MOS 3330 Test 1
Review Problems & Solutions

General Information

Course grade distribution policy:
- **DAN Management 3000 & 4000 level courses**: Mean of between 70-77% for all sections of the same course taught by the same instructor in that semester

Test date, time, location:
- See the course outline
- See also the course web site: [dan.uwo.ca/courses/3330](http://dan.uwo.ca/courses/3330)
- Test time conflict (due to having a Wed. evening class) – must report to the instructor no later than **one week before** the test date
- Exam conflict consists of having 3 exams **within 23 hours**
- Missing the test – check the course web site for instruction

Test coverage:
- Topic areas covered in Test 1:
  - Introduction to Operations Management
  - Supply chain management
  - Inventory management
  - Forecasting
- Test 1 covers **all materials covered in the lecture slide book** for the topics mentioned above
- Materials that are in the textbook but NOT in the lecture slide book will NOT be on the test
- Therefore, **you do not have to memorize everything in the textbook**; in the textbook, read only the same materials covered in the lecture slide book.

Test structure:
- Test 1 is worth 25% of your course grade
- Test 1 = total 65 marks
  - Question 1 – Computational, 4 parts, total 16 marks
  - Question 2 – Short answers, 1 question (conceptual, **no** calculation), total 9 marks
  - Question 3 – Multiple choice, 40 questions (concepts and simple calculations), 1 mark each, total 40 marks
  - **Formula sheet** – provided on the last page of the test (you can get an exact copy from the course web site prior to the test)

Don’t forget to bring to test:
- Student ID
- Non-programmable calculator
- Pencils for multiple choice scantron sheet
- No cell phones on person or on desk during the test
- No personal scrap paper
A. Computational

General Tips

Recommended steps for how to prepare for computational questions in Test 1:

1. Review computational examples in the lecture notes.
   - Understand input and output numbers for each formula.
   - Understand when to use each formula/model.
   - The test questions will not specify which formula/model to use; you have to identify which one to use based on information given (i.e., numerical data, the context of the question, and what the question is asking for).
   - The test questions may also contain unneeded numbers; you have to identify which number should be included or omitted in your calculation.

2. Download the formula sheet from the course web site.
   - Familiarize yourself with what is on the sheet.
   - Formula sheet is for the entire course; Test 1 covers the top $\frac{1}{3}$ of the formula sheet.
   - Symbols are not defined on the formula sheet; you should know what the symbols stand for as part of your understanding (e.g., you should know that TC in Inventory Management stands for “Total Cost”).

3. Study end-of-chapter problems in the textbook.
   - Practice how to carry out calculations using different formulas and models.
   - Familiarize yourself with typical input numbers and typical phrases that describe the context of the question.
   - You don’t have to do all problems in the textbook; see A1 below for suggested problems.

4. Study questions from the old exams.
   - See A2 below.

Notes on Rounding

- In most cases, just use “normal” rounding. For example, 32.15 should be rounded down to 32, and 47.85 should be rounded up to 48, if the final answer has to be an integer.
- For a physical quantity (e.g., order quantity), the final answer should be an integer.
- For a dollar amount, the final answer should have two decimal points (e.g., if the calculated total cost is $4608.9142, then the final answer is $4608.91$).
- For all intermediate calculations, use the decimal numbers before rounding (2 or 3 decimal places will suffice). For example, one question asks you to calculate EOQ and the total cost. Let’s say that EOQ = 32.15. Then 32.15 will be rounded down to 32 in your final statement of what the order quantity is. In order to calculate the total cost, however, use 32.15 (not 32) in the TC formula because it will give you a more precise answer.
A1. Textbook Computational Problems

<table>
<thead>
<tr>
<th>Topic</th>
<th>Suggested textbook end-of-chapter problems</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Inventory Management</strong></td>
<td></td>
</tr>
<tr>
<td>#9</td>
<td></td>
</tr>
<tr>
<td>#11</td>
<td></td>
</tr>
<tr>
<td>#13 – Use holding cost of $5/bag/year throughout this question; see the alternate solution provided in this review document</td>
<td></td>
</tr>
<tr>
<td>#14 – Use holding cost of $5/bag/year throughout this question; see the alternate solution provided in this review document</td>
<td></td>
</tr>
<tr>
<td>#17</td>
<td></td>
</tr>
<tr>
<td>#22 – Assume Q system</td>
<td></td>
</tr>
<tr>
<td>#23 – (b) Holding cost given is $0.55 per bag, but what you need is the holding cost per pound; also in (b), textbook calculates total cost differently from the lecture notes, but the answer is the same either way. <strong>FOR THE TEST, STICK TO THE LECTURE NOTES FORMULAS.</strong></td>
<td></td>
</tr>
<tr>
<td>#25 – (a) Holding cost given is $3 per bag, but what you need is the holding cost per pound; (b) textbook calculates total cost differently from the lecture notes, but the answer is the same either way. <strong>FOR THE TEST, STICK TO THE LECTURE NOTES FORMULAS.</strong></td>
<td></td>
</tr>
</tbody>
</table>

Notes for #23&25: pound vs. bag– convert pound to bag (or bag to pound, whichever is easier) once at the beginning; then you don’t have to worry about conversion after that. **FOR THE TEST, IF YOU NEED TO DO ANY CONVERSION, DO IT ONCE AT THE BEGINNING AND MAKE THE UNIT CONSISTENT THROUGHOUT THE QUESTIONS.**

