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UNIVERSITI KUALA LUMPUR
BUSINESS SCHOOL

FINAL EXAMINATION
MARCH 2026 SEMESTER

COURSE CODE	:	EIB11103
COURSE NAME	:	BUSINESS STATISTICS
PROGRAMME NAME	:	BACHELOR OF SCIENCE (HONOURS) IN ANALYTICAL ECONOMICS
DATE	:	30 JUNE 2026
TIME	:	9.00AM – 12.00PM
DURATION	:	3 HOURS

INSTRUCTIONS TO CANDIDATES

1. **Please CAREFULLY read the instructions given on this question paper.**
2. **This question paper has information printed on both sides of the paper.**
3. This examination comprises of only **ONE (1)** section.
4. You are required to answer only **FOUR (4)** questions
5. Please write your answer in the answer booklet provided.
6. All questions must be answered in **English** (any other language is not allowed).
7. Refer to the attached Formula/Appendices. ☑ *Tick if applicable*

THERE ARE THIRTEEN (13) PAGES OF QUESTIONS, INCLUDING THIS PAGE.

SECTION A (Total: 100 marks)

Answer FOUR (4) questions.

Please use the answer booklet provided.

Question 1

Answer all questions below.

(a) A machine used in a bottling plant fills bottles with a volume of liquid that is uniformly distributed between 490 ml and 510 ml, and a quality control inspector needs to determine the probability that a randomly selected bottle contains less than 495 ml so they can assess the likelihood of under-filled products reaching customers.

(3 marks)

(b) A financial survey finds that 77% of customers use digital payment methods regularly, and a bank randomly samples 180 customers to assess usage patterns after introducing a cashback incentive; what is the probability that the sample proportion of digital payment users exceeds 0.80?

(4 marks)

(c) A transportation authority in Thailand is studying the difference between the proportion of commuters who prefer using electric train services and the proportion of commuters who prefer using public buses for daily transportation during peak hours in major urban areas. A random sample of 1,100 train commuters found that 748 commuters preferred train services, while a random sample of 950 bus commuters found that 551 commuters preferred bus transportation. Construct a 95% confidence interval for the difference between the two population proportions.
Refer Below - Table1 :..

(5 marks)

Table 1: .

Electric Train	Public Bus
$n_1 = 1100$	$n_2 = 950$
$x_1 = 748$	$x_2 = 551$
$p_1 = 0.68$	$p_2 = 0.58$

(d) A national election research group is interested in determining whether support for a proposed environmental policy differs between younger voters and older voters. In a random sample of 400 voters aged between 18 and 35 years old, 276 individuals supported the policy, while in a random sample of 380 voters aged above 35 years old, 228 individuals expressed support. At the 5% significance level, test whether there is enough statistical evidence to conclude that the support proportions differ between the two age groups.
Refer Below - Table2 : . .

Table 2: .

Aged 18-35 years old	Aged >35 years old
$n_1 = 400$	$n_2 = 380$
$x_1 = 276$	$x_2 = 228$
$\bar{p}_1 = \frac{276}{400} = 0.69$	$\bar{p}_2 = \frac{228}{380} = 0.60$

i. Compute the test statistic.

(4 marks)

ii. Decide whether to reject or fail to reject the null hypothesis. Interpret your decision.

(3 marks)

(e) A logistics company wants to study the relationship between the weight of delivery packages and the fuel consumption of delivery trucks, because management believes that heavier cargo loads increase fuel usage and operating costs. Data collected from seven delivery trips are shown below:
Refer Below - Table3 : . .

Table 3: .

Package Weight (Tonnes) (x)	Fuel Consumption (Liters) (y)
1.0	18
1.5	22
2.0	27
2.8	33
3.2	38
3.8	45
4.5	53

i. Draw a scatter diagram.

(3 marks)

ii. Compute the correlation coefficient.

(3 marks)

Question 2

Answer all questions below.

(a) In a busy metropolitan city, the time it takes for office workers to commute from home to work is approximately normally distributed with a mean of 42 minutes and a standard deviation of 9 minutes, depending on traffic conditions and route choices. Calculate the probability of workers take between 30 and 50 minutes.

(4 marks)

(b) A public health agency estimates that 80% of adults are willing to receive a new vaccine, and a researcher randomly surveys 100 adults in a metropolitan are to verify this estimate. Calculate the probability that the sample proportion of willing individuals falls between 0.75 and 0.85.

