

University of Toronto, Faculty of Applied Science and Engineering
APS112 & APS113 Engineering Strategies and Practice
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Midterm Examination
Start: February 02, 2021, 6am EST (Toronto Time)
Finish: February 02, 2021, 6pm EST (Toronto Time)

Declaration

In submitting this assessment, I confirm that my conduct during this exam adheres to the Code of Behaviour on Academic Matters. I confirm that I did NOT act in such a way that would constitute cheating, misrepresentation, or unfairness, including but not limited to, using unauthorized aids and assistance, impersonating another person, and committing plagiarism. I pledge upon my honour that I have not violated the Faculty of Applied Science & Engineering's Honour Code during this assessment.

[No signature is required; agreement is indicated by submission of the exam]

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Midterm Instructions

- We estimate this midterm will take 60-minute to complete the five questions.
- Type X: An "open book" examination. The candidate may bring to the examination and use, any books, notes or other printed or written material, without restriction.

While you are free to access any of these resources, the midterm is still intended as an individual evaluation. As such you are not to communicate with anyone outside of the teaching team regarding the exam until after the close of the exam.

- Type your responses directly into this exam booklet. Answer each question only on the page on which the question is written. The markers will only mark one page per question.
- The word count indicates our expectations for each question, but it is not an enforced word limit. We want you to get to the point and not ramble, but also do not spend excessive time editing for concision.
- The marks listed on each question indicate our expectations.
- You can submit your completed exam booklet as a .docx or PDF into Quercus as per the instructions below.
- Remember to save your work frequently! Good luck!

Part 1: Writing the Exam

1. Download the exam booklet (.docx) to your computer. There is also a .PDF version of this exam supplied only to have a fixed reference for the formatting. Do not write your answers into that file.
2. Rename the exam answer booklet to the following where you insert your name and student number for the placeholders.

APS112_Midterm_First name_Last name_Student number

APS113 students should use "APS113" in place of "APS112" in the naming convention.

3. Answer all questions by typing directly into this exam booklet. Be sure to save the document frequently as you work.

Note: Completing the exam answer booklet does not in itself constitute submission of the exam. You must submit in Part 2: Submitting the Exam.

Part 2: Submitting the Exam

Once you have completed the exam answer booklet in Part 1: Writing the Exam, you must submit it. You must do this through Quercus. **DO NOT** email the files to us. The process of submitting your exam through Quercus is detailed below.

The exam submission deadline is 6 pm EST (Toronto time). **DO NOT** wait until the last minute to start submitting your exam. Submit as early as possible to allow you to seek technical assistance if you have any technical difficulties.

To submit your exam booklet (.docx or PDF) into Quercus.

1. Click on Submit Assignment.
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3. Check off the box "I agree to the tool's End-User Licence Agreement. This assignment submission is my own, original work."
4. Click on *Submit Assignment*.

Midterm Questions

Q1: Project Management

A project with eight tasks has a Gantt Chart as shown on the next page in Figure 1. The Gantt Chart has the task identification number (ID #), the start date for each task, end date of each task, duration for each task. Tasks dependencies are also illustrated in the Gantt Chart. The task descriptions are removed so that their description does not influence your decision process. Note that any person in the team can complete any task in the chart. Task ID#8 requires two people while all other tasks require only one person. Please answer the questions that appear on the pages following the Gantt Chart.

*****DO NOT ANSWER ON THIS PAGE. ANSWER ON THE PAGES FOLLOWING THE GANTT CHART UNDER THE QUESTIONS. WORK ON THIS PAGE WILL NOT BE MARKED.*****