<table>
<thead>
<tr>
<th>Forecasting</th>
<th>#3</th>
</tr>
</thead>
<tbody>
<tr>
<td>#5 – Start forecast from period 2 (i.e., F_1 is not needed); use F_2 = D_1 to start calculation</td>
<td></td>
</tr>
<tr>
<td>#6 – Start forecast from period 2 (i.e., F_1 is not needed); use F_2 = D_1 to start calculation</td>
<td></td>
</tr>
<tr>
<td>#9 – Solve the problem by the method shown in the lecture notes; see the alternate solution provided in this review document</td>
<td></td>
</tr>
<tr>
<td>#14 – Solve the problem by the method shown in the lecture notes; see the alternate solution provided in this review document</td>
<td></td>
</tr>
<tr>
<td>#19</td>
<td></td>
</tr>
<tr>
<td>#21 – Also use MAPD and CE to compare two methods; see the alternate solution provided in this review document</td>
<td></td>
</tr>
</tbody>
</table>

A2. Computational Questions from Old Exams

1. You are given the following partial demand and forecast data for a product:

<table>
<thead>
<tr>
<th>Quarter (t):</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forecast (F_t):</td>
<td>400</td>
<td>430</td>
<td>600</td>
</tr>
<tr>
<td>Demand (D_t):</td>
<td>420</td>
<td>370</td>
<td>680</td>
</tr>
</tbody>
</table>

a) Compute a 3-quarter simple moving average forecast for quarter 7.

b) The actual demand for quarter 7 turned out to be 1060. Compute an exponentially smoothed forecast for quarter 8 with $\alpha = 0.15$. Use the forecast for quarter 7 from part a).
c) Observing the actual demands for quarters 4 through 7, you are thinking about updating the value of \( \alpha \) in part b). Would you choose a smaller or larger value than 0.15? Justify your answer briefly.

d) For the forecasts given in part a) (quarters 4 to 6) and the forecast computed in a) (quarter 7), compute a measure of bias error. Is there any bias, and if so, has the forecast been biased low or high?

e) The product turns out to be popular homemade-style ice cream made in a small plant. The complete demand data for years 1, 2, and 3 are given below. Compute the forecast for each of quarters in year 4, given that the forecast for the total demand in year 4 is 2980 gallons.

<table>
<thead>
<tr>
<th>Year</th>
<th>Quarterly demand (in gallons)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Quarter 1</td>
</tr>
<tr>
<td>1</td>
<td>350</td>
</tr>
<tr>
<td>2</td>
<td>370</td>
</tr>
<tr>
<td>3</td>
<td>450</td>
</tr>
</tbody>
</table>

2. The University Gift Shop purchases sweatshirts emblazoned with the school name and logo from a vendor in Toronto. The vendor sells the sweatshirts to the Gift Shop for $34.99 apiece. Shipping from Toronto to London costs $110 per order. When an order arrives, it has been estimated that receiving and inspection tasks cost the Gift Shop $25. The annual holding cost for a sweatshirt is calculated as 11% of the purchase cost. The Gift Shop manager estimates that 3100 sweatshirts will be sold during the upcoming academic year.

   a) Determine the optimal order quantity using the basic EOQ model.

   b) The vendor has recently offered a 3% discount on the purchase price if the Gift Shop orders 500 or more but less than 2000 at a time, and a 5% discount if the Shop orders 2000 or more at a time. Would you take up one of these offers? If so, what is the new optimal order quantity, and if not, why not? Use the same holding cost from part a) throughout this question.

   c) Based on your answer in part b), how many orders will there be in a year? What is the annual average inventory level?

   d) Based on your answer in part b), what is the reorder point if the lead time is 3 business days? Assume that there are 260 business days a year.

   e) In parts a) and b), one type of the main inventory management costs has not been included in calculating the optimal order quantity. What is it and why has it been left out?

3. Big Value Supermarket stocks Crunchies Cereal. The demand for Crunchies was 10,200 boxes in year 6. The demand forecast for year 7 is calculated using exponential smoothing with \( \alpha = 0.12 \) (the forecast for year 6 was 9500 boxes). It costs Big Value $80 per order of Crunchies and $0.85 per box annually to keep the cereal in storage. The store manager wants to know what the optimal inventory management policy is for Crunchies in year 7. Determine the optimal policy and describe it based on a periodic review system. What is the total cost associated with the optimal policy, and what is the average inventory level of Crunchies? Assume that Big Value operates 365 days per year.

4. ABC Computers assembles microcomputers from generic components. It purchases its colour monitors from a manufacturer in Taiwan with a lead time of 21 days. Daily demand for monitors is normally distributed with a mean of 3.5 monitors and a standard deviation of 1.7 monitors. ABC has determined that the ordering cost is $325 per order, the annual holding cost is $25 per monitor, and the stockout cost is $450 per lost sale. Currently ABC calculates the safety stock level for monitors based on a 90% service level. If ABC is willing to spend 50% more on managing safety stock, what service level could be achieved? The number of standard deviations is 1.28 for 90% service level, 1.65 for 95%, 2.05 for 98%, and 2.33 for 99%. ABC uses a continuous review system.
5. The manager of Petro North gasoline service station wants to forecast the demand for unleaded gasoline next month so that the proper number of gallons can be ordered from the distributor. The manager has accumulated the sales data and forecast accuracy measures during the past 10 months, which are shown in the table below. Fill all blank spaces in the table labeled a through f.

