HELSINKI UNIVERSITY OF TECHNOLOGY **Exercise 1**
Laboratory of Telecommunications Technology 20.9.2000
S-38.145 Introduction to Teletraffic Theory, Fall 2000 Aalto/Nyberg

Note: Problem 3 is a homework exercise. Deliver your answer sheet (labelled with your student id, name, and signature) into the mail box of the course (located near the notice board of the laboratory at G-wing/2nd floor), or directly to the course assistant *before* the next exercise class on 27 September.

1. a) Consider a link between two telephone exchanges with 5 parallel channels. Traffic consists of the ongoing telephone calls on the link. Each call occupies one channel. Model this as a pure loss system. Assume that new calls arrive according to a Poisson process at rate 2 calls per minute. Assume further that call holding times are independently and identically distributed with mean 3 minutes. Calculate the traffic offered, the traffic carried, and the traffic lost.

   b) Consider the processor of a packet router in a packet switched data network. Traffic consists of data packets to be processed. Model this as a pure waiting system with a single server. Assume that new packets arrive according to a Poisson process at rate 2 packets per ms. Assume further that packet processing times are independently and exponentially distributed with mean 0.4 ms. Determine the traffic load of this system. What is the probability that an arriving packet will be processed immediately after the arrival (without any waiting delays)? What is the probability that it has to wait longer than 2 ms?

2. a) Let (as in slide 32 of lecture 1)

$$\mathrm{Erl}(n, a) = \frac{a^n/n!}{\sum_{i=0}^{n} a^i/i!}$$

   Derive the following recursive formula:

$$\mathrm{Erl}(0, a) = 1$$
$$\mathrm{Erl}(n, a) = \frac{1}{1 + \frac{n}{a \cdot \mathrm{Erl}(n-1, a)}}$$

   (*Tip:* Calculate first the quotient $\mathrm{Erl}(n, a)/\mathrm{Erl}(n-1, a)$.)

3. *Homework exercise* (deadline 27 September at 9 o'clock): Consider a link from router A to router B in a packet switched data network. Traffic consists of packets to be transmitted via the link. Whenever there is a packet in transmission, the link is said to be busy. If the link is busy, when a new packet arrives, it has to wait in a buffer located at the corresponding output port of router A. Model this as a pure waiting system with a single server, Poisson arrivals, and independently and exponentially distributed packet lengths. Assume that new packets arrive at rate 2 packets per ms, the average packet length is 500 bytes, and the link speed is 10 Mbps.

   a) Calculate the traffic load ρ. Is this system stable?

   b) What is the probability that an arriving packet has to wait in the buffer before its transmission?

   c) What is the average number of packets in transmission? (*Tip*: Little's formula)

   d) What is the proportion of time that the link is busy, i.e., the utilization factor?