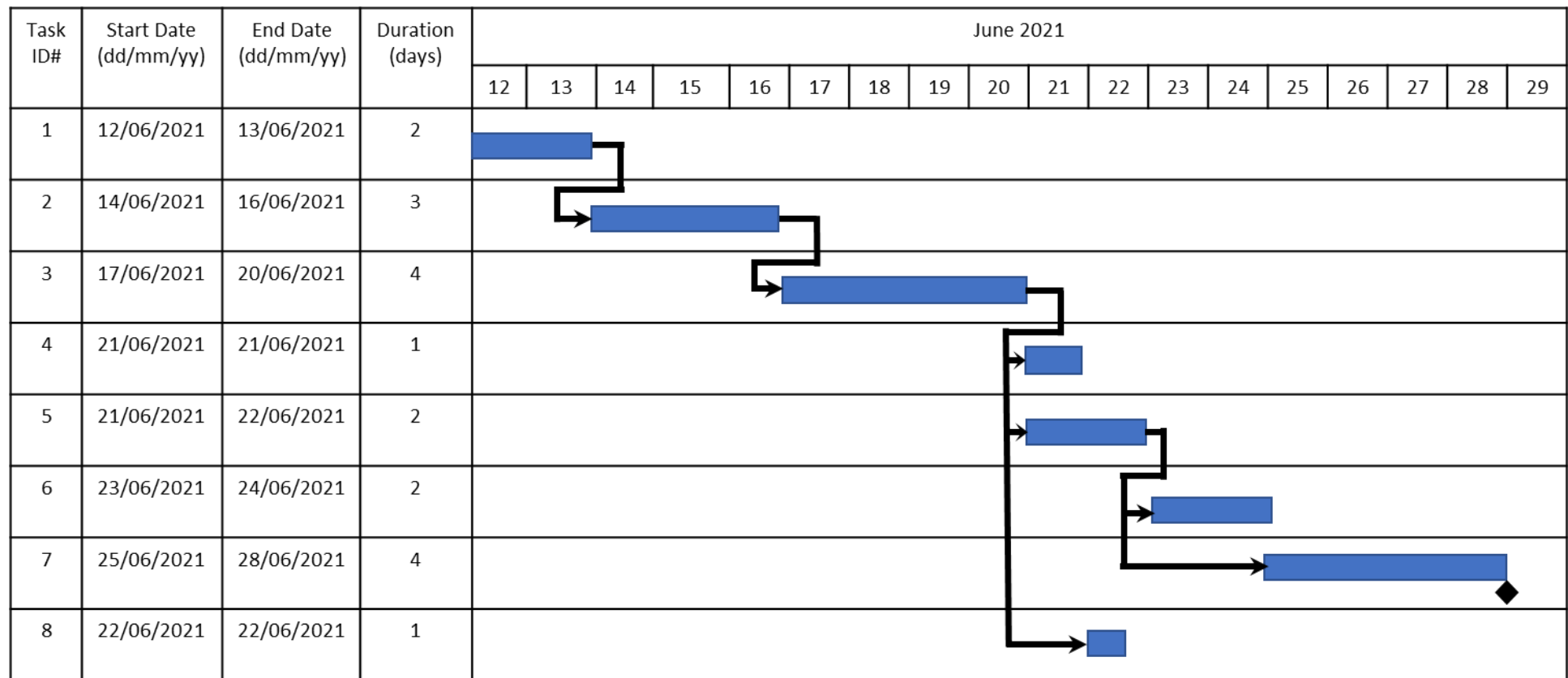


Figure 1 Gantt Chart for Question 1.

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- a. **[3 marks]** In the ESP Status Report (see Table 1) fill in the task number and due date for each task shown on the Gantt chart in Figure 1. You do not have to fill in task name, person assigned, outcome, or date completed.

2 marks for #s, 1 mark for dates due

Table 1: ESP Status Report

#	Task Name	Person Assigned	Date Due	Date Completed
1			13/06/2021	
Outcome:				
2			16/06/2021	
Outcome:				
3			20/06/2021	
Outcome:				
4			21(22)/06/2021	
Outcome:				
5			22(23)/06/2021	
Outcome:				
6			24(25)/06/2021	
Outcome:				
7			28(29)/06/2021	
Outcome:				
8			22/06/2021	
Outcome:				
Outcome:				
Outcome:				

