HELSINKI UNIVERSITY OF TECHNOLOGY — **Exercise 8**
Laboratory of Telecommunications Technology — 17.11.1999
S-38.145 Introduction to Teletraffic Theory, Fall 1999 — Aalto/Nyberg

1. Consider the following simple teletraffic model:

   - Customers arrive according to a Poisson process with intensity λ.
   - There is one server ($n = 1$).
   - Service times are IID and exponentially distributed with mean $1/\mu > 0$.
   - The number of waiting places is finite ($0 < m < \infty$).
   - Queueing discipline is FIFO.

   According to Kendall's notation, what is this queueing model? Let $X(t)$ denote the number of customers in the system at time t. Process $X(t)$ is a Markov process. Determine the state transition diagram of this Markov process, and tell whether the process is irreducible or not. Does the equilibrium distribution exist? If it exists, determine the equilibrium distribution.

2. Consider still the teletraffic model defined in the previous problem. Determine the time blocking B_t and the call blocking B_c. Determine further the probability p_W that an arriving customer has to wait. Calculate B_t, B_c, and p_W in the following cases:

   (a) $\lambda = 0.5$, $\mu = 1.0$, $m = 4$;

   (b) $\lambda = 1.0$, $\mu = 1.0$, $m = 4$.

3. Consider data traffic on a link between two routers (from router R1 to router R2) in a packet switching network. Traffic consists of packets arriving at rate λ (packets per second) into the output buffer of router R1. Let L and C denote the mean packet length (in bits) and the link speed (in bits per second), respectively. Assume that the buffer capacity is B packets. Consider this as an $M/M/1/B$ queueing model. Determine the loss probability p_L (that is: probability that the buffer is full when a packet arrives). Calculate p_L in the following cases:

   (a) $1/\lambda = 0.10$, $L = 3200$, $C = 64000$, $B = 5$;

   (b) $1/\lambda = 0.05$, $L = 3200$, $C = 64000$, $B = 5$.