STOP *GRADED ASSIGNMENT!!* *Only the student's instructor may help.*

Project Cover Sheet

Grade: This project is worth 8% of your course grade

Assessment: This project allows you to demonstrate your ability to apply the mathematics learned to a business application. The project assessment includes points for mathematics, your technological competency, research and writing skills.

Mathematical Ability
Demonstrate your ability to use Business calculus for a practical application.

Technological Competency
This course is designated as meeting the Howard Community College General Education Technological Competency Goal; An HCC graduate selects and applies technology to investigate, create, communicate, and complete tasks.

Demonstrate your ability to select, and apply appropriate technologies for mathematical notation, graphs (*hand-drawn graphs are not acceptable*) and other visual representations as well as word processing for the completion of this project.

Research and Writing Skills
Effective written communication is an important skill in the Business world. Use college level writing and formal language, as well as correct grammar and punctuation. Use appropriate headings for clarity and well formed explanations and justifications. References should be given in APA format.

If you need help with research, you can contact use the **HCC Library Services**.
If you need help with writing, feel free to use the **HCC Writing Center**.
PGCC students at the Laurel College Center should see the PGCC Writing Center for assistance.

Review the grading rubric carefully to ensure you are familiar with the expectations for each section.

Project Audience: Non-Specialist
Someone that is not taking Business Calculus should be able to read your business report and understand it. A well-structured report will provide clarity for the reader. The report

should start with an introduction or opening description with headings and embedded graphs throughout the report. The report should *not* be formatted as an extended homework.

Writing a Business Report

When preparing a business or science report, the following steps are taken –

1. Data Analysis
2. Create Graphs and Tables
3. Write Report

Independent Project: No group work is allowed.

Checklist

- **Mathematics** – check work
- **Technological Competency** - check graphs are complete with titles
- **Writing –** check grammar, punctuation, headings, and flow of writing
- **Audience –** does the report start with an introduction or description and is it easy to follow for a non-specialist audience?
- **Check rubric**

Submission

- Projects should be submitted electronically on **Canvas** as a **pdf file**
- **Vericite** is used as a deterrent to plagiarism. All submissions are given an originality score
- **Ten percent will be deducted** for each calendar day the project is submitted after the due date. **After five days late the project earns a zero grade**

Business Calculus Project

In this project you are to present all your results in a "business report". This report must be typed. The details of your calculus and algebra work that support your results are to be included at the end. This project is worth 100 points.

A Global and Business Perspective on Income Inequality

Consider yourself a Business analyst consulting for a global social policy research institute as well as for a regional business research institute. In this report you will present the trends of income inequality in America and compare these to trends in two other countries. Use this information and your research to discuss what social policies can be implemented to reduce income inequality in America. You will also discuss income inequality and the impact on businesses.

The mathematics involved includes learning about the Lorenz function, and using calculus to determine the gini index. You will perform data analysis (**1. Data Analysis)**, and global data collection (**2. Global Data Collection).**

The mathematics is completed first in order have the information to write the report. The written report should begin with an introduction and the mathematics and graphs and images are embedded to support and illustrate the points made in the writing.

Be creative and clear in your report, choose appropriate headings, and citations. Use additional graphs and/or images for visual impact and for emphasizing your points.

Mathematics of Income Inequality

Income distribution amongst families is an important economic and social issue that has been brought to the public's attention over the past few years.
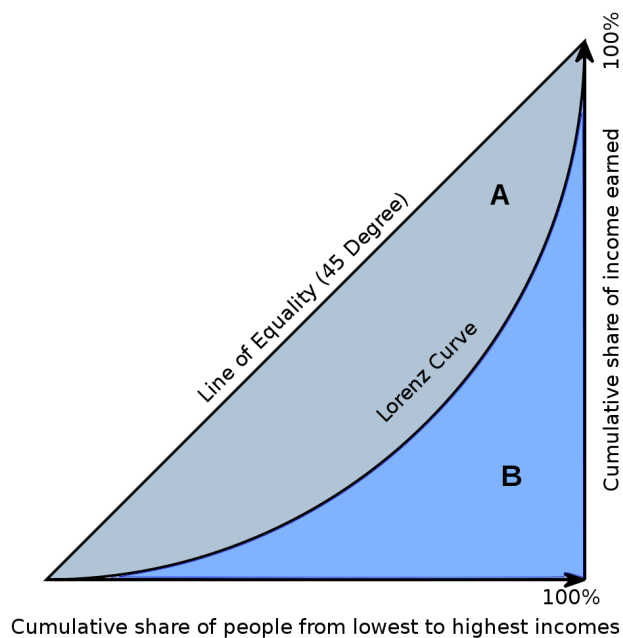
The U.S Bureau of the Census has collected and analyzed data for income distribution amongst families. To quantify income distribution economists use Lorenz curves. Economists use the Gini coefficient to compare Lorenz curves over different years or different nations.