(4 marks)

(c) A retail analytics company in Malaysia is analyzing whether there is a difference in the average amount spent per transaction between customers shopping during weekday promotional campaigns and customers shopping during weekend promotional campaigns, as marketing strategies are being evaluated to maximize sales performance. A random sample of 27 weekday promotional shoppers recorded an average spending of RM85 with a sample standard deviation of RM18, while a random sample of 29 weekend promotional shoppers recorded an average spending of RM97 with a sample standard deviation of RM21. Construct a 99% confidence interval for the difference between the two population mean transaction amounts.

Refer Below - Figure1 : . .

(6 marks)

$n_1 = 27$	$n_2 = 29$
$\bar{x}_1 = 85$	$\bar{x}_2 = 97$
$s_1 = 18$	$s_2 = 21$

Figure 1: .

(d) A local government claims that at least 60% of households in the city actively participate in recycling programs after the introduction of stricter environmental policies. An environmental group conducts a random survey of 350 households and finds that only 189 households regularly recycle. Using a significance level of 0.01, test whether there is sufficient evidence to conclude that the actual participation rate is below 60%.

i. Compute the test statistic.

(3 marks)

ii. Find the critical value. Make a decision and interpret your answer.

(3 marks)

(e) A university researcher wants to study the relationship between the number of hours students spend playing video games each week and their cumulative grade point averages (CGPA), because excessive gaming may influence academic performance. The following data in the table below are collected from seven students. Compute the correlation coefficient and interpret your answer.
Refer Below - Table4 : . .

(5 marks)

Table 4: .

Video Game Hours per Week (x)	CGPA (y)
2	3.82
4	3.65
6	3.42
8	3.21
10	3.05
12	2.88
15	2.60

Question 3

Answer all questions below.

(a) A factory produces metal rods whose lengths are uniformly distributed between 95 cm and 105 cm due to small but consistent variations in the manufacturing process, and an engineer needs to determine the probability that a randomly selected rod will have a length between 98 cm and 102 cm in order to meet a specific tolerance requirement for a construction project.

(3 marks)

(b) A tech company claims that 60% of smartphone users actively use their fitness tracking app at least three times a week, and a data analyst randomly selects 150 users to assess engagement levels during a new feature rollout, find the probability that the sample proportion of active users is between 0.55 and 0.65.

(4 marks)

(c) A cinema company in Vietnam is conducting a study to estimate the proportion of moviegoers who purchase premium snack packages when attending films in cinema halls, as part of a strategy to increase concession revenue during peak viewing seasons. A random sample of 1,050 customers was selected, and 609 customers reported that they purchased premium snack packages. Using a 95% confidence level, construct a confidence interval for the true proportion of customers who purchase premium snacks.

(4 marks)

(d) A cinema company claims that customers spend an average of 2.5 hours at its movie theaters, including time spent watching movies and purchasing refreshments. A business analyst believes that the average time has increased because more customers are attending extended premium screenings. A random sample of 27 customers shows an average stay of 2.9 hours with a sample standard deviation of 0.7 hours. Using a significance level of 0.05, test whether there is sufficient evidence to support the analyst's belief.

i. State the hypothesis.

(1 marks)

ii. Calculate the test statistic.

(2 marks)

iii. Make your decision and interpret your answer.

(2 marks)

(e) A manufacturing engineer wants to examine the relationship between the number of hours a machine operates continuously and the amount of energy consumed during production, because understanding energy usage patterns may help reduce operating costs. Data from six production days are given below:
Refer Below - Table5 : . .

Table 5: .

Machine Operating Hours (x)	Energy Consumption (kWh) (y)
3	120
5	165
6	190
8	245
10	295
12	360

i. Draw a scatter diagram.

(3 marks)

ii. Compute the correlation coefficient, r.

(5 marks)

iii. Interpret the relationship between x and y.

(1 marks)

Question 4

Answer all questions below.

(a) A large electronics company in Kuala Lumpur manufactures rechargeable batteries for electric scooters, and the quality control department has determined that the battery life follows a normal distribution with a mean of 520 charging cycles and a standard deviation of 35 charging cycles. During a safety inspection, a random battery is selected from the production line. Calculate the probability that the battery will last more than 580 charging cycles before its performance significantly decreases.

(3 marks)

(b) A manufacturing company such as Panasonic produces air conditioners with an average lifespan of 9 years and a standard deviation of 1.5 years, and a quality engineer randomly selects 100 units for testing; what is the probability that the sample mean lifespan exceeds 9.2 years?

(3 marks)

(c) A hotel management association in Indonesia is interested in estimating the proportion of tourists who book hotel rooms using online travel applications instead of traditional booking methods. In a random sample of 920 tourists staying at different hotels, 736 tourists reported that they used online applications for their bookings. Using a 95% confidence level, construct a confidence interval for the true population proportion.

