UNIVERSITY OF BOLTON

OFF CAMPUS DIVISION

WESTERN INTERNATIONAL COLLEGE

BA (HONS) ACCOUNTANCY

SEMESTER 1 EXAMINATION 2023/24

QUANTITATIVE METHODS FOR ACCOUNTANTS

MODULE NO: ACC4018

Date: Wednesday 10th January 2024 **Time: 1.00pm – 4.00pm**

INSTRUCTIONS TO CANDIDATES:

There are FOUR questions on this paper.

Answer all FOUR questions.

All questions carry equal marks. Calculators may be used but full workings must be shown.

PROVIDED:
Formulae books, containing statistical tables.
Four sheets of graph paper.

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Question 1

An aircraft obstruction lighting company produces two products: LED high intensity obstruction lights and LED medium intensity obstruction lights. The contribution to profit that can be obtained is £25 per unit from LED high intensity obstruction lights, and £35 per unit from LED medium intensity obstruction lights. The factory employs 200 skilled workers and 150 unskilled workers, and they work a 40 hour week. The time required to produce 1 unit of LED high intensity obstruction lights is 6 skilled hours and 4 unskilled hours, whilst for 1 unit of LED medium intensity obstruction lights is 5 skilled hours and 7 unskilled hours.

Required:

a) Arrange the given information into tabular form.

(5 Marks)

b) Translate the problem into a linear programming one, identifying and writing down the objective function and the constraints.

(3 marks)

c) Use the algebraic method to calculate how many units of product X and Y would be produced to maximise profitability.

(7 marks)

d) Plot the inequalities on a graph and identify the feasible region.

(10 marks)

(Total 25 marks)

End of question 1
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Question 2

Sean's machine parts Ltd sell a wide variety of equipment, including valves. The quarterly management accounts for recent quarters show that the following numbers of valves were sold in the four quarters (seasons) of the year:

	Quarter 1	**Quarter 2**	**Quarter 3**	**Quarter 4**
2020	500	260	310	580
2021	550	300	350	620
2022	580	340	410	660
2023	610	380	440	690

Required:

a) Use a 4-point moving average to analyse the data to show the trend.

(10 marks)

b) Calculate the seasonal variations from the trend.

(7 marks)

c) Use the data to forecast the sales for each quarter of 2024.

(8 marks)

(Total 25 marks)

End of question 2
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Question 3

The Table below shows the age of a sample of 40 patients on a covid-19 ward.

27	54	38	62	21	57	48	33
37	30	55	35	64	32	54	46
62	42	22	57	28	51	26	37
20	66	46	52	41	39	43	53
32	41	56	39	26	39	62	36

Required:

a) **Produce a grouped frequency distribution (GFD) table for this data.**
(5 marks)

b) **Draw a histogram of the grouped frequency distribution, and on the same graph calculate the mode salary.**
(5 marks)

c) **From the GFD calculate the mean deviation**
(5 marks)

d) **From the GFD calculate the mean age.**
(5 marks)

e) **Calculate the corresponding variance and standard deviation.**
(5 marks)

(Total 25 marks)

End of question 3
Questions continue over the page
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Question 4

A new piece of AI equipment has been installed and some of the employees are having difficulty logging on to it. A technician has given them some training and the problems encountered during the practice session are recorded. These data result in the following probabilities:

An employee has a 0.9 probability of logging on successfully at their first attempt. If they are successful at any time, the same probability applies on their next two attempts.

If they are not successful at any time, they lose confidence and the probability of succeeding on any subsequent attempt is only 0.5.

Required:

Use a tree diagram to find the probabilities that:

a) **They are successful on all their first three attempts.**
(5 marks)

b) **They fail at the first attempt but succeed on the next two.**
(5 marks)

c) **They are successful just once in three attempts.**
(5 marks)

d) **They fail just once in three attempts.**
(5 marks)

e) **They are still not successful after the third attempt.**
(5 marks)

(Total 25 marks)

END OF QUESTIONS

PLEASE TURN OVER FOR FORMULAE

STATISTICAL FORMULAE

FREQUENCY DISTRIBUTIONS

Required fractile from a GFD = Lower class limit of fractile class +

$$\left[\frac{\text{Fractile item} - \text{cumulative frequency up to lower class limit of fractile class}}{\text{Fractile class frequency}} \times \text{Fractile class interval}\right]$$