<table>
<thead>
<tr>
<th>Month</th>
<th>3-month Simple Moving Average</th>
<th>Sales (in gallons)</th>
<th>MAD</th>
<th>MAPD</th>
<th>MSE</th>
<th>CE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feb</td>
<td>N/A</td>
<td>1130</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Mar</td>
<td>N/A</td>
<td>1360</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Apr</td>
<td>N/A</td>
<td>1440</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>May</td>
<td>1310.00</td>
<td>b</td>
<td>90.00</td>
<td>0.074</td>
<td>8100</td>
<td>–90</td>
</tr>
<tr>
<td>Jun</td>
<td>1340.00</td>
<td>1670</td>
<td>210.00</td>
<td>d</td>
<td>58500</td>
<td>240.00</td>
</tr>
<tr>
<td>Jul</td>
<td>1443.33</td>
<td>1810</td>
<td>262.22</td>
<td>0.167</td>
<td>e</td>
<td>606.67</td>
</tr>
<tr>
<td>Aug</td>
<td>1566.67</td>
<td>1920</td>
<td>c</td>
<td>0.172</td>
<td>94072</td>
<td>960.00</td>
</tr>
<tr>
<td>Sep</td>
<td>1800.00</td>
<td>1630</td>
<td>262.00</td>
<td>0.159</td>
<td>81038</td>
<td>790.00</td>
</tr>
<tr>
<td>Oct</td>
<td>a</td>
<td>1470</td>
<td>271.11</td>
<td>0.167</td>
<td>f</td>
<td></td>
</tr>
<tr>
<td>Nov</td>
<td>1673.33</td>
<td>1510</td>
<td>255.71</td>
<td>0.159</td>
<td>76021</td>
<td>310.00</td>
</tr>
</tbody>
</table>

6. Richmond Street Microbrewery makes Western Beer, which it bottles and sells in its adjoining pub/restaurant and by the case. It costs $1100 to set up, brew and bottle a batch of the beer. The annual cost to store the beer is $2.75 per bottle. The annual demand for the beer is 16,000 bottles and the brewery has the capacity to produce 28,000 bottles annually. The current production policy is to continue producing the beer until the storage gets full. The storage holds a maximum of 750 bottles of beer. Production starts again when the inventory of beer is depleted. The owners of the brewery are considering an option of increasing the beer storage space to hold a maximum of 3000 bottles as part of their expansion strategy for the next five years. Is this a good option in terms of the cost savings? Why or why not? Comment also on the current policy of producing the beer until the storage is full. What would be an optimal production policy for the brewery? Lastly, determine how many production days are required for the optimal production policy (assume one year = 365 days).

7. The following table shows demand and forecast data for a product in number of units.

<table>
<thead>
<tr>
<th>Period</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demand</td>
<td>70</td>
<td>100</td>
<td>160</td>
<td>100</td>
<td>85</td>
</tr>
<tr>
<td>Forecast</td>
<td>90</td>
<td>110</td>
<td>100</td>
<td>110</td>
<td>100</td>
</tr>
</tbody>
</table>

a) Select and compute appropriate measures of forecast error. Give an interpretation for each of the error measure value. Based on your interpretation, how would you improve the future forecast in general?

b) Your friend, Norman Bates, calculated F₆ from the data above, and told you that F₆ is 165. Could he have used a 3-period weighted moving average to obtain his F₆? Justify your answer briefly.

c) You are considering using exponential smoothing or simple moving average to calculate F₆. Norman tells you that exponential smoothing only includes the most recent demand and ignores earlier demands, so simple moving average is better. Is his right? Justify your answer briefly.
B. Multiple Choice

General Tips

Recommended steps for how to prepare for multiple choice questions in Test 1:

1. Focus on the lecture slide book.
   - All multiple choice questions are based on the lecture notes.
   - Be able to define/explain all terms and concepts contained in the lecture notes.
   - If you are not sure about a term or concept, make a note of that and look it up in the textbook later (see Step 2).

2. Read the textbook chapters that correspond to the test coverage.
   - DO NOT read the textbook unless you are clear about what is in the lecture notes.
   - Take notes only on the materials covered in the lecture notes.
   - Take notes on terms/concepts that you were not sure about in the lecture notes.
   - Read quickly through the terms/concepts that are not in the lecture notes (don’t take any notes).
   - Generally, you can find the materials covered in the lecture notes in the following chapters/pages: Chapter 1 (pp. 1-9, 15-27), Chapter 4 (pp. 98-150), Chapter 12 (pp. 432-458), and Chapter 8 (pp. 267-288, 293-315)

3. Study questions from the old exams.
   - See B1 below.

B1. Multiple Choice Questions from Old Exams

1) Service level of 95% means that
   a. the service goal is to meet 95% of annual demand
   b. the service goal is to meet 95% of demand during lead time
   c. there is a 95% chance that 95% of demand during lead time will be met
   d. there is a 95% chance that all of demand during lead time will be met

2) In ABC inventory classification system, class A items may
   a. require higher safety stock
   b. require frequent deliveries
   c. require a periodic inventory system
   d. require batch updating of inventory records

3) The simple moving average technique
   a. works better for long-range forecasts than short-range forecasts when large N is used
   b. reacts well to random variations
   c. reacts well to variations that occur for a reason
   d. requires minimal amount of data

4) An advantage of P system over Q system may be
   a. small inventory
   b. large inventory
   c. accurate inventory control
   d. low inventory control cost
5) Which of the following is true concerning the smoothing parameter \( (\alpha) \) used in exponential smoothing?
   a. \( \alpha = 0.4 \) means the forecast for the next period is based on 40% older data and 60% recent data.
   b. If \( \alpha = 0 \), the forecast is equivalent to the naive forecast.
   c. The higher the value of \( \alpha \), the less the effect of smoothing.
   d. The higher the value of \( \alpha \), the more the effect of smoothing.