(4 marks)

(d) A public health department claims that at least 85% of residents in a city have received the annual influenza vaccine after an aggressive vaccination campaign was conducted throughout the year. However, a medical researcher suspects that the actual vaccination rate is lower than the department's claim. In a random survey of 300 residents, only 243 individuals report that they received the vaccine. Using a significance level of 0.05, test whether there is sufficient evidence to support the researcher's suspicion that fewer than 85% of residents were vaccinated.

i. Calculate the test statistic.

(3 marks)

ii. Find the p-value, decide whether to reject of fail to reject the null hypothesis. Interpret.

(3 marks)

(e) A health researcher wants to study the relationship between the number of hours individuals exercise each week and their resting heart rates, because regular physical activity is believed to improve cardiovascular health. The following data are collected from seven adults:

Refer Below - Table6 : . .

Table 6: .

[illegible]	[illegible]
1	84
2	81
3	78
5	74
6	71
8	68
10	64

i. Find the correlation coefficient.

(4 marks)

ii. Find the least squares regression line.

(5 marks)

Question 5

Answer all questions below.

(a) At a large university, the final exam scores for a statistics course are known to follow a normal distribution with a mean score of 68 and a standard deviation of 12, and the professor is interested in analyzing student performance across different grade thresholds.

i. Compute the probability of students scored above 85.

(3 marks)

ii. Compute the probability of students scored between 50 and 75.

(4 marks)

(b) A busy coffee shop in downtown Kuala Lumpur records that the average waiting time for customers during peak hours is 8 minutes with a standard deviation of 3 minutes, and the manager randomly selects 64 customers on a particular day to evaluate whether the waiting time has improved after introducing a new ordering system, assuming the waiting times are approximately normally distributed, find the probability that the sample mean waiting time is less than 7.5 minutes.

(4 marks)

(c) A human resource department in a multinational corporation in Thailand is studying the average number of overtime hours worked per employee per week in the production division, as management is reviewing employee workload distribution and labor cost efficiency. A random sample of 78 employees was surveyed, and the average overtime was 7.4 hours per week with a standard deviation of 3.2 hours. Construct a 99% confidence interval for the true mean overtime hours per week.

(4 marks)

(d) A sports scientist is comparing the average sprint completion times of athletes following two different training programs. A random sample of 14 athletes using Training Program A records an average sprint time of 11.8 seconds with a sample standard deviation of 0.6 seconds, while a random sample of 15 athletes using Training Program B records an average sprint time of 12.3 seconds with a sample standard deviation of 0.7 seconds. At the 5% significance level, determine whether there is enough evidence to conclude that the mean sprint times differ between the two training programs.

Refer Below - Table7 : . .

(6 marks)

Table 7: .

Training Program A	Training Program B
$n_1 = 14$	$n_2 = 15$
$x_1 = 11.8$	$x_2 = 12.3$
$s_1 = 0.6$	$s_2 = 0.7$

(e) A logistics company wants to study the relationship between delivery distance and fuel costs for transportation vehicles, because understanding fuel expenses is important for planning and budgeting operations. The following data are collected from seven delivery trips. Find the least squares regression line.

Refer Below - Table8 : . .

(4 marks)

Table 8: .

Delivery Distance (x)	Fuel Cost (y)
20	18
35	27
50	36
65	47
80	56
95	68
110	79

END OF EXAMINATION PAPER

FORMULAS AND STATISTICAL TABLE

PROBABILITY DISTRIBUTIONS

Uniform distribution:

$$P(x) = \frac{1}{(b-a)} \text{ if } a \le x \le b \text{ and } 0 \text{ elsewhere}$$

$$\mu = \frac{a+b}{2}$$

$$\sigma = \sqrt{\frac{(b-a)^2}{12}}$$

Exponential distribution:

$$P(arrival\ time < x) = 1 - e^{-\lambda x}$$

$$P(arrival\ time > x) = e^{-\lambda x}$$

Normal distribution:

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

Sampling distribution:

$$z = \frac{\bar{x}-\mu}{\sigma/\sqrt{n}}, \quad z = \frac{\bar{p}-p_0}{\sqrt{\frac{pq}{n}}}$$

Standard error:

$$\sigma_{\bar{x}} = \frac{\sigma}{\sqrt{n}}, \quad \sigma_{\bar{p}} = \sqrt{\frac{pq}{n}}$$

ESTIMATIONS

Population mean:

$$\mu = \frac{\sum x}{n}$$

Sample mean:

$$\bar{x} = \frac{\sum x}{n}$$

Sample variance:

$$s^2 = \frac{\sum(x-\bar{x})^2}{n-1} \ @ \ s^2 = \frac{\sum x^2 - \frac{(\sum x)^2}{n}}{n-1}$$

