r, where β is unknown and r is known. You wish to estimate β based on n observations, where $\bar{x}$ is the mean of these observations.

Determine the maximum likelihood estimate of β.

(A) $\bar{x} / r^2$

(B) $\bar{x} / r$

(C) $\bar{x}$

(D) $r\bar{x}$

(E) $r^2\bar{x}$

35. You are given the following information about a credibility model:

First Observation	Unconditional Probability	Bayesian Estimate of Second Observation
1	1/3	1.50
2	1/3	1.50
3	1/3	3.00

Calculate the Bühlmann credibility estimate of the second observation, given that the first observation is 1.

(A) 0.75

(B) 1.00

(C) 1.25

(D) 1.50

(E) 1.75

36. DELETED

37. A random sample of three claims from a dental insurance plan is given below:

225 525 950

Claims are assumed to follow a Pareto distribution with parameters $\theta = 150$ and α.

Calculate the maximum likelihood estimate of α.

(A) Less than 0.6

(B) At least 0.6, but less than 0.7

(C) At least 0.7, but less than 0.8

(D) At least 0.8, but less than 0.9

(E) At least 0.9

38. An insurer has data on losses for four policyholders for 7 years. The loss from the *i*th policyholder for year *j* is X_{ij}.

You are given:

$$\sum_{i=1}^{4}\sum_{j=1}^{7}(X_{ij}-\bar{X}_i)^2 = 33.60, \quad \sum_{i=1}^{4}(\bar{X}_i-\bar{X})^2 = 3.30$$

Using nonparametric empirical Bayes estimation, calculate the Bühlmann credibility factor for an individual policyholder.

(A) Less than 0.74

(B) At least 0.74, but less than 0.77

(C) At least 0.77, but less than 0.80

(D) At least 0.80, but less than 0.83

(E) At least 0.83

39. You are given the following information about a commercial auto liability book of business:

(i) Each insured's claim count has a Poisson distribution with mean λ, where λ has a gamma distribution with $\alpha = 1.5$ and $\theta = 0.2$.

(ii) Individual claim size amounts are independent and exponentially distributed with mean 5000.

(iii) The full credibility standard is for aggregate losses to be within 5% of the expected with probability 0.90.

Using limited fluctuated credibility, calculate the expected number of claims required for full credibility.

(A) 2165

(B) 2381

(C) 3514

(D) 7216

(E) 7938

40. You are given:

(i) A sample of claim payments is: 29 64 90 135 182

(ii) Claim sizes are assumed to follow an exponential distribution.

(iii) The mean of the exponential distribution is estimated using the method of moments.

Calculate the value of the Kolmogorov-Smirnov test statistic.

(A) 0.14

(B) 0.16

(C) 0.19

(D) 0.25

(E) 0.27

41. You are given:

(i) Annual claim frequency for an individual policyholder has mean λ and variance σ^2.

(ii) The prior distribution for λ is uniform on the interval [0.5, 1.5].

(iii) The prior distribution for σ^2 is exponential with mean 1.25.

A policyholder is selected at random and observed to have no claims in Year 1.

Using Bühlmann credibility, estimate the number of claims in Year 2 for the selected policyholder.

(A) 0.56

(B) 0.65

(C) 0.71

(D) 0.83

(E) 0.94

42. DELETED

43. You are given:

(i) The prior distribution of the parameter Θ has probability density function:

$$\pi(\theta) = \frac{1}{\theta^2}, \quad 1 < \theta < \infty$$

(ii) Given $\Theta = \theta$, claim sizes follow a Pareto distribution with parameters $\alpha = 2$ and θ.

A claim of 3 is observed.

Calculate the posterior probability that Θ exceeds 2.

(A) 0.33

(B) 0.42

(C) 0.50

(D) 0.58

(E) 0.64

44. You are given:

(i) Losses follow an exponential distribution with mean θ.

(ii) A random sample of 20 losses is distributed as follows:

Loss Range	Frequency
[0, 1000]	7
(1000, 2000]	6
(2000, ∞)	7

Calculate the maximum likelihood estimate of θ.

(A) Less than 1950

(B) At least 1950, but less than 2100

(C) At least 2100, but less than 2250

(D) At least 2250, but less than 2400

(E) At least 2400

45. You are given:

(i) The amount of a claim, X, is uniformly distributed on the interval $[0,\theta]$.

(ii) The prior density of θ is $\pi(\theta)=\dfrac{500}{\theta^2}, \quad \theta>500$.

Two claims, $x_1=400$ and $x_2 600$, are observed. You calculate the posterior distribution as:

$$f(\theta \mid x_1,x_2)=3\left(\frac{600^3}{\theta^4}\right), \quad \theta>600$$

Calculate the Bayesian premium, $E(X_3 \mid x_1,x_2)$.

(A) 450

(B) 500

(C) 550

(D) 600

(E) 650

46. DELETED

47. You are given the following observed claim frequency data collected over a period of 365 days:

Number of Claims per Day	Observed Number of Days
0	50
1	122
2	101
3	92
4+	0

Fit a Poisson distribution to the above data, using the method of maximum likelihood.

Regroup the data, by number of claims per day, into four groups:

0 1 2 3+

Apply the chi-square goodness-of-fit test to evaluate the null hypothesis that the claims follow a Poisson distribution.

Determine the result of the chi-square test.

(A) Reject at the 0.005 significance level.

(B) Reject at the 0.010 significance level, but not at the 0.005 level.

(C) Reject at the 0.025 significance level, but not at the 0.010 level.

(D) Reject at the 0.050 significance level, but not at the 0.025 level.

(E) Do not reject at the 0.050 significance level.

48. You are given the following joint distribution:

X	Θ = 0	Θ = 1
0	0.4	0.1
1	0.1	0.2
2	0.1	0.1

For a given value of Θ and a sample of size 10 for X:

$$\sum_{i=1}^{10} x_i = 10$$

Calculate the Bühlmann credibility premium.

(A) 0.75

(B) 0.79

(C) 0.82

(D) 0.86

(E) 0.89

49. DELETED

50. You are given four classes of insureds, each of whom may have zero or one claim, with the following probabilities:

Class	Number of Claims	
	0	1
I	0.9	0.1
II	0.8	0.2
III	0.5	0.5
IV	0.1	0.9

A class is selected at random (with probability 0.25), and four insureds are selected at random from the class. The total number of claims is two.

If five insureds are selected at random from the same class, estimate the total number of claims using Bühlmann-Straub credibility.

(A) 2.0

(B) 2.2

(C) 2.4

(D) 2.6

(E) 2.8

51. DELETED

52. DELETED

53. You are given:

Number of Claims	Probability	Claim Size	Probability
0	1/5		
1	3/5	25 150	1/3 2/3
2	1/5	50 200	2/3 1/3

Claim sizes are independent.

Calculate the variance of the aggregate loss.

(A) 4,050

(B) 8,100

(C) 10,500

(D) 12,510

(E) 15,612

54. DELETED

55. You are given:

Class	Number of Insureds	Claim Count Probabilities				
		0	1	2	3	4
1	3000	1/3	1/3	1/3	0	0
2	2000	0		2/3	1/6	0
3	1000	0	0	1/6	2/3	1/6

A randomly selected insured has one claim in Year 1.

Calculate the Bayesian expected number of claims in Year 2 for that insured.

(A) 1.00

(B) 1.25

(C) 1.33

(D) 1.67

(E) 1.75

56. You are given the following information about a group of policies:

Claim Payment	Policy Limit
5	50
15	50
60	100
100	100
500	500
500	1000

Determine the likelihood function.

(A) $f(50)f(50)f(100)f(100)f(500)f(1000)$

(B) $f(50)f(50)f(100)f(100)f(500)f(1000)/[1-\mathrm{F}(1000)]$

(C) $f(5)f(15)f(60)f(100)f(500)f(500)$

(D) $f(5)f(15)f(60)f(100)f(500)f(1000)/[1-\mathrm{F}(1000)]$

(E) $f(5)f(15)f(60)[1-\mathrm{F}(100)][1-\mathrm{F}(500)]f(500)$

57. DELETED

58. You are given:

(i) The number of claims per auto insured follows a Poisson distribution with mean λ.

(ii) The prior distribution for λ has the following probability density function:

$$f(\lambda) = \frac{(500\lambda)^{50} e^{-500\lambda}}{\lambda\Gamma(50)}$$

(iii) A company observes the following claims experience:

	Year 1	Year 2
Number of claims	75	210
Number of autos insured	600	900

The company expects to insure 1100 autos in Year 3.

Calculate the Bayesian expected number of claims in Year 3.

(A) 178

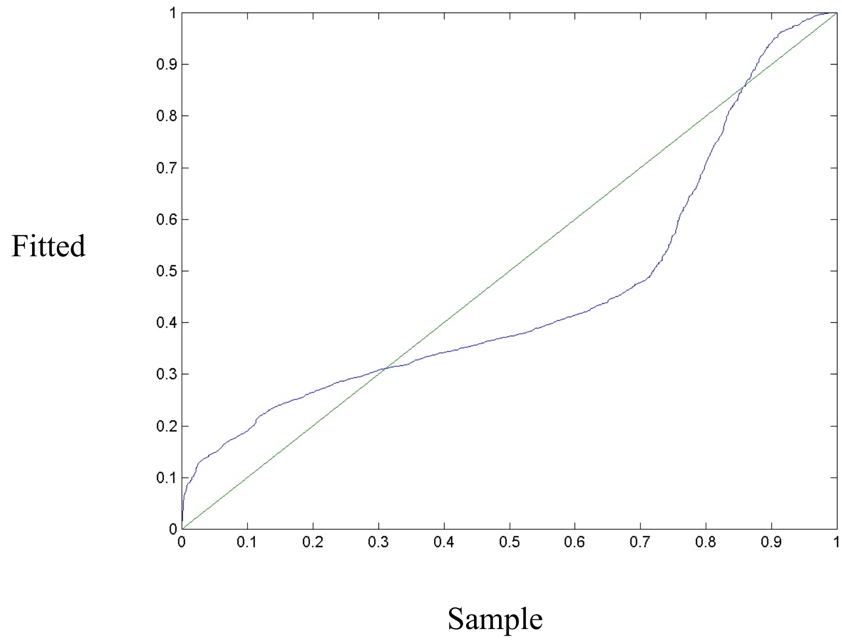
(B) 184

(C) 193

(D) 209

(E) 224

59. The graph below shows a *p-p* plot of a fitted distribution compared to a sample.



Which of the following is true?

(A) The tails of the fitted distribution are too thick on the left and on the right, and the fitted distribution has less probability around the median than the sample.

(B) The tails of the fitted distribution are too thick on the left and on the right, and the fitted distribution has more probability around the median than the sample.

(C) The tails of the fitted distribution are too thin on the left and on the right, and the fitted distribution has less probability around the median than the sample.

(D) The tails of the fitted distribution are too thin on the left and on the right, and the fitted distribution has more probability around the median than the sample.

(E) The tail of the fitted distribution is too thick on the left, too thin on the right, and the fitted distribution has less probability around the median than the sample.

60. You are given the following information about six coins:

Coin	Probability of Heads
1 – 4	0.50
5	0.25
6	0.75

A coin is selected at random and then flipped repeatedly. X_i denotes the outcome of the ith flip, where "1" indicates heads and "0" indicates tails. The following sequence is obtained:

$$S = \{X_1, X_2, X_3, X_4\} = \{1,1,0,1\}$$

Calculate $E(X_5 \mid S)$ using Bayesian analysis.

(A) 0.52

(B) 0.54

(C) 0.56

(D) 0.59

(E) 0.63

61. You observe the following five ground-up claims from a data set that is truncated from below at 100:

125 150 165 175 250

You fit a ground-up exponential distribution using maximum likelihood estimation.

Calculate the mean of the fitted distribution.

(A) 73

(B) 100

(C) 125

(D) 156

(E) 173

62. An insurer writes a large book of home warranty policies. You are given the following information regarding claims filed by insureds against these policies:

(i) A maximum of one claim may be filed per year.

(ii) The probability of a claim varies by insured, and the claims experience for each insured is independent of every other insured.

(iii) The probability of a claim for each insured remains constant over time.

(iv) The overall probability of a claim being filed by a randomly selected insured in a year is 0.10.

(v) The variance of the individual insured claim probabilities is 0.01.

An insured selected at random is found to have filed 0 claims over the past 10 years.

Calculate the Bühlmann credibility estimate for the expected number of claims the selected insured will file over the next 5 years.

(A) 0.04

(B) 0.08

(C) 0.17

(D) 0.22

(E) 0.25

63. DELETED

64. For a group of insureds, you are given:

(i) The amount of a claim is uniformly distributed but will not exceed a certain unknown limit θ.

(ii) The prior distribution of θ is $\pi(\theta) = \frac{500}{\theta^2}, \quad \theta > 500$.

(iii) Two independent claims of 400 and 600 are observed.

Calculate the probability that the next claim will exceed 550.

(A) 0.19

(B) 0.22

(C) 0.25

(D) 0.28

(E) 0.31

65. You are given the following information about a general liability book of business comprised of 2500 insureds:

(i) $X_i = \sum_{j=1}^{N_i} Y_{ij}$ is a random variable representing the annual loss of the ith insured.

(ii) $N_1, N_2, \ldots, N_{2500}$ are independent and identically distributed random variables following a negative binomial distribution with parameters $r = 2$ and $\beta = 0.2$.

(iii) $Y_{i1}, Y_{i2}, \ldots, Y_{iN_i}$ are independent and identically distributed random variables following a Pareto distribution with $\alpha = 3.0$ and $\theta = 1000$.

(iv) The full credibility standard is to be within 5% of the expected aggregate losses 90% of the time.

Using limited fluctuation credibility theory, calculate the partial credibility of the annual loss experience for this book of business.

(A) 0.34

(B) 0.42

(C) 0.47

(D) 0.50

(E) 0.53

66. DELETED

67. You are given the following information about a book of business comprised of 100 insureds:

(i) $X_i = \sum_{j=1}^{N_i} Y_{ij}$ is a random variable representing the annual loss of the ith insured.

(ii) $N_1, N_2, \ldots, N_{100}$ are independent random variables distributed according to a negative binomial distribution with parameters r (unknown) and $\beta = 0.2$.

(iii) The unknown parameter r has an exponential distribution with mean 2.

