**Solutions:**

1. This is problem 4.2
2. This is problem 4.5, with 2 nodes as opposed to 3.
3. For closed Jackson network, everything is the same (special case) except the normalizing constant (no need to re-derive balance equations as they are special case). In brief, for a closed Jackson network with customers, it holds that:
4. For and we get a simpler formula for (using ). This case corresponds to the case in the machine repair problem ()
5. Two parts
   1. is included in the sum because a customer at node
      1. first waits (=1) at node , then
      2. visits each node on average times and spends time, before coming back to node .
   2. Derivation: see book pages 208-209. Note: on page 208, upper bounds in sums should be as opposed to in the first three equations; in the fourth, lower bound should be instead of ; finally, the summation over should be from to

Interpretation:

* + 1. *Out-flow* out is equal to : upon departure, the node sees a system with customers (and its own number decreases to ), i.e., it is as if this customer “disappears” (hence transition to ())
    2. *In-flow* is equal to : arrivals occur from the system without the arriving customer ( customers), and lead to increasing the number at node to (from ); the rate of arrivals is, however, since customers do not actually disappear (this is the perception of a node only)

[Note: these detailed balance equations are the equivalent of in open Jackson networks]

1. Solve traffic equations numerically to obtain ; then use derived formulas for open Jackson network (essentially M/M/1 formulas)
2. Traffic equations were solved in 6. For MVA and Buzen’s algorithm *scripts needs to be shown* along with the numerical answers (no score otherwise).