Sample standard deviation:

$$s = \sqrt{\frac{\sum(x-\bar{x})^2}{n-1}} \ @ \ s = \sqrt{\frac{\sum x^2 - \frac{(\sum x)^2}{n}}{n-1}}$$

Sample proportion:

$$\hat{p} = \frac{x}{n}$$

Sample size:

$$n = \left(\frac{z\sigma}{E}\right)^2$$

$$n = \frac{(z)^2 pq}{E^2}$$

Margin of error:

$$E = Z_{\frac{\alpha}{2}} \frac{\sigma}{\sqrt{n}}, \quad E = t_{\frac{\alpha}{2}} \frac{s}{\sqrt{n}}$$

$$E = Z_{\frac{\alpha}{2}} \sqrt{\frac{\bar{p}(1-\bar{p})}{n}}$$

Confidence interval (one population):

1) σ known:

$$CI = \bar{x} \pm z_{\alpha/2} \left(\frac{\sigma}{\sqrt{n}}\right)$$

2) σ unknown:

$$CI = \bar{x} \pm t_{\alpha/2, df} \left(\frac{s}{\sqrt{n}}\right)$$ where df = n – 1

3) population proportion:

$$CI = \bar{p} \pm z_{\alpha/2} \sqrt{\frac{\bar{p}(1-\bar{p})}{n}}$$

Confidence intervals (two populations):

1) σ_1 and σ_2 are known:

$$CI = (\bar{x}_1 - \bar{x}_2) \pm z_{\alpha/2}\left(\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}\right)$$

2) σ_1 and σ_2 are unknown:

$$CI = (\bar{x}_1 - \bar{x}_2) \pm t_{\alpha/2}\left(\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}\right)$$

$$df = \frac{\left(\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}\right)^2}{\frac{1}{n_1-1}\left(\frac{s_1^2}{n_1}\right)^2 + \frac{1}{n_2-1}\left(\frac{s_2^2}{n_2}\right)^2}$$

3) two population proportions:

$$CI = (\hat{p}_1 - \hat{p}_2) \pm z_{\alpha/2}\left(\sqrt{\frac{\hat{p}_1\hat{q}_1}{n_1} + \frac{\hat{p}_2\hat{q}_2}{n_2}}\right)$$

HYPOTHESIS TESTING ONE SAMPLE

1) σ known

$$z = \frac{\bar{x} - \mu}{\sigma/\sqrt{n}}$$

2) σ unknown

$$t = \frac{\bar{x} - \mu}{s/\sqrt{n}}$$

3) population proportion

$$z = \frac{\bar{p} - p_0}{\sqrt{\frac{p_0 q_0}{n}}}$$

HYPOTHESIS TESTING TWO SAMPLE

1) σ_1 and σ_2 are known

$$z = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}}$$

2) σ_1 and σ_2 are unknown

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

$$df = \frac{\left(\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}\right)^2}{\frac{1}{n_1-1}\left(\frac{s_1^2}{n_1}\right)^2 + \frac{1}{n_2-1}\left(\frac{s_2^2}{n_2}\right)^2}$$

3) two population proportions

$$z = \frac{\hat{p}_1 - \hat{p}_2}{\sqrt{\bar{p}\bar{q}\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}} \text{ where } \bar{p} = \frac{p_1 n_1 + p_2 n_2}{n_1 + n_2}$$

$\therefore \bar{p} = \text{pooled estimator}$

4) matched sample

$$t = \frac{\bar{x}_d - \mu_d}{\frac{s_d}{\sqrt{n}}}$$

REGRESSION AND CORRELATION

Correlation coefficient:

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

Regression equation line:

$y = a + bx$

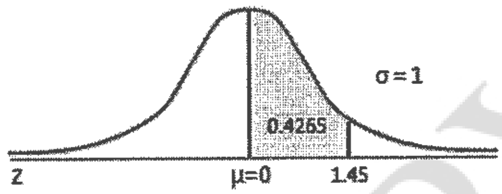
Where:

$$a = \frac{(\sum y)(\sum x^2) - (\sum x)(\sum xy)}{n(\sum x^2) - (\sum x)^2}$$

$$b = \frac{n(\sum xy) - (\sum x)(\sum y)}{n(\sum x^2) - (\sum x)^2}$$

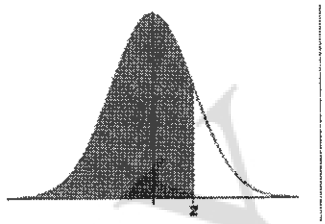
Areas Under the One-Tailed Standard Normal Curve

This table provides the area between the mean and some Z score.
For example, when Z score = 1.45 the area = 0.4265.