6) For a company that uses a continuous review inventory system, which of the following is true?
   a. The order interval is fixed.
   b. The order interval may vary with each order.
   c. The order quantity and the order interval are fixed.
   d. The order quantity may vary with each order.

7) Suppose that the EOQ for an inventory problem was first calculated to be \( Q^* \). Then you found out that the ordering cost would be lower than anticipated. Without recalculating the EOQ, what can you say about the relationship between the new \( Q^* (= Q^*_{new}) \) and the original \( Q^* \)?
   a. \( Q^* = Q^*_{new} \)
   b. \( Q^* < Q^*_{new} \)
   c. \( Q^* > Q^*_{new} \)
   d. Inconclusive without knowing how much the ordering cost decreased

8) Among the following, the most suitable forecasting method when a trend exists is
   a. simple moving average with large \( N \)
   b. weighted moving average with a large weight on the most recent demand
   c. exponential smoothing with small \( \alpha \)
   d. adjusted exponential smoothing with small \( \alpha \) and small \( \beta \)

9) Quantitative and qualitative forecasting methods
   a. may produce conflicting results
   b. require historical data
   c. are mostly used for short- to medium-range forecasts
   d. cannot be used together

10) Inventory holding cost may include
    a. material purchase cost
    b. interest on loans
    c. penalty charge if demand is not met
    d. inspection of incoming supplies at warehouses

11) Given demands, \( D_1 = 20 \), \( D_2 = 16 \), and \( D_3 = 12 \), what is \( F_5 \) using the naive forecasting method?
    a. \( F_5 = 8 \)
    b. \( F_5 = 12 \)
    c. \( F_5 = 16 \)
    d. Inconclusive from the given data

12) In the EPQ model, which EOQ assumption does no longer hold?
    a. Lead time is constant
    b. Demand is constant
    c. Items are received all at once
    d. Supply is certain

13) A company has two sets of demand forecasts, one for the basic model and the other for the luxury model. The basic model forecast consists of dollar values under 500 and the luxury model forecast consists of values over 10000. If the company currently uses one forecasting method for both basic and luxury models, which forecast error should be used to assess the accuracy of the forecast method?
    a. MAD
    b. MAPD
    c. MSE
    d. CE
14) Considering a steak-house restaurant as an operations system, which of the following would not generally be used to describe the transformation process?
   a. Physical
   b. Locational
   c. Exchange
   d. Psychological

15) Which of the following is true about Operations Management?
   a. In order to create a stable and efficient working environment, Operations should be kept in isolation from outside influences such as customers.
   b. Since service organizations do not produce a product, the principles of inventory management do not apply.
   c. Operations managers are involved in managing people, processes and products.
   d. Operations managers are concerned about how to finance new equipment.

16) Large batch size orders
   a. are easier for the supplier to manage
   b. are more costly for the supplier
   c. decrease the customer’s inventory levels
   d. increase the customer’s flexibility to deal with sudden market changes

17) Which of the following does not contribute to uncertainty in the supply chain?
   a. demand forecasting
   b. inventory
   c. batch ordering
   d. price fluctuations

18) Vendor managed inventory means that
   a. vendors generate forecasts
   b. vendors often receive data electronically
   c. vendors take advantage of the distributor’s expertise
   d. vendors produce and deliver products to their customers

19) When a company withholds customization of its final products as long as possible, this is an example of
   a. postponement
   b. delayed warehousing
   c. extended storage
   d. cross docking

20) Which forecasting method suffers from the possibility of having one person’s opinion dominate the forecast?
   a. Market research
   b. Executive opinion
   c. Simple moving average
   d. Naïve method

21) Which companies are more likely to use 3PL services to handle most of their logistics needs?
   a. Transportation companies
   b. Warehousing companies
   c. Hospital equipment manufacturers
   d. Companies engaged in international business
C. Short Answers

General Tips

Recommended steps for how to prepare for short answer questions in Test 1:

1. Study the lecture slide book.
   - For short answer questions, the justification of your answer starts from the understanding of terms and concepts covered in the lecture notes.
   - Be able to define/explain all terms and concepts contained in the lecture notes.
   - Keep in mind that, if you study the lecture notes for multiple choice questions, then you are studying for short answers at the same time!

2. Read the textbook chapters that correspond to the test coverage.
   - DO NOT read the textbook unless you are clear about what is in the lecture notes.
   - Take notes only on the materials covered in the lecture notes.
   - For short answers, take notes on different examples and alternate explanations, which can help you with the building of your justification.
   - In regard to the terms/concepts that are not in the lecture notes but are in the textbook, reading through them once is recommended for short answers because it provides you with a broad perspective, which is helpful for building your justification.
   - Generally, you can find the materials covered in the lecture notes in the following chapters/pages: Chapter 1 (pp. 1-9, 15-27), Chapter 4 (pp. 98-150), Chapter 12 (pp. 432-458), and Chapter 8 (pp. 267-288, 293-315)

3. Study end-of-chapter discussion questions from the textbook.
   - You don’t have to do all questions in the textbook; see C1 below for suggested problems.

