

Name: _____ Admission No: _____

Class: _____

SINGAPORE POLYTECHNIC2019/2020 SEMESTER ONE MID SEMESTER TEST**MS2215/MS4215/MS6215****STATISTICS AND ANALYTICS FOR ENGINEERS**

Time Allowed: 1 hour 30 min + 10 min reading time

Instructions to Candidates:

- a) The Singapore Polytechnic examination rules are to be complied with. Any candidate who cheats or attempts to cheat will face disciplinary action and is liable to be expelled from the Polytechnic.
- b) This paper consists of 9 printed pages including the cover page.
- c) Answer **ALL** questions on this question paper itself.
- d) Give all non-exact answers to 3 significant figures.
- e) The total marks for this paper is 100.
- f) Do not turn over this cover sheet until you are told to do so.
- g) This test requires a data file which can be downloaded from Blackboard > Learning Resources > CA Data folder. Please follow your invigilator's instructions.
- h) Password: **s@fePasswor5**
- i) You are allowed one double-sided A4-sized handwritten notes for reference and laptop with Minitab Express installed. Sharing is not allowed.

| Question | Marks |
|----------|-------|
| 1 | /35 |
| 2 | /15 |
| 3 | /15 |
| 4 | /15 |
| 5 | /10 |
| 6 | /10 |
| Total | /100 |

Question 1

This question requires the use of data in an Excel file “cars.xlsx”.

A vintage car magazine catalogues 74 car types manufactured in the 1970s and 1980s. Albert is an enthusiastic car collector and wants to buy a vintage car. Six variables on each car type are recorded in worksheet “Q1”. The meaning of the variables in the file are as follows:

| Variable | Meaning |
|----------|--|
| Model | Name of the car model |
| Price | Price of car in dollars |
| Mileage | Distance travelled by car in km per litre of petrol |
| Repair | Quality of repairs (rated by the car magazine on a 5-point scale: 5 best, 1 worst) |
| Weight | Weight of car in kg |
| Country | Country of origin |

- a) Identify the population and the sample in which the study was based on. (2 marks)

Population: _____

Sample: _____

- b) What is the type of data for each of the variable below? (10 marks)

| Variable | Qualitative / Quantitative | Nominal / Ordinal / Discrete / Continuous |
|----------|----------------------------|---|
| Mileage | | |
| Repair | | |
| Country | | |
| Weight | | |
| Price | | |

- c) Fill in the following blanks. (14 marks)

i) Mean mileage: _____ km / litre

ii) Interquartile range for mileage: _____ km / litre

iii) Shape of distribution of mileage: _____

iv) Percentage of car types from the United States: _____ %

v) Country with the lowest standard deviation in price: _____

vi) State whether the following statement is True or False: “Cars having the worst repair record are also the cars with the highest **median** weight.” _____

- d) Find the correlation coefficient, r , between Mileage and Weight. Hence, comment on the relationship between Mileage and Weight. (4 marks)

- e) Albert wants to buy a vintage car. One of his main considerations apart from price is the repair record of the car. Based on the data, which is the best **country** to buy a car from taking into consideration **price** and **repair** only? Give reasons for your answer. Use **Minitab Express** to generate suitable summaries to help you. (5 marks)

Question 2

Three factories produce transistors. The following table shows the number of acceptable and defective transistors produced by the respective factories.

| | Factory X | Factory Y | Factory Z | Total |
|------------------------|-----------|-----------|-----------|-------|
| Acceptable transistors | 1400 | 1350 | 2000 | 4750 |
| Defective transistors | 200 | 140 | 300 | 640 |
| Total | 1600 | 1490 | 2300 | 5390 |

- a) A transistor is selected at random from the three factories. Determine the probability that the transistor is (6 marks)

(i) produced by Factory Y:

(ii) a defective transistor produced by Factory Z.

(iii) produced by Factory X or Factory Y.

- b) Ali has 7 fuse boxes and each fuse box has a 3% chance to be faulty.

By showing all working, find the probability that

(i) all 7 fuse boxes are not faulty.

(3 marks)

(ii) at least one fuse box is faulty

(2 marks)

(iii) If a fuse box is faulty, Ali needs to replace this box. Is replacing fuse boxes a rare event? Justify.

(4 marks)

Question 3

Concrete blocks are used in footpaths and parking lots. Due to variations in wear and tear, about 4% of the concrete blocks in footpaths and parking lots are chipped. A random sample of 300 concrete blocks from various locations are examined. Let X be the random variable for the number of blocks that are chipped.

