Exam Modeling of Business Processes
11th December 2000, 13.30-16.30, S2.03

This exam consists of **5** problems, each consisting of several questions.
All answers should be motivated, including calculations, formulas used, etc.

1. In a call center 70% of the incoming calls are handled directly by the agents, 30% is transferred to another unit in the company (the "back office"). Management is considering increasing the number of calls handled directly by the call center by changing the process rules.
a. Give the definition of operational, tactical and strategic decisions.
b. What type of decision is the above call center decision?
The management would like to have an understanding of the consequences of this decision on the needed personnel.
c. What kind of model would be helpful to support this decision? Motivate your answer!
d. What kind of support is needed (a DSS, just a report, ...) and why?

2. Consider a machine that processes two types of parts. the parts have deterministic processing times, with average 1 and 2 hours for type 1 and type 2, respectively. Parts to be processed arrive according to a Poisson process, with an average of 0.1 and 0.2 per hour, respectively. There are holding costs in the system. For type 1 they are equal to c per hour and part, for type 2 they are equal to $3c$.
a. Calculate the total expected holding costs if the processing order is FIFO.
b. Calculate the total expected holding costs under both non-preemptive priority rules.
(Hint: The following formula might be helpful (in the notation of the lecture notes):

$$\mathbb{E}W_Q(p) = \frac{\mathbb{E}R}{(1-\sigma_p)(1-\sigma_{p-1})},$$

with $\mathbb{E}R = \lambda \mathbb{E}S^2/2$ and $\sigma_p = \sum_{i=1}^{p} \rho_i = \sum_{i=1}^{p} \lambda_i \mathbb{E}S_i$.)

3. Consider a system consisting of n parts that each fails, independently of the other parts, after a time that is uniformly $[0, 1]$ distributed, i.e., the density of the time to failure of each component is 1 in $[0, 1]$, 0 otherwise.
a. Give the definition of the failure rate and the system function.
b. Compute the failure rate of the life time of a single component.
c. Let the system consist of n parts in series. Compute the failure rate of the life time of the system.
d. Let the system consist of n parts in parallel. Compute the failure rate of the life time of the system.

4. A perishable good has order price c. It is sold on day 1 for a selling price r_1. Any remaining goods are sold on day 2 for a discount price of $r_2 < r_1$. Remaining goods after day 2 have no value. Let the demand on day 1 be exponential with rate μ_1, and on day two also exponential with rate μ_2. An order can only be placed at the beginning of day 1.
a. Give a formula for the expected costs if the order size is S.
b. Simplify the formula found in a as much as possible.

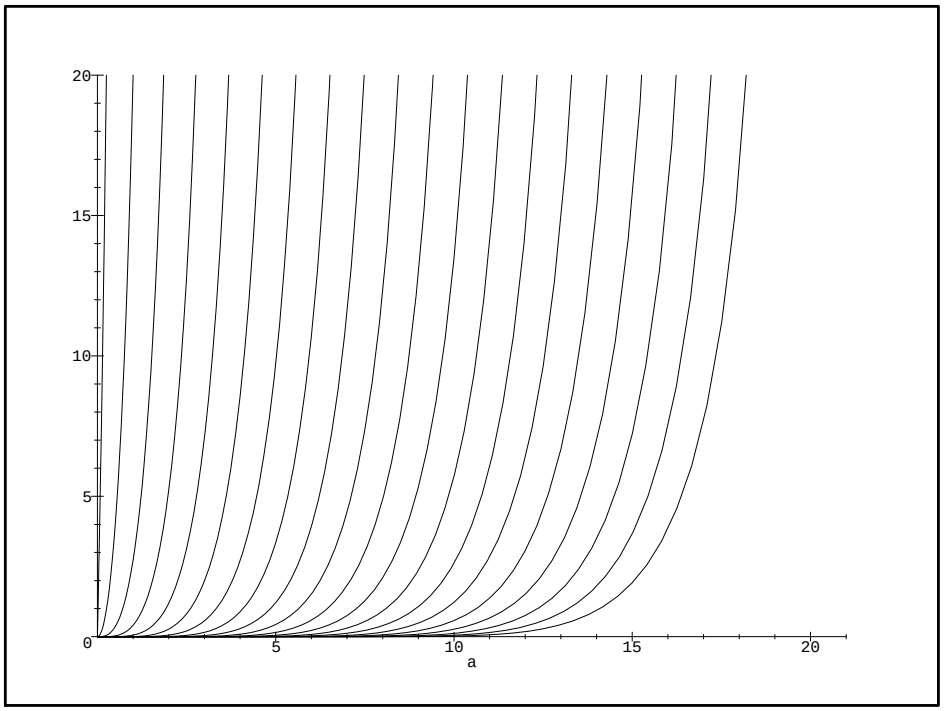
5. Calls in a call center arrive at a rate of on average 3 per minute. They require on average 2 minutes of call handling time, and after that also on average 2 minutes of additional work. The additional work can be done later, by the same or another agent. The manager of the call center is considering two ways to deal with the workload. One possibility is letting agents do all the work for a call at once, which results in call holding times of 4 minutes. The other possibility is having two separate groups of agents, one dealing with incoming calls, the other with the additional work. For both systems it is considered that the Erlang delay model is appropriate. An average waiting time of 10 seconds is acceptable.

a. Compute the minimum number of agents needed for both possibilities (using the figure below).

A quantitative consultant suggests using call blending.

b. Explain what call blending is and how it can be implemented in practice.

c. Describe a mathematical model for call blending, how it can be solved, and how it should be used in a DSS.



Values of $\mathbb{E}W$ as a function of the load a for (from left to right) $s = 1$ t/ m 20 and $\beta = 60$.

Do not forget to motivate **all** answers.

All problems have equal weight in the final note.

Final notes will be emailed after correction of the exams.