4. Study questions from the old exams.
   - See C2 below.

A short answer question may ask you:
- To apply a concept covered in the lecture notes to a real-world setting.
- Whether or not a strategy/method/model is a good idea for a particular organization.
- To choose among different strategies/methods/models for a particular organization.
- To suggest improvement for various operational issues.
- To provide a real-world example of a concept.

Do’s and Don’ts:
- Do demonstrate the basic understanding of concepts covered in the course.
- Do provide a sound and comprehensive justification/explanation that fits the context of the question.
- Do answer the question as directly as possible (read the question carefully!).
- Don’t include irrelevant ideas.
- Don’t go off at a tangent.
- Don’t repeat/rephrase the same points.
C1. Textbook Discussion Questions

<table>
<thead>
<tr>
<th>Topic</th>
<th>Suggested end-of-chapter discussion questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intro to OM</td>
<td>#1, 2, 3, 4, 8</td>
</tr>
<tr>
<td>Supply Chain Management</td>
<td>#10, 11 + Case: DIMCO #1</td>
</tr>
<tr>
<td>Inventory Management</td>
<td>#2, 3, 7, 8, 9, 10, 11, 13, 15, 16, 18, 19</td>
</tr>
<tr>
<td>Forecasting</td>
<td>#3, 4, 5, 6, 8, 9 + Case: Bram-Wear #1</td>
</tr>
</tbody>
</table>

C2. Short Answer Questions from Old Exams

1. How could a convenience store like 7-Eleven or Mac’s, which sells a variety of goods (snack foods, drinks, lottery tickets, sun tan lotions, etc.), implement the ABC system? Explain how you would categorize store items (give examples) and what type of inventory management policy you would use for each category.

2. Name a competitive strategy that Canadian Tire could use to manage its supply chain. Justify your answer briefly. Your answer will be graded based on the validity of your justification, not for what Canadian Tire may actually do.

3. For a grape farm in Southern California, which quantitative method would be appropriate for forecasting its demand and how would you select the values of parameters in those methods? Make sure to explain why you would choose certain methods and certain parameter values.
Solutions

A1. Textbook Computational Problems

Inv, #9  Appendix A (look for chapter 3 answers)
Inv, #11 Appendix A (look for chapter 3 answers)
Inv, #13  **Alternate solution:**
Basic EOQ = \( \left[ \frac{2(1560)(10)}{5} \right]^{\frac{1}{2}} \approx 78.99 \) not qualified for the lowest purchase price
TC@$19 = 10(1560/78.99) + 5(78.99/2) + 19(1560) = $30034.97
TC@$18 = 10(1560/100) + 5(100/2) + 18(1560) = $28486.00; the optimal quantity is 100

Inv, #14  **Alternate solution:**
Basic EOQ = \( \left[ \frac{2(1560)(10)}{5} \right]^{\frac{1}{2}} \approx 78.99 \) not qualified for the lowest purchase price
TC@$19 = 10(1560/78.99) + 5(78.99/2) + 19(1560) = $30034.97
TC@$18 = 10(1560/100) + 5(100/2) + 18(1560) = $28486.00
TC@$16 = 10\left(\frac{1560}{(1560/12) \times 3}\right) + 5(390/2) + 16(1560) = $25975.00
TC@$14.50 = 10\left(\frac{1560}{(1560/12) \times 6}\right) + 5(780/2) + 14.5(1560) = $24590.00; the optimal quantity is 780

Inv, #17 Appendix A (look for chapter 3 answers)
Inv, #22 (a) EOQ = 365.1 \approx 365
(b) \( R = dL + z\sigma(L)^{\frac{1}{2}} = (8)(2) + (1.88)(3)(2)^{\frac{1}{2}} = 23.98 \approx 24 \) rolls
(c) \( SS = z\sigma(L)^{\frac{1}{2}} = 7.98 \approx 8 \) rolls
(d) \( R = 25.88 \approx 26 \) rolls
(e) \( SS = 9.88 \approx 10 \) rolls

Inv, #23 Appendix A (look for chapter 3 answers) – (b) Note that the textbook provides an alternative way of calculating total cost; if you use the formula from the lecture notes, the final solution should be the same

Inv, #25 Appendix A (look for chapter 3 answers) – (b) Note that the textbook provides an alternative way of calculating total cost; if you use the formula from the lecture notes, the final solution should be the same

Fcst, #3 Appendix A (look for chapter 4 answers)
Fcst, #5 Appendix A (look for chapter 4 answers)
Fcst, #6 (a) \( \alpha = 0.1: \) \( F_2 = 430, F_3 = 415.9, F_4 = 411.01, F_5 = 416.91, F_6 = 422.02, \) MAD (over 5 periods) = 71.4; \( \alpha = 0.7: \) \( F_2 = 430, F_3 = 331.3, F_4 = 356.29, F_5 = 435.89, F_6 = 458.37, \) MAD (over 5 periods) = 83.18
(b) the answer is the same, \( \alpha = 0.1 \) is better; both data sets do not exhibit a trend and the variation in the data appears to be random

Fcst, #9  **Alternate solution:**
\( D_{\text{Fall}} = 200 + 230 = 430, D_{\text{Winter}} = 3000, D_{\text{Spring}} = 1100, D_{\text{Summer}} = 1551; \Sigma D_t = 6081 \)
\( S_{\text{Fall}} = 430/6081 = 0.07, S_{\text{Winter}} = 0.49, S_{\text{Spring}} = 0.18, S_{\text{Summer}} = 0.26 \)
\( F_{\text{Year3,Fall}} = 0.07 \times 4000 = 280, F_{\text{Year3,Winter}} = 1960, F_{\text{Year3,Spring}} = 720, F_{\text{Year3,Summer}} = 1040 \)

