# Advanced Queuing Models Theory

## 1. M/M/c/K Queue (Finite Capacity)

Description: Multi-server queue with finite system capacity (K). Customers arriving when the system is full are blocked.

Parameters: lambda (arrival rate), mu (service rate per server), c (number of servers), K (system capacity).

Performance Measures:

- P0: Probability system is empty.
- Pk: Probability system has k customers.
- Blocking probability: P(K).
- Effective arrival rate = lambda * (1 - P(K)).

Applications: Parking lots, hospital beds, call centers with fixed lines.

## 2. M/M/Infinity Queue (Infinite Servers)

Description: Each arrival gets immediate service, no queue forms.

Parameters: lambda (arrival rate), mu (service rate per server).

Performance Measures:

- Number in system follows Poisson distribution with mean = lambda / mu.
- Little's Law applies: L = lambda * W.

Applications: Cloud computing, phone switching centers, large-scale resource systems.

## 3. Priority Queues (M/M/1 with Priority)

Description: Customers divided into classes with different service priorities.

Types:

- Preemptive: High-priority customers interrupt service of lower-priority ones.
- Non-preemptive: High priority served first but ongoing service is not interrupted.

Performance Measures depend on priority discipline and arrival/service rates for each class.

Applications: Hospital ER triage, network packet handling, emergency dispatch systems.