(iv) $Y_{i1}, Y_{i2}, \ldots, Y_{iN_i}$ are independent random variables distributed according to a Pareto distribution with $\alpha = 3.0$ and $\theta = 1000$.

Calculate the Bühlmann credibility factor, Z, for the book of business.

(A) 0.000

(B) 0.045

(C) 0.500

(D) 0.826

(E) 0.905

68. DELETED

69. You fit an exponential distribution to the following data:

1000 1400 5300 7400 7600

Calculate the coefficient of variation of the maximum likelihood estimate of the mean, θ.

(A) 0.33

(B) 0.45

(C) 0.70

(D) 1.00

(E) 1.21

70. You are given the following information on claim frequency of automobile accidents for individual drivers:

	Business Use		Pleasure Use	
	Expected Claims	Claim Variance	Expected Claims	Claim Variance
Rural	1.0	0.5	1.5	0.8
Urban	2.0	1.0	2.5	1.0
Total	1.8	1.06	2.3	1.12

You are also given:

(i) Each driver's claims experience is independent of every other driver's.

(ii) There are an equal number of business and pleasure use drivers.

Calculate the Bühlmann credibility factor for a single driver.

(A) 0.05

(B) 0.09

(C) 0.17

(D) 0.19

(E) 0.27

71. You are investigating insurance fraud that manifests itself through claimants who file claims with respect to auto accidents with which they were not involved. Your evidence consists of a distribution of the observed number of claimants per accident and a standard distribution for accidents on which fraud is known to be absent. The two distributions are summarized below:

Number of Claimants per Accident	Standard Probability	Observed Number of Accidents
1	0.25	235
2	0.35	335
3	0.24	250
4	0.11	111
5	0.04	47
6+	0.01	22
Total	1.00	1000

Determine the result of a chi-square test of the null hypothesis that there is no fraud in the observed accidents.

(A) Reject at the 0.005 significance level.

(B) Reject at the 0.010 significance level, but not at the 0.005 level.

(C) Reject at the 0.025 significance level, but not at the 0.010 level.

(D) Reject at the 0.050 significance level, but not at the 0.025 level.

(E) Do not reject at the 0.050 significance level.

72. You are given the following data on large business policyholders:

(i) Losses for each employee of a given policyholder are independent and have a common mean and variance.

(ii) The overall average loss per employee for all policyholders is 20.

(iii) The variance of the hypothetical means is 40.

(iv) The expected value of the process variance is 8000.

(v) The following experience is observed for a randomly selected policyholder:

Year	Average Loss per Employee	Number of Employees
1	15	800
2	10	600
3	5	400

Calculate the Bühlmann-Straub credibility premium per employee for this policyholder.

(A) Less than 10.5

(B) At least 10.5, but less than 11.5

(C) At least 11.5, but less than 12.5

(D) At least 12.5, but less than 13.5

(E) At least 13.5

73. DELETED

74. DELETED

75. DELETED

76. You are given:

(i) The annual number of claims for each policyholder follows a Poisson distribution with mean θ.

(ii) The distribution of θ across all policyholders has probability density function:

$$f(\theta) = \theta e^{-\theta}, \quad \theta > 0$$

(iii) $\int_0^\infty \theta e^{-n\theta} d\theta = \frac{1}{n^2}$

A randomly selected policyholder is known to have had at least one claim last year.

Calculate the posterior probability that this same policyholder will have at least one claim this year.

(A) 0.70

(B) 0.75

(C) 0.78

(D) 0.81

(E) 0.86

77. DELETED

78. You are given:

(i) Claim size, X, has mean μ and variance 500.

(ii) The random variable μ has a mean of 1000 and variance of 50.

(iii) The following three claims were observed: 750, 1075, 2000

Calculate the expected size of the next claim using Bühlmann credibility.

(A) 1025

(B) 1063

(C) 1115

(D) 1181

(E) 1266

79. Losses come from a mixture of an exponential distribution with mean 100 with probability p and an exponential distribution with mean 10,000 with probability 1 - p.

Losses of 100 and 2000 are observed.

Determine the likelihood function of p.

(A) $\left(\frac{pe^{-1}}{100} \cdot \frac{(1-p)e^{-0.01}}{10{,}000}\right) \cdot \left(\frac{pe^{-20}}{100} \cdot \frac{(1-p)e^{-0.2}}{10{,}000}\right)$

(B) $\left(\frac{pe^{-1}}{100} \cdot \frac{(1-p)e^{-0.01}}{10{,}000}\right) + \left(\frac{pe^{-20}}{100} \cdot \frac{(1-p)e^{-0.2}}{10{,}000}\right)$

(C) $\left(\frac{pe^{-1}}{100} + \frac{(1-p)e^{-0.01}}{10{,}000}\right) \cdot \left(\frac{pe^{-20}}{100} + \frac{(1-p)e^{-0.2}}{10{,}000}\right)$

(D) $\left(\frac{pe^{-1}}{100} + \frac{(1-p)e^{-0.01}}{10{,}000}\right) + \left(\frac{pe^{-20}}{100} + \frac{(1-p)e^{-0.2}}{10{,}000}\right)$

(E) $p\left(\frac{e^{-1}}{100} + \frac{e^{-0.01}}{10{,}000}\right) + (1-p)\left(\frac{e^{-20}}{100} + \frac{e^{-0.2}}{10{,}000}\right)$

80. DELETED

81. DELETED

82. DELETED

83. DELETED

84. A health plan implements an incentive to physicians to control hospitalization under which the physicians will be paid a bonus B equal to c times the amount by which total hospital claims are under 400 $(0 \le c \le 1)$.

The effect the incentive plan will have on underlying hospital claims is modeled by assuming that the new total hospital claims will follow a two-parameter Pareto distribution with $\alpha = 2$ and $\theta = 300$.

$E(B) = 100$

Calculate c.

(A) 0.44

(B) 0.48

(C) 0.52

(D) 0.56

(E) 0.60

85. Computer maintenance costs for a department are modeled as follows:

(i) The distribution of the number of maintenance calls each machine will need in a year is Poisson with mean 3.

(ii) The cost for a maintenance call has mean 80 and standard deviation 200.

(iii) The number of maintenance calls and the costs of the maintenance calls are all mutually independent.

The department must buy a maintenance contract to cover repairs if there is at least a 10% probability that aggregate maintenance costs in a given year will exceed 120% of the expected costs.

Using the normal approximation for the distribution of the aggregate maintenance costs, calculate the minimum number of computers needed to avoid purchasing a maintenance contract.

(A) 80

(B) 90

(C) 100

(D) 110

(E) 120

86. Aggregate losses for a portfolio of policies are modeled as follows:

(i) The number of losses before any coverage modifications follows a Poisson distribution with mean λ.

(ii) The severity of each loss before any coverage modifications is uniformly distributed between 0 and b.

The insurer would like to model the effect of imposing an ordinary deductible, d $(0 < d < b)$, on each loss and reimbursing only a percentage, c $(0 < c \le 1)$, of each loss in excess of the deductible.

It is assumed that the coverage modifications will not affect the loss distribution.

The insurer models its claims with modified frequency and severity distributions. The modified claim amount is uniformly distributed on the interval $[0, c(b-d)]$.

Determine the mean of the modified frequency distribution.

(A) λ

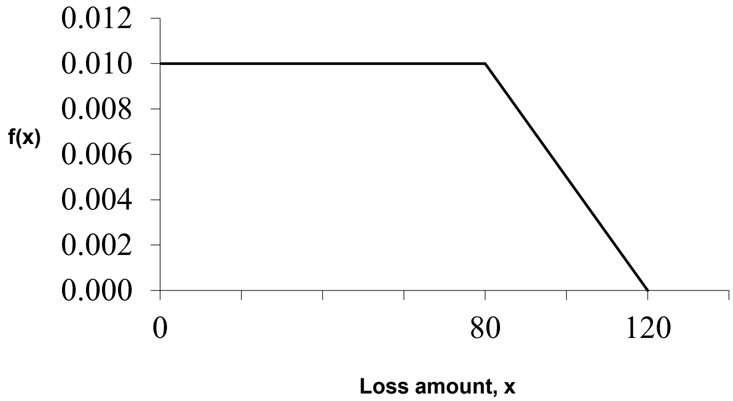
(B) λc

(C) $\lambda \dfrac{d}{b}$

(D) $\lambda \dfrac{b-d}{b}$

(E) $\lambda c \dfrac{b-d}{b}$

87. The graph of the density function for losses is:



Calculate the loss elimination ratio for an ordinary deductible of 20.

(A) 0.20

(B) 0.24

(C) 0.28

(D) 0.32

(E) 0.36

88. A towing company provides all towing services to members of the City Automobile Club. You are given:

Towing Distance	Towing Cost	Frequency
0-9.99 miles	80	50%
10-29.99 miles	100	40%
30+ miles	160	10%

(i) The automobile owner must pay 10% of the cost and the remainder is paid by the City Automobile Club.

(ii) The number of towings has a Poisson distribution with mean of 1000 per year.

(iii) The number of towings and the costs of individual towings are all mutually independent.

Using the normal approximation for the distribution of aggregate towing costs, calculate the probability that the City Automobile Club pays more than 90,000 in any given year.

(A) 3%

(B) 10%

(C) 50%

(D) 90%

(E) 97%

89. You are given:

(i) Losses follow an exponential distribution with the same mean in all years.

(ii) The loss elimination ratio this year is 70%.

(iii) The ordinary deductible for the coming year is 4/3 of the current deductible.

Calculate the loss elimination ratio for the coming year.

(A) 70%

(B) 75%

(C) 80%

(D) 85%

(E) 90%

90. Actuaries have modeled auto windshield claim frequencies. They have concluded that the number of windshield claims filed per year per driver follows the Poisson distribution with parameter λ, where λ follows the gamma distribution with mean 3 and variance 3.

Calculate the probability that a driver selected at random will file no more than 1 windshield claim next year.

(A) 0.15

(B) 0.19

(C) 0.20

(D) 0.24

(E) 0.31

91. The number of auto vandalism claims reported per month at Sunny Daze Insurance Company (SDIC) has mean 110 and variance 750. Individual losses have mean 1101 and standard deviation 70. The number of claims and the amounts of individual losses are independent.

Using the normal approximation, calculate the probability that SDIC's aggregate auto vandalism losses reported for a month will be less than 100,000.

(A) 0.24

(B) 0.31

(C) 0.36

(D) 0.39

(E) 0.49

92. Prescription drug losses, *S*, are modeled assuming the number of claims has a geometric distribution with mean 4, and the amount of each prescription is 40.

Calculate $E[(S-100)_+]$.

(A) 60

(B) 82

(C) 92

(D) 114

(E) 146

93. At the beginning of each round of a game of chance the player pays 12.5. The player then rolls one die with outcome N. The player then rolls N dice and wins an amount equal to the total of the numbers showing on the N dice. All dice have 6 sides and are fair.

Using the normal approximation, calculate the probability that a player starting with 15,000 will have at least 15,000 after 1000 rounds.

(A) 0.01

(B) 0.04

(C) 0.06

(D) 0.09

(E) 0.12

94. X is a discrete random variable with a probability function that is a member of the $(a,b,0)$ class of distributions.

You are given:

(i) $\Pr(X=0)=\Pr(X=1)=0.25$

(ii) $\Pr(X=2)=0.1875$

Calculate $\Pr(X=3)$.

(A) 0.120

(B) 0.125

(C) 0.130

(D) 0.135

(E) 0.140

95. The number of claims in a period has a geometric distribution with mean 4. The amount of each claim X follows $\Pr(X = x) = 0.25, \quad x = 1, 2, 3, 4$, The number of claims and the claim amounts are independent. S is the aggregate claim amount in the period.

Calculate $F_S(3)$.

(A) 0.27

(B) 0.29

(C) 0.31

(D) 0.33

(E) 0.35

96. Insurance agent Hunt N. Quotum will receive no annual bonus if the ratio of incurred losses to earned premiums for his book of business is 60% or more for the year. If the ratio is less than 60%, Hunt's bonus will be a percentage of his earned premium equal to 15% of the difference between his ratio and 60%. Hunt's annual earned premium is 800,000.

Incurred losses are distributed according to the Pareto distribution, with $\theta = 500,000$ and $\alpha = 2$.

Calculate the expected value of Hunt's bonus.

(A) 13,000

(B) 17,000

(C) 24,000

(D) 29,000

(E) 35,000

97. A group dental policy has a negative binomial claim count distribution with mean 300 and variance 800.

Ground-up severity is given by the following table:

Severity	Probability
40	0.25
80	0.25
120	0.25
200	0.25

You expect severity to increase 50% with no change in frequency. You decide to impose a per claim deductible of 100.

Calculate the expected total claim payment after these changes.

(A) Less than 18,000

(B) At least 18,000, but less than 20,000

(C) At least 20,000, but less than 22,000

(D) At least 22,000, but less than 24,000

(E) At least 24,000

98. You own a light bulb factory. Your workforce is a bit clumsy – they keep dropping boxes of light bulbs. The boxes have varying numbers of light bulbs in them, and when dropped, the entire box is destroyed.

You are given:

- Expected number of boxes dropped per month: 50
- Variance of the number of boxes dropped per month: 100
- Expected value per box: 200
- Variance of the value per box: 400

You pay your employees a bonus if the value of light bulbs destroyed in a month is less than 8000.

Assuming independence and using the normal approximation, calculate the probability that you will pay your employees a bonus next month.

(A) 0.16

(B) 0.19

(C) 0.23

(D) 0.27

(E) 0.31

99. For a certain company, losses follow a Poisson frequency distribution with mean 2 per year, and the amount of a loss is 1, 2, or 3, each with probability 1/3. Loss amounts are independent of the number of losses, and of each other.

An insurance policy covers all losses in a year, subject to an annual aggregate deductible of 2.

Calculate the expected claim payments for this insurance policy.

(A) 2.00

(B) 2.36

(C) 2.45

(D) 2.81

(E) 2.96

100. The unlimited severity distribution for claim amounts under an auto liability insurance policy is given by the cumulative distribution:

$$F(x) = 1 - 0.8e^{-0.02x} - 0.2e^{-0.001x}, \quad x \geq 0$$

The insurance policy pays amounts up to a limit of 1000 per claim.