Fcst, #14  **Alternate solution:**
\( D_{\text{Fall}} = 352 + 391 = 743, D_{\text{Winter}} = 368, D_{\text{Spring}} = 1007, D_{\text{Summer}} = 666; \Sigma D_t = 2784 \)
\( S_{\text{Fall}} = 743/2784 = 0.27, S_{\text{Winter}} = 0.13, S_{\text{Spring}} = 0.36, S_{\text{Summer}} = 0.24 \)
\( F_{\text{Year3,Fall}} = 0.27 \times 1525 = 411.75 \approx 412, F_{\text{Year3,Winter}} \approx 198, F_{\text{Year3,Spring}} = 549, F_{\text{Year3,Summer}} = 366 \)

Fcst, #19 Appendix A (look for chapter 4 answers)
A2. Computational Questions from Old Exams

1. a) \( F_7 = \frac{(420 + 370 + 680)}{3} = 490 \)
   
   b) \( F_8 = \alpha D_7 + (1 - \alpha) F_7 = 0.15(1060) + 0.85(490) = 575.5 \pm 576 \)
   
   c) Since the demand for quarter 7 is notably larger than the demand for quarters 4-6, the sudden demand increase in quarter 7 should not be disregarded as a result of random variation. In order to reflect the recent change in demand, choose a higher value of \( \alpha \).
   
   d) Cumulative Error = \( \sum (D_t - F_t) = (420 - 400) + (370 - 430) + (680 - 600) + (1060 - 490) = 610 \); the large positive cumulative error indicates that the forecast has been highly underestimated.
   
   e) Ice cream can be a seasonal product, and in this case, a seasonal pattern is observed in the given demand data. So compute the forecast based on the seasonal forecast method.

   Seasonal factors: \( S_1 = \frac{D_1}{\Sigma D_i} = \frac{1170}{7830} \approx 0.15, S_2 = \frac{2140}{7830} \approx 0.27, S_3 = \frac{3030}{7830} \approx 0.39, S_4 = \frac{1490}{7830} \approx 0.19 \)

   Forecast for each quarter: \( F_{yr4,1} = (S_1)(F_{yr4}) = (0.15)(2980) = 447, F_{yr4,2} = (0.27)(2980) = 804.6 \approx 805, F_{yr4,3} = (0.39)(2980) = 1162.2 \approx 1162, F_{yr4,4} = (0.19)(2980) = 566.2 \approx 566 \)

2. a) \( P = $34.99 \) per unit, \( D = 3100 \) per year, \( C_0 = 110 + 25 = $135 \) per order, \( C_H = 0.11(34.99) = 3.8489 \approx $3.85 \) per unit per year

   \( EOQ = \left(\frac{2DC_0}{CH}\right)^{1/2} = \left[2(3100)(135)/3.85\right]^{1/2} = 466.2645 \approx 466 \) sweatshirts

   b) Compare the total cost for the following three scenarios:
   
   - Order basic EOQ: \( TC = C_0(D/EOQ) + C_H(EOQ/2) + P \cdot D = 135(3100/466.26) + 3.85(466.26/2) + 34.99(3100) = $110,264.12 \)
   
   - Order 500 to qualify for the first purchase discount (3%): \( TC = 135(3100/500) + 3.85(500/2) + 0.97(34.99)(3100) = $107,014.43 \Rightarrow lowest \ TC \)
   
   - Order 2000 to qualify for the second purchase discount (5%): \( TC = 135(3100/2000) + 3.85(2000/2) + 0.95(34.99)(3100) = $107,104.80 \)

   Take 3% discount; the new optimal order quantity is 500.

   c) Optimal order quantity (from part b) = 500

   Number of orders per year = \( 3100/500 = 6.2 \Rightarrow 6 \)

   Average inventory = \( 500/2 = 250 \)

   d) Lead time, \( L = 3 \)

   Daily demand rate, \( d = 3100/260 = 11.923 \approx 12 \)

   Reorder point = \( dL = (12)(3) = 36 \)

   e) Shortage cost has not been included in calculation because shortage never occurs in the basic EOQ model and EOQ with quantity discount due to the assumptions on demand (known and constant) and supply (certain and receive all at once).

3. \( F_7 = \alpha D_7 + (1 - \alpha) F_6 = 0.12(10200) + 0.88(9500) = 9584 \) boxes

   \( EOQ = \left(\frac{2DC_0}{CH}\right)^{1/2} = \left[2(9584)(80)/(0.85)\right]^{1/2} = 1343.15 \approx 1343 \) boxes

   Order interval = \( (\text{No. of days in a year})/(\text{No. of orders}) = 365/(D/\text{EOQ}^*) = 365/(9584/1343) = 51.147 \approx 51 \) days
Periodic review system: order 1343 boxes every 51 days

\[
\text{TC} = C_0(D/\text{EOQ}) + C_R(\text{EOQ}/2) = 80(9584/1343.15) + 0.85(1343.15/2) = $1141.68
\]

Average inventory level = \(\text{EOQ}/2 = 1343.15/2 = 671.575 \approx 672\) boxes

4. Current **safety stock** level = \(z \sigma \sqrt{L} = (1.28)(1.7)(21)^{\frac{1}{2}} = 9.972 \approx 10\) monitors

Once you obtain safety stock, the main inventory cost associated with safety stock is **holding cost**.

