THE COVER PAGE OF YOUR EXAM WILL BE THE FOLLOWING. NOTE THE LENGTH (120 MIN) AND THE INSTRUCTIONS.

THESE PROBLEMS ARE EXAM-STYLE. HOWEVER, THE ACTUAL EXAM WILL LIKELY BE SOMEWHAT LONGER.

British Columbia Institute of Technology

MATH 3042 – Final Exam

Program:	Computer Systems Technology
Course Name:	Applied Probability and Statistics for CST
Course Number:	Math 3042
Date:	December 9, 2025
Time Allotted:	120 min
Exam Pages:	X (including this page)
Total Marks:	Y (40% weight for the course)

Instructions

1) Do not open the exam or write anything on these pages before you are told to begin.

2) You may use a scientific calculator with statistical functions. No other devices are allowed.

3) If your answer is a probability, round it to four digits after the decimal point. Otherwise, round to three significant digits.

4) A formula sheet is provided separately. No other notes or written materials are allowed.

5) No communication of any sort is allowed with other students or any other person besides your instructor or other exam invigilator.

6) All answers are to be written clearly in this examination booklet.

Q1. Correlation Test + Linear Regression

A chemical company performed an experiment to study the effect of extraction time on the efficiency of an extraction operation, and obtained the data in the table to the right.

Extraction Time (minutes)	Extraction Efficiency (%)
27	57
45	64
38	78
19	46
35	62
38	70
19	52
49	77
15	57
31	68

The researchers also ran the following R commands (with output as shown)

```
> time <- c(27, 45, 38, 19, 35, 38, 19, 49, 15, 31)
> efficiency <- c(57, 64, 78, 46, 62, 70, 52, 77, 57, 68)
> favstats(time)
 min Q1 median Q3 max mean  sd   n missing
  15 21     33 38  49 31.6 11.50 10       0
> favstats(efficiency)
 min Q1 median  Q3  max mean  sd   n missing
  46 57     63 69.5  78 63.1 10.43 10       0
> cor(time, efficiency)
[1] 0.8072386
```

a. Is there a statistically significant linear correlation between extraction time and extraction efficiency? Perform an appropriate hypothesis test.

b. Estimate the extraction efficiency when the extraction time is 25 min.

Q2. Confidence Intervals for μ

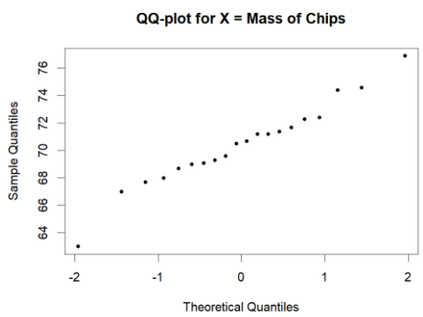
A potato chip product claims that a bag contains 66 g of chips. One interpretation of this is the claim that the *mean* mass of a bag of chips is at least 66 g.

To test this claim, you sample $n = 20$ bags of chips. The measurements are:

$X =$

72.4	76.9	70.7	63.0	68.7	71.4	67.0	71.2	74.6	67.7
72.3	74.4	70.5	69.6	68.0	69.1	71.2	69.3	69.0	71.7

A QQ-plot indicates that the distribution is normal.



a. Calculate the sample statistics:

$\bar{X} =$

$s =$

$n =$

b. Determine the 95% confidence intervals for μ, the mean mass of a chip bag.

c. Test the hypothesis that the mean mass, μ, is greater than 66 g. Use $\alpha = 5\%$.

Q3. Confidence Interval for p

A random sample of 50 BCIT students has 7 left-handed and 43 right-handed students.

a. Test the claim at the 5% significance level that 11% of BCIT students are left-handed.

b. If your hypothesis test led to the wrong conclusion, what kind of error was it (Type 1 or Type 2)? How could you have reduced the probability of making such a mistake?

c. Determine the 90% confidence interval for p, the population proportion of left-handed students at BCIT.

Q4. Central Limit Theorem

Let X = the volume of liquid in a bottle of Gatorade. Assume that X has:

- mean: $\mu = 595\ \text{mL}$
- std dev: $\sigma = 3\ \text{mL}$

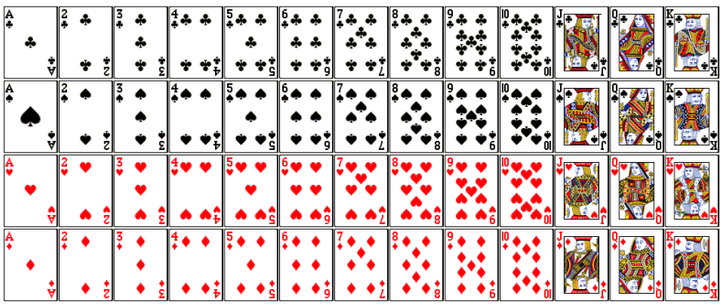
a. What is the probability that a bottle of Gatorade contains more than 600 mL?

   i. Assuming X is normal.

   ii. Without assuming X is normal. *Hint: Chebyshev*.

b. If you pour 100 bottles of Gatorade into a larger container, what is the probability that the resulting volume is greater than 59.6 L?

Q5. General Probability



a. Suppose you select four cards from a standard deck. What is the probability that all four cards have a different *value* (e.g., A, 2, 3, 4 have different value)?

b. Suppose you select *six* cards. What is the probability that all six cards have different value?

Q6. Discrete – Geometric, Binomial, Poisson

The number of flaws in cables produced by a certain manufacturer follows a Poisson distribution with mean 0.2 flaws per meter. Cables are 4m long and are considered to be acceptable if they contain at most one flaw.

a. What is the probability that a randomly-selected cable is not acceptable?

b. If the manufacturer ships 10 cables to a customer, what is the probability that more than 25% of the cables are not acceptable?

Q7. Continuous – Exponential Distribution, Normal Distribution

The average time between global pandemics is 15 yrs. Suppose that the time X until the next global pandemic can be modelled as an *exponential* random variable.

Let's say COVID-19 started in December 2019.

a. In Dec 2019, what was the probability that the next global pandemic would start before December 2024?

b. There has been no new global pandemic (as of Dec 2024) since COVID-19. What is the probability that the next global pandemic will occur before Dec 2029?

c. Find the median value of X.

Q8. Conditional Probability

Suppose that 27% of Canadians own a cat, 36% of Canadians own a dog, and that 21% of Canadians that own a cat also own a dog.

a. What is the probability that a randomly chosen Canadian dog owner also owns a cat?

b. In addition, suppose that 15% of Canadians that own both a dog and a cat also own a bird. What is the probability that a randomly chosen Canadian owns all three of these types of pet (cat, dog, bird)?