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
3.5	0.4998	0.4998	0.4998	0.4998	0.4998	0.4998	0.4998	0.4998	0.4998	0.4998
3.6	0.4998	0.4998	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999
3.7	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999
3.8	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999
3.9	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000

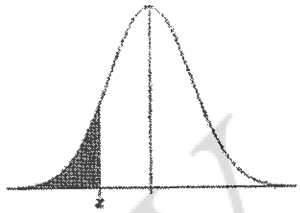
Standard Normal Cumulative Probability Table



Cumulative probabilities for POSITIVE z-values are shown in the following table:

z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.5000	0.5040	0.5080	0.5120	0.5160	0.5199	0.5239	0.5279	0.5319	0.5359
0.1	0.5398	0.5438	0.5478	0.5517	0.5557	0.5596	0.5636	0.5675	0.5714	0.5753
0.2	0.5793	0.5832	0.5871	0.5910	0.5948	0.5987	0.6026	0.6064	0.6103	0.6141
0.3	0.6179	0.6217	0.6255	0.6293	0.6331	0.6368	0.6406	0.6443	0.6480	0.6517
0.4	0.6554	0.6591	0.6628	0.6664	0.6700	0.6736	0.6772	0.6808	0.6844	0.6879
0.5	0.6915	0.6950	0.6985	0.7019	0.7054	0.7088	0.7123	0.7157	0.7190	0.7224
0.6	0.7257	0.7291	0.7324	0.7357	0.7389	0.7422	0.7454	0.7486	0.7517	0.7549
0.7	0.7580	0.7611	0.7642	0.7673	0.7704	0.7734	0.7764	0.7794	0.7823	0.7852
0.8	0.7881	0.7910	0.7939	0.7967	0.7995	0.8023	0.8051	0.8078	0.8106	0.8133
0.9	0.8159	0.8186	0.8212	0.8238	0.8264	0.8289	0.8315	0.8340	0.8365	0.8389
1.0	0.8413	0.8438	0.8461	0.8485	0.8508	0.8531	0.8554	0.8577	0.8599	0.8621
1.1	0.8643	0.8665	0.8686	0.8708	0.8729	0.8749	0.8770	0.8790	0.8810	0.8830
1.2	0.8849	0.8869	0.8888	0.8907	0.8925	0.8944	0.8962	0.8980	0.8997	0.9015
1.3	0.9032	0.9049	0.9066	0.9082	0.9099	0.9115	0.9131	0.9147	0.9162	0.9177
1.4	0.9192	0.9207	0.9222	0.9236	0.9251	0.9265	0.9279	0.9292	0.9306	0.9319
1.5	0.9332	0.9345	0.9357	0.9370	0.9382	0.9394	0.9406	0.9418	0.9429	0.9441
1.6	0.9452	0.9463	0.9474	0.9484	0.9495	0.9505	0.9515	0.9525	0.9535	0.9545
1.7	0.9554	0.9564	0.9573	0.9582	0.9591	0.9599	0.9608	0.9616	0.9625	0.9633
1.8	0.9641	0.9649	0.9656	0.9664	0.9671	0.9678	0.9686	0.9693	0.9699	0.9706
1.9	0.9713	0.9719	0.9726	0.9732	0.9738	0.9744	0.9750	0.9756	0.9761	0.9767
2.0	0.9772	0.9778	0.9783	0.9788	0.9793	0.9798	0.9803	0.9808	0.9812	0.9817
2.1	0.9821	0.9826	0.9830	0.9834	0.9838	0.9842	0.9846	0.9850	0.9854	0.9857
2.2	0.9861	0.9864	0.9868	0.9871	0.9875	0.9878	0.9881	0.9884	0.9887	0.9890
2.3	0.9893	0.9896	0.9898	0.9901	0.9904	0.9906	0.9909	0.9911	0.9913	0.9916
2.4	0.9918	0.9920	0.9922	0.9925	0.9927	0.9929	0.9931	0.9932	0.9934	0.9936
2.5	0.9938	0.9940	0.9941	0.9943	0.9945	0.9946	0.9948	0.9949	0.9951	0.9952
2.6	0.9953	0.9955	0.9956	0.9957	0.9959	0.9960	0.9961	0.9962	0.9963	0.9964
2.7	0.9965	0.9966	0.9967	0.9968	0.9969	0.9970	0.9971	0.9972	0.9973	0.9974
2.8	0.9974	0.9975	0.9976	0.9977	0.9977	0.9978	0.9979	0.9979	0.9980	0.9981
2.9	0.9981	0.9982	0.9982	0.9983	0.9984	0.9984	0.9985	0.9985	0.9986	0.9986
3.0	0.9987	0.9987	0.9987	0.9988	0.9988	0.9989	0.9989	0.9989	0.9990	0.9990
3.1	0.9990	0.9991	0.9991	0.9991	0.9992	0.9992	0.9992	0.9992	0.9993	0.9993
3.2	0.9993	0.9993	0.9994	0.9994	0.9994	0.9994	0.9994	0.9995	0.9995	0.9995
3.3	0.9995	0.9995	0.9995	0.9996	0.9996	0.9996	0.9996	0.9996	0.9996	0.9997
3.4	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9998