Lorenz Curve

The Lorenz curve is the graph of the Lorenz function that shows the proportion of national income earned by a given percentage of the population.
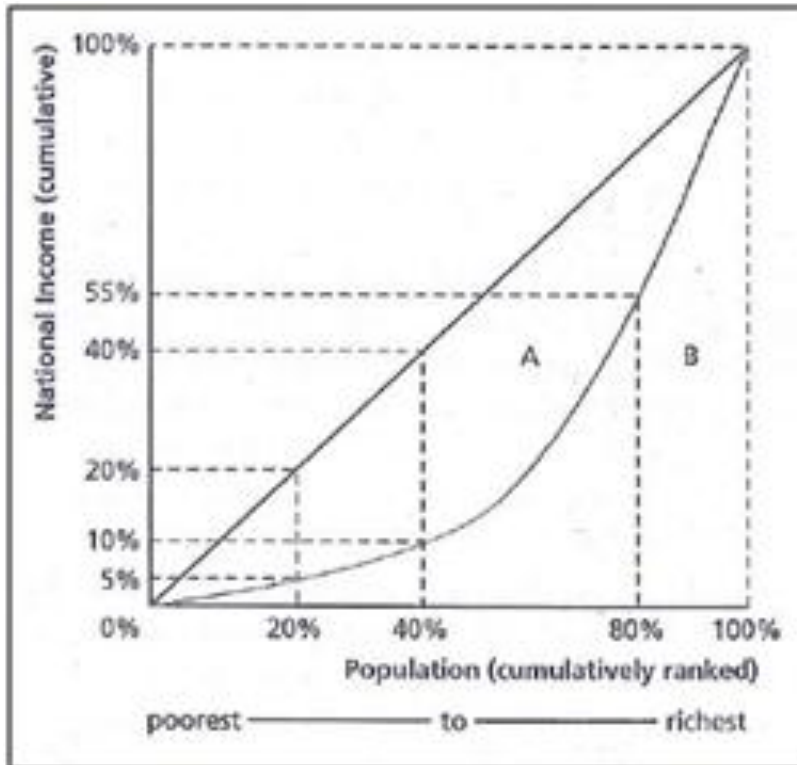
For example according to the above Lorenz curve 20% of the population receives 5% of the total income for all families in this year.

Cumulative share of income earned (100%)

Line of Equality (45 Degree)

A

Lorenz Curve

B

100%

Cumulative share of people from lowest to highest incomes

Absolute equality would be if 10% of the population received 10% of the total income. This is represented by the line $y = x$ as shown above. The greater the area between the Lorenz curve and the line $y = x$ the greater the income inequality.

Gini Index

The Gini Index allows more precise comparison of Lorenz curves. It is the proportion of the area taken up by the Lorenz curve (A) in relation to the overall area under the line of equality.

In this project you will use Calculus to determine the Gini index for given Lorenz functions over a period of years. Subsequently you will discuss and synthesize the Gini indices and what this means for income distribution.

Gini index = $2\int_{0}^{1}[x - f(x)]\,dx$ **where $f(x)$ is the Lorenz function**

1. USA Data Collection [10 points]

The following data, table 693 is from the US Census Bureau. It can be used to model a Lorenz function for a given year. As an example, let's consider income distribution in 1970. According to the data here, the poorest 20% (lowest 5th) of the population receives 4.1% of total income for families.