Calculate the expected payment under this policy for one claim.

(A) 57

(B) 108

(C) 166

(D) 205

(E) 240

101. The random variable for a loss, X, has the following characteristics:

x	$F(x)$	$E(X \wedge x)$
0	0.0	0
100	0.2	91
200	0.6	153
1000	1.0	331

Calculate the mean excess loss for a deductible of 100.

(A) 250

(B) 300

(C) 350

(D) 400

(E) 450

102. WidgetsRUs owns two factories. It buys insurance to protect itself against major repair costs. Profit equals revenues, less the sum of insurance premiums, retained major repair costs, and all other expenses. WidgetsRUs will pay a dividend equal to the profit, if it is positive.

You are given:

(i) Combined revenue for the two factories is 3.

(ii) Major repair costs at the factories are independent.

(iii) The distribution of major repair costs for each factory is

k	Prob (k)
0	0.4
1	0.3
2	0.2
3	0.1

(iv) At each factory, the insurance policy pays the major repair costs in excess of that factory's ordinary deductible of 1. The insurance premium is 110% of the expected claims.

(v) All other expenses are 15% of revenues.

Calculate the expected dividend.

(A) 0.43

(B) 0.47

(C) 0.51

(D) 0.55

(E) 0.59

103. DELETED

104. DELETED

105. An actuary for an automobile insurance company determines that the distribution of the annual number of claims for an insured chosen at random is modeled by the negative binomial distribution with mean 0.2 and variance 0.4.

The number of claims for each individual insured has a Poisson distribution and the means of these Poisson distributions are gamma distributed over the population of insureds.

Calculate the variance of this gamma distribution.

(A) 0.20

(B) 0.25

(C) 0.30

(D) 0.35

(E) 0.40

106. A dam is proposed for a river that is currently used for salmon breeding. You have modeled:

(i) For each hour the dam is opened the number of salmon that will pass through and reach the breeding grounds has a distribution with mean 100 and variance 900.

(ii) The number of eggs released by each salmon has a distribution with mean 5 and variance 5.

(iii) The number of salmon going through the dam each hour it is open and the numbers of eggs released by the salmon are independent.

Using the normal approximation for the aggregate number of eggs released, calculate the least number of whole hours the dam should be left open so the probability that 10,000 eggs will be released is greater than 95%.

(A) 20

(B) 23

(C) 26

(D) 29

(E) 32

107. For a stop-loss insurance on a three person group:

(i) Loss amounts are independent.

(ii) The distribution of loss amount for each person is:

Loss Amount	Probability
0	0.4
1	0.3
2	0.2
3	0.1

(iii) The stop-loss insurance has a deductible of 1 for the group.

Calculate the net stop-loss premium.

(A) 2.00

(B) 2.03

(C) 2.06

(D) 2.09

(E) 2.12

108. For a discrete probability distribution, you are given the recursion relation

$$p(k) = \frac{2}{k} p(k-1), \quad \mathrm{k} = 1, 2, \ldots$$

Calculate $p(4)$.

(A) 0.07

(B) 0.08

(C) 0.09

(D) 0.10

(E) 0.11

109. A company insures a fleet of vehicles. Aggregate losses have a compound Poisson distribution. The expected number of losses is 20. Loss amounts, regardless of vehicle type, have exponential distribution with $\theta = 200$.

To reduce the cost of the insurance, two modifications are to be made:

(i) a certain type of vehicle will not be insured. It is estimated that this will reduce loss frequency by 20%.

(ii) a deductible of 100 per loss will be imposed.

Calculate the expected aggregate amount paid by the insurer after the modifications.

(A) 1600

(B) 1940

(C) 2520

(D) 3200

(E) 3880

110. You are the producer of a television quiz show that gives cash prizes. The number of prizes, N, and prize amounts, X, have the following distributions:

n	$\Pr(N = n)$
1	0.8
2	0.2

x	$\Pr(X = x)$
0	0.2
100	0.7
1000	0.1

Your budget for prizes equals the expected prizes plus the standard deviation of prizes.

Calculate your budget.

(A) 306

(B) 316

(C) 416

(D) 510

(E) 518

111. The number of accidents follows a Poisson distribution with mean 12. Each accident generates 1, 2, or 3 claimants with probabilities 1/2, 1/3, and 1/6, respectively.

Calculate the variance of the total number of claimants.

(A) 20

(B) 25

(C) 30

(D) 35

(E) 40

112. In a clinic, physicians volunteer their time on a daily basis to provide care to those who are not eligible to obtain care otherwise. The number of physicians who volunteer in any day is uniformly distributed on the integers 1 through 5. The number of patients that can be served by a given physician has a Poisson distribution with mean 30.

Determine the probability that 120 or more patients can be served in a day at the clinic, using the normal approximation with continuity correction.

(A) $1-\Phi(0.68)$

(B) $1-\Phi(0.72)$

(C) $1-\Phi(0.93)$

(D) $1-\Phi(3.13)$

(E) $1-\Phi(3.16)$

113. The number of claims, N, made on an insurance portfolio follows the following distribution:

n	$\Pr(N = n)$
0	0.7
2	0.2
3	0.1

If a claim occurs, the benefit is 0 or 10 with probability 0.8 and 0.2, respectively.

The number of claims and the benefit for each claim are independent.

Calculate the probability that aggregate benefits will exceed expected benefits by more than 2 standard deviations.

(A) 0.02

(B) 0.05

(C) 0.07

(D) 0.09

(E) 0.12

114. A claim count distribution can be expressed as a mixed Poisson distribution. The mean of the Poisson distribution is uniformly distributed over the interval [0, 5].

Calculate the probability that there are 2 or more claims.

(A) 0.61

(B) 0.66

(C) 0.71

(D) 0.76

(E) 0.81

115. A claim severity distribution is exponential with mean 1000. An insurance company will pay the amount of each claim in excess of a deductible of 100.

Calculate the variance of the amount paid by the insurance company for one claim, including the possibility that the amount paid is 0.

(A) 810,000

(B) 860,000

(C) 900,000

(D) 990,000

(E) 1,000,000

116. Total hospital claims for a health plan were previously modeled by a two-parameter Pareto distribution with $\alpha = 2$ and $\theta = 500$.

The health plan begins to provide financial incentives to physicians by paying a bonus of 50% of the amount by which total hospital claims are less than 500. No bonus is paid if total claims exceed 500.

Total hospital claims for the health plan are now modeled by a new Pareto distribution with $\alpha = 2$ and $\theta = K$. The expected claims plus the expected bonus under the revised model equals expected claims under the previous model.

Calculate *K*.

(A) 250

(B) 300

(C) 350

(D) 400

(E) 450

117. DELETED

118. For an individual over 65:

(i) The number of pharmacy claims is a Poisson random variable with mean 25.

(ii) The amount of each pharmacy claim is uniformly distributed between 5 and 95.

(iii) The amounts of the claims and the number of claims are mutually independent.

Determine the probability that aggregate claims for this individual will exceed 2000 using the normal approximation.

(A) $1-\Phi(1.33)$

(B) $1-\Phi(1.66)$

(C) $1-\Phi(2.33)$

(D) $1-\Phi(2.66)$

(E) $1-\Phi(3.33)$

119. DELETED

120 An insurer has excess-of-loss reinsurance on auto insurance. You are given:

(i) Total expected losses in the year 2001 are 10,000,000.

(ii) In the year 2001 individual losses have a Pareto distribution with

$$F(x) = 1 - \left(\frac{2000}{x + 2000}\right)^2, \quad x > 0$$

(iii) Reinsurance will pay the excess of each loss over 3000.

(iv) Each year, the reinsurer is paid a ceded premium, C_{year} equal to 110% of the expected losses covered by the reinsurance.

(v) Individual losses increase 5% each year due to inflation.

(vi) The frequency distribution does not change.

Calculate C_{2002} / C_{2001}.

(A) 1.04

(B) 1.05

(C) 1.06

(D) 1.07

(E) 1.08

121. DELETED

122. DELETED

123. Annual prescription drug costs are modeled by a two-parameter Pareto distribution with $\theta = 2000$ and $\alpha = 2$.

A prescription drug plan pays annual drug costs for an insured member subject to the following provisions:

(i) The insured pays 100% of costs up to the ordinary annual deductible of 250.

(ii) The insured then pays 25% of the costs between 250 and 2250.

(iii) The insured pays 100% of the costs above 2250 until the insured has paid 3600 in total.

(iv) The insured then pays 5% of the remaining costs.

Calculate the expected annual plan payment.

(A) 1120

(B) 1140

(C) 1160

(D) 1180

(E) 1200

124. DELETED

125. Two types of insurance claims are made to an insurance company. For each type, the number of claims follows a Poisson distribution and the amount of each claim is uniformly distributed as follows:

Type of Claim	Poisson Parameter λ for Number of Claims in one year	Range of Each Claim Amount
I	12	(0, 1)
II	4	(0, 5)

The numbers of claims of the two types are independent and the claim amounts and claim numbers are independent.

Calculate the normal approximation to the probability that the total of claim amounts in one year exceeds 18.

(A) 0.37

(B) 0.39

(C) 0.41

(D) 0.43

(E) 0.45

126. The number of annual losses has a Poisson distribution with a mean of 5. The size of each loss has a two-parameter Pareto distribution with $\theta = 10$ and $\alpha = 2.5$. An insurance for the losses has an ordinary deductible of 5 per loss.

Calculate the expected value of the aggregate annual payments for this insurance.

(A) 8

(B) 13

(C) 18

(D) 23

(E) 28

127. Losses in 2003 follow a two-parameter Pareto distribution with $\alpha = 2$ and $\theta = 5$. Losses in 2004 are uniformly 20% higher than in 2003. An insurance covers each loss subject to an ordinary deductible of 10.

Calculate the Loss Elimination Ratio in 2004.

(A) 5/9

(B) 5/8

(C) 2/3

(D) 3/4

(E) 4/5

128. DELETED

129. DELETED

130. Bob is a carnival operator of a game in which a player receives a prize worth $W = 2^N$ if the player has N successes, $N = 0, 1, 2, 3, \ldots$ Bob models the probability of success for a player as follows:

(i) N has a Poisson distribution with mean Λ.

(ii) Λ has a uniform distribution on the interval (0, 4).

Calculate $E[W]$.

(A) 5

(B) 7

(C) 9

(D) 11

(E) 13

131. DELETED

132. DELETED

133. You are given:

(i) The annual number of claims for an insured has probability function:

$$p(x) = \binom{3}{x} q^x (1-q)^{3-x}, \quad x = 0,1,2,3$$

(ii) The prior density is $\pi(q) = 2q, \quad 0 < q < 1$.

A randomly chosen insured has zero claims in Year 1.

Using Bühlmann credibility, calculate the estimate of the number of claims in Year 2 for the selected insured.

(A) 0.33

(B) 0.50

(C) 1.00

(D) 1.33

(E) 1.50

134. DELETED

135. DELETED

136. You are given:

(i) Two classes of policyholders have the following severity distributions:

Claim Amount	Probability of Claim Amount for Class 1	Probability of Claim Amount for Class 2
250	0.5	0.7
2,500	0.3	0.2
60,000	0.2	0.1

(ii) Class 1 has twice as many claims as Class 2.

A claim of 250 is observed.

Calculate the Bayesian estimate of the expected value of a second claim from the same policyholder.

(A) Less than 10,200

(B) At least 10,200, but less than 10,400

(C) At least 10,400, but less than 10,600

(D) At least 10,600, but less than 10,800

(E) At least 10,800

137. You are given the following three observations:

0.74 0.81 0.95

You fit a distribution with the following density function to the data:

$$f(x) = (p+1)x^p, \quad 0 < x < 1, \ p > -1$$

Calculate the maximum likelihood estimate of p.

(A) 4.0

(B) 4.1

(C) 4.2

(D) 4.3

(E) 4.4

138. DELETED

139. Members of three classes of insureds can have 0, 1 or 2 claims, with the following probabilities:

Class	Number of Claims		
	0	1	2
I	0.9	0.0	0.1
II	0.8	0.1	0.1
III	0.7	0.2	0.1

A class is chosen at random, and varying numbers of insureds from that class are observed over 2 years, as shown below:

Year	Number of Insureds	Number of Claims
1	20	7
2	30	10

Calculate the Bühlmann-Straub credibility estimate of the number of claims in Year 3 for 35 insureds from the same class.

(A) 10.6

(B) 10.9

(C) 11.1

(D) 11.4

(E) 11.6

140. You are given the following random sample of 30 auto claims:

54	140	230	560	600	1,100	1,500	1,800	1,920	2,000
2,450	2,500	2,580	2,910	3,800	3,800	3,810	3,870	4,000	4,800
7,200	7,390	11,750	12,000	15,000	25,000	30,000	32,300	35,000	55,000

You test the hypothesis that auto claims follow a continuous distribution $F(x)$ with the following percentiles:

x	310	500	2,498	4,876	7,498	12,930
$F(x)$	0.16	0.27	0.55	0.81	0.90	0.95

You group the data using the largest number of groups such that the expected number of claims in each group is at least 5.

Calculate the chi-square goodness-of-fit statistic.

(A) Less than 7

(B) At least 7, but less than 10

(C) At least 10, but less than 13

(D) At least 13, but less than 16

(E) At least 16

141. DELETED

142. You are given:

(i) The number of claims observed in a 1-year period has a Poisson distribution with mean θ.

(ii) The prior density is:

$$\pi(\theta) = \frac{e^{-\theta}}{1-e^{-k}}, \quad 0 < \theta < k$$

(iii) The unconditional probability of observing zero claims in 1 year is 0.575.

Calculate k.

(A) 1.5

(B) 1.7

(C) 1.9

(D) 2.1

(E) 2.3

143. DELETED

144. DELETED

145. You are given the following commercial automobile policy experience:

	Company	Year 1	Year 2	Year 3
Losses Number of Automobiles	I	50,000 100	50,000 200	? ?
Losses Number of Automobiles	II	? ?	150,000 500	150,000 300
Losses Number of Automobiles	III	150,000 50	? ?	150,000 150

Calculate the nonparametric empirical Bayes credibility factor, Z, for Company III.