Mean $\bar{x} = \dfrac{\text{sum of values}}{\text{total number of items}} = \dfrac{\sum x}{n}$

with GFD: $\bar{x} = \dfrac{\sum(f \times MP)}{\sum f}$ MP = class Mid Point

Range = Highest value – Lowest value

Quartile deviation = $(Q_3 - Q_1)/2$

Mean deviation $= \dfrac{\sum(x - \bar{x})}{n}$ The sign of $(x - \bar{x})$ must be ignored

with GFD: **M.D.** $= \dfrac{\sum(f \times (MP - \bar{x}))}{\sum f}$

Standard deviation (s) $= \sqrt{\left[\dfrac{\sum(x - \bar{x})^2}{n}\right]}$

If the mean is not a rounded number: $s = \sqrt{\left[\dfrac{\sum x^2}{n} - \bar{x}^2\right]}$

with GFD: $s = \sqrt{\left[\dfrac{\sum(f \times MP^2)}{\sum f} - \bar{x}^2\right]}$

Variance: s^2

Coefficient of variation $= \dfrac{s}{\bar{x}} \times 100$

Pearson's Coefficient of Skewness (Sk) $= \dfrac{3\,(\text{Mean} - \text{Median})}{\text{Standard Deviation}}$

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CORRELATION

Regression line of "y on x": $\mathbf{y = a + bx}$

where $b = \dfrac{n \times \sum xy - \sum x \times \sum y}{n \times \sum x^2 - (\sum x)^2}$ $\quad \mathbf{a} = \dfrac{\sum y - b \times \sum x}{n}$ $\quad$ **n** = number of pairs

Regression line of "x on y": $\mathbf{x = a + by}$

where $b = \dfrac{n \times \sum yx - \sum y \times \sum x}{n \times \sum y^2 - (\sum y)^2}$ $\quad \mathbf{a} = \dfrac{\sum x - b \times \sum y}{n}$

Pearson product-moment Coefficient of Correlation (r)

$$r = \frac{n \times \sum xy - \sum x \times \sum y}{\sqrt{((n \times \sum x^2 - (\sum x)^2)\,(n \times \sum y^2 - (\sum y)^2))}}$$

Coefficient of determination $\quad r^2 = b_{yx} \times b_{xy} \quad \Rightarrow \quad \mathbf{r} = \sqrt{b_{yx} \times b_{xy}}$

Covariance: Cov (x,y) $= \dfrac{\sum(x - \bar{x})(y - \bar{y})}{n} \quad \Rightarrow \quad \mathbf{r} = \dfrac{\text{Cov}(x,y)}{(s_x \times s_y)}$

Spearman's Coefficient of Rank Correlation: $\quad r' = 1 - \dfrac{6\sum d^2}{n(n^2 - 1)}$

where **d** = the *difference* between the rankings of the same item in each series

PROBABILITY

Multiplication rule: the prob. of a *sequential* event is the product of all its elementary events

$$\mathbf{P(A \cap B \cap C \cap \ldots) = P(A) \times P(B) \times P(C) \ldots}$$

Addition rule: the prob. of one of a number of *mutually exclusive* events occurring is the sum of the probabilities of the events

$$\mathbf{P(X \cup Y \cup Z \cup \ldots) = P(X) + P(Y) + P(Z) \ldots}$$

Bayes' Theorem $\quad \mathbf{P(E \mid S) = \dfrac{P(E) \times P(S \mid E)}{\sum_i (P(E_i) \times P(S \mid E_i))}}$

where **S** is the subsequent event and there are **n** prior events, **E.**

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PROBABILITY DISTRIBUTIONS

Binomial distribution $P(x) = \binom{n}{x} p^x q^{n-x}$ *where* p = constant probability of a success
$q = 1 - p$ = probability of a failure
Mean = np
Standard deviation = $\sqrt{npq}$

Poisson distribution $P(x) = e^{-a} \frac{a^x}{x!}$ *where* $e \cong 2.718$ is a constant
Mean = $a = np$
Standard deviation = $\sqrt{a}$

Simplified Poisson $P(x+1) = P(x) \times \frac{a}{x+1}$

Normal distribution: *standardised value* $z = \frac{x - \mu}{\sigma}$

where μ and σ are the mean and standard deviation of the actual distribution

ESTIMATION & CONFIDENCE INTERVALS

- $\bar{x}$, s, p – **sample** mean, standard deviation, proportion/percentage
- μ, σ, π – **population** mean, standard deviation, proportion/percentage

⇒ $\bar{x}$ is a **point estimate** of μ
s is a **point estimate** of σ
p is a **point estimate** of π

Confidence intervals for a population percentage or proportion

$\pi = p \pm z\sqrt{\frac{p(100-p)}{n}}$ for a percentage $\pi = p \pm z\sqrt{\frac{p(1-p)}{n}}$ for a proportion

When using **normal tables**: $\boxed{\alpha = 100 - \text{confidence level}}$

Estimation of population mean (μ) when σ is *known*

$\mu = \bar{x} \pm z\, \sigma/\sqrt{n}$ (**normal tables** for z)

Estimation of population mean (μ) for *large sample size* and σ *unknown*

$\mu = \bar{x} \pm z\, s/\sqrt{n}$ (**normal tables** for z)

