Simulation will always yield the best (best meaning maximum profit, etc.) solution to a problem.  
\[ T \quad F \]

If two different people run identical simulation models, they will obtain identical results.  
\[ T \quad F \]

A probability distribution is always referring to a discrete variable.  
\[ T \quad F \]

With small numbers of trials, simulations can be very sensitive to the initial conditions  
\[ T \quad F \]

A random number refers to:  
- An observation from a set of numbers (i.e. the real numbers from 0-1), each of which is equally likely  
- An observation selected at random from a normal distribution  
- An observation selected at random from any distribution provided by the manager  
- None of the above

Consider the following simulation of a coin toss, with the experiment performed 3 times.  
Toss a coin 8 times and count the number of HEADS

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th># of Heads</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>0.498</td>
<td>0.746</td>
<td>0.044</td>
<td>0.511</td>
<td>0.218</td>
<td>0.783</td>
<td>0.121</td>
<td>0.869</td>
<td>4</td>
</tr>
<tr>
<td>0.139</td>
<td>0.547</td>
<td>0.490</td>
<td>0.336</td>
<td>0.462</td>
<td>0.476</td>
<td>0.332</td>
<td>0.052</td>
<td>1</td>
</tr>
<tr>
<td>0.493</td>
<td>0.694</td>
<td>0.792</td>
<td>0.678</td>
<td>0.740</td>
<td>0.517</td>
<td>0.619</td>
<td>0.042</td>
<td>6</td>
</tr>
</tbody>
</table>

\[ \text{AVERAGE} = \frac{11}{24} = .458 \]

Fill in the blanks in the table above. Write the rule you used in the space below.

If the random number is greater than 0.5, then I called it "Heads", else "Tails"

7. "All random numbers greater than 0.75 will be called Heads". What is wrong with the preceding rule as it applies to a coin toss simulation? Circle the correct response.
   - There will be too many "Heads" generated in the long run.
   - There will be 75% "Tails", in the long run.
   - The number of "Heads" will be 75% of all outcomes, in the long run.
   - There is nothing wrong with the rule, if it is truly a fair coin.
Answer: b) There will be 75% "Tails", in the long run. This is because the rule says that numbers from 0 to 0.75 will be tails and above .75 will be heads, so the proportion of tails to heads is 75 to 25.

8. The RAND() function in Excel generates random numbers that range from ______ to ______, with a ____________________ distribution. 
Answer: From 0 to 1, with a Uniform (Even) distribution.

9. The following table shows a portion of a simulation for a queuing system involving trucks. Fill in the blanks for truck numbers 8 and 10. The blank boxes have been highlighted.

<table>
<thead>
<tr>
<th>Truck #</th>
<th>Arrival Interval</th>
<th>Truck Arrives at</th>
<th>Wait Time</th>
<th>Service Begins at</th>
<th>Loading Time</th>
<th>Service Ends at</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>0.89</td>
<td>3.85</td>
<td>0.00</td>
<td>3.85</td>
<td>0.18</td>
<td>4.03</td>
</tr>
<tr>
<td>6</td>
<td>0.52</td>
<td>4.37</td>
<td>0.00</td>
<td>4.37</td>
<td>0.11</td>
<td>4.48</td>
</tr>
<tr>
<td>7</td>
<td>0.11</td>
<td>4.48</td>
<td>0.00</td>
<td>4.48</td>
<td>0.01</td>
<td>4.49</td>
</tr>
<tr>
<td>8</td>
<td>0.23</td>
<td>4.71</td>
<td>0.00</td>
<td>4.71</td>
<td>0.81</td>
<td>5.52</td>
</tr>
<tr>
<td>9</td>
<td>0.08</td>
<td>4.78</td>
<td>0.74</td>
<td>5.52</td>
<td>1.91</td>
<td>7.43</td>
</tr>
<tr>
<td>10</td>
<td>0.33</td>
<td>5.11</td>
<td>2.32</td>
<td>7.43</td>
<td>0.85</td>
<td>8.28</td>
</tr>
</tbody>
</table>

10. The random number 0.57 has been selected. The corresponding observation, r, from the following discrete probability distribution would be:

<table>
<thead>
<tr>
<th>r</th>
<th>Prob(r)</th>
<th>Cumulative Pr</th>
<th>Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.30</td>
<td>.3</td>
<td>0-.3</td>
</tr>
<tr>
<td>1</td>
<td>0.20</td>
<td>.5</td>
<td>&gt;.3-.5</td>
</tr>
<tr>
<td>2</td>
<td>0.40</td>
<td>.9</td>
<td>&gt;.5-.9</td>
</tr>
<tr>
<td>3</td>
<td>0.10</td>
<td>1</td>
<td>&gt;.9-1</td>
</tr>
</tbody>
</table>

A) 0
B) 1
C) 2
D) 3
E) None of the above

Since .57 falls in the interval >.5-.9, the answer is 2 (C).

