QUEENS COLLEGE
DEPARTMENT OF MATHEMATICS
FINAL EXAMINATION
2.5 HOURS

Mathematics 110 **Spring 2025**

<u>Instructions</u>: Answer all questions. Show all work in the exam booklet. Box final answers.

1) A large group is deciding on a location for their conference with their preference rankings listed below. Please note that "√" indicates approval.

Number of Votes

City	7	6	6	5	9	2	1
New York	1√	1√	2	2√	3√	3	4
Seattle	2√	4	1√	3√	2√	4	1√
London	3	2	3	1√	1√	2√	2
Toronto	4	3	4	4	4	1√	3

A) Which city wins using plurality voting?
B) Which city wins using plurality with a runoff between the top two finishers?
C) Which city wins using Borda's method?
D) Which city wins using approval voting?
E) Which city, if any, would be the Condorcet winner?

2) **A)** If 4,225 votes are cast in an election that is to be decided by plurality, what is the smallest number of votes a candidate can win with in a seven-candidate race if no ties are allowed?

B) There are 300 votes to be cast in a plurality election among four candidates- Naomi, Orlando, Penelope, and Quentin. After the first 250 votes are counted, the tallies are as follows:

Naomi - 78
Orlando - 59
Penelope - 48
Quentin - 65

What is the minimal number of remaining votes Orlando needs to be assured of a win?

3) A certain college would like to apportion 50 custodians to various buildings on campus based on the number of rooms in each building, as listed below.

Building	Cornwall	Lunder	Placidus	Venetia	York
No. of Rooms	207	307	210	409	67

A) What is the natural divisor? What are the natural quotas?
B) Apportion the custodians using Hamilton's method.
C) Apportion the custodians using Lowndes' method.
D) Apportion the custodians using Jefferson's method.
E) How many custodians would a building with a natural quota of 5.4852 be initially allocated using Hill-Huntington's method?

4) Determine the mean (rounded to the nearest whole number) and the standard deviation given the following sample: **42 34 30 19 17 31 27 40**.

(continued on the back)

5) A random sample of n=17 grades on a quiz are listed below:

5	**36**	**21**	**38**	**28**	**36**	**14**	**36**	**7**
28	**31**	**28**	**32**	**36**	**2**	**38**	**39**	

A) Construct a frequency table and frequency polygon using the grade intervals 0-9, 10-19, 20-29, and 30-39.
B) Find the five-number summary, then construct a box-and-whisker plot.
C) Determine the mode and range for this data.

6) Out of ten applicants for a scholarship, four applicants are to be selected as winners.
A) How many groups of four winners are possible?
B) How many groups of ordered winners are possible, where the winners are distinguished as first place, second place, third place, and fourth place?

7) In a standard 52-card deck (2, 3, 4, 5, 6, 7, 8, 9, 10, J, Q, K, A with four suits (clubs, spades, diamonds, and hearts)), find the probability that
A) one card is selected which is a 9 or a heart.
B) a 9 is selected, replaced, and then a heart is selected.
C) three cards are selected with replacement between selections, and all cards are diamonds.
D) three cards are selected without replacement between selections, and all cards are diamonds.

8) An experiment has outcomes 0, 1, 3, 5, 7, and 9 with the probabilities as shown below.

p(x)	.3	.2	?	.14	.16	.1
x	0	1	3	5	7	9

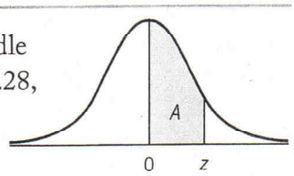
A) Find the missing p(x).
B) Determine the mean. (Round to the nearest whole number.)
C) Determine the standard deviation. (Round to one decimal place.)
D) Calculate the probability of having an outcome greater than 3.
E) Construct the probability histogram.

9) At one company, employees were asked to take an auditory test so their reaction times could be measured. The reaction times were approximately normal with $\boldsymbol{\mu = 80}$ milliseconds (*ms*) and $\boldsymbol{\sigma = 10}$ *ms*.
A) Find the percentage of employees with reaction times greater than 80 *ms*.
B) Find the percentage of employees with reaction times between 75 *ms* and 86 *ms*.
C) Find the percentage of employees with reaction times between 86 *ms* and 91 *ms*.
D) If there are 15,000 employees at the company, how many have a reaction time below 63 *ms*?
E) Above what reaction time is the slowest 2% of reaction times?

Statistical Tables

Table A Normal Curve (z) Table

The normal curve table gives only the percentage of data starting from the middle ($z = 0$), out to whatever z score you look up. For instance, if you look up $z = 1.28$, you get .3997. This means .3997 or 39.97% of the data in the normal curve is found between $z = 0$ and $z = 1.28$.



	Normal									
z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	.0000	.0040	.0080	.0120	.0160	.0199	.0239	.0279	.0319	.0359
0.1	.0398	.0438	.0478	.0517	.0557	.0596	.0636	.0675	.0714	.0753
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	.2257	.2291	.2324	.2357	.2389	.2422	.2454	.2486	.2517	.2549
0.7	.2580	.2611	.2642	.2673	.2704	.2734	.2764	.2794	.2823	.2852
0.8	.2881	.2910	.2939	.2967	.2995	.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	.4996	.4996	.4996	.4996	.4996	.4996	.4996	.4997
3.4	.4997	.4997	.4997	.4997	.4997	.4997	.4997	.4997	.4998	.4998
3.5	.4998	.4998	.4998	.4998	.4998	.4998	.4998	.4998	.4998	.4998