- a) Is X a discrete or continuous random variable? (2 marks)

- b) Explain why the Binomial distribution is appropriate in this case. (2 marks)

- c) **By showing all working**, calculate the probability that out of the 300 manufactured concrete blocks, 10 are chipped. Is this a rare event? Explain. (5 marks)

- d) **Use Minitab Express** to determine the probability that out of the 300 manufactured concrete blocks, fewer than 10 are chipped. (3 marks)

- e) To replace the concrete blocks that are chipped, the manufacturer will have to incur a cost of \$15 per block. What is the expected replacement cost for this batch of concrete blocks? (3 marks)

Question 4**All working must be shown for this question.**

- a) Cholesterol levels, measured in mg/dL, among adult men in the United States are normally distributed with mean 215 mg/dL, and standard deviation 27 mg/dL. Adrian, a 40 year-old man, goes for a blood test and finds that his cholesterol level is 242 mg/dL.

- i) By using the Empirical Rule, estimate the percentile level of his cholesterol level. (2 marks)

- ii) Cholesterol levels among male teenagers (12-16) in the United States are normally distributed with mean 175 mg/dL and standard deviation 30 mg/dL. Benedict, a 15 year-old boy in the US, goes for a blood test and finds that his cholesterol level is 190 mg/dL.

Calculate the z-score for Benedict's cholesterol level and its percentile. (2 marks)

- iii) Relative to their peers, who has a higher level of cholesterol? Adrian or Benedict? Explain. (2 marks)

- b) The waiting time (in minutes) for orders of Dian Dian chicken rice at a hawker stall is modelled after a normal distribution with mean, 14, and standard deviation, 2.1.

- i) Find the proportion of customers who will need to wait between 10 to 13 minutes. (4 marks)

- ii) The store owner of Dian Dian chicken rice promises free chicken rice for customers who wait for too long. How should he word his promotion if he is willing to give away for free only 2.5% of their chicken rice? (5 marks)

Question 5

A brand of smartphone, Aye-fone, states that their batteries on a full charge, under typical usage, lasts 11.2 hours on average with standard deviation of 2.1 hours. An online reviewer plans to round up 36 random Aye-fone users to conduct an experiment on the life of their smartphone batteries.

- a) Explain why the sampling distribution of mean battery life of 36 Aye-fones is normally distributed. Hence, state the mean and standard error of the sampling distribution for sample means. (4 marks)

- b) What is the probability that the sample mean battery life of 36 Aye-fones will last at most 10 hours? **Show all relevant working.** (6 marks)

Question 6

A car tank containing petrol was sampled for testing of Research Octane Number (RON), a measure of fuel performance. The results are as follows.

98.1 99.5 94.5 93.6 96.5 99.6 97.4 101.3 92.7

Using Minitab Express, construct a 95% confidence interval to estimate the average RON for the petrol in the tank.

- a) What is the point estimate for the population mean? (2 marks)

- b) What is the margin of error? (3 marks)

- c) This car was supposed to use petrol with an average RON of 92.0. Do you think that this car is using a suitable petrol in its tank? Justify. (5 marks)

