MCL361 Minor 2 Exam

March 25, 2019

Total Marks: 20

**Use only blue/black ink pens. Return the question paper along with your answer booklet.**

**Section I. Each question below carries 1 mark. Justify your answer in not more than one sentence.**

1. True or false: the bottleneck rate $r_b$ of a production is the rate (in parts per unit time) of the slowest workstation.
2. Given a choice between increasing capacity of the bottleneck workstation in a production line or a non-bottleneck workstation, which would you opt for?
3. True or false: the process capability index is an indicator of whether the process under consideration is under control or not.
4. Consider a Poisson arrival process with a mean arrival rate of 10 customers/hour. An observer notes at time t = 5 minutes that the previous customer arrived t = 4 minutes. What is the probability that a customer will arrive within the next five minutes from the current time?
5. In the basic product mix aggregate planning formulation, how can a bottleneck workstation be identified from the solution to the LP formulation?
6. What are the two parameters required to characterize the long-run behavior of an M/M/1 workstation? Why are only two required?
7. What are the conditions under which the practical worst-case expressions for throughput and cycle time at a given work in process level are derived?

**Section II. Answer all questions.**

8. (1.5) Derive the expression for the expected WIP level of an M/G/m workstation with utilization u, arrival and effective process time parameters $(t_a, c_a)$ and $(t_e, c_e)$, respectively.
9. (2) Consider a production line with 3 workstations. The first machine has a process time of 5 minutes, the second has a process time of 3 minutes, and the third has a process time of 4.5 minutes. Assume jobs arrive at a constant rate of 10 jobs/hour, and the first job arrives at t = 1 minutes. Conduct a simulation of this line on paper until the end of the 25th minute (starting from t = 0). Find (a) the number of jobs completed by the end of the simulation and (b) the utilization of the first workstation measured from t = 0.
10. (3) Modify the multi-product aggregate planning formulation for backorders (m products, n workstations) to include overtime. Assume that the cost of one hour of overtime at workstation j is $g_j$. Assume that capacity and overtime are expressed in the same units (e.g., time units). Use the notation discussed in class to the extent possible.
11. (2) Consider a single machine workstation with a natural process time of 10 minutes per job and a CV of 0.6. Without fail, the workstation requires maintenance after every job, and the maintenance work lasts for an average of 2 minutes, with a CV of 0.5. The maintenance time and the natural process time are correlated and have a coefficient of

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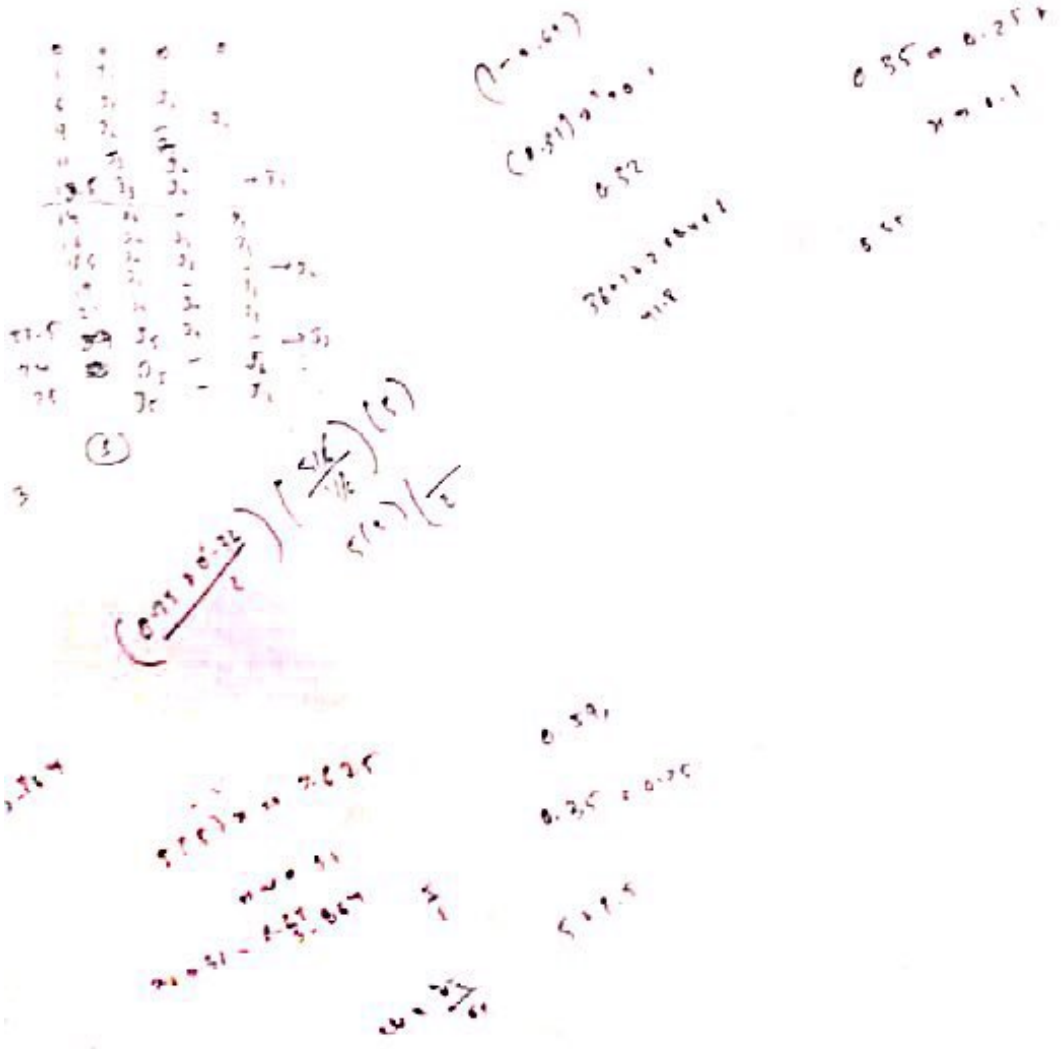
correlation of 0.4. Find the mean and standard deviation of the effective process time of the workstation.

12. (1.5) Derive the expressions for the lower and upper control limits of the p-chart, assuming that the probability of a given item being defective is **p**. Assume **n** samples are tested in each lot.
13. (3) A 2 workstation production line has a mean interarrival time of 6 minutes and a CV of 0.5. The average effective process times of the workstations are 5 minutes and 4 minutes, respectively, and the corresponding CVs are 0.6 and 0.8, respectively. Find the expected number of jobs waiting in queue in the production line.



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