# ASSIGNMENT # 1
## FORECASTING and AGREGATE PLANNING

A group of minimum of two (2) and maximum of three (3) students from **the same section** must submit their assignment. Students must work in groups. No individual assignment is allowed unless approved by the professor.
tudents are reminded that submitted assignments must be neat, readable, and well-organized. Assignment marks will be adjusted for sloppiness, poor grammar, spelling, for technical errors as well as if you submit a PDF file. The assignment is to be submitted electronically as a **single Word Document file** via BrightSpace learn by Saturday February 16th prior to 23:59. Front page of the Word document has to include title of the assignment, course code and section, student names and ID number. Plagiarism on assignments will not be accepted, *each student must sign the statement of integrity.*

**Please show your work/calculations. This assignment can NOT be hand written. ONE submission on Brightspace per group and you can NOT work with students from another section.**

E-mail questions related to the assignment should be sent to the Teaching Assistant or posted on the Brightspace course website "Discussion page" (viewed by all).

Section M: Michael Inglis (mingl095@uottawa.ca)
Section N: Mitchell McEwen (mmcew044@uottawa.ca)
Section P: Peyman Varshoei (pvars059@uottawa.ca)

**Problem # 1 - Jackson Manufacturing Corporation (30 points)**

Management of the Jackson Manufacturing Corporation wishes to choose a forecasting method for forecasting total sales for the corporation. Total sales (in million of dollars) for each month of the last year are shown below.

| Month | Sales | Month | Sales |
|---|---|---|---|
| January | 126 | July | 148 |
| February | 137 | August | 145 |
| March | 142 | September | 147 |
| April | 150 | October | 151 |
| May | 153 | November | 159 |
| June | 154 | December | 166 |

a) Plot the monthly sales data. Note how the sales is shifting significantly from month to month- first trending upward and then dipping down before resuming an upward trend. Assuming that similar patterns would continue in the future, evaluate how well you feel naïve, moving average, simple exponential smoothing and exponential smoothing with trend adjustment (i.e. double exponential smoothing) and trend projection methods would perform in forecasting future sales. (3 points)

b) Forecast sales using the naïve method and four-month simple moving average. Compare MAD and MSE values and provide your recommendation. (6 points)

c) Using initial estimates of 120 (i.e. F1 = 120), apply exponential smoothing with a smoothing constant alpha equal to 0.1, 0.3 and 0.5 to forecast sales. Compare both MAD and MSE for these three values of the smoothing constant alpha and provide your recommendation. (6 points)

d) Using initial estimates of 120 for the average value and 10 for the trend (i.e. F1 = 120, T1 = 10), apply exponential smoothing with trend adjustment (i.e. double exponential smoothing) to forecast sales. Use combination of the smoothing constant alpha equal to 0.3 or 0.5 and betta equal to 0.3 or 0.5. Compare MAD and MSE for these four combinations and provide recommendation. (6 points)

e) Which one of the above forecasting methods would you recommend that management use? Using this method, what is the forecast of total sales for January of the new year? (3 points)

f) The shift in total sales from month to month is due to the release of new products on top of a stable product base. Given this fact, how might the quantitative approach to forecasting total sales be improved? (3 points)

g) Describe the role of managerial judgment in applying the quantitative approach developed/suggested in part f). Be specific in your response. (3 points)

**Problem # 2 – Better Health Inc. (22 points)**

Better Health Inc. (BH Inc.) is a small company that conducts seminars on productivity and quality issues for hospitals and healthcare organizations. They focus on issue such as how to improve the quality of care for patients, how to motivate nursing staff and employees in healthcare organizations. The company tries to provide seminar participants with the tools essential for dealing with hard-to-measure issues. Originally, its seminars were geared toward healthcare administration only across Canada. However, over the years, the demand for seminars has grown, as has the company's client base. Clients now include healthcare managers and hospital executives from across the world who want to improve the quality and productivity of their department and provide better working environment for their staff.