- b. **[5 marks]** What is the minimum number of workers required to finish this project and justify your result? (demonstrate your structured thinking and justify your answer with a word count of 100 words)

After looking over the Gantt Chart we see that there are overlapping tasks, the worst case is

Task 3 -> 4,5,8: Task 8 requires 2 persons and Task 5 overlaps Task 8 so we have 3 persons

Now looking backward in time from task 4

Task 1 -> Task 2 -> Task 3 are independent, and follow a predecessor—successor relationship so no new persons are need as one of the 3 or each of the 3 can do the tasks

Looking forward in time from Task 5

No overlap, existing team members can carry out the tasks

Team size is 3

OR

Shift Task 7 left and then shift Task 8 to the right → Team size is 2 AND milestone is improved.

2 marks for recognizing task relationships.

2 marks for recognizing work distribution.

1 mark for any Team size.

- c. **[5 marks]** You are asked to speed up the delivery time. The Vice President gives you an additional team member so that your new team size is your result from Part (b) plus one. You cannot change any task durations nor any dependencies. Provide a written explanation as to whether you can speed up the delivery time (and by how much time) with the new team member or you cannot speed up the delivery time with the new team member. (demonstrate your structured thinking and justify your answer with a word count of 180 words).

First we look at “finding time”

Task 7 is the final task in the plan. It can be moved up by two days because it has a time gap with its predecessor. Looking at the Gantt Chart, Tasks 1, 2 and 3 are pinned due to their dependencies and there is no time gap in their start dates. As such, there is no room for improvement in time and *adding personal also does not speed things up*. Tasks 4, 5, 6 also have no time gap before their start date and the end date of their predecessor.

Second we look at personnel needs

If we shift Task 7, we have a new overlap with Task 6. Since each task requires one person (therefore two in total). If Task 8 is shifted right, there is no task overlap, only 2 team members are needed.

Conclusion: Extra member not needed.

2 marks analysis of time analysis

2 marks team size analysis

1 mark that additional team member has no impact OR save time and lose one team member

- d. **[8 marks]** Draw a new Gantt Chart (you can cut and paste from software or provide a clear and legible hand drawn sketch) if each person on your team (from part a) can only work during their normal working hours (i.e. 9 am to 5 pm), no work during the weekend (assume that the Gantt Chart in Figure 1 did permit weekend work), assume that there are no statutory holidays. Your team members work in the following times zones. The first member is in Toronto, if you need more team members they are as follows; the second member is 14 hours ahead, the third member is 3 hours behind, all remaining persons are 6 hours ahead. Your Gantt Chart must use Toronto time and day. Note that there may be a new deadline.

1 mark: Gantt chart with eight bar graphs

1 mark: Task dependencies are the same as in Figure 1

1 mark: There are task numbers

1 mark: There are dates

1 mark: Bar graphs resemble Figure 1. Note that some students may shift Task 7 and Task 8 for optimization and that is fine.

1 mark: Milestone is shown on the Gantt Chart

2 marks: Notes/arguments showing who/how each person is assigned to each task (is the student using random procedures or are they thinking about using the best allocation of people to achieve the best milestone)

Q2: Cost Estimation

You are working for a consulting company and you are asked to prepare an estimate for a construction proposal. The project is in the pre-planning phase and you are required to submit the estimate in just 15 minutes. The information you are given is that land will have to be purchased, the building is an office building, the building will be 12 stories high, there will be underground parking, each floor of the building will have a footprint of 20,000 ft², and the construction project will be in the GTA (Greater Toronto Area). To help you, the company provides you information on building projects in Canada (See Appendix A and Appendix B at the end of this examination paper).

- a. **[2 marks]** What method of estimation is best suited for this request (demonstrate your structured thinking and justify your answer with a word count of 25 words)?

Analogous. Very little time available and Appendix A is best suited for analogous estimates.

1 mark analogous (or any similar word)

1 mark for reasoning

- b. **[4 marks]** What is your estimate for the cost of land? (demonstrate your structured thinking and justify your answer with a word count of 100 words)

From Appendix A, we only have land price.