Estimation of population mean (μ) for *small sample size* and σ *unknown*

$\mu = \bar{x} \pm t\, s/\sqrt{n}$ (**t-tables** for t)

When using **t-tables**: $\boxed{\nu = n-1}$

Confidence intervals for paired (dependent) data

$\mu_d = \bar{x}_d \pm t\, s_d/\sqrt{n_d}$ *where* "$_d$" refers to the *calculated differences*

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FINANCIAL MATHEMATICS

Simple interest $A_n = P\left(1 + \frac{i}{100} \times n\right)$

Compound interest $A_n = P\left(1 + \frac{i}{100}\right)^n$

Effective APR $= \left(\left(1 + \frac{i}{100}\right)^n - 1\right) \times 100\%$

Straight line depreciation $A_n = P\left(1 - \frac{i}{100} \times n\right)$

Depreciation $A = P\left(1 - \frac{i}{100}\right)^n$

The future value of an initial investment A_0 is given by $A = A_0\left(1 + \frac{i}{100}\right)^n$ and the present value of an accumulated investment A_n is given by $A_0 = \frac{A_n}{\left(1 + \frac{i}{100}\right)^n}$ or $A\left(1 + \frac{i}{100}\right)^{-n}$

Loan account

If an annuity is purchased for a sum of A_0 at a rate of i% compounded each period then the periodic repayment is

$$R = \frac{iA_0}{1 - (1+i)^{-n}}$$

and the present value of the annuity A_0 (the loan) is

$$A_0 = R \times \frac{(1+i)^n - 1}{i(1+i)^n} \text{ or equivalently } A_0 = \frac{R[1 - (1+i)^{-n}]}{i}$$

Savings account

A savings plan/sinking fund invested for n periods at a nominal rate of i% compounded each period with a periodic investment of £P matures to S where

$$S = P(1+i) \times \left(\frac{(1+i)^n - 1}{i}\right)$$

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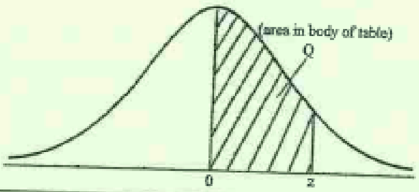
Table 1 Areas under the standard normal curve



z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.0000	0.0040	0.0080	0.0120	0.0160	0.0199	0.0239	0.0279	0.0319	0.0359
0.1	0.0398	0.0438	0.0478	0.0517	0.0557	0.0596	0.0636	0.0675	0.0714	0.0753
0.2	0.0793	0.0832	0.0871	0.0910	0.0948	0.0987	0.1026	0.1064	0.1103	0.1141
0.3	0.1179	0.1217	0.1255	0.1293	0.1331	0.1368	0.1406	0.1443	0.1480	0.1517
0.4	0.1554	0.1591	0.1628	0.1664	0.1700	0.1736	0.1772	0.1808	0.1844	0.1879
0.5	0.1915	0.1950	0.1985	0.2019	0.2054	0.2088	0.2123	0.2157	0.2190	0.2224
0.6	0.2257	0.2291	0.2324	0.2357	0.2389	0.2422	0.2454	0.2486	0.2517	0.2549
0.7	0.2580	0.2611	0.2642	0.2673	0.2704	0.2734	0.2764	0.2794	0.2823	0.2852
0.8	0.2881	0.2910	0.2939	0.2967	0.2995	0.3023	0.3051	0.3078	0.3106	0.3133
0.9	0.3159	0.3186	0.3212	0.3238	0.3264	0.3289	0.3315	0.3340	0.3365	0.3389
1.0	0.3413	0.3438	0.3461	0.3485	0.3508	0.3531	0.3554	0.3577	0.3599	0.3621
1.1	0.3643	0.3665	0.3686	0.3708	0.3729	0.3749	0.3770	0.3790	0.3810	0.3830
1.2	0.3849	0.3869	0.3888	0.3907	0.3925	0.3944	0.3962	0.3980	0.3997	0.4015
1.3	0.4032	0.4049	0.4066	0.4082	0.4099	0.4115	0.4131	0.4147	0.4162	0.4177
1.4	0.4192	0.4207	0.4222	0.4236	0.4251	0.4265	0.4279	0.4292	0.4306	0.4319
1.5	0.4332	0.4345	0.4357	0.4370	0.4382	0.4394	0.4406	0.4418	0.4429	0.4441
1.6	0.4452	0.4463	0.4474	0.4484	0.4495	0.4505	0.4515	0.4525	0.4535	0.4545
1.7	0.4554	0.4564	0.4573	0.4582	0.4591	0.4599	0.4608	0.4616	0.4625	0.4633
1.8	0.4641	0.4649	0.4656	0.4664	0.4671	0.4678	0.4686	0.4693	0.4699	0.4706
1.9	0.4713	0.4719	0.4726	0.4732	0.4738	0.4744	0.4750	0.4756	0.4761	0.4767
2.0	0.4772	0.4778	0.4783	0.4788	0.4793	0.4798	0.4803	0.4808	0.4812	0.4817
2.1	0.4821	0.4826	0.4830	0.4834	0.4838	0.4842	0.4846	0.4850	0.4854	0.4857
2.2	0.4861	0.4864	0.4868	0.4871	0.4875	0.4878	0.4881	0.4884	0.4887	0.4890
2.3	0.4893	0.4896	0.4898	0.4901	0.4904	0.4906	0.4909	0.4911	0.4913	0.4916
2.4	0.4918	0.4920	0.4922	0.4925	0.4927	0.4929	0.4931	0.4932	0.4934	0.4936
2.5	0.4938	0.4940	0.4941	0.4943	0.4945	0.4946	0.4948	0.4949	0.4951	0.4952
2.6	0.4953	0.4955	0.4956	0.4957	0.4959	0.4960	0.4961	0.4962	0.4963	0.4964
2.7	0.4965	0.4966	0.4967	0.4968	0.4969	0.4970	0.4971	0.4972	0.4973	0.4974
2.8	0.4974	0.4975	0.4976	0.4977	0.4977	0.4978	0.4979	0.4979	0.4980	0.4981
2.9	0.4981	0.4982	0.4982	0.4983	0.4984	0.4984	0.4985	0.4985	0.4986	0.4986
3.0	0.4987	0.4987	0.4987	0.4988	0.4988	0.4989	0.4989	0.4989	0.4990	0.4990
3.1	0.4990	0.4991	0.4991	0.4991	0.4992	0.4992	0.4992	0.4992	0.4993	0.4993
3.2	0.4993	0.4993	0.4994	0.4994	0.4994	0.4994	0.4994	0.4995	0.4995	0.4995
3.3	0.4995	0.4995	0.4995	0.4996	0.4996	0.4996	0.4996	0.4996	0.4996	0.4997
3.4	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4998