Table 693. Share of Aggregate Income Received by Each Fifth and Top 5 Percent of Households: 1970 to 2008

Year	Number of house-holds (1,000)	Income at selected positions (dollars)					Percent distribution of aggregate income					
		Upper limit of each fifth				Top 5 percent	Lowest 5th	Second 5th	Third 5th	Fourth 5th	Highest 5th	Top 5 percent
		Lowest	Second	Third	Fourth							
1970......	64,778	18,250	34,960	50,849	72,548	114,678	4.1	10.8	17.4	24.5	43.3	16.6
1980......	82,368	18,604	34,889	53,488	78,316	126,035	4.2	10.2	16.8	24.7	44.1	16.5
1990......	94,312	19,962	37,787	57,810	88,161	151,310	3.8	9.6	15.9	24.0	46.6	18.5
1995 [1]	99,627	20,201	37,756	58,922	91,359	158,521	3.7	9.1	15.2	23.3	48.7	21.0
2000 [2, 3] ...	108,209	22,405	41,260	65,233	102,232	181,568	3.6	8.9	14.8	23.0	49.8	22.1
2001......	109,297	21,854	40,515	64,456	101,549	183,030	3.5	8.7	14.6	23.0	50.1	22.4
2002......	111,278	21,442	39,946	63,625	100,552	179,525	3.5	8.8	14.8	23.3	49.7	21.7
2003......	112,000	21,053	39,803	63,747	101,693	180,425	3.4	8.7	14.8	23.4	49.8	21.4
2004 [4]	113,343	21,072	39,525	62,955	100,311	179,133	3.4	8.7	14.7	23.2	50.1	21.8
2005......	114,384	21,151	39,704	63,593	101,141	183,081	3.4	8.6	14.6	23.0	50.4	22.2
2006......	116,011	21,395	40,338	64,073	103,619	185,824	3.4	8.6	14.5	22.9	50.5	22.3
2007......	116,783	21,071	40,602	64,382	103,842	183,801	3.4	8.7	14.8	23.4	49.7	21.2
2008......	117,181	20,712	39,000	62,725	100,240	180,000	3.4	8.6	14.7	23.3	50.0	21.5

Source: U.S. Census Bureau, Income, Poverty and Health Insurance Coverage in the United States: 2008, Current Population
Reports, P60-236RV, and Historical Tables—Tables H1 and H2, September 2009. (2015, Oct 31) retrieved from Census data.

In order to model the data, we need to consider cumulative population and cumulative percentage of national income. Using the data from table 693 for 1970, the cumulative population and cumulative percentage of national income is calculated:

Table 1

Cumulative Population (%) x	Cumulative Income (%) y	Data Points (x,y)
20%	4.1%	(0.2,0.041)
40% (20% + 20%)	14.9% (4.1% + 10.8%)	(0.4,0.149)
60% (40% + 20%)	32.3% (14.9% + 17.4%)	(0.6,0.323)
80% (60% + 20%)	56.3% (32.3% + 24.5%)	(0.8,0.568)
100% (80% + 20%)	100% (56.3% + 43.3%)	(1,1)

A power function is used to model the Lorenz function. Using regression and the data points above (in the last column in the table above), you should get the following equation:

$$y = 0.92x^{1.96}$$

- As described above, select a year between 1970 and 1990 (do not select 1970 or 1990), this year is referred to as Year A. Use table 693 for the data for Year A, calculate the cumulative population and cumulative percentage of national income, and create a table (like **Table 1** for 1970).
- As described above, select a year between 1990 and 2008, this year is referred to as Year B. Use table 693 for the data for Year B, calculate the cumulative population and cumulative percentage of national income, and create a table (like **Table 1** for 1970).
- All work for **1. USA Data Collection**, **2. Data Analysis** and **3. Global Data Collection** should be included at the end of your report as an appendix.

