Consider the design of plastic housing for the electronic components shown in Figure 1. Prototype parts produced by injection moulding exhibits a warping problem labelled “A” in Figure 2. An FEM analysis shows that this problem can be eliminated if the thickness of the warped walls is increased to 3/16”.

1) Discuss the effects of an increase in the wall thickness from a manufacturing point of view.

2) How would you redesign the housing to minimize the effects discussed in 1).

3) The critical dimension is the gap distance between two mounting holes. A statistical process control (SPC) method is implemented as a tool to control the quality of the production process. The optimum sample size is determined to be 9. The gap distance has a sample mean of 5.002 and a sample standard deviation of 0.0005”. The tolerance is specified as +/- 0.005”. Calculate the percentage of parts that are within the specification limits. What is the process capability, $C_p$, of the process? Will $C_{pk}$ be larger or smaller than the $C_p$ and why? Refer to the appendix for the areas under the Normal Distribution Curve.

4) Consider the production process shown in Figure 3. It consists of three separate steps, including injection moulding, trimming and assembly. The operations data for each steps are given in Table 1. What would be the maximum production rate in a 8-hour period? Discuss how you can achieve the maximum rate given that it will be very expensive to change the operation times, MTTFs and MTTRs.
Figure 3: Housing manufacturing process

Table 1: Operations data

<table>
<thead>
<tr>
<th></th>
<th>M₁: Injection Moulding</th>
<th>M₂: Trimming</th>
<th>M₃: Assembly</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operation time</td>
<td>2 minutes</td>
<td>1.9 minutes</td>
<td>2.1 minutes</td>
</tr>
<tr>
<td>MTTF</td>
<td>39 hrs</td>
<td>18 hrs</td>
<td>45 hrs</td>
</tr>
<tr>
<td>MTTR</td>
<td>3 hrs</td>
<td>3 hrs</td>
<td>2 hrs</td>
</tr>
</tbody>
</table>

MTTF: Mean-time-to-fail
MTTR: Mean-time-to-repair
Figure 1: Housing top view (Unit: inches)

Figure 2: Housing bottom view

All walls 1/8" thick.