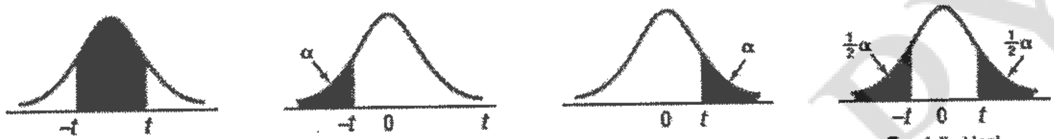
Standard Normal Cumulative Probability Table



Cumulative probabilities for NEGATIVE z-values are shown in the following table:

z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
-3.4	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0002
-3.3	0.0005	0.0005	0.0005	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0003
-3.2	0.0007	0.0007	0.0006	0.0006	0.0006	0.0006	0.0006	0.0005	0.0005	0.0005
-3.1	0.0010	0.0009	0.0009	0.0009	0.0008	0.0008	0.0008	0.0008	0.0007	0.0007
-3.0	0.0013	0.0013	0.0013	0.0012	0.0012	0.0011	0.0011	0.0011	0.0010	0.0010
-2.9	0.0019	0.0018	0.0018	0.0017	0.0016	0.0016	0.0015	0.0015	0.0014	0.0014
-2.8	0.0026	0.0025	0.0024	0.0023	0.0023	0.0022	0.0021	0.0021	0.0020	0.0019
-2.7	0.0035	0.0034	0.0033	0.0032	0.0031	0.0030	0.0029	0.0028	0.0027	0.0026
-2.6	0.0047	0.0045	0.0044	0.0043	0.0041	0.0040	0.0039	0.0038	0.0037	0.0036
-2.5	0.0062	0.0060	0.0059	0.0057	0.0055	0.0054	0.0052	0.0051	0.0049	0.0048
-2.4	0.0082	0.0080	0.0078	0.0075	0.0073	0.0071	0.0069	0.0068	0.0066	0.0064
-2.3	0.0107	0.0104	0.0102	0.0099	0.0096	0.0094	0.0091	0.0089	0.0087	0.0084
-2.2	0.0139	0.0136	0.0132	0.0129	0.0125	0.0122	0.0119	0.0116	0.0113	0.0110
-2.1	0.0179	0.0174	0.0170	0.0166	0.0162	0.0158	0.0154	0.0150	0.0146	0.0143
-2.0	0.0228	0.0222	0.0217	0.0212	0.0207	0.0202	0.0197	0.0192	0.0188	0.0183
-1.9	0.0287	0.0281	0.0274	0.0268	0.0262	0.0256	0.0250	0.0244	0.0239	0.0233
-1.8	0.0359	0.0351	0.0344	0.0336	0.0329	0.0322	0.0314	0.0307	0.0301	0.0294
-1.7	0.0446	0.0436	0.0427	0.0418	0.0409	0.0401	0.0392	0.0384	0.0375	0.0367
-1.6	0.0548	0.0537	0.0526	0.0516	0.0505	0.0495	0.0485	0.0475	0.0465	0.0455
-1.5	0.0668	0.0655	0.0643	0.0630	0.0618	0.0606	0.0594	0.0582	0.0571	0.0559
-1.4	0.0808	0.0793	0.0778	0.0764	0.0749	0.0735	0.0721	0.0708	0.0694	0.0681
-1.3	0.0968	0.0951	0.0934	0.0918	0.0901	0.0885	0.0869	0.0853	0.0838	0.0823
-1.2	0.1151	0.1131	0.1112	0.1093	0.1075	0.1056	0.1038	0.1020	0.1003	0.0985
-1.1	0.1357	0.1335	0.1314	0.1292	0.1271	0.1251	0.1230	0.1210	0.1190	0.1170
-1.0	0.1587	0.1562	0.1539	0.1515	0.1492	0.1469	0.1446	0.1423	0.1401	0.1379
-0.9	0.1841	0.1814	0.1788	0.1762	0.1736	0.1711	0.1685	0.1660	0.1635	0.1611
-0.8	0.2119	0.2090	0.2061	0.2033	0.2005	0.1977	0.1949	0.1922	0.1894	0.1867
-0.7	0.2420	0.2389	0.2358	0.2327	0.2296	0.2266	0.2236	0.2206	0.2177	0.2148
-0.6	0.2743	0.2709	0.2676	0.2643	0.2611	0.2578	0.2546	0.2514	0.2483	0.2451
-0.5	0.3085	0.3050	0.3015	0.2981	0.2946	0.2912	0.2877	0.2843	0.2810	0.2776
-0.4	0.3446	0.3409	0.3372	0.3336	0.3300	0.3264	0.3228	0.3192	0.3156	0.3121
-0.3	0.3821	0.3783	0.3745	0.3707	0.3669	0.3632	0.3594	0.3557	0.3520	0.3483
-0.2	0.4207	0.4168	0.4129	0.4090	0.4052	0.4013	0.3974	0.3936	0.3897	0.3859
-0.1	0.4602	0.4562	0.4522	0.4483	0.4443	0.4404	0.4364	0.4325	0.4286	0.4247
0.0	0.5000	0.4960	0.4920	0.4880	0.4840	0.4801	0.4761	0.4721	0.4681	0.4641

