

AQS110 – Fall 2016

FINAL EXAM (75 pts)

**Due Wednesday, December 14, 2016**

**MUST be posted on BB or emailed by 7:30 p.m.**

1. The best evidence of acceptable quality is a satisfied customer. Why? (5 pts)  
*The definition of quality is “*
2. List and provide an example of how each of the seven basic quality tools could be used in the workplace. (15 pts)

3. There are 8 types of waste (muda). List each and provide an example. (15 pts)

*Downtime*

*Defects - this is non-conforming product*

*Overproduction - this making more than required (i.e. building 1000 when only 100 ordered)*

*Waiting – either machine waiting for human or human waiting for machine*

*Non-Utilized talent:*

*Transportation: this is either the operator having to walk back and forth or the material to move across the plant rather*

*Inventory- this having excess raw material stored in a warehouse*

*Motion - this is having to repeat operations*

*Excess Processing - this is having to reinspect or rework previously manufactured product*

4. Referring to the recipe below, identify the measurement fundamentals that have been included and describe why they apply. (10 pts)

**Heavenly Angel Food Cake**  
([bettycrocker.com](http://bettycrocker.com))

**Ingredients**

1½ cups powdered sugar  
1 cup cake flour  
1½ cups egg whites (12)  
1½ teaspoons cream of tartar  
1 cup granulated sugar  
1½ teaspoons vanilla  
½ teaspoon almond extract  
¼ teaspoon salt

**Directions**

1. Move oven rack to lowest position. Heat oven to 375°F.
2. Mix powdered sugar and flour, set aside.
3. Beat egg whites and cream of tartar in large bowl with electric mixer on medium speed until foamy.
4. Beat in granulated sugar, 2 tablespoons at a time, on high speed. With last addition of sugar add vanilla, almond extract and salt.
5. Continue beating until stiff and glossy meringue forms. DO NOT under beat.
6. Sprinkle sugar-flour mixture (step #1), ¼ cup at a time over meringue; fold in just until sugar-flour mixture disappears. Do this GENTLY, do not overmix or deflate the meringue.
7. Push batter into ungreased 10x4 inch tube pan. Cut gently through batter with metal spatula.
8. Bake 30-35 minutes or until top is golden brown and cracked. The cracks will feel dry and the top springs back when touched lightly. Do not under bake.
9. Remove cake from oven and immediately turn pan upside down on heatproof funnel or bottle. Let hang minimum 2 hours or until cake is completely cool.
10. Loosen side of cake with knife and remove from pan.

**Expert Tips**

- Creating a meringue requires CLEAN bowls and beater.
- Whip it up! Egg whites whip best when they're at room temperature; be sure to pull them from the refrigerator an hour or so before you make the cake
- Use an egg separator to separate the eggs quickly. Place the separator over a small bowl, and crack an egg into it. The white slips through the slots into the bowl, leaving the yolk behind.
  - If an egg separator is not available, be very careful to make sure no yolk gets into the bowl of egg whites or the meringue will not form properly
- Hanging the cake upside down during cooling allows it to hold the shape and height.
- If baking at elevation greater than 10,000 feet, add 2T flour.

5. Company A currently manufactures black markers. A new manufacturing line will be added so that red markers can now be produced. Create a flow chart of the manufacturing process, including QC checks and indicate what needs to be validated, what type of validation is needed and why. (10 pts)

*Black marker process*

*Felt is cut to length*

*Felt is then saturated with black ink*

*Felt is then placed inside housing*

*Bottom cap is welded on*

*Top cap then placed on marker*

Red markers would presumably be manufactured in the same sequence. Therefore, the design has already been validated/verified (the markers are being marketed, the only change is color). The process has been established, so this will simply need verification.

However the new line equipment will need to have

- 1) an IQ (installation qualification) to demonstrate that the new equipment functions as intended (turns on, moves parts, safety stops, etc.)
- 2) a PQ (process qualification) to demonstrate that the new equipment and process manufacture the red marker in a similar fashion to the black marker.

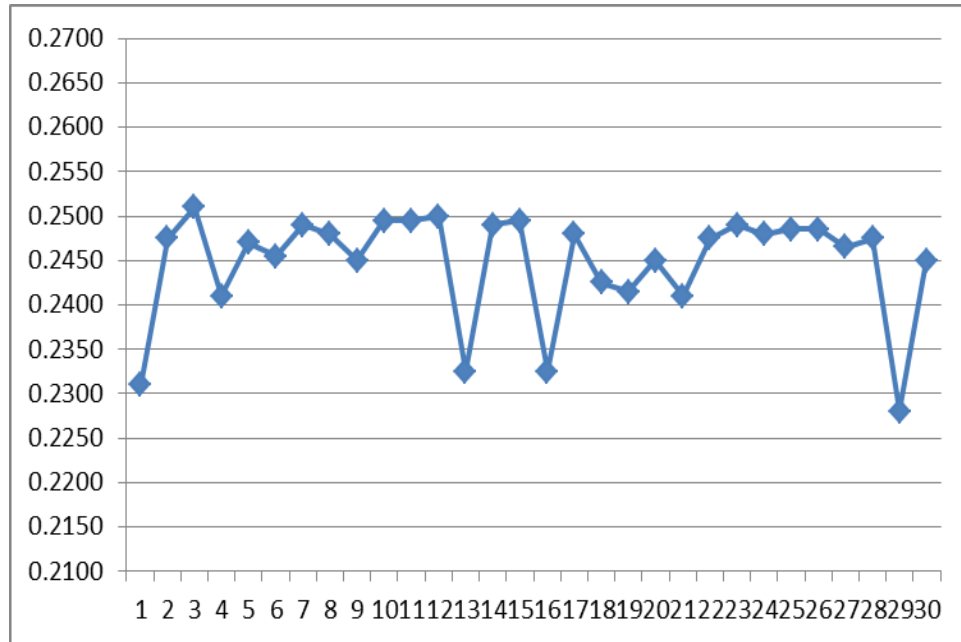
An OQ (Operational qualification) is likely unneeded as this was performed when the black marker was initially validated. Since the red marker will be manufactured in the same manner, the same process parameters (Ranges) can be used.

6. A capability study was conducted on a new product. The measurement results are tabulated and graphed below. (10 pts)

a. Is the data normal? (hint – compare mean, median, mode)

b. Is the process capable of maintaining the specification 0.220 – 0.260 inches? Why?

$$\text{Hint - } C_{pk} > 1.33 = \text{capable} \quad C_{pk \text{ upper}} = \frac{USL - \text{average}}{3s} \quad C_{pk \text{ lower}} = \frac{\text{average} - LSL}{3s}$$



Mean = 0.2448 median = 0.2475 mode = 0.2475 [std dev = 0.0061]

The data is likely normal as the mean/median, mode are similar

$$C_{pk \text{ upper}} = 0.83$$

$$C_{pk \text{ lower}} = 1.36$$

Process not capable of meeting specification as the  $C_{pk \text{ upper}}$  is  $< 1.0$ , therefore likely to make product that exceeds the 0.260 requirement.

6. Company B needs to have the part in the attached print manufactured. (10 pts)
  - a. Identify the GDT symbols and their respective dimensions.
  - b. Select 2 – 4 dimensions that could be considered critical and provide the following information:
    - i. Why they were selected?
    - ii. What tool is recommended for measurement? Consider both accuracy and precision.