(A) Less than 0.2

(B) At least 0.2, but less than 0.4

(C) At least 0.4, but less than 0.6

(D) At least 0.6, but less than 0.8

(E) At least 0.8

146. Let $x_1, x_2, \ldots, x_n$ and $y_1, y_2, \ldots, y_m$ denote independent random samples of losses from Region 1 and Region 2, respectively. Single-parameter Pareto distributions with $\theta = 1$, but different values of α are used to model losses in these regions.

Past experience indicates that the expected value of losses in Region 2 is 1.5 times the expected value of losses in Region 1. You intend to calculate the maximum likelihood estimate of α for Region 1, using the data from both regions.

Which of the following equations must be solved?

(A) $\dfrac{n}{\alpha} - \sum \ln(x_i) = 0$

(B) $\dfrac{n}{\alpha} - \sum \ln(x_i) + \dfrac{m(\alpha+2)}{3\alpha} - \dfrac{2\sum \ln(y_i)}{(\alpha+2)^2} = 0$

(C) $\dfrac{n}{\alpha} - \sum \ln(x_i) + \dfrac{2m}{3\alpha(\alpha+2)} - \dfrac{2\sum \ln(y_i)}{(\alpha+2)^2} = 0$

(D) $\dfrac{n}{\alpha} - \sum \ln(x_i) + \dfrac{2m}{\alpha(\alpha+2)} - \dfrac{6\sum \ln(y_i)}{(\alpha+2)^2} = 0$

(E) $\dfrac{n}{\alpha} - \sum \ln(x_i) + \dfrac{3m}{\alpha(3-\alpha)} - \dfrac{6\sum \ln(y_i)}{(3-\alpha)^2} = 0$

147. DELETED

148. You are given:

(i) The number of claims has probability function:

$$p(x) = \binom{m}{x} q^x (1-q)^{m-x}, \quad x = 0, 1, \ldots, m$$

(ii) The actual number of claims must be within 1% of the expected number of claims with probability 0.95.

(iii) The expected number of claims for full credibility is 34,574.

Calculate q.

(A) 0.05

(B) 0.10

(C) 0.20

(D) 0.40

(E) 0.80

149. DELETED

150. DELETED

151. You are given:

(i) A portfolio of independent risks is divided into two classes.

(ii) Each class contains the same number of risks.

(iii) For each risk in Class 1, the number of claims per year follows a Poisson distribution with mean 5.

(iv) For each risk in Class 2, the number of claims per year follows a binomial distribution with $m = 8$ and $q = 0.55$.

(v) A randomly selected risk has three claims in Year 1, r claims in Year 2 and four claims in Year 3.

The Bühlmann credibility estimate for the number of claims in Year 4 for this risk is 4.6019.

Calculate r.

(A) 1

(B) 2

(C) 3

(D) 4

(E) 5

152. You are given:

(i) A sample of losses is:

600 700 900

(ii) No information is available about losses of 500 or less.

(iii) Losses are assumed to follow an exponential distribution with mean θ.

Calculate the maximum likelihood estimate of θ.

(A) 233

(B) 400

(C) 500

(D) 733

(E) 1233

153. DELETED

154. You are given:

(v) Claim counts follow a Poisson distribution with mean λ.

(vi) Claim sizes follow a lognormal distribution with parameters μ and σ.

(vii) Claim counts and claim sizes are independent.

(viii) The prior distribution has joint probability density function:

$$f(\lambda, \mu, \sigma) = 2\sigma, \quad 0 < \lambda < 1, 0 < \mu < 1, 0 < \sigma < 1$$

Calculate Bühlmann's k for aggregate losses.

(A) Less than 2

(B) At least 2, but less than 4

(C) At least 4, but less than 6

(D) At least 6, but less than 8

(E) At least 8

155. DELETED

156. You are given:

(i) The number of claims follows a Poisson distribution with mean λ.

(ii) Observations other than 0 and 1 have been deleted from the data.

(iii) The data contain an equal number of observations of 0 and 1.

Calculate the maximum likelihood estimate of λ.

(A) 0.50

(B) 0.75

(C) 1.00

(D) 1.25

(E) 1.50

157. You are given:

(i) In a portfolio of risks, each policyholder can have at most one claim per year.

(ii) The probability of a claim for a policyholder during a year is q.

(iii) The prior density is $\pi(q) = \dfrac{q^3}{0.07}, \quad 0.6 < q < 0.8$

A randomly selected policyholder has one claim in Year 1 and zero claims in Year 2.

For this policyholder, calculate the posterior probability that $0.7 < q < 0.8$.

(A) Less than 0.3

(B) At least 0.3, but less than 0.4

(C) At least 0.4, but less than 0.5

(D) At least 0.5, but less than 0.6

(E) At least 0.6

158. DELETED

159. For a portfolio of motorcycle insurance policyholders, you are given:

(i) The number of claims for each policyholder has a conditional Poisson distribution.

(ii) For Year 1, the following data are observed:

Number of Claims	***Number of Policyholders***
0	2000
1	600
2	300
3	80
4	20
Total	3000

Calculate the credibility factor, Z, for Year 2.

(A) Less than 0.30

(B) At least 0.30, but less than 0.35

(C) At least 0.35, but less than 0.40

(D) At least 0.40, but less than 0.45

(E) At least 0.45

160. You are given a random sample of observations:

0.1 0.2 0.5 0.7 1.3

You test the hypothesis that the probability density function is:

$$f(x) = \frac{4}{(1+x)^5}, \quad x > 0$$

Calculate the Kolmogorov-Smirnov test statistic.

(A) Less than 0.05

(B) At least 0.05, but less than 0.15

(C) At least 0.15, but less than 0.25

(D) At least 0.25, but less than 0.35

(E) At least 0.35

161. DELETED

162. A loss, *X*, follows a 2-parameter Pareto distribution with $\alpha = 2$ and unspecified parameter θ. You are given:

$$E[X-100 \mid X > 100] = \frac{5}{3} E[X-50 \mid X > 50]$$

Calculate $E[X-150 \mid X > 150]$.

(A) 150

(B) 175

(C) 200

(D) 225

(E) 250

163. The scores on the final exam in Ms. B's Latin class have a normal distribution with mean θ and standard deviation equal to 8. θ is a random variable with a normal distribution with mean 75 and standard deviation 6.

Each year, Ms. B chooses a student at random and pays the student 1 times the student's score. However, if the student fails the exam (score < 65), then there is no payment.

Calculate the conditional probability that the payment is less than 90, given that there is a payment.

(A) 0.77

(B) 0.85

(C) 0.88

(D) 0.92

(E) 1.00

164. For a collective risk model the number of losses, N, has a Poisson distribution with $\lambda = 20$. The common distribution of the individual losses has the following characteristics:

(i) $E[X] = 70$

(ii) $E[X \wedge 30] = 25$

(iii) $\Pr(X > 30) = 0.75$

(iv) $E[X^2 \mid X > 30] = 9000$

An insurance covers aggregate losses subject to an ordinary deductible of 30 per loss.

Calculate the variance of the aggregate payments of the insurance.

(A) 54,000

(B) 67,500

(C) 81,000

(D) 94,500

(E) 108,000

165. For a collective risk model:

(i) The number of losses has a Poisson distribution with $\lambda = 2$.

(ii) The common distribution of the individual losses is:

x	$f_X(x)$
1	0.6
2	0.4

An insurance covers aggregate losses subject to a deductible of 3.

Calculate the expected aggregate payments of the insurance.

(A) 0.74

(B) 0.79

(C) 0.84

(D) 0.89

(E) 0.94

166. A discrete probability distribution has the following properties:

(i) $p_k = c\left(1+\frac{1}{k}\right)p_{k-1}$ for $k = 1, 2, \ldots$

(ii) $p_0 = 0.5$

Calculate c.

(A) 0.06

(B) 0.13

(C) 0.29

(D) 0.35

(E) 0.40

167. The repair costs for boats in a marina have the following characteristics:

Boat type	Number of boats	Probability that repair is needed	Mean of repair cost given a repair	Variance of repair cost given a repair
Power boats	100	0.3	300	10,000
Sailboats	300	0.1	1000	400,000
Luxury yachts	50	0.6	5000	2,000,000

At most one repair is required per boat each year. Repair incidence and cost are mutually independent.

The marina budgets an amount, Y, equal to the aggregate mean repair costs plus the standard deviation of the aggregate repair costs.

Calculate Y.

(A) 200,000

(B) 210,000

(C) 220,000

(D) 230,000

(E) 240,000

168. For an insurance:

(i) Losses can be 100, 200 or 300 with respective probabilities 0.2, 0.2, and 0.6.

(ii) The insurance has an ordinary deductible of 150 per loss.

(iii) Y^P is the claim payment per payment random variable.

Calculate $\mathrm{Var}(Y^P)$.

(A) 1500

(B) 1875

(C) 2250

(D) 2625

(E) 3000

169. The distribution of a loss, X, is a two-point mixture:

(i) With probability 0.8, X has a two-parameter Pareto distribution with $\alpha = 2$ and $\theta = 100$.

(ii) With probability 0.2, X has a two-parameter Pareto distribution with with $\alpha = 4$ and $\theta = 3000$.

Calculate $\Pr(X \le 200)$.

(A) 0.76

(B) 0.79

(C) 0.82

(D) 0.85

(E) 0.88

170. In a certain town the number of common colds an individual will get in a year follows a Poisson distribution that depends on the individual's age and smoking status. The distribution of the population and the mean number of colds are as follows:

	Proportion of population	Mean number of colds
Children	0.30	3
Adult Non-Smokers	0.60	1
Adult Smokers	0.10	4

Calculate the conditional probability that a person with exactly 3 common colds in a year is an adult smoker.

(A) 0.12

(B) 0.16

(C) 0.20

(D) 0.24

(E) 0.28

171. For aggregate losses, S:

(i) The number of losses has a negative binomial distribution with mean 3 and variance 3.6.

(ii) The common distribution of the independent individual loss amounts is uniform from 0 to 20.

Calculate the 95^{th} percentile of the distribution of S as approximated by the normal distribution.

(A) 61

(B) 63

(C) 65

(D) 67

(E) 69

172. You are given:

(i) A random sample of five observations from a population is:

0.2 0.7 0.9 1.1 1.3

(ii) You use the Kolmogorov-Smirnov test for testing the null hypothesis, H_0, that the probability density function for the population is:

$$f(x) = \frac{4}{(1+x)^5}, \quad x > 0$$

(iii) Critical values for the Kolmogorov-Smirnov test are:

Level of Significance	0.10	0.05	0.025	0.01
Critical Value	$\frac{1.22}{\sqrt{n}}$	$\frac{1.36}{\sqrt{n}}$	$\frac{1.48}{\sqrt{n}}$	$\frac{1.63}{\sqrt{n}}$

Determine the result of the test.

(A) Do not reject H_0 at the 0.10 significance level.

(B) Reject H_0 at the 0.10 significance level, but not at the 0.05 significance level.

(C) Reject H_0 at the 0.05 significance level, but not at the 0.025 significance level.

(D) Reject H_0 at the 0.025 significance level, but not at the 0.01 significance level.

(E) Reject H_0 at the 0.01 significance level.

173. You are given:

(i) The number of claims follows a negative binomial distribution with parameters r and $\beta = 3$.

(ii) Claim severity has the following distribution:

Claim Size	Probability
1	0.4
10	0.4
100	0.2

(iii) The number of claims is independent of the severity of claims.

Calculate the expected number of claims needed for aggregate losses to be within 10% of expected aggregate losses with 95% probability.

(A) Less than 1200

(B) At least 1200, but less than 1600

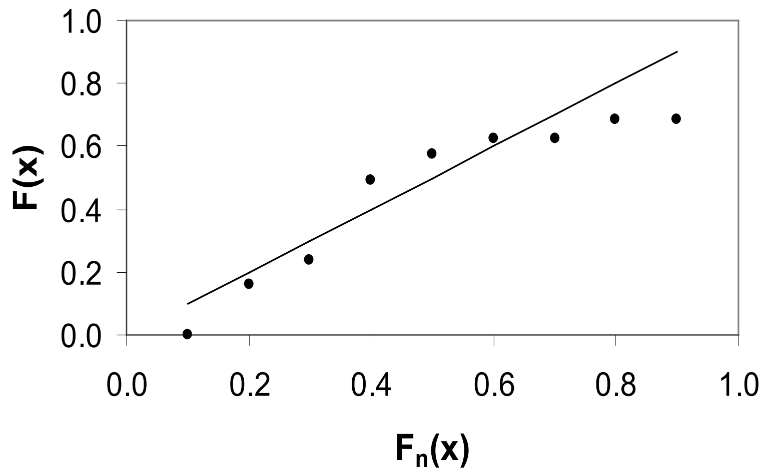
(C) At least 1600, but less than 2000

(D) At least 2000, but less than 2400

(E) At least 2400

174. DELETED

175. DELETED



The plot is based on the sample:

1 2 3 15 30 50 51 99 100

Determine the fitted model underlying the *p*-*p* plot.

(A) $F(x) = 1 - x^{-0.25}, x \ge 1$

(B) $F(x) = x/(1+x), x \ge 0$

(C) Uniform on [1, 100]

(D) Exponential with mean 10

(E) Normal with mean 40 and standard deviation 40

177. You are given:

(i) Claims are conditionally independent and identically Poisson distributed with mean Θ.

(ii) The prior distribution function of Θ is:

$$F(\theta) = 1 - \left(\frac{1}{1+\theta}\right)^{2.6}, \quad \theta > 0$$

Five claims are observed.

Calculate the Bühlmann credibility factor.

(A) Less than 0.6

(B) At least 0.6, but less than 0.7

(C) At least 0.7, but less than 0.8

(D) At least 0.8, but less than 0.9

(E) At least 0.9

178. DELETED

179. The time to an accident follows an exponential distribution. A random sample of size two has a mean time of 6.

Let Y denote the mean of a new sample of size two.

Calculate the maximum likelihood estimate of $\Pr(Y > 10)$.

(A) 0.04

(B) 0.07

(C) 0.11

(D) 0.15

(E) 0.19

180. The time to an accident follows an exponential distribution. A random sample of size two has a sample mean time of 6.

Let Y denote the mean of a new sample of size two.

Calculate the delta method approximation of the variance of the maximum likelihood estimator of $F_Y(10)$.

(A) 0.08

(B) 0.12

(C) 0.16

(D) 0.19

(E) 0.22

181. You are given:

(i) The number of claims in a year for a selected risk follows a Poisson distribution with mean λ.

