Clerk service rate:

* Clerk 1: 1 customer / min
* Clerk 2: 0.5 customer / min
* Clerk 3: 0.75 customer / min

Combined rate = 2.25 customer/ min

Arrival rate = 4 customers/ min

Since the **arrival rate > service rate**, the line **will grow over time**.

**If queue ≥ 5**, then **add a clerk** with the same rate as Clerk 1 → 1 customer / min

Since the queue growth rate is constantly changing adding a clerk Every 75 seconds cannot hold

So we find how much the queue is growing per second:

**arrival rate =** λ = 4 customers per min

**service rate** = μ = 2.25 customers per min

net queue growth rate:

r = λ – μ = 1.75 customers per min

**First Growth Phase: (3 clerks)**

find amount of time it takes for queue to reach 5:

Q(t) = r \* t

5 = 0.0292 \* t

t = ≈ 171 seconds = 2.86 mins

∴ add clerk 4 at 171 seconds

**Second Growth Phase: (4 clerks)**

Once clerk 4 joins service rate changes:

μ = 2.25 + 1 = 3.25customers/ minutes

Then new net queue growth rate:

r = λ – μ = 0.75 customers per mins

Time to grow from 0 → 5 customers:

5/0.75 = 6.67 minutes

Add clerk 5 after 2.86 + 6.67 = 9.53 minutes

**Third Growth Phase: (5 clerks)**

Once clerk 5 joins service rate changes:

μ = 3.25 + 1 = 4.25 customers per min

Then new net queue growth rate:

r = λ – μ = -0.25 customers per mins

Now the line **shrinks** at 0.25 customers per minute.

Clerk 5 joined when the queue hit another 5 **customers**, so Clerk 5 leaves when queue reaches 0

That’s a drop of 5 customers at a rate of 0.25/min:

T =5/0.25 = 20 minutes

Clerk 5 leaves after 9.53 + 20 = 29.53 minutes

Returns to second growth phase and loops till 8 hours (480 minutes) is completed

**Average Customer Wait Time**

Avg clerks = ≈ 4.33 clerks

Each clerk serves 1 customer/min (except Clerks 2 and 3 are slower but the extra clerks are 1/min), so approximately:

average clerks \* rate of Clerk = 4.33\* 1= 4.33 customers per minute

ρ =arrival rate/service rate ≈ 0.92

average queue wait time ≈

where c = 4.33, ρ = 0.92, = 4.33

average queue wait time ≈ 0.5145 minutes = **30.87 seconds**

max number of customers in the line is **roughly 5 customers** based on earlier analysis on the third growth phase