In each of the following cases, unless specified otherwise:

- customers arrive according to a Poisson process at the rate $\lambda$
- each of 2 servers works at the rate $\mu$, with the service time having an exponential distribution.

Note: A birth-death model is not appropriate for all of these queues!

If a customer arrives and finds both servers busy, there is a 25% probability that he departs without entering the queue.

If a server finishes serving a customer and no customers are waiting, he helps out the other server if that server is busy, reducing the mean time for the job by 25%.
Arrivals are according to a Poisson process, but each arrival consists of either 1 or 2 customers, with probability 75% and 25%, respectively.

One-third of the customers require only a minor service, requiring only half the time of a regular service.

A waiting customer may get discouraged and leave the queue at any time—the length of time which he will wait having exponential distribution with mean \( \frac{1}{3\lambda} \).

Server B works at half the rate of server A. When both servers are idle, an arriving customer prefers server A, and if a customer is being served by B when A becomes free, he immediately switches to A.
Server B works at half the rate of server A. When both servers are idle, an arriving customer prefers server A. A customer may not switch servers once his service has begun.

Two types of customers arrive at a single-server queue, each according to a Poisson process: VIPs with rate $\lambda_1$, and NBs (nobodys) with rate $\lambda_2$. Service rates are $\mu_1$ and $\mu_2$, respectively. The VIPs have complete priority over NBs. If a NB is being served when a VIP arrives, he is “dropped” immediately. His service then resumes when no VIPs are in the system.

There is a 10% probability that service of the customers is done improperly, in which case the customer re-enters the queue to be served again. (Mean service time in this case is the same as the original mean service time, $1/\mu$.)

Each service operation for a customer consists of 2 separate tasks, each requiring a time having exponential distribution with mean $\frac{1}{2\mu}$.
There is a single server. When he becomes idle, he takes a break until 3 customers have arrived and wait for service.

At any time, a “catastrophe” may occur, and all customers in the queue immediately depart. The time between such events is exponentially distributed with mean 5 hours.

There is a single server, who takes a break when he becomes idle. In this case, the length of the break is exponentially distributed with mean 15 minutes.

At a taxi stand, taxis looking for customers and customers looking for taxis arrive according to Poisson processes with rates $\lambda_t$ and $\lambda_c$, respectively. A taxi will always wait if no customers are at the stand. However, an arriving customer waits only if there are 2 or fewer customers already waiting.
Four customers circulate between two single-server systems, i.e., all customers leaving server A enter the queue of server B, and vice versa. Server B works at half the rate of server A.

Customers arrive one at a time at a single-server queue, but the server processes the customers two at a time, unless only one customer remains in the queue when ready to begin the next service, in which case that single customer is served. If a single customer is being served and a new customer arrives, the new customer must wait until service is completed.