(ii) The severity of claims for the selected risk follows an exponential distribution with mean θ.

(iii) The number of claims is independent of the severity of claims.

(iv) The prior distribution of λ is exponential with mean 1.

(v) The prior distribution of θ is Poisson with mean 1.

(vi) A priori, λ and θ are independent.

Using Bühlmann's credibility for aggregate losses, calculate k.

(A) 1

(B) 4/3

(C) 2

(D) 3

(E) 4

182. DELETED

183. DELETED

184. You are given:

(i) Annual claim frequencies follow a Poisson distribution with mean λ.

(ii) The prior distribution of λ has probability density function:

$$\pi(\lambda) = (0.4)\frac{1}{6}e^{-\lambda/6} + (0.6)\frac{1}{12}e^{-\lambda/12}, \quad \lambda > 0$$

Ten claims are observed for an insured in Year 1.

Calculate the Bayesian expected number of claims for the insured in Year 2.

(A) 9.6

(B) 9.7

(C) 9.8

(D) 9.9

(E) 10.0

185. DELETED

186. DELETED

187. You are given:

(i) The annual number of claims on a given policy has a geometric distribution with parameter β.

(ii) The prior distribution of β has the Pareto density function

$$\pi(\beta) = \frac{\alpha}{(\beta+1)^{\alpha+1}}, \quad 0 < \beta < \infty$$

Where α is a known constant greater than 2.

A randomly selected policy had x claims in Year 1.

Determine the Bühlmann credibility estimate of the number of claims for the selected policy in Year 2.

(A) $\dfrac{1}{\alpha - 1}$

(B) $\dfrac{\alpha - 1}{\alpha} x + \dfrac{1}{\alpha(\alpha - 1)}$

(C) x

(D) $\dfrac{x+1}{\alpha}$

(E) $\dfrac{x+1}{\alpha - 1}$

188. DELETED

189. Which of the following statements is true?

(A) For a null hypothesis that the population follows a particular distribution, using sample data to estimate the parameters of the distribution tends to decrease the probability of a Type II error.

(B) The Kolmogorov-Smirnov test can be used on individual or grouped data.

(C) (Removed as this statement referred to the Anderson-Darling test)

(D) For a given number of cells, the critical value for the chi-square goodness-of-fit test becomes larger with increased sample size.

(E) None of (A), (B), or (D) is true.

190. For a particular policy, the conditional probability of the annual number of claims given $\Theta = \theta$, and the probability distribution of Θ are as follows:

Number of claims	0	1	2
Probability	2θ	θ	$1-3\theta$

θ	0.05	0.30
Probability	0.80	0.20

Two claims are observed in Year 1.

Calculate the Bühlmann credibility estimate of the number of claims in Year 2.

(A) Less than 1.68

(B) At least 1.68, but less than 1.70

(C) At least 1.70, but less than 1.72

(D) At least 1.72, but less than 1.74

(E) At least 1.74

191. You are given:

(i) The annual number of claims for a policyholder follows a Poisson distribution with mean Λ.

(ii) The prior distribution of Λ is gamma with probability density function:

$$f(\lambda) = \frac{(2\lambda)^5 e^{-2\lambda}}{24\lambda}, \quad \lambda > 0$$

An insured is selected at random and observed to have $x_1 = 5$ claims during Year 1 and $x_2 = 3$ claims during Year 2.

Calculate $E[\Lambda \mid x_1 = 5, x_2 = 3]$.

(A) 3.00

(B) 3.25

(C) 3.50

(D) 3.75

(E) 4.00

192. DELETED

193. DELETED

194. You are given:

	Group	Year 1	Year 2	Year 3	Total
Total Claims	1		10,000	15,000	25,000
Number in Group			50	60	110
Average			200	250	227.27
Total Claims	2	16,000	18,000		34,000
Number in Group		100	90		190
Average		160	200		178.95
Total Claims					59,000
Number in Group					300
Average					196.67

You are also given $\hat{a} = 651.03$.
Calculate the nonparametric empirical Bayes credibility factor for Group 1.

(A) 0.48

(B) 0.50

(C) 0.52

(D) 0.54

(E) 0.56

195. DELETED

196. You are given the following 20 bodily injury losses (before the deductible is applied):

Loss	Number of Losses	Deductible	Policy Limit
750	3	200	∞
200	3	0	10,000
300	4	0	20,000
>10,000	6	0	10,000
400	4	300	∞

Past experience indicates that these losses follow a Pareto distribution with parameters α and $\theta = 10,000$.

Calculate the maximum likelihood estimate of α.

(A) Less than 2.0

(B) At least 2.0, but less than 3.0

(C) At least 3.0, but less than 4.0

(D) At least 4.0, but less than 5.0

(E) At least 5.0

197. You are given:

(i) During a 2-year period, 100 policies had the following claims experience:

Total Claims in Years 1 and 2	Number of Policies
0	50
1	30
2	15
3	4
4	1

(ii) The number of claims per year follows a Poisson distribution.

(iii) Each policyholder was insured for the entire 2-year period.

A randomly selected policyholder had one claim over the 2-year period.

Using semiparametric empirical Bayes estimation, calculate the Bühlmann estimate for the number of claims in Year 3 for the same policyholder.

(A) 0.380

(B) 0.387

(C) 0.393

(D) 0.403

(E) 0.443

198. DELETED

199. Personal auto property damage claims in a certain region are known to follow the Weibull distribution:

$$F(x) = 1 - \exp\left[-\left(\frac{x}{\theta}\right)^{0.2}\right], \quad x > 0$$

A sample of four claims is:

130 240 300 540

The values of two additional claims are known to exceed 1000.

Calculate the maximum likelihood estimate of θ.

(A) Less than 300

(B) At least 300, but less than 1200

(C) At least 1200, but less than 2100

(D) At least 2100, but less than 3000

(E) At least 3000

200. For five types of risks, you are given:

(i) The expected number of claims in a year for these risks ranges from 1.0 to 4.0.

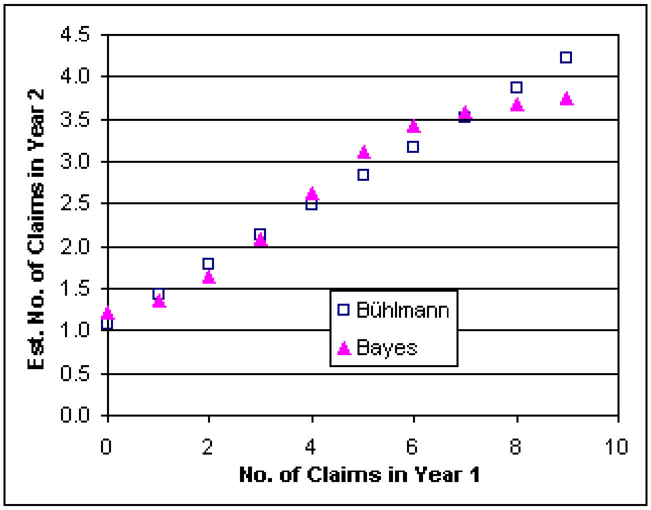
(ii) The number of claims follows a Poisson distribution for each risk.

During Year 1, n claims are observed for a randomly selected risk.

For the same risk, both Bayes and Bühlmann credibility estimates of the number of claims in Year 2 are calculated for $n = 0,1,2, \ldots ,9$.

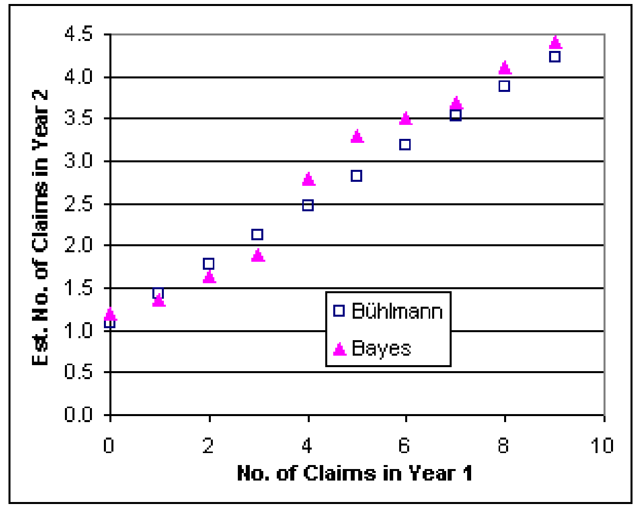
Which graph on the next page represents these estimates?

(A)



4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
2
4
6
8
10
Est. No. of Claims in Year 2
No. of Claims in Year 1
Bühlmann
Bayes

(B)



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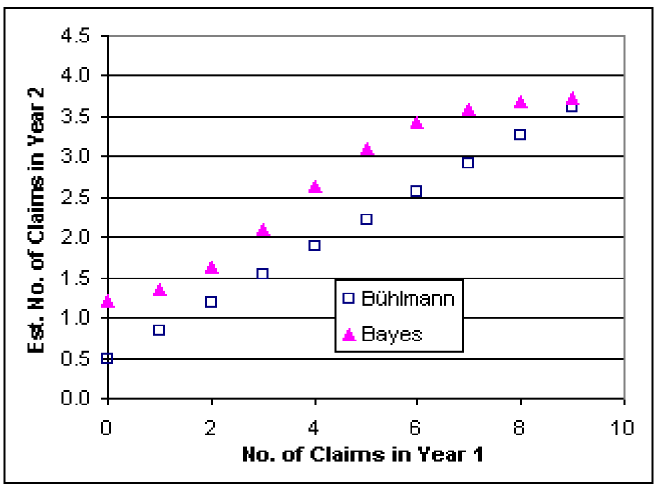
Est. No. of Claims in Year 2
No. of Claims in Year 1
Bühlmann
Bayes

(C)



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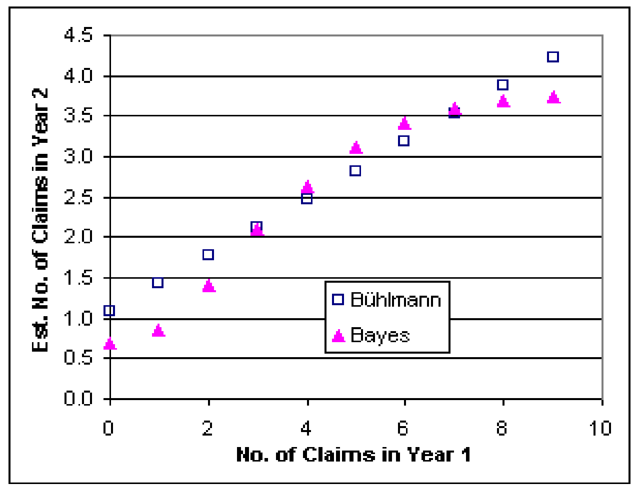
Est. No. of Claims in Year 2
No. of Claims in Year 1
Bühlmann
Bayes

(D)



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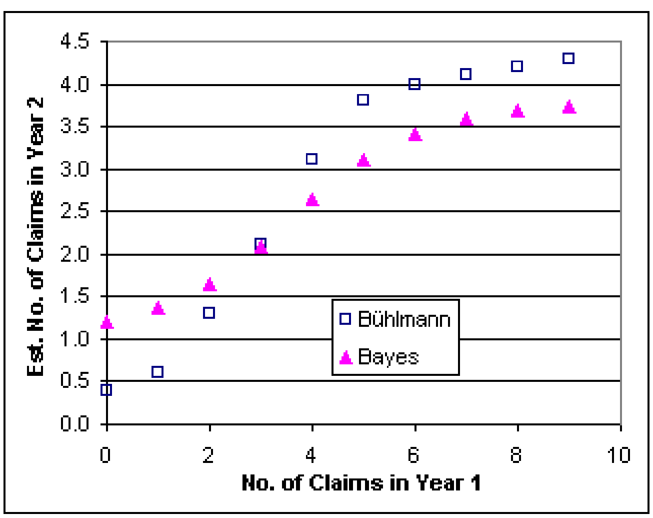
10
Est. No. of Claims in Year 2
No. of Claims in Year 1
Bühlmann
Bayes

(E)



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1.5
1.0
0.5
0.0
0
2
4
6
8
10
Est. No. of Claims in Year 2
No. of Claims in Year 1
Bühlmann
Bayes

201. You test the hypothesis that a given set of data comes from a known distribution with distribution function $F(x)$. The following data were collected:

Interval	$F(x_i)$	Number of Observations
$x < 2$	0.035	5
$2 \le x < 5$	0.130	42
$5 \le x < 7$	0.630	137
$7 \le x < 8$	0.830	66
$8 \le x$	1.000	50
Total		300

where x_i is the upper endpoint of each interval.

You test the hypothesis using the chi-square goodness-of-fit test.

Determine the result of the test.

(A) The hypothesis is not rejected at the 0.10 significance level.

(B) The hypothesis is rejected at the 0.10 significance level, but is not rejected at the 0.05 significance level.

(C) The hypothesis is rejected at the 0.05 significance level, but is not rejected at the 0.025 significance level.

(D) The hypothesis is rejected at the 0.025 significance level, but is not rejected at the 0.01 significance level.

(E) The hypothesis is rejected at the 0.01 significance level.

202. DELETED

203. You are given:

(i) The annual number of claims on a given policy has the geometric distribution with parameter β.

(ii) One-third of the policies have $\beta = 2$, and the remaining two-thirds have $\beta = 5$.

A randomly selected policy had two claims in Year 1.

Calculate the Bayesian expected number of claims for the selected policy in Year 2.

(A) 3.4

(B) 3.6

(C) 3.8

(D) 4.0

(E) 4.2

204. The length of time, in years, that a person will remember an actuarial statistic is modeled by an exponential distribution with mean $1/Y$. In a certain population, Y has a gamma distribution with $\alpha = \theta = 2$.

Calculate the probability that a person drawn at random from this population will remember an actuarial statistic less than 1/2 year.

(A) 0.125

(B) 0.250

(C) 0.500

(D) 0.750

(E) 0.875

205. In a CCRC, residents start each month in one of the following three states: Independent Living (State #1), Temporarily in a Health Center (State #2) or Permanently in a Health Center (State #3). Transitions between states occur at the end of the month.