Current cost of holding 10 units of safety stock = (per-unit holding cost) \(\times\) (# of safety stock) = (25)(10) = $250 → if ABC is willing to spend 50% more on safety stock, then ABC's new holding cost = $375

New holding cost = 375 = (per-unit holding cost) \(\times\) (safety stock @ new service level)

\[25 \times (z (1.7)(21)^{\frac{1}{2}})\] → solve for \(z\) to find out what new service level could be achieved → \(z = 1.925\)

ABC could achieve **at least 97%** service level with 50% more spent on safety stock holding cost.

5. \(a = 3\)-month SMA = \((1630+1920+1810)/3 = 1786.67\)

\[b \rightarrow\] set up any forecast equation that includes \(b\): for example,

\[F_6 = (D_5+D_4+D_3)/3 = (b+1440+1360)/3 \Rightarrow \text{then solve for } b = 1220\]

\[c = \left(\begin{array}{|c|c|c|c|c|c|}
\end{array}\right)/4 = 285\]

Similarly:

\[d = 0.145\]

\[e = 83816\]

\[f = 473.33\]

6. **Is the storage expansion a good idea?**

One year = 365 days

\[d = 16000/365 = 43.84\]

\[p = 28000/365 = 76.71\]

Max inventory level = \(Q(1 - d/p)\)

\[750 = Q(1 - 43.84/76.71) \rightarrow Q = 1750\text{ bottles} = \text{current production quantity}\]

\[\text{TC} = C_0(D/Q) + C_R(Q/2)(1 - d/p) = 1100(16000/1750) + 2.75(1750/2)(1 - 43.84/76.71) = $11,088.39\]

Following the "full storage" production policy with storage expansion: \(3000 = Q(1 - 43.84/76.71) \rightarrow Q = 7000\text{ bottles} = \text{production quantity after storage expansion}\]

\[\text{TC} = 1100(16000/7000) + 2.75(7000/2)(1 - 43.84/76.71) = $6639.29 \rightarrow \text{storage expansion leads to a } $4449.10 \text{ cost saving; hence, storage expansion is a good idea}\]

**What would be an optimal production quantity?**

\[\text{EPQ} = \sqrt{\frac{2DC_0}{C_R(1 - d/p)}} = \sqrt{\frac{2(16000)(1100)}{(2.75)(1 - 43.84/76.71)}} = 5465.04 \approx 5465; \text{ TC} = 1100(16000/5465) + 2.75(5465/2)(1 - 43.84/76.71) = $6440.94 \rightarrow \text{cost savings compared to the current production policy}\]

However, max inventory level = \(\text{EPQ}(1 - d/p) = 5465.04(1 - 43.84/76.71) = 2342.14 \approx 2342 > \text{current storage capacity} \rightarrow \text{if EPQ were to be used, the storage space must be expanded}\]

Length of a production run = \(\text{EPQ}/p = 5465.04/(28000/365) = 71.24 \approx 71\) days

7. a) The data set given is small (only 5 periods). By observation, demand and forecast figures are relatively close in magnitude ⇒ **no need for MSE to reveal the existence of large forecast errors.**
**MAD vs. MAPD:** MAD and MAPD are essentially measuring the same thing = the average size of forecast errors; MAD reports it in units, and MAPD reports it in % (compared to the demand size). MAD is difficult to interpret without knowing more about the product or company (the context is not given in this question) ⇒ hence, **MAPD is easier to interpret** in this case (the closer MAPD to 0%, the better forecasting accuracy; the closer MAPD to 100%, the worse forecasting accuracy).

CE is the only method to measure bias (overestimate vs. underestimate); use **CE to find out whether or not the forecasts have been overestimated or underestimated.**

\[
\text{MAPD} = \frac{\sum |D_t - F_t|}{\sum D_t} = \frac{(20 + 10 + 60 + 10 + 15) / (70 + 100 + 160 + 100 + 85)}{115/515} = 0.223; \text{ quite high level of error relative to the size of demand}
\]

\[
\text{CE} = \sum (D_t - F_t) = (-20) + (-10) + (60) + (-10) + (-15) = +5; \text{ the forecasts have been biased slightly low; however, looking at the data reveals that 4 out 5 forecasts were biased \textit{high}, not low}
\]

General Improvement: lower forecast value in general; demand data exhibit quite a bit of fluctuation ⇒ be more responsive to change in demand, rather than smoothing; investigate the cause for the rather big increase in period 3 (was it random or by some special cause?); the product may also be a seasonal product ⇒ if so, make use of the seasonal forecast method

d) **Not possible** to get \(F_6 = 165\) from \(D_3 = 160, D_4 = 100,\) and \(D_5 = 85\) using a 3-period weighted moving average; the largest forecast based on the weighted moving average is with the weights, \(w_3 = 1, w_4 = 0\) and \(w_5 = 0: F_6 = (1)(160) + (0)(100) + (0)(85) = 160,\) which is still smaller than 165; hence, Norman could not have been using a 3-period weighted moving average for his calculation.

c) The claim “exponential smoothing only includes the most recent demand” is not true; the formula for exponential smoothing implies that all past demands are included: \(F_{t+1} = \alpha D_t + (1-\alpha)F_t = \alpha D_t + (1-\alpha)[\alpha D_{t-1} + (1-\alpha)F_{t-1}]\) and so on. Exponential smoothing and simple moving average have different advantages and limitations, so we cannot conclude that simple moving average is always better than exponential smoothing.