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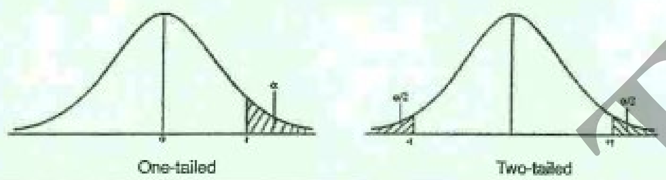
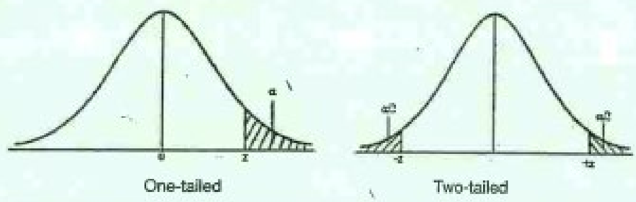
Table 2 Percentage points of the t-distribution



One tail α / Two tails α	5% / 10%	2.5% / 5%	1% / 2%	0.5% / 1%	0.1% / 0.2%	0.05% / 0.1%
ν = 1	6.31	4.30	12.71	31.82	63.66	636.6
2	2.92	4.30	6.96	9.92	22.33	31.60
3	2.35	3.18	4.54	5.84	10.21	12.92
4	2.13	2.78	3.75	4.60	7.17	8.61
5	2.02	2.57	3.36	4.03	5.89	6.87
6	1.94	2.45	3.14	3.71	5.21	5.96
7	1.89	2.36	3.00	3.50	4.79	5.41
8	1.86	2.31	2.90	3.36	4.50	5.04
9	1.83	2.26	2.82	3.25	4.30	4.78
10	1.81	2.23	2.76	3.17	4.14	4.59
12	1.78	2.18	2.68	3.05	3.93	4.32
15	1.75	2.13	2.60	2.95	3.73	4.07
20	1.72	2.09	2.53	2.85	3.55	3.85
24	1.71	2.06	2.49	2.80	3.47	3.75
30	1.70	2.04	2.46	2.75	3.39	3.65
40	1.68	2.02	2.42	2.70	3.31	3.55
60	1.67	2.00	2.39	2.66	3.23	3.46
∞	1.64	1.96	2.33	2.58	3.09	3.29

ν = degrees of freedom   α = total percentage in tails

Table 3 Percentage points of the standard normal curve



One tail / Two tails	5% / 10%	2.5% / 5%	1% / 2%	0.5% / 1%	0.1% / 0.2%	0.05% / 0.1%
z	1.64	1.96	2.33	2.58	3.09	3.29

END OF FORMULAE
END OF EXAM