Exercise 8: Multi-Stage Production Line

Problem:
Model a production line with three stages:

1. Stage 1 ($\mu=10$\mu = 10$\mu=10$)
2. Stage 2 ($\mu=8$\mu = 8$\mu=8$)
3. Stage 3 ($\mu=12$\mu = 12$\mu=12$).

```
# Install and load the required package

if (!require("queueing")) install.packages("queueing", dependencies = TRUE)

library(queueing)


# Define the production line stages as M/M/1 queues

stage1 <- NewInput.MM1(lambda = 7, mu = 10)

stage2 <- NewInput.MM1(lambda = 7, mu = 8)

stage3 <- NewInput.MM1(lambda = 7, mu = 12)


# Create queueing models for each stage

model1 <- QueueingModel(stage1)

model2 <- QueueingModel(stage2)

model3 <- QueueingModel(stage3)


# Output performance measures for each stage

cat("=== Stage 1 Performance ===\n")

summary(model1)

cat("\n=== Stage 2 Performance ===\n")

summary(model2)

cat("\n=== Stage 3 Performance ===\n")

summary(model3)
```

output:

```
# Install and load the required package
> if (!require("queueing")) install.packages("queueing", dependencies = TRUE)
> library(queueing)
>
> # Define the production line stages as M/M/1 queues
> stage1 <- NewInput.MM1(lambda = 7, mu = 10)
> stage2 <- NewInput.MM1(lambda = 7, mu = 8)
> stage3 <- NewInput.MM1(lambda = 7, mu = 12)
>
> # Create queueing models for each stage
> model1 <- QueueingModel(stage1)
> model2 <- QueueingModel(stage2)
> model3 <- QueueingModel(stage3)
>
> # Output performance measures for each stage
> cat("=== Stage 1 Performance ===\n")
=== Stage 1 Performance ===
> summary(model1)
  lambda mu c  k  m  RO  P0       Lq        Wq X        L         W        Wqq      Lqq
1      7 10 1 NA NA 0.7 0.3 1.633333 0.2333333 7 2.333333 0.3333333 0.3333333 3.333333
> cat("\n=== Stage 2 Performance ===\n")

=== Stage 2 Performance ===
> summary(model2)
  lambda mu c  k  m    RO    P0    Lq    Wq X L W Wqq Lqq
1      7  8 1 NA NA 0.875 0.125 6.125 0.875 7 7 1   1   8
> cat("\n=== Stage 3 Performance ===\n")

=== Stage 3 Performance ===
> summary(model3)
  lambda mu c  k  m        RO        P0        Lq        Wq X   L   W Wqq Lqq
1      7 12 1 NA NA 0.5833333 0.4166667 0.8166667 0.1166667 7 1.4 0.2 0.2 2.4


>
```