11. The number of machine breakdowns in a day is 0, 1, or 2, with probabilities 0.6, 0.3, and 0.1, respectively. The following random numbers have been generated: .13, .10, .02, .18, .31, .19, .32, .85, .31, .94. Use these numbers to generate the number of breakdowns for 10 consecutive days. What proportion of these days had at least 1 breakdown?

A) 0.2
B) 0.3
C) 0.4
D) 0.5
E) 0.6
<table>
<thead>
<tr>
<th>breakdowns</th>
<th>PDF</th>
<th>CDF</th>
<th>Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.6</td>
<td>0.6</td>
<td>0-.6</td>
</tr>
<tr>
<td>1</td>
<td>0.3</td>
<td>0.9</td>
<td>&gt;.6-.9</td>
</tr>
<tr>
<td>2</td>
<td>0.1</td>
<td>1</td>
<td>&gt;.9-1</td>
</tr>
</tbody>
</table>

1. To simulate a discrete variable, why do we compute cumulative probabilities?

Because cumulative probs. range from 0 to 1, just like the random numbers that are generated in Excel, and thus the probs. give us the cutoff points for mapping the variable values to the random numbers.

17. Variation that is inherent in a production process itself is called common variation.

   A. True
   B. False

18. If the fraction defective is 0.12 based on a sample size of 16, the standard deviation used in the “p” chart is about 0.08.

   A. True
   B. False

   [square root of (.12)(.88)/16), or 0.081]

19. Quality characteristics that are classified as either conforming or not conforming to specifications are considered to be attribute measurements.

   A. True
   B. False

20. A quality control chart has upper and lower control limits expressed as lines on a chart. As long as the sample values fall between these two lines there is no need to investigate process behavior.

   A. True
   B. False

21. Six Sigma is a version of Total Quality Management created by Motorola and popularized by General Electric.

   A. True
   B. False
22. For which of the following should we use a “p” chart to monitor process quality?
   A. The dimensions of brick entering a kiln
   B. Lengths of boards cut in a mill
   C. The weight of fluid in a container
   D. **Grades in a freshman “pass/fail” course**
   E. Temperatures in a classroom

23. Before calculating process capability, assignable variation (also called “special cause” variation) should be investigated and removed from the process if possible.
   A. True
   B. False

24. A process capability index that indicates the process is capable at six sigma level is:
   A. Less than 1.0
   B. Greater than 1.0 but less than 1.33
   C. Greater than 1.33 but less than 1.67
   D. Greater than 1.67 but less than 2.0
   E. Greater than 2.0

25. A part has a length specification of 5 inches with tolerances of ± .004 inches. The current process has an average length of 5.001 inches with a standard deviation of .001 inches. Calculate the $C_{pk}$ for this process.
   
   A. 1.00
   B. 1.09
   C. 1.45
   D. 1.67
   E. 1.99

   $C_{pk} = \text{Minimum} \left[ \frac{\bar{x} - LSL}{3\sigma}, \frac{USL - \bar{x}}{3\sigma} \right] = \text{Minimum} \left[ \frac{5.001 - 4.996}{3(.001)}, \frac{5.004 - 5.001}{3(.001)} \right] = \text{Minimum}[1.67, 1.00] = 1.00$

26. A manufacturing company uses a production process that mills components to an average thickness of .005 inch, with an average range of .0015 inch. Using samples of size 3, what is the upper control limit on the X-bar chart?
   A. 0.001
   B. 0.002
   C. 0.003
   D. 0.005
   E. **0.007**

   UCL for x-bar = .005+(1.02)(.0015)=.005+.00153=.00653=.007, where R-bar=.0015; n=3 and therefore $A_2=1.02$ (from the Shewhart table of control chart constants given in the problem).