2. Data Analysis Using Calculus [20 points]

Gini Index for 1970 to 2014

Table 2

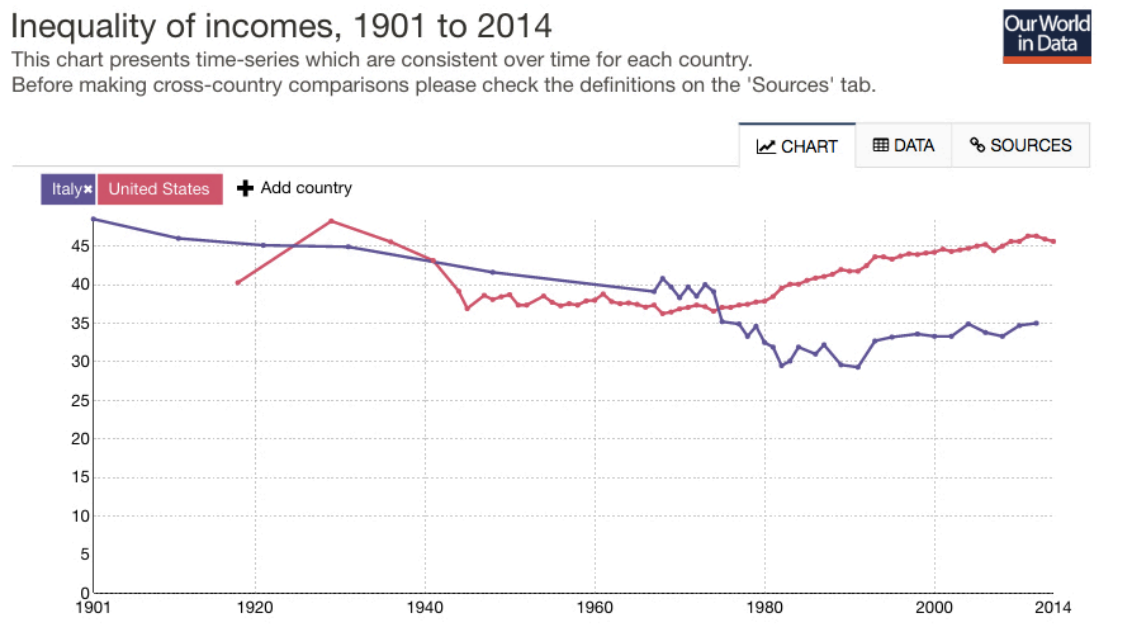| Year	Lorenz Function	Gini Index
1970	$y = 0.92x^{1.96}$	0.378
Year A (Year between 1970 and 1990)		
1990	$y = 0.88x^{1.99}$	0.411
Year B (Year between 1990 and 2008)		
2012	$y = 0.84x^{2.09}$	0.456
* 2014	$y = 0.84x^{2.09}$	0.479

Complete **Table 2**.

- Enter the year you selected for Year A into table 2. Calculate the Lorenz function for Year A, using power regression as described for 1970.
- Use Calculus to determine the Gini Index for Year A. Show all your work. The Calculus has to be done by hand, include the hand written work as part of the appendix. Please type the work in the document using appropriate software that has the capability to type mathematics. (Give your answer to 3 decimal places) [10 points]

- Enter the year you selected for Year B into table 2. Calculate the Lorenz function for Year B, using power regression as described for 1970.
- Use Calculus to determine the Gini Index for Year B. Show all your work. The Calculus has to be done by hand, please type the work in the document using appropriate software that has the capability to type mathematics. (3 decimal places) [10 points]

3. Global Data Collection [10 points]

The following chart shows income inequality for selected countries:

Inequality of incomes, 1901 to 2014
This chart presents time-series which are consistent over time for each country.
Before making cross-country comparisons please check the definitions on the 'Sources' tab.

- Go to https://ourworldindata.org/income-inequality/ find the Inequality of Incomes interactive chart. You have to scroll down to see it.
- Create a chart with three countries, USA and two other countries selected from the following: Canada, France, Finland, Germany, Netherlands, Norway, Sweden
- Countries can be added by selecting + **Add country**
- Click on **DATA, download the excel file, inequality-of-incomes-chartbook.csv.**
- **Open the excel file and find the GINI index** for the two countries you selected other than the USA, make a note of the GINI index for 1970 (or closest year available), Year B (as above) and 2014. Put this information in a table. One table can be used for both countries, or a table for each country.