If a resident receives physical therapy, the number of sessions that the resident receives in a month has a geometric distribution with a mean that depends on the state in which the resident begins the month. The numbers of sessions received are independent. The number in each state at the beginning of a given month, the probability of needing physical therapy in the month, and the mean number of sessions received for residents receiving therapy are displayed in the following table:

State #	Number in state	Probability of needing therapy	Mean number of visits
1	400	0.2	2
2	300	0.5	15
3	200	0.3	9

Using the normal approximation for the aggregate distribution, calculate the probability that more than 3000 physical therapy sessions will be required for the given month.

(A) 0.21

(B) 0.27

(C) 0.34

(D) 0.42

(E) 0.50

206. In a given week, the number of projects that require you to work overtime has a geometric distribution with $\beta = 2$. For each project, the distribution of the number of overtime hours in the week is the following:

x	$f(x)$
5	0.2
10	0.3
20	0.5

The number of projects and number of overtime hours are independent. You will get paid for overtime hours in excess of 15 hours in the week.

Calculate the expected number of overtime hours for which you will get paid in the week.

(A) 18.5

(B) 18.8

(C) 22.1

(D) 26.2

(E) 28.0

207. For an insurance:

(i) Losses have density function

$$f(x) = \begin{cases} 0.02x, & 0 < x < 10 \\ 0, & \text{elsewhere} \end{cases}$$

(ii) The insurance has an ordinary deductible of 4 per loss.

(iii) Y^P is the claim payment per payment random variable.

Calculate $E[Y^P]$.

(A) 2.9

(B) 3.0

(C) 3.2

(D) 3.3

(E) 3.4

208. DELETED

209. In 2005 a risk has a two-parameter Pareto distribution with $\alpha = 2$ and $\theta = 3000$. In 2006 losses inflate by 20%.

An insurance on the risk has a deductible of 600 in each year. P_i, the premium in year *i*, equals 1.2 times the expected claims.

The risk is reinsured with a deductible that stays the same in each year. R_i, the reinsurance premium in year *i*, equals 1.1 times the expected reinsured claims.

$$\frac{R_{2005}}{P_{2005}} = 0.55$$

Calculate $\dfrac{R_{2006}}{P_{2006}}$.

(A) 0.46

(B) 0.52

(C) 0.55

(D) 0.58

(E) 0.66

210. Each life within a group medical expense policy has loss amounts which follow a compound Poisson process with $\lambda = 0.16$. Given a loss, the probability that it is for Disease 1 is 1/16.

Loss amount distributions have the following parameters:

	Mean per loss	Standard Deviation per loss
Disease 1	5	50
Other diseases	10	20

Premiums for a group of 100 independent lives are set at a level such that the probability (using the normal approximation to the distribution for aggregate losses) that aggregate losses for the group will exceed aggregate premiums for the group is 0.24.

A vaccine that will eliminate Disease 1 and costs 0.15 per person has been discovered.

Define:
A = the aggregate premium assuming that no one obtains the vaccine, and
B = the aggregate premium assuming that everyone obtains the vaccine and the cost of the vaccine is a covered loss.

Calculate A/B.

(A) 0.94

(B) 0.97

(C) 1.00

(D) 1.03

(E) 1.06

211. An actuary for a medical device manufacturer initially models the failure time for a particular device with an exponential distribution with mean 4 years.

This distribution is replaced with a spliced model whose density function:

(i) is uniform over [0, 3]

(ii) is proportional to the initial modeled density function after 3 years

(iii) is continuous

Calculate the probability of failure in the first 3 years under the revised distribution.

(A) 0.43

(B) 0.45

(C) 0.47

(D) 0.49

(E) 0.51

212. For an insurance:

(i) The number of losses per year has a Poisson distribution with $\lambda = 10$.

(ii) Loss amounts are uniformly distributed on (0, 10).

(iii) Loss amounts and the number of losses are mutually independent.

(iv) There is an ordinary deductible of 4 per loss.

Calculate the variance of aggregate payments in a year.

(A) 36

(B) 48

(C) 72

(D) 96

(E) 120

213. For an insurance portfolio:

(i) The number of claims has the probability distribution

n	p_n
0	0.1
1	0.4
2	0.3
3	0.2

(ii) Each claim amount has a Poisson distribution with mean 3; and

(iii) The number of claims and claim amounts are mutually independent.

Calculate the variance of aggregate claims.

(A) 4.8

(B) 6.4

(C) 8.0

(D) 10.2

(E) 12.4

214. DELETED

215. You are given:

(i) The conditional distribution of the number of claims per policyholder is Poisson with mean λ.

(ii) The variable λ has a gamma distribution with parameters α and θ.

(iii) For policyholders with 1 claim in Year 1, the credibility estimate for the number of claims in Year 2 is 0.15.

(iv) For policyholders with an average of 2 claims per year in Year 1 and Year 2, the credibility estimate for the number of claims in Year 3 is 0.20.

Calculate θ.

(A) Less than 0.02

(B) At least 0.02, but less than 0.03

(C) At least 0.03, but less than 0.04

(D) At least 0.04, but less than 0.05

(E) At least 0.05

216. DELETED

217. DELETED

218. The random variable X has survival function:

$$S_X(x) = \frac{\theta^4}{(\theta^2 + x^2)^2}$$

Two values of X are observed to be 2 and 4. One other value exceeds 4.

Calculate the maximum likelihood estimate of θ.

(A) Less than 4.0

(B) At least 4.0, but less than 4.5

(C) At least 4.5, but less than 5.0

(D) At least 5.0, but less than 5.5

(E) At least 5.5

219. For a portfolio of policies, you are given:

(i) The annual claim amount on a policy has probability density function:

$$f(x \mid \theta) = \frac{2x}{\theta^2}, \quad 0 < x < \theta$$

(ii) The prior distribution of θ has density function:

$$\pi(\theta) = 4\theta^3, \quad 0 < \theta < 1$$

(iii) A randomly selected policy had claim amount 0.1 in Year 1.

Calculate the Bühlmann credibility estimate of the claim amount for the selected policy in Year 2.

(A) 0.43

(B) 0.45

(C) 0.50

(D) 0.53

(E) 0.56

220. DELETED

221. DELETED

222. 1000 workers insured under a workers compensation policy were observed for one year. The number of work days missed is given below:

Number of Days of Work Missed	Number of Workers
0	818
1	153
2	25
3 or more	4
Total	1000
Total Number of Days Missed	230

The chi-square goodness-of-fit test is used to test the hypothesis that the number of work days missed follows a Poisson distribution where:

(i) The Poisson parameter is estimated by the average number of work days missed.

(ii) Any interval in which the expected number is less than one is combined with the previous interval.

Determine the results of the test.

(A) The hypothesis is not rejected at the 0.10 significance level.

(B) The hypothesis is rejected at the 0.10 significance level, but is not rejected at the 0.05 significance level.

(C) The hypothesis is rejected at the 0.05 significance level, but is not rejected at the 0.025 significance level.

(D) The hypothesis is rejected at the 0.025 significance level, but is not rejected at the 0.01 significance level.

(E) The hypothesis is rejected at the 0.01 significance level.

223. You are given the following data:

	Year 1	Year 2
Total Losses	12,000	14,000
Number of Policyholders	25	30

The estimate of the variance of the hypothetical means is 254.

Calculate the credibility factor for Year 3 using the nonparametric empirical Bayes method.

(A) Less than 0.73

(B) At least 0.73, but less than 0.78

(C) At least 0.78, but less than 0.83

(D) At least 0.83, but less than 0.88

(E) At least 0.88

224. DELETED

225. You are given:

(i) Fifty claims have been observed from a lognormal distribution with unknown parameters μ and σ.

(ii) The maximum likelihood estimates are $\hat{\mu} = 6.84$ and $\hat{\sigma} = 1.49$.

(iii) The covariance matrix of $\hat{\mu}$ and $\hat{\sigma}$ is:

$$\begin{bmatrix} 0.0444 & 0 \\ 0 & 0.0222 \end{bmatrix}$$

(iv) The partial derivatives of the lognormal cumulative distribution function are:

$$\frac{\partial F}{\partial \mu} = \frac{-\phi(z)}{\sigma} \quad \text{and} \quad \frac{\partial F}{\partial \sigma} = \frac{-z\phi(z)}{\sigma}$$

(v) An approximate 95% confidence interval for the probability that the next claim will be less than or equal to 5000 is [L, U]

Calculate L.

(A) 0.73

(B) 0.76

(C) 0.79

(D) 0.82

(E) 0.85

226. For a particular policy, the conditional probability of the annual number of claims given $\Theta = \theta$, and the probability distribution of Θ are as follows:

Number of Claims	0	1	2
Probability	2θ	θ	$1-3\theta$

θ	0.10	0.30
Probability	0.80	0.20

One claim was observed in Year 1.

Calculate the Bayesian estimate of the expected number of claims for Year 2.

(A) Less than 1.1

(B) At least 1.1, but less than 1.2

(C) At least 1.2, but less than 1.3

(D) At least 1.3, but less than 1.4

(E) At least 1.4

227. DELETED

228. DELETED

229. A random sample of size n is drawn from a distribution with probability density function:

$$f(x) = \frac{\theta}{(\theta + x)^2}, \quad 0 < x < \infty, \theta > 0$$

Calculate the asymptotic variance of the maximum likelihood estimator of θ.

(A) $\frac{3\theta^2}{n}$

(B) $\frac{1}{3n\theta^2}$

(C) $\frac{3}{n\theta^2}$

(D) $\frac{n}{3\theta^2}$

(E) $\frac{1}{3\theta^2}$

230. For a portfolio of independent risks, the number of claims for each risk in a year follows a Poisson distribution with means given in the following table:

Class	Mean Number of Claims per Risk	Number of Risks
1	1	900
2	10	90
3	20	10

You observe x claims in Year 1 for a randomly selected risk.

The Bühlmann credibility estimate of the number of claims for the same risk in Year 2 is 11.983.

Calculate x.

(A) 13

(B) 14

(C) 15

(D) 16

(E) 17

231. DELETED

232. DELETED

233. You are given:

(i) A region is comprised of three territories. Claims experience for Year 1 is as follows:

Territory	Number of Insureds	Number of Claims
A	10	4
B	20	5
C	30	3

(ii) The number of claims for each insured each year has a Poisson distribution.

(iii) Each insured in a territory has the same expected claim frequency.

(iv) The number of insureds is constant over time for each territory.

Calculate the Bühlmann-Straub empirical Bayes estimate of the credibility factor Z for Territory A.

(A) Less than 0.4

(B) At least 0.4, but less than 0.5

(C) At least 0.5, but less than 0.6

(D) At least 0.6, but less than 0.7

(E) At least 0.7

234. DELETED

235. You are given:

(i) A random sample of losses from a Weibull distribution is:

595 700 789 799 1109

(ii) At the maximum likelihood estimates of θ and τ, $\sum \ln[f(x_i)] = -33.05$.

(iii) When $\tau = 2$, the maximum likelihood estimate of θ is 816.7.

(iv) You use the likelihood ratio test to test the hypothesis

$$H_0 : \tau = 2 \text{ vs. } H_1 : \tau \neq 2$$

Determine the result of the test.

(A) Do not reject the null hypotheses at the 0.10 level of significance.

(B) Reject the null hypothesis at the 0.10 level of significance, but not at the 0.05 level of significance.

(C) Reject the null hypothesis at the 0.05 level of significance, but not at the 0.025 level of significance.

(D) Reject the null hypotheses at the 0.025 level of significance, but not at the 0.01 level of significance.

(E) Reject the null hypothesis at the 0.01 level of significance.

236. For each policyholder, losses $X_1, \ldots, X_n$, conditional on Θ , are independently and identically distributed with mean,

$$\mu(\theta) = E[X_j \mid \Theta = \theta], \quad j = 1, 2, \ldots, n$$

and variance,

$$v(\theta) = \mathrm{Var}[X_j \mid \Theta = \theta], \quad j = 1, 2, \ldots, n .$$

You are given:

(i) The Bühlmann credibility assigned for estimating X_5 based on $X_1, \ldots, X_4$ is $Z = 0.4$.

(ii) The expected value of the process variance is known to be 8.

Calculate $\mathrm{Cov}(X_i, X_j), \quad i \neq j$.

(A) Less than -0.5

(B) At least -0.5, but less than 0.5

(C) At least 0.5, but less than 1.5

(D) At least 1.5, but less than 2.5

(E) At least 2.5

237. DELETED

238. DELETED

239. DELETED

240. For a group of auto policyholders, you are given:

(i) The number of claims for each policyholder has a conditional Poisson distribution.

(ii) During Year 1, the following data are observed for 8000 policyholders:

Number of Claims	Number of Policyholders
0	5000
1	2100
2	750
3	100
4	50
5+	0

A randomly selected policyholder had one claim in Year 1.

Calculate the semiparametric empirical Bayes estimate of the number of claims in Year 2 for the same policyholder.

(A) Less than 0.15

(B) At least 0.15, but less than 0.30

(C) At least 0.30, but less than 0.45

(D) At least 0.45, but less than 0.60

(E) At least 0.60

241. You are given:

(i) The following are observed claim amounts:

400 1000 1600 3000 5000 5400 6200

(ii) An exponential distribution with $\theta = 3300$ is hypothesized for the data.

(iii) The goodness of fit is to be assessed by a *p*-*p* plot and a $D(x)$ plot.

Let (s, t) be the coordinates of the *p*-*p* plot for a claim amount of 3000.

Calculate $(s - t) - D(3000)$.

(A) −0.12

(B) −0.07

(C) 0.00

(D) 0.07

(E) 0.12

242. You are given:

(i) In a portfolio of risks, each policyholder can have at most two claims per year.

(ii) For each year, the distribution of the number of claims is:

Number of Claims	Probability
0	0.10
1	$0.90-q$
2	q

(iii) The prior density is:

$$\pi(q)=\frac{q^2}{0.039}, \quad 0.2<q<0.5$$

A randomly selected policyholder had two claims in Year 1 and two claims in Year 2. For this insured, calculate the Bayesian estimate of the expected number of claims in Year 3.

(A) Less than 1.30

(B) At least 1.30, but less than 1.40

(C) At least 1.40, but less than 1.50

(D) At least 1.50, but less than 1.60

(E) At least 1.60

243. DELETED

244. Which of statements (A), (B), (C), and (D) is false?

(A) The chi-square goodness-of-fit test works best when the expected number of observations varies widely from interval to interval.

