1. (10 points) A farm tractor manufacturing company called HNC in Detroit, Michigan is using a special environment friendly engine in its brand new tractor model. The tractor sales for this model show a fairly steady demand of 5600 tractors per year. HNC purchases these engines from an engine producer in Detroit area at a price of $4000. It costs HNC $10,000 to place an order. Inventory holding costs are based on an annual interest rate of 20% and HNC works 50 weeks in a year.

Suppose that the engine supplier is offering an incremental quantity discount with the following unit cost:

\[
c = \begin{cases} 
4000 & \text{for } Q < 200 \\
3800 & \text{for } 200 \leq Q < 400 \\
3500 & \text{for } 400 \leq Q 
\end{cases}
\]

(a) What is the optimal order quantity?
(b) What is the annual total cost of ordering, holding, and purchasing cost?

2. (10 points) MMC, a producer of mobile homes, experiences a yearly demand of 500 units. MMC incurs a cost of $250 for placing a new order with the factory. The estimated inventory holding costs is $1,200 per unit per year. When an item is not in stock, MMC’s customers are willing to wait to receive the unit, but such backorders cost MMC $1,500 per unit per year. Compute,

(a) (2 points) The optimal order quantity.
(b) (1 point) The maximum inventory level.
(c) (1 point) The maximum shortage level.
(d) (1 point) The length of the order cycle.
(e) (1 point) The total annual inventory, ordering, and backordering cost.
(f) (2 points) If MMC is not allowed to backorder the demand (i.e., if it must meet all the demand on time), what would be the total cost?
(g) (2 points) From your previous answers, explain why MMC’s total cost is lower with backordering.
3. (15 points) Fancy Shirts is a retail store that sells high quality dress shirts. They divided the shirts into four major categories: men’s casual, men’s formal, women’s casual, and women’s formal. The weekly demands and average prices for the shoes in these categories are given below:

<table>
<thead>
<tr>
<th>Category</th>
<th>men’s casual</th>
<th>men’s formal</th>
<th>women’s casual</th>
<th>women’s formal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demand</td>
<td>60</td>
<td>20</td>
<td>100</td>
<td>30</td>
</tr>
<tr>
<td>Price</td>
<td>14</td>
<td>18</td>
<td>16</td>
<td>20</td>
</tr>
</tbody>
</table>

The ordering cost for each of these categories is $100 and the holding cost is computed based on a 20% annual interest rate.

(a) (10 points) If the store has capacity to store 1000 shirts, what lot sizes should they order for each category such that they do not exceed the storage space availability at any time? (There are 52 weeks in a year. For this part of the problem, you can use a spreadsheet if you like.)

(b) (5 points) Now suppose the store does not have a capacity restriction (they built extra storage space in the back to hold up to 5,000 shirts), but they have a budget restriction. In particular, they do not want to invest more than $20,000 in inventory at any given time. What lot sizes should they order for each category such that they do not exceed the available budget at any time?