B.5 Student's *t* Distribution



Confidence interval · Left-tailed test · Right-tailed test · Two-tailed test

	Confidence Intervals, *c*					
	80%	90%	95%	98%	99%	99.9%
	Level of Significance for One-Tailed Test, α					
df	0.10	0.05	0.025	0.01	0.005	0.0005
	Level of Significance for Two-Tailed Test, α					
	0.20	0.10	0.05	0.02	0.01	0.001
1	3.078	6.314	12.706	31.821	63.657	636.619
2	1.886	2.920	4.303	6.965	9.925	31.599
3	1.638	2.353	3.182	4.541	5.841	12.924
4	1.533	2.132	2.776	3.747	4.604	8.610
5	1.476	2.015	2.571	3.365	4.032	6.869
6	1.440	1.943	2.447	3.143	3.707	5.959
7	1.415	1.895	2.365	2.998	3.499	5.408
8	1.397	1.860	2.306	2.896	3.355	5.041
9	1.383	1.833	2.262	2.821	3.250	4.781
10	1.372	1.812	2.228	2.764	3.169	4.587
11	1.363	1.796	2.201	2.718	3.106	4.437
12	1.356	1.782	2.179	2.681	3.055	4.318
13	1.350	1.771	2.160	2.650	3.012	4.221
14	1.345	1.761	2.145	2.624	2.977	4.140
15	1.341	1.753	2.131	2.602	2.947	4.073
16	1.337	1.746	2.120	2.583	2.921	4.015
17	1.333	1.740	2.110	2.567	2.898	3.965
18	1.330	1.734	2.101	2.552	2.878	3.922
19	1.328	1.729	2.093	2.539	2.861	3.883
20	1.325	1.725	2.086	2.528	2.845	3.850
21	1.323	1.721	2.080	2.518	2.831	3.819
22	1.321	1.717	2.074	2.508	2.819	3.792
23	1.319	1.714	2.069	2.500	2.807	3.768
24	1.318	1.711	2.064	2.492	2.797	3.745
25	1.316	1.708	2.060	2.485	2.787	3.725
26	1.315	1.706	2.056	2.479	2.779	3.707
27	1.314	1.703	2.052	2.473	2.771	3.690
28	1.313	1.701	2.048	2.467	2.763	3.674
29	1.311	1.699	2.045	2.462	2.756	3.659
30	1.310	1.697	2.042	2.457	2.750	3.646
31	1.309	1.696	2.040	2.453	2.744	3.633
32	1.309	1.694	2.037	2.449	2.738	3.622
33	1.308	1.692	2.035	2.445	2.733	3.611
34	1.307	1.691	2.032	2.441	2.728	3.601
35	1.306	1.690	2.030	2.438	2.724	3.591