**B1. Multiple Choice Questions from Old Exams**

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
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<th>Answer</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>d</td>
<td>12</td>
<td>c</td>
</tr>
<tr>
<td>2</td>
<td>b</td>
<td>13</td>
<td>b</td>
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<td>11</td>
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</tbody>
</table>
C1. Textbook Discussion Questions

Intro, #1 Lecture notes, Introduction, slide 4
Intro, #2 E.g., operations managers must plan the production schedule, manage quality levels, and manage inventory
Intro, #3 E.g., fast food restaurant: the inputs include the cook, the grill, and the materials such as the meat, bun, and toppings; the materials are then transformed into the cooked hamburger
Intro, #4 Lecture notes, Introduction, slide 3
Intro, #8 Lecture notes, Introduction, slide 7
SCM, #10 Partnering is the development of a close relationship with a supplier, based on trust, shared information and vision; the advantages are the ability to reduce costs, improve quality and planning; the disadvantages are the violation of trust that can cause problems and the inability to quickly change suppliers if problems arise
SCM, #11 Lecture notes, Supply Chain Management, slide 9
SCM Case DIMCO #1 – DIMCO currently has 375 different suppliers from around the world. They supply 1350 different components or raw material items. DIMCO sends all of its finished goods to a central warehouse that next supplies ten regional distributions centers (RDCs). Each of the RDCs supplies an average of 12 local distributors that supply an average of 35 retailers.
Inv, #2 Lecture notes, Inventory Management, slide 2-3
Inv, #3 Lecture notes, Inventory Management, slide 4
Inv, #7 Lecture notes, Inventory Management, slide 9
Inv, #8 Lecture notes, Inventory Management, slide 9
Inv, #9 Lecture notes, Inventory Management, slide 9
Inv, #10 Lecture notes, Inventory Management, slide 9
Inv, #11 Lecture notes, Inventory Management, slide 10
Inv, #13 Increases in the demand or ordering costs will increase the EOQ since they have a positive relationship, which also means that decreases in them will decrease the EOQ; there is an inverse or negative relationship between holding costs and EOQ, e.g., as they increase, the EOQ decreases, and vice versa
Inv, #15 Lecture notes, Inventory Management, slide 20
Inv, #16 Safety stock increases the reorder point
Inv, #18 Lecture notes, Inventory Management, slide 7
Inv, #19 Perpetual review is the same as continuous updating of the inventory record
Fcst, #3 Lecture notes, Forecasting, slide 5
Fcst, #4 Lecture notes, Forecasting, slide 4
Fcst, #5 Lecture notes, Forecasting, slide 6-7
Fcst, #6 Time series models assume that the demand is only related to its own past demand patterns; causal models assume that the some other factor affects the variable we are trying to predict
Fcst, #8 Using the same forecasting model may not continue to be the best way to accurately forecast demand if changes in the environment occur
Fcst, #9 We should consider the amount and type of available data, the degree of accuracy, the length of forecast horizons, and whether data patterns exist; we should evaluate the trade-offs between data accuracy and the cost to forecast
Fcst Case Bra-Wear #1 – No, seasonal exponential smoothing is not the best model for forecasting Urban Run athletic wear because the demand pattern is no longer seasonal.
C2. Short Answer Questions from Old Exams

The following are **guidelines** only since there is more than one way to answer short answer questions.

1. An **example** of ABC inventory management system for a convenience store:

<table>
<thead>
<tr>
<th></th>
<th>Item</th>
<th>Inventory Management Policy</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>• Fast moving, high volume – e.g., chips, chocolate bars, drinks</td>
<td>– Continuous review</td>
</tr>
<tr>
<td></td>
<td>• Relatively fast moving, high $value per item – e.g., cigarettes</td>
<td>– Tight control</td>
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<tr>
<td></td>
<td></td>
<td>– Frequent deliveries</td>
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<tr>
<td></td>
<td></td>
<td>– Accurate inventory required</td>
</tr>
<tr>
<td>B</td>
<td>• Moderate moving, moderate $value – e.g., packaged candies, stamps,</td>
<td>– Continuous or periodic review</td>
</tr>
<tr>
<td></td>
<td>lottery tickets</td>
<td>– Moderate control</td>
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<tr>
<td></td>
<td></td>
<td>– Weekly or monthly deliveries</td>
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<tr>
<td></td>
<td></td>
<td>– Order in batches</td>
</tr>
<tr>
<td>C</td>
<td>• Slow moving – e.g., “emergency” items such as toothpaste, sun</td>
<td>– Periodic review</td>
</tr>
<tr>
<td></td>
<td>tan lotion, can openers</td>
<td>– Simple control</td>
</tr>
<tr>
<td></td>
<td>• Very low $value per item – e.g., loose candies with 5¢ and 10¢</td>
<td>– Monthly or quarterly deliveries</td>
</tr>
<tr>
<td></td>
<td>value</td>
<td>– Visual review</td>
</tr>
</tbody>
</table>

2. **Examples** of strategies: vendor managed inventory, plant-direct shipping, cross docking, virtual integration; each strategy requires a justification based on, for example, the nature of business, products, company size, etc.

3. **Examples** of appropriate methods: simple moving average if the demand is generally stable; seasonality method if the demand exhibits a seasonal pattern; each method requires a justification based on, for example, what you think about the demand pattern, data availability, etc.

   The selection of parameter values is an iterative process in general; the starting values may be low, medium, or high depending on the demand pattern.