Exam Optimization of Business Processes
29 May 2006

This exam consists of **4** problems, each consisting of several questions.
All answers should be motivated, including calculations, formulas used, etc.
It is allowed to use 1 sheet of paper (or 2 sheets written on one side) with **hand-written** notes.
The minimal note is 1. Questions 1 and 2 each give 2 points when correctly answered, questions 3 and 4 can give 2.5 points.
The use of a calculator and a dictionary are allowed.

1. Consider a machine with two types of jobs. Type 1 has exponential service times, type 2 has deterministic service times, with the same expectation. Arrivals are according to independent Poisson processes.
a. Give the expected waiting times for both classes in the case of production in FIFO order.
b. Give the expected waiting times for both classes in the case of strict non-preemptive priority to class 1.

2. Consider a call center with two different types of calls.
a. Give two advantages of having cross-trained agents.
b. Give two different ways to assign calls to cross-trained agents, and give their respective advantages and disadvantages.
c. Which way to assign would you prefer in a big call center? Motivate your answer.

3. A call center has a single skill and shifts defined by 0-1 vectors. There are K different types of shifts, and shift k costs c_k.
a. Formulate a mathematical programming model for shift scheduling during one day that obeys a service level constraint for each interval.
Now overwork is possible. A second 0-1 vector for each shift gives the intervals in which overwork is possible, with costs d_k for shift k.
b. Formulate a mathematical programming model for shift scheduling during one day that obeys a service level constraint for each interval in which the possibility of overwork is incorporated.
Finally, we consider a single overall SL constraint instead of one for the whole day.
c. Formulate a mathematical programming model for shift scheduling during one day that obeys an overall service level constraint in which the possibility of overwork is incorporated.

4. A system consists of 2 parallel 2-out-of-3 systems.
a. Give the expected time until the system is down if the lifetimes are i.i.d. and exponentially distributed.
b. Give all minimal path sets.
c. Give the system function in terms of the availability probabilities of the components and simplify this expression as much as possible.
d. Give an expression for the availability at t for i.i.d. and exponentially distributed lifetimes.