**Exercise 8: Multi-Stage Production Line**

**Problem**:  
Model a production line with three stages:

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

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| # 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 |
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