Standard Normal Table

Area under the
Standard Normal
Curve from 0 to z

$$z = \frac{x - \mu}{\sigma}$$



| z | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|-----|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 0.0 | .0000 | .0040 | .0080 | .0120 | .0160 | .0199 | .0239 | .0279 | .0319 | .0359 |
| 0.1 | .0398 | .0438 | .0478 | .0517 | .0557 | .0596 | .0636 | .0675 | .0714 | .0754 |
| 0.2 | .0793 | .0832 | .0871 | .0910 | .0948 | .0987 | .1026 | .1064 | .1103 | .1141 |
| 0.3 | .1179 | .1217 | .1255 | .1293 | .1331 | .1368 | .1406 | .1443 | .1480 | .1517 |
| 0.4 | .1554 | .1591 | .1628 | .1664 | .1700 | .1736 | .1772 | .1808 | .1844 | .1879 |
| 0.5 | .1915 | .1950 | .1985 | .2019 | .2054 | .2088 | .2123 | .2157 | .2190 | .2224 |
| 0.6 | .2258 | .2291 | .2324 | .2357 | .2389 | .2422 | .2454 | .2486 | .2518 | .2549 |
| 0.7 | .2580 | .2612 | .2642 | .2673 | .2704 | .2734 | .2764 | .2794 | .2823 | .2852 |
| 0.8 | .2881 | .2910 | .2939 | .2967 | .2996 | .3023 | .3051 | .3078 | .3106 | .3133 |
| 0.9 | .3159 | .3186 | .3212 | .3238 | .3264 | .3289 | .3315 | .3340 | .3365 | .3389 |
| 1.0 | .3413 | .3438 | .3461 | .3485 | .3508 | .3531 | .3554 | .3577 | .3599 | .3621 |
| 1.1 | .3643 | .3665 | .3686 | .3708 | .3729 | .3749 | .3770 | .3790 | .3810 | .3830 |
| 1.2 | .3849 | .3869 | .3888 | .3907 | .3925 | .3944 | .3962 | .3980 | .3997 | .4015 |
| 1.3 | .4032 | .4049 | .4066 | .4082 | .4099 | .4115 | .4131 | .4147 | .4162 | .4177 |
| 1.4 | .4192 | .4207 | .4222 | .4236 | .4251 | .4265 | .4279 | .4292 | .4306 | .4319 |
| 1.5 | .4332 | .4345 | .4357 | .4370 | .4382 | .4394 | .4406 | .4418 | .4429 | .4441 |
| 1.6 | .4452 | .4463 | .4474 | .4484 | .4495 | .4505 | .4515 | .4525 | .4535 | .4545 |
| 1.7 | .4554 | .4564 | .4573 | .4582 | .4591 | .4599 | .4608 | .4616 | .4625 | .4633 |
| 1.8 | .4641 | .4649 | .4656 | .4664 | .4671 | .4678 | .4686 | .4693 | .4699 | .4706 |
| 1.9 | .4713 | .4719 | .4726 | .4732 | .4738 | .4744 | .4750 | .4756 | .4761 | .4767 |
| 2.0 | .4772 | .4778 | .4783 | .4788 | .4793 | .4798 | .4803 | .4808 | .4812 | .4817 |
| 2.1 | .4821 | .4826 | .4830 | .4834 | .4838 | .4842 | .4846 | .4850 | .4854 | .4857 |
| 2.2 | .4861 | .4864 | .4868 | .4871 | .4875 | .4878 | .4881 | .4884 | .4887 | .4890 |
| 2.3 | .4893 | .4896 | .4898 | .4901 | .4904 | .4906 | .4909 | .4911 | .4913 | .4916 |
| 2.4 | .4918 | .4920 | .4922 | .4925 | .4927 | .4929 | .4931 | .4932 | .4934 | .4936 |
| 2.5 | .4938 | .4940 | .4941 | .4943 | .4945 | .4946 | .4948 | .4949 | .4951 | .4952 |
| 2.6 | .4953 | .4955 | .4956 | .4957 | .4959 | .4960 | .4961 | .4962 | .4963 | .4964 |
| 2.7 | .4965 | .4966 | .4967 | .4968 | .4969 | .4970 | .4971 | .4972 | .4973 | .4974 |
| 2.8 | .4974 | .4975 | .4976 | .4977 | .4977 | .4978 | .4979 | .4979 | .4980 | .4981 |
| 2.9 | .4981 | .4982 | .4982 | .4983 | .4984 | .4984 | .4985 | .4985 | .4986 | .4986 |
| 3.0 | .4987 | .4987 | .4987 | .4988 | .4988 | .4989 | .4989 | .4989 | .4990 | .4990 |
| 3.1 | .4990 | .4991 | .4991 | .4991 | .4992 | .4992 | .4992 | .4992 | .4993 | .4993 |
| 3.2 | .4993 | .4993 | .4994 | .4994 | .4994 | .4994 | .4994 | .4995 | .4995 | .4995 |
| 3.3 | .4995 | .4995 | .4995 | .4996 | .4996 | .4996 | .4996 | .4996 | .4996 | .4997 |
| 3.4 | .4997 | .4997 | .4997 | .4997 | .4997 | .4997 | .4997 | .4997 | .4997 | .4998 |
| 3.5 | .4998 | .4998 | .4998 | .4998 | .4998 | .4998 | .4998 | .4998 | .4998 | .4998 |
| 3.6 | .4998 | .4998 | .4999 | .4999 | .4999 | .4999 | .4999 | .4999 | .4999 | .4999 |
| 3.7 | .4999 | .4999 | .4999 | .4999 | .4999 | .4999 | .4999 | .4999 | .4999 | .4999 |
| 3.8 | .4999 | .4999 | .4999 | .4999 | .4999 | .4999 | .4999 | .4999 | .4999 | .4999 |
| 3.9 | .5000 | .5000 | .5000 | .5000 | .5000 | .5000 | .5000 | .5000 | .5000 | .5000 |

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