Question 1
A) 3marks
The Academic Computing Center has five trainers available in its computer labs to provide training sessions to students. Assume that the capacity of the system is 1900 students per semester and the utilization is 90%. If the number of students who actually got their orientation session is 1500, what is the efficiency of the system?

Solution:

\[
\text{Utilization} = \frac{\text{actual output}}{\text{design capacity}} = \frac{1500}{1900} = 0.90 = 90\%
\]

Actual output ? = 1710 = this is effective capacity

\[
\text{Efficiency} = \frac{\text{actual output}}{\text{effective capacity}} = \frac{1500}{1710} = 0.877 = 87.7\%
\]

Question 1
B) 5marks
A fabrication company wants to increase capacity by adding a new machine. The firm is considering proposals from vendor A and vendor B. The fixed costs for machine A are $90,000 and for machine B, $75,000. The variable cost for A is $15.00 per unit and for B, $18.00. The revenue generated by the units processed on these machines is $21 per unit. If the estimated output is 5000 units, which machine should be purchased?

Solution:

Vendor A:
Fixed cost: \( F_A = 90000 \)  
Variable cost: \( V_A = 15 \)  
Price per unit \( P_A = 21 \)  
Profit = Total revenue – Total cost  
Profit = \( TR - TC = (P * X) - (F + V * X) \)  
Profit = \( (21*5000) - (90000 + 15 * 5000) \)  
Profit = \(-60000 \) $ (Loss by adding a new machine from vendor A)

Vendor B:
Fixed cost: \( F_B = 75000 \)  
Variable cost: \( V_B = 18 \)  
Price per unit \( P_B = 21 \)  
Profit = Total revenue – Total cost  
Profit = \( TR - TC = (P * X) - (F + V * X) \)  
Profit = \( (21*5000) - (75000 + 18 * 5000) \)  
Profit = \(-60000 \) $ (Loss by adding a new machine from vendor B)

No purchase of new machine because neither machine yields a profit at that volume
Question 1
C) 7 marks
A product is currently made in a process-focused shop, where fixed costs are $9,000 per year and variable cost is $50 per unit. The firm sells the product for $200 per unit. What is the break-even point (in units and in $) for this operation? What is the profit (or loss) on a demand of 200 units per year?

Solution:
\[ \text{BEP}_x = \frac{\text{Fixed cost}}{\text{Unit price} - \text{Variable cost}} = \frac{9000}{200-50} = 60 \text{ units} \]
\[ \text{BEP}_y = \text{BEP}_x \times \text{Unit Price} = 60 \times 200 = 12000 \text{ $} \]
\[ \text{Profit} = \text{TR} - \text{TC} = (200 \times 200) - (9000 + 50 \times 200) = 21000 \text{ $} \]

BEP = 60 units; TR = $40,000, TC = $19,000, therefore Profit = $21,000.

Question 2
A) 3 marks
A certain type of computer costs $1,000, and the annual holding cost is 25%. Annual demand is 10,000 units, and the order cost is $150 per order. What is the approximate economic order quantity?

Solution:
\[ \text{EOQ} = \sqrt{\frac{2DS}{H}} = \sqrt{\frac{2DS}{ip}} \]
\[ \text{EOQ} = \sqrt{\frac{2 \times 10000 \times 150}{0.25 \times 1000}} = 110 \text{ units} \]

Question 2
B) 3 marks
The assumptions of the production order quantity model are met in a situation where annual demand is 3650 units, setup cost is $50, holding cost is $1 per unit per month, the daily demand rate is 10 and the daily production rate is 100. What is the production order quantity?

Solution:
\[ \text{POQ} = \sqrt{\frac{2DS}{(1 - \frac{d}{p})H}} \]
\[ \text{POQ} = \sqrt{\frac{2 \times 3650 \times 50}{(1 - \frac{10}{100}) \times 12}} = 184 \text{ units} \]

H=1 per unit per month *12= 12 per unit per year
**Question 2**  
**C) 14 marks**  
The annual demand, ordering cost, and the inventory carrying cost rate for a certain item are \( D = 600 \) units, \( S = \$20 \)/order and \( I = 30\% \) of item price. Price is established by the following quantity discount schedule. What should the order quantity be in order to minimize the total annual cost?