[10 points]

4. Writing Business Report - Economic and Business Discussion [60 points]

You are a Business analyst consulting for a global social policy research institute as well as for a regional business research institute. Use the following to write your business report;

1. Data Collection
2. Data Analysis
3. Global Data Collection
4. Research on Income inequality

In this section everything that should be addressed in the report is outlined. Be creative and clear in your report, choose appropriate headings, and citations. Use additional graphs and/or images for visual impact and for emphasizing your points.

. Introduction

Write one to two paragraphs explaining income inquality. Define what income inequality means. Explain how it is quantified by economists using the Lorenz curve and the Gini index. Be sure to explain what the Lorenz function and Gini index are. Include diagrams or images that may be helpful.

[7 points]

In your explanation include the following –

Absolute Equality/Inequality

Absolute equality is indicated by a Gini index value of _____.
Interpret the meaning of this Gini index

Absolute inequality is indicated by a Gini index value of _____.
Interpret the meaning of this Gini index

[3 points]

. Graphical Representation
USA

- Include your completed table 2 (from **2. Data Analysis**)
  [1 point]
- Use appropriate technology to create one graph of the Lorenz function and the line of equality on the same set of axes for the following years: Ensure that the graph is clearly labeled with a title.   [5 points]
  - 1970
  - Year B
  - 2014

GLOBAL

- Embed the **time series graph** of the USA and the two countries you selected from the website https://ourworldindata.org/ or create your own graph with this information. Add an appropriate specific tittle to the graph.
  [4 points]

. Income Inequality – How Does the USA Compare Globally?

Use the Gini indices for the years 1970 to 2014 state whether income inequality is rising or declining in the USA. Use the **time series graph** to compare trends of income inequality in America to trends in the two other countries you selected.

Discuss in one to two paragraphs possible causes in the differences in income inequality in the different countries. Discuss at least four possible causes. Give in-depth reasoning with references.

Use this information and your research to discuss in two to three paragraphs what social policies can be implemented to reduce income inequality in America and improve upward mobility. Make sure to use a wide spectrum of articles and do not rely on web searches (such as Google) to produce the required diversity. Note that popular media sites cannot necessarily be relied on for unbiased articles. Include a discussion on social policies that work better in other countries. Give in-depth reasoning with references.

[15 points]

. Interest in Income Distribution

In one-page, describe at least five categories of concerned groups or individuals interested in income distribution. One of the categories must be businesses and retailers. How does income inequality impact each of the concerned groups? Use references and cite where appropriate.   [10 points]

. Technology Considerations

Discuss what technology you chose for modeling and graphing Lorenz functions and why these technologies were chosen. Also include any websites that you used to obtain information in regards to this project. What other technologies could you have considered for this project that were not used? Indicate why you decided not to use these technologies. [5 points]

. Professional Report With College Level Writing and References

Your report should be professionally written; that is, it should be well organized, easy to decipher with correct grammar, spelling and punctuation. Please note, this is a report, appropriate headings should be used. The report should be written for a general audience, that is someone who is not taking a Business Calculus course would be able to read the report and understand it. This document should not be submitted with the answers under each question. You should be comfortable submitting this report to your boss and feel confident presenting your report in a business meeting or professional conference. Be creative with the report. There should be a minimum of three references; they should be in APA format.

[10 points]

Grading Rubric: All Parts will be graded as a whole according to the following guidelines with comments provided to students.

USA Data Collection (Part I) – 10 points total

10 Points	8 Points	6 Points	4 Points	2 Point	0 Points
Correct tables of the cumulative population and cumulative percentage of national income for BOTH Years A and B.	**Minor** errors in table for Year A **OR** Year B	**Major** errors in table for Year A **OR** Year B	**Major** errors in tables for Year A **AND** Year B	An attempt was made to create a table that included the cumulative population and cumulative percentage of national income for Years A and B.	No submission, submission is plagiarized, or submission does not match assignment.

Data Analysis (Part II) – Lorenz Function – 10 points total

10 Points	8 Points	6 Points	4 Points	2 Points	0 Points
Lorenz Functions are correct for BOTH Years A and Year B.	Minor errors in Lorenz Functions for Years A OR Year B	One of the Lorenz Functions for Year A or Year B is incorrect	Incorrect Lorenz Functions for Years A AND Year B	Attempt to find Lorenz functions	No submission, submission is plagiarized, or submission does not match assignment.