(B) For the Kolmogorov-Smirnov test, when the parameters of the distribution in the null hypothesis are estimated from the data, the probability of rejecting the null hypothesis decreases.

(C) For the Kolmogorov-Smirnov test, the critical value for right censored data should be smaller than the critical value for uncensored data.

(D) (Removed as this statement referred to the Anderson-Darling test).

(F) None of (A), (B), or (C) is false.

245. You are given:

(i) The number of claims follows a Poisson distribution.

(ii) Claim sizes follow a gamma distribution with parameters α (unknown) and $\theta = 10,000$.

(iii) The number of claims and claim sizes are independent.

(iv) The full credibility standard has been selected so that actual aggregate losses will be within 10% of expected aggregate losses 95% of the time.

Using limited fluctuation (classical) credibility, calculate the expected number of claims required for full credibility.

(A) Less than 400

(B) At least 400, but less than 450

(C) At least 450, but less than 500

(D) At least 500

(E) The value cannot be determined from the information given.

246. DELETED

247. An insurance company sells three types of policies with the following characteristics:

Type of Policy	Proportion of Total Policies	Annual Claim Frequency
I	5%	Poisson with mean 0.25
II	20%	Poisson with mean 0.50
III	75%	Poisson with mean 1.00

A randomly selected policyholder is observed to have a total of one claim for Year 1 through
Year 4.

For the same policyholder, calculate the Bayesian estimate of the expected number of claims in Year 5.

(A) Less than 0.4

(B) At least 0.4, but less than 0.5

(C) At least 0.5, but less than 0.6

(D) At least 0.6, but less than 0.7

(E) At least 0.7

248. DELETED

249. DELETED

250. You have observed the following three loss amounts:

186 91 66

Seven other amounts are known to be less than or equal to 60. Losses follow an inverse exponential with distribution function

$$F(x) = e^{-\theta/x}, \quad x > 0$$

Calculate the maximum likelihood estimate of the population mode.

(A) Less than 11

(B) At least 11, but less than 16

(C) At least 16, but less than 21

(D) At least 21, but less than 26

(E) At least 26

251. For a group of policies, you are given:

(i) The annual loss on an individual policy follows a gamma distribution with parameters $\alpha = 4$ and θ.

(ii) The prior distribution of θ has mean 600.

(iii) A randomly selected policy had losses of 1400 in Year 1 and 1900 in Year 2.

(iv) Loss data for Year 3 was misfiled and unavailable.

(v) Based on the data in (iii), the Bühlmann credibility estimate of the loss on the selected policy in Year 4 is 1800.

(vi) After the estimate in (v) was calculated, the data for Year 3 was located. The loss on the selected policy in Year 3 was 2763.

Calculate the Bühlmann credibility estimate of the loss on the selected policy in Year 4 based on the data for Years 1, 2 and 3.

(A) Less than 1850

(B) At least 1850, but less than 1950

(C) At least 1950, but less than 2050

(D) At least 2050, but less than 2150

(E) At least 2150

252. DELETED

253. You are given:

(i) For $Q = q$, $X_1, X_2, \ldots, X_m$ are independent, identically distributed Bernoulli random variables with parameter q.

(ii) $S_m = X_1 + X_2 + \cdots + X_m$

(iii) The prior distribution of Q is beta with $a = 1$, $b = 99$, and $\theta = 1$.

Calculate the smallest value of m such that the mean of the marginal distribution of S_m is greater than or equal to 50.

(A) 1082

(B) 2164

(C) 3246

(D) 4950

(F) 5000

254. You are given:

(i) A portfolio consists of 100 identically and independently distributed risks.

(ii) The number of claims for each risk follows a Poisson distribution with mean λ.

(iii) The prior distribution of λ is:

$$\pi(\lambda) = \frac{(50\lambda)^4 e^{-50\lambda}}{6\lambda}, \quad \lambda > 0$$

During Year 1, the following loss experience is observed:

Number of Claims	Number of Risks
0	90
1	7
2	2
3	1
Total	100

Calculate the Bayesian expected number of claims for the portfolio in Year 2.

(A) 8

(B) 10

(C) 11

(D) 12

(E) 14

255. DELETED

256. You are given:

(i) The distribution of the number of claims per policy during a one-year period for 10,000 insurance policies is:

Number of Claims per Policy	Number of Policies
0	5000
1	5000
2 or more	0

(ii) You fit a binomial model with parameters m and q using the method of maximum likelihood.

Calculate the maximum value of the loglikelihood function when $m = 2$.

(A) −10,397

(B) −7,781

(C) −7,750

(D) −6,931

(E) −6,730

257. You are given:

(i) Over a three-year period, the following claim experience was observed for two insureds who own delivery vans:

		Year		
Insured		**1**	**2**	**3**
A	Number of Vehicles	2	2	1
	Number of Claims	1	1	0
B	Number of Vehicles	N/A	3	2
	Number of Claims	N/A	2	3

(ii) The number of claims for each insured each year follows a Poisson distribution.

Calculate the semiparametric empirical Bayes estimate of the claim frequency per vehicle for Insured A in Year 4.

(A) Less than 0.55

(B) At least 0.55, but less than 0.60

(C) At least 0.60, but less than 0.65

(D) At least 0.65, but less than 0.70

(E) At least 0.70

258. DELETED

259. You are given:

(i) A hospital liability policy has experienced the following numbers of claims over a 10-year period:

10 2 4 0 6 2 4 5 4 2

(ii) Numbers of claims are independent from year to year.

(iii) You use the method of maximum likelihood to fit a Poisson model.

Calculate the estimated coefficient of variation of the estimator of the Poisson parameter.

(A) 0.10

(B) 0.16

(C) 0.22

(D) 0.26

(E) 1.00

260. You are given:

(i) Claim sizes follow an exponential distribution with mean θ.

(ii) For 80% of the policies, $\theta = 8$.

(iii) For 20% of the policies, $\theta = 2$.

A randomly selected policy had one claim in Year 1 of size 5.

Calculate the Bayesian expected claim size for this policy in Year 2.

(A) Less than 5.8

(B) At least 5.8, but less than 6.2

(C) At least 6.2, but less than 6.6

(D) At least 6.6, but less than 7.0

(E) At least 7.0

261. DELETED

262. You are given:

(i) At time 4 hours, there are 5 working light bulbs.

(ii) The 5 bulbs are observed for p more hours.

(iii) Three light bulbs burn out at times 5, 9, and 13 hours, while the remaining light bulbs are still working at time $4 + p$ hours.

(iv) The distribution of failure times is uniform on $(0, \omega)$.

(v) The maximum likelihood estimate of ω is 29.

Calculate p.

(A) Less than 10

(B) At least 10, but less than 12

(C) At least 12, but less than 14

(D) At least 14, but less than 16

(E) At least 16

263. You are given:

(i) The number of claims incurred in a month by any insured follows a Poisson distribution with mean λ.

(ii) The claim frequencies of different insureds are independent.

(iii) The prior distribution of λ is Weibull with $\theta = 0.1$ and $\tau = 2$.

(iv) Some values of the gamma function are

$\Gamma(0.5) = 1.77245, \Gamma(1) = 1, \Gamma(1.5) = 0.88623, \Gamma(2) = 1$

(v)

Month	Number of Insureds	Number of Claims
1	100	10
2	150	11
3	250	14

Calculate the Bühlmann-Straub credibility estimate of the number of claims in the next 12 months for 300 insureds.

(A) Less than 255

(B) At least 255, but less than 275

(C) At least 275, but less than 295

(D) At least 295, but less than 315

(E) At least 315

264. DELETED

265. DELETED

266. DELETED

267. You are given:

(i) The annual number of claims for an individual risk follows a Poisson distribution with mean λ.

(ii) For 75% of the risks, $\lambda = 1$.

(iii) For 25% of the risks, $\lambda = 3$.

A randomly selected risk had r claims in Year 1. The Bayesian estimate of this risk's expected number of claims in Year 2 is 2.98.

Calculate the Bühlmann credibility estimate of the expected number of claims for this risk in Year 2.

(A) Less than 1.9

(B) At least 1.9, but less than 2.3

(C) At least 2.3, but less than 2.7

(D) At least 2.7, but less than 3.1

(E) At least 3.1

268. DELETED

269. DELETED

270. Three individual policyholders have the following claim amounts over four years:

Policyholder	Year 1	Year 2	Year 3	Year 4
X	2	3	3	4
Y	5	5	4	6
Z	5	5	3	3

Using the nonparametric empirical Bayes procedure, calculate the estimated variance of the hypothetical means.

(A) Less than 0.40

(B) At least 0.40, but less than 0.60

(C) At least 0.60, but less than 0.80

(D) At least 0.80, but less than 1.00

(E) At least 1.00

271. DELETED

272. You are given:

(i) The number of claims made by an individual in any given year has a binomial distribution with parameters $m = 4$ and q.

(ii) The prior distribution of q has probability density function

$$\pi(q) = 6q(1-q), \quad 0 < q < 1.$$

(iii) Two claims are made in a given year.

Calculate the mode of the posterior distribution of q.

(A) 0.17

(B) 0.33

(C) 0.50

(D) 0.67

(E) 0.83

273. A company has determined that the limited fluctuation full credibility standard is 2000 claims if:

(i) The total number of claims is to be within 3% of the true value with probability p.

(ii) The number of claims follows a Poisson distribution.

The standard is changed so that the total cost of claims is to be within 5% of the true value with probability p, where claim severity has probability density function:

$$f(x) = \frac{1}{10,000}, \quad 0 \le x \le 10,000$$

Using limited fluctuation credibility, calculate the expected number of claims necessary to obtain full credibility under the new standard.

(A) 720

(B) 960

(C) 2160

(D) 2667

(E) 2880

274. DELETED

275. DELETED

276. For a group of policies, you are given:

(i) Losses follow the distribution function

$$F(x) = 1 - \theta / x, \quad x > \theta .$$

(ii) A sample of 20 losses resulted in the following:

Interval	Number of Losses
(0,10]	9
(10, 25]	6
$(25, \infty)$	5

Calculate the maximum likelihood estimate of θ.

(A) 5.00

(B) 5.50

(C) 5.75

(D) 6.00

(E) 6.25

277. You are given:

(i) Loss payments for a group health policy follow an exponential distribution with unknown mean.

(ii) A sample of losses is:

100 200 400 800 1400 3100

Using the delta method, calculate the approximation of the variance of the maximum likelihood estimator of $S(1500)$.

(A) 0.019

(B) 0.025

(C) 0.032

(D) 0.039

(E) 0.045

278. DELETED

279. Loss amounts have the distribution function

$$F(x)=\begin{cases}(x/100)^2, & 0\le x\le 100\\ 1, & x>100\end{cases}$$

An insurance pays 80% of the amount of the loss in excess of an ordinary deductible of 20, subject to a maximum payment of 60 per loss.

Calculate the conditional expected claim payment, given that a payment has been made.

(A) 37

(B) 39

(C) 43

(D) 47

(E) 49

280. A compound Poisson claim distribution has $\lambda = 5$ and individual claim amounts distributed as follows:

x	$f_X(x)$	
5	0.6	
k	0.4	Where $k > 5$

The expected cost of an aggregate stop-loss insurance subject to a deductible of 5 is 28.03.

Calculate k.

(A) 6

(B) 7

(C) 8

(D) 9

(E) 10

281. DELETED

282. Aggregate losses are modeled as follows:

(i) The number of losses has a Poisson distribution with $\lambda = 3$.

(ii) The amount of each loss has a Burr distribution with $\alpha = 3, \theta = 2, \gamma = 1$.

(iii) The number of losses and the amounts of the losses are mutually independent.

Calculate the variance of aggregate losses.

(A) 12

(B) 14

(C) 16

(D) 18

(E) 20

283. The annual number of doctor visits for each individual in a family of 4 has a geometric distribution with mean 1.5. The annual numbers of visits for the family members are mutually independent. An insurance pays 100 per doctor visit beginning with the 4th visit per family.

Calculate the expected payments per year for this family.

(A) 320

(B) 323

(C) 326

(D) 329

(E) 332

284. A risk has a loss amount that has a Poisson distribution with mean 3.

An insurance covers the risk with an ordinary deductible of 2. An alternative insurance replaces the deductible with coinsurance α , which is the proportion of the loss paid by the insurance, so that the expected insurance cost remains the same.

Calculate α .

(A) 0.22

(B) 0.27

(C) 0.32

(D) 0.37

(E) 0.42

285. You are the producer for the television show Actuarial Idol. Each year, 1000 actuarial clubs audition for the show. The probability of a club being accepted is 0.20.

The number of members of an accepted club has a distribution with mean 20 and variance 20. Club acceptances and the numbers of club members are mutually independent.

Your annual budget for persons appearing on the show equals 10 times the expected number of persons plus 10 times the standard deviation of the number of persons.

Calculate your annual budget for persons appearing on the show.

(A) 42,600

(B) 44,200

(C) 45,800

(D) 47,400

(E) 49,000

286. Michael is a professional stuntman who performs dangerous motorcycle jumps at extreme sports events around the world.

The annual cost of repairs to his motorcycle is modeled by a two parameter Pareto distribution with $\theta = 5000$ and $\alpha = 2$.

An insurance reimburses Michael's motorcycle repair costs subject to the following provisions:

(i) Michael pays an annual ordinary deductible of 1000 each year.

(ii) Michael pays 20% of repair costs between 1000 and 6000 each year.

(iii) Michael pays 100% of the annual repair costs above 6000 until Michael has paid 10,000 in out-of-pocket repair costs each year.

(iv) Michael pays 10% of the remaining repair costs each year.

Calculate the expected annual insurance reimbursement.

(A) 2300

(B) 2500

(C) 2700

(D) 2900

(E) 3100

287. For an aggregate loss distribution S:

(i) The number of claims has a negative binomial distribution with $r = 16$ and $\beta = 6$.

(ii) The claim amounts are uniformly distributed on the interval (0, 8).

(iii) The number of claims and claim amounts are mutually independent.

Using the normal approximation for aggregate losses, calculate the premium such that the probability that aggregate losses will exceed the premium is 5%.