Better Health Inc. has offered one seminar each season since 2010. Each seminar lasts for one week and is typically held at a resort or Hotel. The location has varied over the years, but the winter seminars have tended to be in Florida, the spring seminars in Ottawa, the summer seminars in the Vancouver, and the fall seminars in Boston.

The following table shows the number of individuals attending seminars since Better Health Inc. began providing service.

| | Quarter | | | |
|---|---|---|---|---|
| **Year** | **Winter** | **Spring** | **Summer** | **Fall** |
| 2010 | 35 | 44 | 54 | 49 |
| 2011 | 68 | 61 | 61 | 75 |
| 2012 | 70 | 62 | 70 | 74 |
| 2013 | 64 | 72 | 76 | 72 |
| 2014 | 73 | 62 | 85 | 72 |
| 2015 | 89 | 66 | 82 | 92 |
| 2016 | 96 | 78 | 95 | 94 |
| 2017 | 93 | 78 | 95 | 94 |
| 2018 | 95 | 82 | 89 | 87 |

Better Health Inc. is considering a major expansion program. Before committing to it, however, the company would like to be able to forecast the size of its seminars. Better Health Inc. is wondering if it should expand in all four seasons or if it should concentrate on one. The company would like to know if the growth has been even in all four regions or not.

a) Build the multiplicative decomposition forecasting model and answers BH Inc.'s questions above. (14 points)

Show your work for the multiplicative decomposition model and fill in the table below (Round to four decimal places).

| **Seasonal Indices** | |
|---|---|
| **1** | |
| **2** | |
| **3** | |
| **4** | |
| **Intercept** | |
| **Slope** | |

b) Using the multiplicative decomposition model above, is the forecast performing adequately? Justify your answer. (4 points)

c) Perform the forecast for year 2019. Show your calculations. (4 points)

**Problem # 3 – Riverside zoo (18 points)**

The Riverside Zoo is one of eastern Ontario's major tourist attractions. To be successful, the zoo must maintain its image as a high-quality place for its visitors to spend their time. Its animal exhibits must be clean, and the animals, birds, and reptiles look well cared for. As resources become available for construction and continuing operations, the zoo keeps adding new exhibits and activities. Attendance has increased from 53,353 in 2009 to an all-time record of 133,762 in 2014.

| | | Admission Fee ($) | | |
|---|---|---|---|---|
| Year | Attendance | Adult | Child | Group |
| 2009 | 53,353 | 1.50 | 0.75 | 0.50 |
| 2010 | 61,417 | 1.50 | 0.75 | 0.50 |
| 2011 | 63,853 | 1.50 | 0.75 | 0.50 |
| 2012 | 63,034 | 1.50 | 0.75 | 0.50 |
| 2013 | 95,504 | 2.00 | 1.00 | 0.50 |
| 2014 | 133,762 | 2.50 | 1.50 | 1.00 |
| 2015 | 108,363 | 2.50 | 1.50 | 1.00 |
| 2016 | 126,853 | 3.00 | 2.00 | 1.50 |
| 2017 | 125,363 | 3.00 | 2.00 | 1.00 |
| 2018 | 117,874 | 4.00 | 2.50 | 1.50 |

Due to its northern climate, the zoo conducts its open season from mid-April until mid-October. It reopens for 1 week at Halloween and for the month of December. Zoo attendance depends largely on the weather. For example, attendance was down during the month of December 2015, which established many local records for the coldest temperature and the most snow. Variations in weather also affect crop yields and prices of fresh animal foods, thereby influencing the costs of animal maintenance.

In normal circumstances, the zoo may be able to achieve its target goal and attract an annual attendance equal to 40% of its community. The city that zoo is located in has not grown appreciably during the past decade. But the zoo became known as an innovative community resource, and as indicated in the table, annual paid attendance has doubled. Approximately 35% of all visitors are adults. Children accounted for one-half of the paid attendance. Group admissions remain a constant 15% of zoo attendance.

The zoo does not have an advertising budget. To gain exposure in its market, then, the zoo depends on public service announcements, the zoo's public television series, and local press and social media coverage of its activities. They are a strong reason that annual zoo attendance has increased.