Price for land in GTA ranges from \$50/ft² to \$200/ft². Since we don't have a location we can choose a mid price of \$125/ft² (at this stage even using the price at the extremes will work since they are of the same order as \$125/ft²).

$$\text{Cost} = \$125/\text{ft}^2 * 20,000\text{ft}^2 = \$2,500,000$$

1 mark using Appendix A

1 mark recognizing cost range

1 mark justification for choosing a cost value

1 mark doing a proper calculation

reasonable value is \$ millions

- c. **[4 marks]** What is your estimate for the cost of the building? For simplicity in reading the chart in the appendix, use a class A building and do not use any interior fitout. (demonstrate your structured thinking and justify your answer with a word count of 55 words)

Using Appendix B, we have a range from \$200/ft² to \$315/ft² for each story using a rate for a class A building between 5 to 30 stories. For our order of magnitude use mid price of \$263/ft².

$$\text{Building cost} = \$263/\text{ft}^2 * 12 * 20,000 \text{ ft}^2 = \$63,120,000$$

Note: Students must use and recognize that 12 stories must be included.

1 mark using Appendix B

1 mark recognizing cost range

1 mark justification for choosing a cost value

1 mark doing a proper calculation

reasonable value is \$ tens of millions

Q3: Estimation

Students in the United States like to storm a football field after a victory. Answer the following questions (Hint: You can search on the internet for the dimensions of an American college football field):

- a. **[3 marks]** For a typical American college football field, estimate how many students can be on the field using a 6 ft separation rule for person-to-person separation. (demonstrate your structured thinking and justify your answer with a word count of 55 words)

1 mark sourcing size of football field: 320 ft x 160 ft playing (includes end zone) or other students may include side lines and that is fine

1 mark determining how to model 6 ft separation: circle, square, packing density of circles are all reasonable

1 mark for a calculation: values of 1500 to 3000 students are possible

- b. **[5 marks]** Estimate the number of students on the American football field in the picture in Figure 2. (demonstrate your structured thinking and justify your answer with a word count of 55 words)



Figure 2 Picture of students storming a football.

1 mark: Using the hash marks on the field (each are 1 yard)

1 mark: Notice that the students are closely packed together but not on the entire field

1 mark: estimating how closely people can be packed in an area

1 mark: estimating how much of the field is closely packed

1 mark: calculation of result (9,500 students is the ballpark)

Q4: Teamwork

When working in a team, different members bring different work styles to the team. Imagine a team of 5 students who describe themselves as: an Amiable, an Analytical, two Expressives and a Driver. One of the Expressive team members, notices that the Driver team member is struggling to work with the Amiable team member.

This question builds off of the lecturette on leveraging difference. The video in the last 12 minutes discusses tensions between styles and how they might manifest in a design team. There is an accompanying “inventory” handout which has descriptions of the styles and some of their strengths/weaknesses in the subsequent pages. These will be most helpful for getting a sense of the content being tested.

- a. **[4 marks]** What is a (one) challenge the driver and amiable team member might have working together? [100 words or less]

The driver will want to move forward and get results faster than the amiable may be comfortable with. The amiable may want to spend more time in discussion ensuring everyone’s voice is being heard and that they reach consensus than the driver likes.

The challenge will boil down to some tension between Driver{efficiency, progress, results/product focus} and Amiable{consensus, inclusion, people focused}.

2 marks for clearly stating what the challenge is, and 2 marks for explaining why it would occur between a driver and an amiable.

- b. **[3 marks]** What is one way of working the team could implement to mitigate this challenge? [60 words or less]

Many possibilities:

- Set time for reaching consensus, and a contingency plan for if it isn’t met
- Have the team come to the meetings with their ideas/arguments prepped in advance so that the whole meeting can focus on discussion
- Review and agree upon the importance of the decision so that it can determine how much time to spend on it

As long as the way of working addresses the way the student has articulated the tension presented in 1, its fine.