Data Analysis (Part II) – Gini Index – 7 points total Calculate

7 Points	5 Points	3 Points	2 Points	1 Points	0 Points
Gini index was correct based on the correct Calculus steps for both Year A and Year B.	Gini index was incorrect based on the correct Calculus steps for Year A OR Year B.	Both Gini indices were incorrect.	No Calculus was used to find the Gini Index for Year A and Year B, but Gini Indices were correctly found.	Attempt to find the Gini index for Year A and B without using Calculus and both Gini indices were incorrect.	No submission, submission is plagiarized, or submission does not match assignment.

Business Report (Part II) –Application of Integration Theory – 3 points Apply

3 Points	2Points	1 Point	0 Points
Work is shown for all three points below – 1.Work is shown to show correct application of using theory of integration to calculate area between curves. 2.Correct integration interval. 3.Integration symbol and "dx" is used.	One of three points is not accurate.	**Attempt is made**.	No submission, submission is plagiarized, or submission does not match assignment.

Global Data Collection (Part II) – 10 points total

10 Points	8 Points	6 Points	4 Points	2 Point	0 Points
GINI index for 1970 (or closest year available), Year B and 2014 given for both countries in a table.	Minor error in table(s) containing GINI index or one year is missing.	GINI indices not given in a table or many errors.	Gini index information given for only one of the countries.	An attempt was made to give a table with GINI indices for two countries.	No submission, submission is plagiarized, or submission does not match assignment.

Business Report (Part III) – Introduction   – 7 points total

7 Points	5 Points	3 Points	2 Points	1 Point	0 Points

Two paragraphs **are provided clearly and appropriately explaining the following;** 1.Income inequality is defined in non-mathematical terms. 2. An explanation of how the Lorenz curve and 3.Gini Index are used to quantify income inequality is provided. Both paragraphs are well written and are **exemplary**; there is use of diagrams or images, and sources to clarify concepts regarding income inequality, the Gini Index, and the Lorenz Curve.	Two paragraphs **are provided.** **One** of the following three are **not explained clearly and/or appropriately;** 1.Income inequality is defined in non-mathematical terms. 2. An explanation of how the Lorenz curve and 3.Gini Index are used to quantify income inequality is provided. Both paragraphs are well written and **sufficient;** there is **some** use of diagrams or images, and sources.	Two paragraphs **were not provided**. **One** of the following three are **not explained clearly and/or appropriately;** 1.Income inequality is defined in non-mathematical terms. 2. An explanation of how the Lorenz curve and 3.Gini Index are used to quantify income inequality is provided. Paragraph(s) are written but **inadequate**; use some diagrams and sources.	Two paragraphs **were not provided**. **Two** out of the following three were **not explained clearly and appropriately;** 1.Income inequality is defined in non-mathematical terms. 2. An explanation of how the Lorenz curve and 3.Gini Index are used to quantify income inequality is provided. Paragraph(s) contained errors and there is **minimal** or no use of diagrams and sources.	Attempt was made.	No submission, submission is plagiarized, or submission does not match assignment.

Business Report (Part III) –Introduction (Absolute Equality/Inequality)– 3points
Interpret

3 Points	2Points	1 Point	0 Points
Absolute Equality and Absolute Inequality have correct Gini index values. **Both** Gini indices were **correctly** interpreted.	Absolute Equality and Absolute Inequality have correct Gini index values. **One** of the Gini indices were **incorrectly** interpreted.	**Attempt is made**.	No submission, submission is plagiarized, or submission does not match assignment.

Business Report (Part III) – Graphical Representation – 10 points total **Represent**

10 Points	8 Points	6 Points	4 Points	2 Points	0 Points
Completed table for the Lorenz Function and Gini Index included. All three graphs for Lorenz function and line of equality are provided for 1970, Year B and 2014.	Completed table for the Lorenz Function and Gini Index **not** included. OR Minor errors in one of three graphs	Completed table for the Lorenz Function and Gini Index **not** included. AND Minor errors in graph display or titles missing or inappropriate axis or one	Completed table for the Lorenz Function and Gini Index **not** included. AND Major errors in graph display or more than one graph is missing.	Attempt is made to include table AND Major errors with graphs. AND No time	No submission, submission is plagiarized, or submission does not match assignment.

		graph is missing. OR Only time series embedded.	. AND time series missing.	series.	
Time series embedded. All three graphs are clear with appropriate axis and a title.	Time series embedded.				