	Confidence Intervals, *c*					
	80%	90%	95%	98%	99%	99.9%
	Level of Significance for One-Tailed Test, α					
df	0.10	0.05	0.025	0.01	0.005	0.0005
	Level of Significance for Two-Tailed Test, α					
	0.20	0.10	0.05	0.02	0.01	0.001
36	1.306	1.688	2.028	2.434	2.719	3.582
37	1.305	1.687	2.026	2.431	2.715	3.574
38	1.304	1.686	2.024	2.429	2.712	3.566
39	1.304	1.685	2.023	2.426	2.708	3.558
40	1.303	1.684	2.021	2.423	2.704	3.551
41	1.303	1.683	2.020	2.421	2.701	3.544
42	1.302	1.682	2.018	2.418	2.698	3.538
43	1.302	1.681	2.017	2.416	2.695	3.532
44	1.301	1.680	2.015	2.414	2.692	3.526
45	1.301	1.679	2.014	2.412	2.690	3.520
46	1.300	1.679	2.013	2.410	2.687	3.515
47	1.300	1.678	2.012	2.408	2.685	3.510
48	1.299	1.677	2.011	2.407	2.682	3.505
49	1.299	1.677	2.010	2.405	2.680	3.500
50	1.299	1.676	2.009	2.403	2.678	3.496
51	1.298	1.675	2.008	2.402	2.676	3.492
52	1.298	1.675	2.007	2.400	2.674	3.488
53	1.298	1.674	2.006	2.399	2.672	3.484
54	1.297	1.674	2.005	2.397	2.670	3.480
55	1.297	1.673	2.004	2.396	2.668	3.476
56	1.297	1.673	2.003	2.395	2.667	3.473
57	1.297	1.672	2.002	2.394	2.665	3.470
58	1.296	1.672	2.002	2.392	2.663	3.466
59	1.296	1.671	2.001	2.391	2.662	3.463
60	1.296	1.671	2.000	2.390	2.660	3.460
61	1.296	1.670	2.000	2.389	2.659	3.457
62	1.295	1.670	1.999	2.388	2.657	3.454
63	1.295	1.669	1.998	2.387	2.656	3.452
64	1.295	1.669	1.998	2.386	2.655	3.449
65	1.295	1.669	1.997	2.385	2.654	3.447
66	1.295	1.668	1.997	2.384	2.652	3.444
67	1.294	1.668	1.996	2.383	2.651	3.442
68	1.294	1.668	1.995	2.382	2.650	3.439
69	1.294	1.667	1.995	2.382	2.649	3.437
70	1.294	1.667	1.994	2.381	2.648	3.435

(continued)

B.5 Student's *t* Distribution (*concluded*)

df	Confidence Intervals, *c*					
	80%	90%	95%	98%	99%	99.9%
	Level of Significance for One-Tailed Test, α					
	0.10	0.05	0.025	0.01	0.005	0.0005
	Level of Significance for Two-Tailed Test, α					
	0.20	0.10	0.05	0.02	0.01	0.001
71	1.294	1.667	1.994	2.380	2.647	3.433
72	1.293	1.666	1.993	2.379	2.646	3.431
73	1.293	1.666	1.993	2.379	2.645	3.429
74	1.293	1.666	1.993	2.378	2.644	3.427
75	1.293	1.665	1.992	2.377	2.643	3.425
76	1.293	1.665	1.992	2.376	2.642	3.423
77	1.293	1.665	1.991	2.376	2.641	3.421
78	1.292	1.665	1.991	2.375	2.640	3.420
79	1.292	1.664	1.990	2.374	2.640	3.418
80	1.292	1.664	1.990	2.374	2.639	3.416
81	1.292	1.664	1.990	2.373	2.638	3.415
82	1.292	1.664	1.989	2.373	2.637	3.413
83	1.292	1.663	1.989	2.372	2.636	3.412
84	1.292	1.663	1.989	2.372	2.636	3.410
85	1.292	1.663	1.988	2.371	2.635	3.409
86	1.291	1.663	1.988	2.370	2.634	3.407
87	1.291	1.663	1.988	2.370	2.634	3.406
88	1.291	1.662	1.987	2.369	2.633	3.405
89	1.291	1.662	1.987	2.369	2.632	3.403
90	1.291	1.662	1.987	2.368	2.632	3.402
91	1.291	1.662	1.986	2.368	2.631	3.401
92	1.291	1.662	1.986	2.368	2.630	3.399
93	1.291	1.661	1.986	2.367	2.630	3.398
94	1.291	1.661	1.986	2.367	2.629	3.397
95	1.291	1.661	1.985	2.366	2.629	3.396
96	1.290	1.661	1.985	2.366	2.628	3.395
97	1.290	1.661	1.985	2.365	2.627	3.394
98	1.290	1.661	1.984	2.365	2.627	3.393
99	1.290	1.660	1.984	2.365	2.626	3.392
100	1.290	1.660	1.984	2.364	2.626	3.390
120	1.289	1.658	1.980	2.358	2.617	3.373
140	1.288	1.656	1.977	2.353	2.611	3.361
160	1.287	1.654	1.975	2.350	2.607	3.352
180	1.286	1.653	1.973	2.347	2.603	3.345
200	1.286	1.653	1.972	2.345	2.601	3.340
∞	1.282	1.645	1.960	2.326	2.576	3.291