<table>
<thead>
<tr>
<th>Quantity</th>
<th>1 to 49</th>
<th>50 to 249</th>
<th>250 and up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price</td>
<td>$5.00 per unit</td>
<td>$4.50 per unit</td>
<td>$4.10 per unit</td>
</tr>
</tbody>
</table>

**Solution:**  
**Range 1**  
1 to 49  
Economic order quantity \( Q_1 = \sqrt{\frac{2DS}{I}} = \sqrt{\frac{2 \times 600 \times 20}{0.3 \times 5}} = 126.49 \) units  
\( Q_1 \) is not in range avoid the calculation

**Range 2**  
50 to 249  
\( EOQ = Q_2 = \sqrt{\frac{2 \times 600 \times 20}{0.3 \times 4.5}} = 133.33 \) units  
\( Q_2 \) is in range calculate the Total cost  
Total cost = Total inventory cost + Product Cost  
\[
\text{Total cost} = \frac{D}{Q} S + \frac{Q}{2} H + D \times \text{price} = \frac{600}{133.33} \times 20 + \frac{133.33}{2} \times 0.3 \times 4.5 + 600 \times 4.5
\]
Total cost = 90 + 90 + 2700 = 2880 $  

**Range 3**  
250 above  
\( EOQ = Q_3 = \sqrt{\frac{2 \times 600 \times 20}{0.3 \times 4.10}} = 139.68 \) units  
\( Q_3 \) is in not in range, adjust the \( Q \), new \( Q_3 = 250 \) calculate the Total cost  
Total cost = Total inventory cost + Product Cost  
\[
\text{Total cost} = \frac{D}{Q} S + \frac{Q}{2} H + D \times \text{price} = \frac{600}{250} \times 20 + \frac{250}{2} \times 0.3 \times 4.1 + 600 \times 4.1
\]
Total cost = 48 + 153.75 + 2460 = 2661.75 $ (minimum)

The firm should order 250 units at a time, paying \$4.10 per unit. The annual total cost is \$2,661.75 (minimum).
Question 3
A) 6 marks
Given the following bill of materials

![Bill of Materials Diagram]

If the demand for product A is 50 units, what will be the gross requirement for components B, C, D, E, F and G?

**Solution:**
Demand of A = 1
Demand of B = 2 * demand of A
Demand of C = 3 * demand of A + 1 * demand of B
Demand of D = 1 * demand of A + 1 * demand of B + 1 * demand of C
Demand of E = 2 * demand of C
Demand of F = 1 * demand of D
Demand of G = 2 * demand of D

Demand of A = 50
Demand of B = 2 * 50 = 100
Demand of C = 3 * 50 + 1 * 100 = 250
Demand of D = 1 * 50 + 1 * 100 + 1 * 250 = 400
Demand of E = 2 * 250 = 500
Demand of F = 1 * 400 = 400
Demand of G = 2 * 400 = 800

Question 3
B) 9 marks
Each R requires 3 of component S and 3 of material A; each S requires 3 of part T. The lead time for assembly of R is 1 week. The lead time for the manufacture of S is 2 weeks. The lead time for material A is 1 week. The lead time for the procurement of T is 4 weeks.

a. Construct the time-phased product structure.
b. Construct the bill of materials.

**Solution:**

<table>
<thead>
<tr>
<th>Item</th>
<th>Bill of Materials</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>R</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>S(3)</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>T(3)</td>
<td></td>
<td>9</td>
</tr>
<tr>
<td>A(3)</td>
<td></td>
<td>3</td>
</tr>
</tbody>
</table>

![Time-Phased Product Structure Diagram]