3 marks – 1 mark for being specific and having a clear process, 1 mark for whether it addresses the challenge presented in part 1, 1 mark for explanation of why.

- c. **[4 marks]** How can the Expressive team member who noticed the challenge, leverage their style to mitigate it? [60 words or less]

Expressives focus on ideas and love discussion, they often will come up with out of the box ways to solve problems and don’t mind confrontation. Amiables, are less comfortable with confrontation.

The expressive could identify the challenge to the team and begin brainstorming ways to address it, taking over the discussion.

The expressive (who likes a blend of product and people focus) could monitor the conversation to ensure both perspectives are brought to the table.

Because they are attuned to the emotional dynamics of the team, they could speak to the team members individually to find out how to address it.

2 marks for clearly stating what the approach is, and 2 marks for explaining why it would come from an Expressive

Appendix A: Land Prices

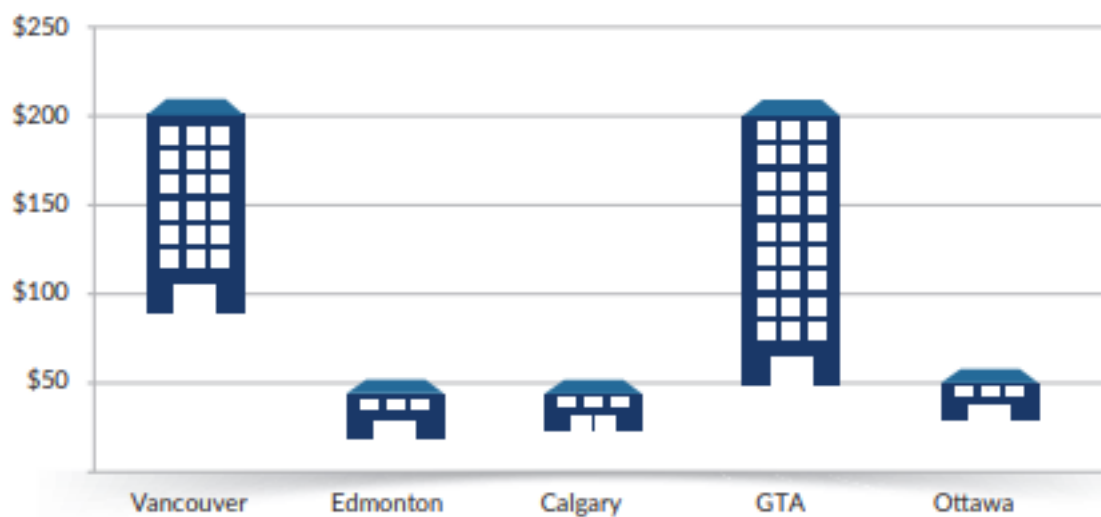


Figure A Land price in \$/ft² footprint for new construction. 2018 Canadian Cost Guide, Altus Group.

Appendix B: Construction Costs

PRIVATE SECTOR:

WESTERN CANADA

EASTERN CANADA

BUILDING TYPE			\$/Sq. Ft.	Vancouver	Calgary	Edmonton	Winnipeg	GTA	Ottawa/Gatineau	Montreal	Halifax	St. John's
RESIDENTIAL	CONDOMINIUMS/APARTMENTS (Includes Underground Parking)	Up to 6 Storeys (Hybrid Construction)		220 - 290	185 - 220	185 - 220	190 - 225	195 - 265	190 - 235	170 - 215	180 - 235	175 - 235
		Up to 12 Storeys		250 - 315	220 - 265	220 - 265	225 - 270	215 - 280	200 - 255	185 - 245	195 - 250	195 - 255
		13-39 Storeys		265 - 325	230 - 285	235 - 295	235 - 295	215 - 290	205 - 275	200 - 280	200 - 260	n/a - n/a
		40-60 Storeys		270 - 350	245 - 305	250 - 305	250 - 315	235 - 310	n/a - n/a	220 - 295	n/a - n/a	n/a - n/a
		60+ Storeys		320 - 370	n/a - n/a	n/a - n/a	n/a - n/a	275 - 330	n/a - n/a	n/a - n/a	n/a - n/a	n/a - n/a
		Premium for High Quality		80 - 200	60 - 160	60 - 160	65 - 165	75 - 200	55 - 160	65 - 170	65 - 170	60 - 170
	WOOD-FRAMED RESIDENTIAL	Row Townhouse with Unfinished Basement		120 - 185	110 - 140	115 - 140	110 - 140	100 - 155	110 - 150	100 - 140	95 - 135	110 - 145
		Single-Family Residential with Unfinished Basement		130 - 230	115 - 150	120 - 155	115 - 155	110 - 210	110 - 180	95 - 160	90 - 150	115 - 150
		3-Storey Stacked Townhouse		160 - 215	135 - 160	140 - 165	130 - 160	135 - 175	140 - 170	115 - 160	115 - 165	135 - 170
		Up to 4-Storey Wood-Framed Condo		165 - 225	145 - 170	150 - 175	150 - 175	145 - 195	150 - 185	115 - 170	125 - 160	125 - 170
		5 to 6-Storey Wood-Framed Condo		190 - 250	150 - 180	155 - 180	150 - 190	155 - 205	150 - 185	n/a - n/a	125 - 170	125 - 175
		Custom-Built Single-Family Residential		400 - 1,000	400 - 850	400 - 850	405 - 850	400 - 900	420 - 870	350 - 700	300 - 600	285 - 600
		Additional Cost for One Level Underground Parking		85 - 130	80 - 120	85 - 125	90 - 130	95 - 150	95 - 130	80 - 135	90 - 120	115 - 140
	SENIORS' HOUSING	Independent / Supportive Living Residences		190 - 280	160 - 250	165 - 255	165 - 255	170 - 270	160 - 245	150 - 240	155 - 235	170 - 240
		Assisted Living Residences		220 - 305	185 - 260	190 - 265	190 - 265	200 - 285	190 - 250	180 - 255	175 - 250	180 - 255
		Complex Care Residences		260 - 340	220 - 295	225 - 310	225 - 300	240 - 320	230 - 295	220 - 280	215 - 290	215 - 295
COMMERCIAL	OFFICE BUILDINGS (Over 5 Storeys incl. Underground Parking)	Under 5 Storeys with Surface Parking (Class B)		200 - 265	175 - 210	175 - 220	180 - 215	175 - 245	180 - 225	155 - 210	165 - 210	170 - 220
		5 - 30 Storeys (Class B)		250 - 285	175 - 265	175 - 270	180 - 275	180 - 265	190 - 245	165 - 245	175 - 240	185 - 230
		5 - 30 Storeys (Class A)		270 - 340	220 - 280	220 - 290	225 - 285	210 - 315	210 - 260	195 - 280	195 - 260	215 - 260
		31 - 60 Storeys (Class A)		295 - 390	265 - 360	265 - 380	275 - 370	280 - 390	n/a - n/a	255 - 370	n/a - n/a	n/a - n/a
		Interior Fitout (Class B)		40 - 105	35 - 85	35 - 85	35 - 90	40 - 90	40 - 85	40 - 90	35 - 85	35 - 85
		Interior Fitout (Class A)		100 - 160	75 - 130	75 - 130	75 - 130	80 - 150	80 - 135	80 - 145	75 - 135	75 - 135
	RETAIL	Strip Plaza		105 - 155	100 - 145	105 - 150	105 - 150	105 - 170	115 - 160	95 - 160	100 - 150	110 - 160
		Supermarket		170 - 220	150 - 200	160 - 205	150 - 205	145 - 200	150 - 180	120 - 170	125 - 190	135 - 180
		Big Box Store		160 - 220	150 - 200	160 - 205	155 - 205	135 - 190	145 - 170	115 - 170	135 - 175	135 - 180

Figure B. Construction costs for a variety of building types in various regions and cities in Canada. 2018 Canadian Cost Guide, Altus Group.