Business Report (Part III) – Global Income Inequality – 15 points total

15 Points	13 Points	10 Points	8 Points	4 Point	0 Points

Exemplary discussion.	Not discussed in-depth.	Superficial or surface level discussion.	Minimal discussion.	An attempt is made to discuss income inequality.	No submission, submission is plagiarized, or submission does not match assignment.
Correctly **state whether income inequality is rising or declining** in the USA from 1970 to 2014. Causes of income inequality are **discussed in-depth in one to two well-formed paragraphs**. **Two to three** paragraphs on social policies that could be implemented to improve upward income mobility, and social policies in other countries. Justifications for rationale are given. Appropriate references are used. **At least two** references.	Correctly **state whether income inequality is rising or declining** in the USA from 1970 to 2014. Causes of income inequality are **not discussed in-depth**. OR Social policies **not discussed in-depth.** OR No references or inappropriate references were used.	Correctly **state whether income inequality is rising or declining** in the USA from 1970 to 2014. **Superficial or surface level discussion** of causes of income inequality. OR Social policies **discussed at a surface level.** AND No references or inappropriate references were used.	Correctly **state whether income inequality is rising or declining** in the USA from 1970 to 2014. **Minimal discussion** of causes of income inequality. AND **Minimal discussion** of social policies. AND No references or inappropriate references were used.	**Many problems** with the attempt.	

Business Report (Part III) – Interest in Income Distribution – 10 points total

10 Points	8 Points	6 Points	4 Points	2 Points	0 Points

At least **four** categories of concerned groups or individuals interested in income distribution were discussed. A detailed explanation of impact for all groups is given with justifications and citations.	At least **four** categories of concerned groups or individuals interested in income distribution were discussed. The impact of **some** of these groups were **not discussed in-depth**.	At least **three** categories of concerned groups or individuals interested in income distribution were discussed. OR **Impact to businesses and retailers is not** discussed The impact of some of these groups were **not discussed in-depth**.	**One to two** categories of concerned groups or individuals interested in income distribution were discussed. OR **Impact to businesses and retailers is not** discussed. AND The impact of some of these groups were **not discussed in-depth**.	An attempt was made to complete the question.	No submission, submission is plagiarized, or submission does not match assignment.

Business Report (Part III) - Technology Considerations – 5 points total

5 Points	4 Points	3 Points	2 Points	1 Point	0 Points

Technology used is given with a reason for using this technology. **Pros and cons** of considered technologies are discussed.	Technology used is given with a reason for using this technology. Technology considered is listed with **minimal discussion of pros and cons**.	Technology used is given with a reason for using this technology. Technology considered is **only listed**.	Technology used is given **without** a reason for using this technology. Technology considered is **not given.**	An attempt is made to discuss technology used.	No submission, submission is plagiarized, or submission does not match assignment.

Business Report (Part III) – Professional Report – 10 points total

10 Points	8 Points	6 Points	4 Points	2 Point	0 Points

Report is professionally written with college level writing and formal language, as well as correct grammar and punctuation. The report has well formed explanations and justifications The writing is well constructed, flows and is easy to decipher. Appropriate headings are used. Citations and References are given. At least 3 references in **APA** style are used.	**Minor** errors in college level writing, grammar or punctuation. OR Explanations and justifications are **not well formed**. OR Some of the writing **does not flow** or is hard to decipher. OR **Mistakes in references** or citations.	**Errors** in college level writing, grammar or punctuation. AND Explanations and justifications are **not well formed**. AND Some of the writing **does not flow** or is hard to decipher. **Less than 3 references** or citations mistakes	**Report is not professionally written** with college level writing and formal language, as well as correct grammar and punctuation. The report is poorly organized, with minimal headings, references and is hard to decipher.	**Report is very difficult to read.**	No submission, submission is plagiarized, or submission does not match assignment.