IEOR 130 Midterm Examination
Fall, 2014, Prof. Leachman
Open notes, no internet access. Work all problems.

1. (20 points) A particular processing machine has a number of components, all sharing the same uniform distribution of time until failure after performance of maintenance:

Weeks since PM or repair	Probability of failure in that week
1	0.10
2	0.10
3	0.10
4	0.10
5	0.10
6	0.10
7	0.10
8	0.10
9	0.10
10	0.10

At present, there are three preventive maintenance procedures performed on the machine: A weekly PM, a PM once every 4 weeks, and a PM once every 8 weeks. The incremental time to add the adjustment, repair or replace-as-necessary of each component to any of existing preventive maintenance procedures is 30 minutes. However, the time to repair and re-qualify the machine if the component fails varies by component, anywhere from 1 hour to 40 hours. As a function of the time to repair and re-qualify the machine if the component fails, determine in which of the existing PM cycles it is best to include the adjustment, repair or replace-as-necessary of the component.

2. A particular manufacturing process has a die yield of 85%. There are two failure mechanisms in the process that lead to die yield loss: particle contamination and mechanical damage. There is a stationary baseline distribution of particle contamination present on every wafer, but there also are occasional "excursions" when particle contamination is excessive. A control chart has been instituted for monitoring particle contamination, and its upper control limit is 200 particles per wafer. Including both the baseline particle contamination and particle excursions, the long-run average particle density is 210 particles per wafer. Each wafer is printed with 5,000 dice. Assume the space between dice is negligible. Assume all particles are fatal to die yield.

(a) (6 points) What is the mean number of particles per wafer when the process is in statistical control?

(b) (3 points) Using a simple Poisson distribution, estimate the baseline defect-limited yield. (The baseline defect-limited yield reflects solely the losses due to particle contamination when such contamination is in statistical control.)

(c) (3 points) Using a simple Poisson distribution, estimate the defect-limited yield of the process. (The defect-limited yield reflects the losses due to particle contamination, both baseline and excursions.)

(d) (2 points) Estimate the mechanical-limited yield. (The mechanical-limited yield reflects solely the losses due to mechanical damage.)

(e) (2 points) What is the systematic mechanisms limited yield of the process?

(f) (4 points) Estimate the yield loss due to particle excursions.

3. (10 points) Answer true or false for the following questions. Two points for each right answer, zero for a blank, and minus four points for each wrong answer.

a. If the rework experienced on a machine is reduced while the good output per week stays the same, then the OEE score computed week by week for the machine increases. F

b. Capacity of a machine type is not a fixed value but depends on the maximum allowed utilization which in turn implies a maximum allowed cycle time across the steps performed by the machine type. T

c. If utilization is increased, then the OEE score must rise.

d. Suppose there is a minimum allowed idle time specified for each machine type in a factory. Then it is always the case that the machine type with the highest ratio of utilization to availability determines the maximum output the factory can attain for the current product mix while achieving the allowed cycle times. F

e. Suppose only product type is in production. Then one can formulate an accurate capacity constraint for a given machine type for the purposes of production planning if one uses theoretical processing times expressed in hours as the coefficients on production variables, and the right hand side is defined as the maximum allowed utilization times the rate efficiency times the quality efficiency times the number of machines times the working hours per planning period.

T PT x # machines x wo

theoretical