1. If \( \{X(t) : t \geq 0\} \) and \( \{Y(t) : t \geq 0\} \) are independent time-reversible continuous time Markov chains, show that the process \( \{(X(t), Y(t)), t \geq 0)\) is also time reversible.

2. Consider two queues with Poisson arrivals and single server with exponentially distributed service times. Suppose that the arrival rate for queue \( i \) is \( \lambda_i \) and service rate is \( \mu_i \) for \( i = 1, 2 \). Assume that the queues share the same waiting room which has finite capacity \( N \). That is whenever this room is full, all potential arrivals to either queue are lost. Compute the limiting probability that there will be \( n \) customers at the first queue and \( m \) at the second queue.

3. \( N \) customers move among \( r \) servers. The service times at server \( i \) are exponential with rate \( \mu_i \) and when a customer leaves server \( i \) it joins the queue (if there are others waiting or else it enters service) at server \( j, j \neq i \), with probability \( 1/(r - 1) \). Let the state be \( (n_1, \ldots, n_r) \) when there are \( n_i \) customers at server \( i, i = 1, \ldots, r \). Show that the corresponding continuous time Markov chain is time reversible and find the limiting probabilities.