The zoo must ensure that its sources of income equal or exceed its operating and physical plant costs. Its continued existence remains totally dependent on its ability to generate revenues and to reduce its expenses.

a) The president of the Riverside Zoo asked you to calculate the expected gate **admittance figures** and **revenues** for both 2019 and 2020.
   Use simple linear regression as forecasting technique. Build two forecasting models; time series (i.e. independent variable is time) and a causal model (i.e. independent variable is expected average admission fees). Explain which one of the two models is more accurate for this prediction. Assume that admission fees are not raised in 2019 and 2020. (15 points)

b) If you were going to use multiple regression to develop such a model, what other quantitative variables might you include? Explain. (3 points).

**Problem # 4 – GB Computer Services (15 points)**

GB Computer Services repairs and services personal computer at its store, and it makes local service calls. It primarily uses part-time university students as technicians. The firm has had a steady growth since it started. Managers purchase generic computer parts in volume at a discount from variety of sources whenever they see a good deal. Thus, they need a good forecast of demand for repairs so that they will know how many computer component parts to purchase and stock, and how many technicians to hire.

The company has accumulated the demand data shown in the table below for repair and service calls for the past 12 months, from which it did consider simple exponential smoothing using a smoothing constant alpha = 0.25, and using the demand of period 1 as both demand and forecast for period 1 (i.e. F1 = A1)

| Period | Month | Demand for Repair and Service Calls | Forecast |
|---|---|---|---|
| 1 | January | 37 | |
| 2 | February | 40 | 37.000 |
| 3 | March | 41 | 37.750 |
| 4 | April | 37 | 38.563 |
| 5 | May | 45 | 38.172 |
| 6 | June | 50 | 39.879 |
| 7 | July | 43 | 42.409 |
| 8 | August | 47 | 42.557 |
| 9 | September | 56 | 43.668 |
| 10 | October | 52 | 46.751 |
| 11 | November | 55 | 48.063 |
| 12 | December | 54 | 49.797 |

a) Construct a Control Chart to monitor the forecast accuracy using control limits of ± 2σ (i.e. σ = standard deviation). Show your work. (10 points)

b) Is the forecast performing adequately? Explain. (5 points)

**Problem # 5 (60 points)**

A company produces a variety of recreation and leisure products. The production manager has developed an aggregate forecast:

| Month | Mar | Apr | May | Jun | Jul | Aug | Sept | Total |
|---|---|---|---|---|---|---|---|---|
| Forecast | 50 | 44 | 55 | 60 | 60 | 40 | 50 | 359 |

Use the following information to develop aggregate plans:

| | |
|---|---|
| Regular production cost | $240 per unit |
| Overtime production cost | $360 $per unit |
| Regular capacity | 40 units per month (i.e. 8 units/employee) |
| Overtime capacity | 8 units per month (i.e. (8/5) units/employee) |
| Subcontracting cost | $420 per unit |
| Subcontracting capacity | 12 units per month |
| Holding cost | $50 per unit per month |
| Back order cost | $100 per unit per month |
| Beginning inventory | 0 units |
| Desired ending inventory in September: | 0 Units (and not backlog) |
| Number of employees: | 5 |
| Hiring cost: | $500 per employee |
| Firing cost: | $1000 per employee |

Develop an aggregate plan using the following strategy and **compute the total cost of each plan.**

a) Develop a chase strategy aggregate production plan that would meet the forecasted demand of each month. (12 points)

b) With the current workforce level of 5 employees, develop a level strategy: the number of units produced regular, overtime and subcontracting are the same for all the months except for September. (12 points)

c) Develop a mix strategy aggregate plan that will minimize cost. Subcontracting is not allowed; however, all the other options are possible. (10 points)

d) With the current workforce level of 5 employees, develop an aggregate plan using the transportation method (i.e. find an initial feasible solution using the intuitive lowest-cost approach). **State the corresponding aggregate schedule plan** and its total costs? (24 points)

e) Among the four plans, which plan which one would you choose? Justify. (2 points)