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UNIVERSITY OF BOLTON

INSTITUTE OF MANAGEMENT

BA (HONS) ACCOUNTANCY

SEMESTER 1 EXAMINATION 2019/2020

QUANTITATIVE METHODS FOR ACCOUNTANTS

MODULE NO: ACC4018

Date: Thursday 16 January 2020 **Time: 10.00 – 1.00**

INSTRUCTIONS TO CANDIDATES:

There are four compulsory questions on this paper.

Answer **all four** questions.

All questions carry equal marks.

Calculators may be used but full workings must be shown.

Formulae books, which contain statistical tables.

Graph paper (four sheets).

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Question 1

A chocolate manufacturer produces two types of chocolates: Star bar and Dream bar. Production of Star bar uses 12g of cocoa and 1 minute of machine time. Whereas, production of Dream bar uses 6g of cocoa and 5 minutes machine time.

In total 2000g of cocoa and 460 minutes of machine time are available each day to the manufacturer. The manufacturer makes 15p profit from each Star bar and 22p profit from each Dream bar.

a) Arrange the given information into tabular form.

(2 Marks)

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

(3 marks)

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

(10 marks)

d) Find the optimum solution that satisfies the objective function including the calculation of the iso-profit lines and illustrated clearly on the graph.

(10 marks)

(Total 25 marks)

Please turn the page

Question 2

A university student takes part in a javelin competition. They take three attempts at throwing the javelin and scoring the highest score.

The probabilities are as follows:

They have a 0.75 probability of successfully scoring the highest score at their first attempt.

If they succeed at the first attempt, the same probability applies on the next two attempts.

If they are not successful at any time, the probability of succeeding on any subsequent attempts is only 0.4.

Use a tree diagram to find the probabilities that:

a) Draw a tree diagram to show the probabilities of success or failure

(5 marks)

b) She is successful on all her first three attempts.

(5 marks)

c) She fails at the first attempt but succeeds on the next two.

(5 marks)

d) She is successful just once in three attempts

(5 marks)

e) She is still not successful after the third attempt

(5 marks)

(Total 25 marks)

Please turn the page

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Question 3

The Table below shows a sample of 40 employee's age working at a textile company.

25	51	36	60	19	58	46	30
34	27	52	33	61	30	51	43
56	39	20	54	44	48	24	25
17	64	43	50	38	38	40	50
30	38	54	37	42	36	59	33

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 estimate the mode age.
(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)

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Question 4

A factory producing aircraft warning lights wants to determine the relationship between the cost of output and the number of lights (units) produced.

The cost of output is thought to depend on the number of units produced.

The table below shows a record for a random sample over 10 months. Data shows:

Month	**Output (Units)**	**Cost (£'000)**
1	3	4
2	5	6
3	1	3
4	7	8
5	5	6
6	9	13
7	4	5
8	1	3
9	3	4
10	5	6

Required:

Please show all calculation workings.

a) Draw a scatter diagram of these results.
(5 Marks)

b) Calculate the equation of the least square regression line of "y on x" and then draw this line on the scatter diagram.
(10 Marks)

c) Calculate the Pearson's correlation coefficient, r and the coefficient of determination r^2.
(6 Marks)

d) Use the regression equation/line to predict the likely cost of 2 months if output is 2, and 8 respectively.

(4 marks)
(Total 25 marks)

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END OF QUESTIONS

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) $= \dfrac{3\,(\text{Mean} - \text{Median})}{\text{Standard Deviation}}$

CORRELATION

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

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

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

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

Pearson product-moment Coefficient of Correlation (r)

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

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

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

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

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

PROBABILITY

Multiplication rule: the prob. of a *sequential* event is the <u>product</u> 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 <u>sum</u> of the probabilities of the events $\qquad \mathbf{P(X \cup Y \cup Z \cup \ldots) = P(X) + P(Y) + P(Z) \ldots}$

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

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

PROBABILITY DISTRIBUTIONS

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

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

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

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

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

$\Rightarrow$ $\bar{x}$ 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

$\pi = p \pm z\sqrt{\dfrac{p(100-p)}{n}}$ for a percentage $\qquad \pi = p \pm z\sqrt{\dfrac{p(1-p)}{n}}$ 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**: $\boxed{\nu = n\text{-}1}$

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*

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 $A_0 = \dfrac{A_n}{\left(1 + \frac{i}{100}\right)^n}$ 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

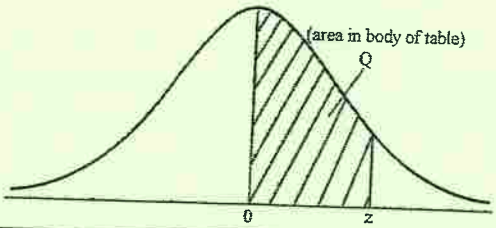
$$A_0 = R \times \frac{(1+i)^n - 1}{i(1+i)^n} \text{ or equivalently } A_0 = \frac{R[1 - (1+i)^{-n}]}{i}$$

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

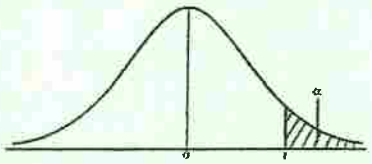
$$S = P(1+i) \times \left(\frac{(1+i)^n - 1}{i}\right)$$

Table 1 Areas under the standard normal curve

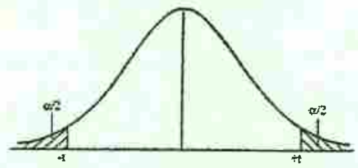


z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.0000	0.0040	0.0080	0.0120	0.0160	0.0199	0.0239	0.0279	0.0319	0.0359
0.1	0.0398	0.0438	0.0478	0.0517	0.0557	0.0596	0.0636	0.0675	0.0714	0.0753
0.2	0.0793	0.0832	0.0871	0.0910	0.0948	0.0987	0.1026	0.1064	0.1103	0.1141
0.3	0.1179	0.1217	0.1255	0.1293	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

Table 2 Percentage points of the t-distribution



One-tailed

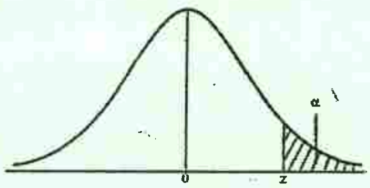


Two-tailed

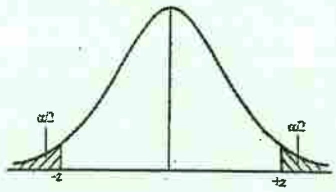
One tail α Two tails α	5% 10%	2.5% 5%	1% 2%	0.5% 1%	0.1% 0.2%	0.05% 0.1%
ν = 1	6.31	4.30	12.71	31.82	63.66	636.6
2	2.92	4.30	6.96	9.92	22.33	31.60
3	2.35	3.18	4.54	5.84	10.21	12.92
4	2.13	2.78	3.75	4.60	7.17	8 .61
5	2.02	2.57	3.36	4.03	5.89	6.87
6	1.94	2.45	3.14	3.71	5.21	5.96
7	1.89	2.36	3.00	3.50	4.79	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-tailed



Two-tailed

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

α = total percentage in tails