(A) 500

(B) 520

(C) 540

(D) 560

(E) 580

288. The random variable N has a mixed distribution:

(i) With probability p, N has a binomial distribution with $q = 0.5$ and $m = 2$.

(ii) With probability $1 - p$, N has a binomial distribution with $q = 0.5$ and $m = 4$.

Which of the following is a correct expression for $\Pr(N = 2)$?

(A) $0.125p^2$

(B) $0.375 + 0.125p$

(C) $0.375 + 0.125p^2$

(D) $0.375 - 0.125p^2$

(E) $0.375 - 0.125p$

289. A compound Poisson distribution has $\lambda = 5$ and claim amount distribution as follows:

x	$p(x)$
100	0.80
500	0.16
1000	0.04

Calculate the probability that aggregate claims will be exactly 600.

(A) 0.022

(B) 0.038

(C) 0.049

(D) 0.060

(E) 0.070

290. DELETED

291. DELETED

292 DELETED

293 DELETED

294 DELETED

295 DELETED

296. DELETED

297. DELETED

298. DELETED

299. DELETED

300. DELETED

301. DELETED

302. DELETED

303. DELETED

304. DELETED

305. DELETED

Use the following information for Questions 306 and 307.

Five models are fitted to a sample of $n = 260$ observations with the following results:

Model	Number of Parameters	Loglikelihood
I	1	–414
II	2	–412
III	3	–411
IV	4	–409
V	6	–409

306. (This question was formerly Question 266.) Determine the model favored by the Schwarz Bayesian criterion.

(A) I

(B) II

(C) III

(D) IV

(E) V

307. (This question is effective with the October 2016 syllabus.) Determine the model favored by the Akaike Information criterion.

(A) I

(B) II

(C) III

(D) IV

(E) V

308. An insurance company sells a policy with a linearly disappearing deductible such that no payment is made on a claim of 250 or less and full payment is made on a claim of 1000 or more.

Calculate the payment made by the insurance company for a loss of 700.

(A) 450

(B) 500

(C) 550

(D) 600

(E) 700

309. The random variable X represents the random loss, before any deductible is applied, covered by an insurance policy. The probability density function of X is

$$f(x) = 2x, \quad 0 < x < 1.$$

Payments are made subject to a deductible, d, where $0 < d < 1$.

The probability that a claim payment is less than 0.5 is equal to 0.64.

Calculate the value of d.

(A) 0.1

(B) 0.2

(C) 0.3

(D) 0.4

(E) 0.5

310. You are given the following loss data:

Size of Loss	Number of Claims	Ground-Up Total Losses
0 – 99	1100	58,500
100 – 249	400	70,000
250 – 499	300	120,000
500 – 999	200	150,000
> 999	100	200,000
Total	**2100**	**598,500**

Calculate the percentage reduction in loss costs by moving from a 100 deductible to a 250 deductible.

(A) 25%

(B) 27%

(C) 29%

(D) 31%

(E) 33%

311. Mr. Fixit purchases a homeowners policy with an 80% coinsurance clause. The home is insured for 150,000. The home was worth 180,000 on the day the policy was purchased. Lightning causes 20,000 worth of damage. On the day of the storm the home is worth 250,000.

Calculate the benefit payment Mr. Fixit receives from his policy.

(A) 15,000

(B) 16,000

(C) 17,500

(D) 18,000

(E) 20,000

312. A company purchases a commercial insurance policy with a property policy limit of 70,000. The actual value of the property at the time of a loss is 100,000. The insurance policy has a coinsurance provision of 80% and a 200 deductible, which is applied to the loss before the limit or coinsurance are applied. A storm causes damage in the amount of 20,000.

Calculate the insurance company's payment.

(A) 15,840

(B) 16,000

(C) 17,300

(D) 17,325

(E) 19,800

313. Mini Driver has an automobile insurance policy with the All-Province Insurance Company. She has 200,000 of third party liability coverage (bodily injury/property damage) and has a 1,000 deductible on her collision coverage.

Mini is at fault for an accident that injures B. Jones, who is insured by Red Deer Insurance Company. M. Driver is successfully sued by B. Jones for Jones' injuries. The court orders Driver to pay Jones 175,000.

Other expenses incurred are:

i) Legal fees to All-Province on behalf of Driver: 45,000
ii) Collision costs to repair Driver's car: 20,000

Calculate the total amount All-Province pays out for this occurrence.

(A) 175,000

(B) 195,000

(C) 200,000

(D) 219,000

(E) 239,000

314. You are given the following earned premiums for three calendar years:

Calendar Year	Earned Premium
CY5	7,706
CY6	9,200
CY7	10,250

All policies have a one-year term and policy issues are uniformly distributed through each year.

The following rate changes have occurred:

Date	Rate Change
July 1, CY3	+ 7%
Nov. 15, CY5	– 4%
October 1, CY6	+ 5%

Rates are currently at the level set on October 1, CY6.

Calculate the earned premium at the current rate level for CY6.

(A) 9300

(B) 9400

(C) 9500

(D) 9600

(E) 9700

315. You are given:

i) Data for three territories as follows:

Territory	Earned Premium At Current Rates	Incurred Loss & ALAE	Claim Count	Current Relativity
1	520,000	420,000	600	0.60
2	1,680,000	1,250,000	1320	1.00
3	450,000	360,000	390	0.52
Total	**2,650,000**	**2,030,000**	**2310**	

ii) The full credibility standard is 1082 claims and partial credibility is calculated using the square root rule.

iii) The complement of credibility is applied to no change to the existing relativity.

Calculate, using the loss ratio method, the indicated territorial relativity for Territory 3.

(A) 0.52

(B) 0.53

(C) 0.54

(D) 0.55

(E) 0.56

316. You use the following information to determine a rate change using the loss ratio method.

(i)

Accident Year	Earned Premium at Current Rates	Incurred Losses	Weight Given to Accident Year
AY8	4252	2260	40%
AY9	5765	2610	60%

(ii) Trend Factor: 7% per annum effective

(iii) Loss Development Factor (to Ultimate): AY8: 1.08
AY9: 1.18

(iv) Permissible Loss Ratio: 0.657

(v) All policies are one-year policies, are issued uniformly through the year, and rates will be in effect for one year.

(vi) Proposed Effective Date: July 1, CY10

Calculate the required portfolio-wide rate change.

(A) –26%

(B) –16%

(C) –8%

(D) –1%

(E) 7%

317. You are given:

i) Policies are written uniformly throughout the year.

ii) Policies have a term of 6 months.

iii) The following rate changes have occurred:

Date	**Amount**
October 1, CY1	+7%
July 1, CY2	+10%
September 1, CY3	–6%

Calculate the factor needed to adjust CY2 earned premiums to December 31, CY3 level.

(A) 0.97

(B) 0.98

(C) 0.99

(D) 1.00

(E) 1.01

318. You are given the following information:

			Cumulative Loss Payments through Development Month			
Accident Year	**Earned Premium**	**Expected Loss Ratio**	**12**	**24**	**36**	**48**
AY5	19,000	0.90	4,850	9,700	14,100	16,200
AY6	20,000	0.85	5,150	10,300	14,900	
AY7	21,000	0.91	5,400	10,800		
AY8	22,000	0.88	7,200			

There is no development past 48 months.

Calculate the indicated loss reserve using the Bornhuetter-Ferguson method and volume-weighted average loss development factors.

(A) 22,600

(B) 23,400

(C) 24,200

(D) 25,300

(E) 26,200

319. You are given the following information:

i)

Accident Year	Cumulative Paid Losses through Development Month			
	12	**24**	**36**	**48**
AY5	27,000	49,000	65,000	72,000
AY6	28,000	57,000	71,000	
AY7	33,000	65,000		
AY8	35,000			

ii)

Interval	**Selected Age-to-Age Paid Loss Development Factors**
12 – 24 months	2.00
24 – 36 months	1.20
36 – 48 months	1.15
48 – ultimate	1.00

iii) The interest rate is 5.0% per annum effective.

Calculate the ratio of discounted reserves to undiscounted reserves as of December 31, CY8.

(A) 0.93

(B) 0.94

(C) 0.95

(D) 0.96

(E) 0.97

320. You are given:

i)

Accident Year	Cumulative Paid Losses through Development Year						Earned premium
	0	1	2	3	4	5	
AY4	1,400	5,200	7,300	8,800	9,800	9,800	18,000
AY5	2,200	6,400	8,800	10,200	11,500		20,000
AY6	2,500	7,500	10,700	12,600			25,000
AY7	2,800	8,700	12,900				26,000
AY8	2,500	7,900					27,000
AY9	2,600						28,000

ii) The expected loss ratio for each Accident Year is 0.550.

Calculate the total loss reserve using the Bornhuetter-Ferguson method and three-year arithmetic average paid loss development factors.

(A) 21,800

(B) 22,500

(C) 23,600

(D) 24,700

(E) 25,400

321. You are given:

i) An insurance company was formed to write workers compensation business in CY1.

ii) Earned premium in CY1 was 1,000,000.

iii) Earned premium growth through CY3 has been constant at 20% per year (compounded).

iv) The expected loss ratio for AY1 is 60%.

v) As of December 31, CY3, the company's reserving actuary believes the expected loss ratio has increased two percentage points each accident year since the company's inception.

vi) Selected incurred loss development factors are as follows:

12 to 24 months	1.500
24 to 36 months	1.336
36 to 48 months	1.126
48 to 60 months	1.057
60 to 72 months	1.050
72 to ultimate	1.000

Calculate the total IBNR reserve as of December 31, CY3 using the Bornhuetter-Ferguson method.

(A) 964,000

(B) 966,000

(C) 968,000

(D) 970,000

(E) 972,000

322. You are given the following loss distribution probabilities for a liability coverage, as well as the average loss within each interval:

Size of Loss Interval	Cumulative Probability	Average Loss
(0, 1,000]	0.358	300
(1,000, 25,000]	0.761	8,200
(25,000, 100,000]	0.879	47,500
(100,000, 250,000]	0.930	145,000
(250,000, 500,000]	0.956	325,000
(500,000, 1,000,000]	0.984	650,000
(1,000,000, 10,000,000]	1.000	3,700,000

Calculate the increased limits factor for a 1,000,000 limit when the basic limit is 100,000 and there is no loading for risk or expenses.

(A) 2.4

(B) 2.5

(C) 2.6

(D) 2.7

(E) 2.8

323. The following developed losses evaluated at various maximum loss sizes are given:

- The total losses limited at 50,000 from all policies with a policy limit of 50,000 or more is 22,000,000.
- The total losses limited at 50,000 from all policies with a policy limit of 250,000 or more is 14,000,000.
- The total losses limited at 250,000 from all policies with a policy limit of 250,000 or more is 25,000,000.

The base rate at the 50,000 basic limit is 300 per exposure unit, consisting of 240 pure premium, 30 fixed expense, and 30 variable expense.

Calculate the rate at the 250,000 limit.

(A) 370

(B) 400

(C) 450

(D) 480

(E) 510

324. A primary insurance company has a 100,000 retention limit. The company purchases a catastrophe reinsurance treaty, which provides the following coverage

Layer 1:	85% of 100,000 excess of 100,000
Layer 2:	90% of 100,000 excess of 200,000
Layer 3:	95% of 300,000 excess of 300,000

The primary insurance company experiences a catastrophe loss of 450,000.

Calculate the total loss retained by the primary insurance company.

(A) 100,000

(B) 112,500

(C) 125,000

(D) 132,500

(E) 150,000

325. A primary liability insurer has a book of business with the following characteristics:

- All policies have a policy limit of 500,000
- The expected loss ratio is 60% on premiums of 4,000,000

A reinsurer provides an excess of loss treaty for the layer 300,000 in excess of 100,000.

The following table of increased limits factors is available:

Limit	ILF
100,000	1.00
200,000	1.25
300,000	1.45
400,000	1.60
500,000	1.70

Calculate the reinsurer's expected losses for this coverage (answer to the nearest 000s).

(A) 840,000

(B) 847,000

(C) 850,000

(D) 862,000

(E) 871,000

326. XYZ's insurance premium is based on an experience rating plan that uses the total of the most recent three years experience compared to an expected pure premium of 475. The most recent three years experience is provided:

Year	Manual Premium	Earned Exposures	Developed Losses
CY1	350,000	600	192,000
CY2	340,000	650	340,000
CY3	365,000	625	220,000
Total	**1,055,000**	**1,875**	**752,000**

- Credibility is based on the formula: $Z = \dfrac{Exposures}{Exposures + 23,000}$.
- The CY4 manual premium for XYZ is determined to be 380,000.
- XYZ also has a schedule rating credit of 10% that is applied after the experience rating modification.

Calculate the CY4 experience rating premium for XYZ.

(A) 319,000

(B) 338,000

(C) 357,000

(D) 375,000

(E) 394,000

327. An insurance company writes policies with three deductible options: 0, 100, and 500.

Policyholders report all claims that are greater than or equal to the deductible, but do not always report claims that are less than the deductible.

For the claims that policyholders report to the insurance company, historical loss experience for the three different policy types is as follows:

	Deductible					
	0		100		500	
Size of Loss	# of Claims	Ground-up Losses	# of Claims	Ground-up Losses	# of Claims	Ground-up Losses
1 – 100	5	300	2	100	0	0
101 – 200	8	1,400	4	600	0	0
201 – 500	4	1,500	2	750	0	0
501 or greater	3	3,900	1	1,500	1	1,300
Total	20	7,100	9	2,950	1	1,300

The company wants to introduce a 200 deductible option.

Calculate the indicated relativity for the 200 deductible, using a base deductible of 100.

(A) 0.62

(B) 0.66

(C) 0.76

(D) 0.79

(E) 0.80

328. Company XYZ sells homeowners insurance policies. You are given:

i) The loss costs by accident year are:

Accident Year	Loss Cost
AY1	1300
AY2	1150
AY3	1550
AY4	1800

ii) The slope of the straight line fitted to the natural log of the loss costs is 0.1275.

iii) Experience periods are 12 months in length. In each accident year the average accident date is July 1.

iv) The current experience period is weighted 80% and the prior experience period is weighted 20% for rate development.

New rates take effect November 1, CY5 for one-year policies and will be in effect for one year.

Calculate the expected loss cost for these new rates.

(A) 2124

(B) 2217

(C) 2264

(D) 2381

(E) 2413