ABSTRACT

Waiting is an unpleasant task in today's fast-paced society, yet it is unavoidable when resources are limited. The goal of service providers is to give service to everyone in a reasonable amount of time. This might be impossible due to a number of causes such as traffic, server failure, server vacation, and so on. It is critical to assess such systems before deploying them in order to meet the goals of service providers. This is achievable using queueing theory.

Some real-world queueing models are theoretically developed in this work, with additional features such as disaster, working breakdown, state dependent arrival, optional re-service, working vacation, restricted admissibility, flexible batch service, multiple sleeps with N-policy, close down, setup, and finite buffer. To derive the probability generating function of all models, the supplementary variable technique was used. Measures such as the steady-state probability of different server states, the mean customer waiting time, the mean number of customers in the system, and so on were determined using analytical, simulation, or both analytical and simulation methodologies. Finally, the findings were numerically confirmed.

Chapter 2 describes an $M^X/G/1$ disaster queueing system, in which a disaster at the main server was handled instantly by replacing it with a substitute server with a different service rate. To make the model more realistic and robust, state-dependent arrival and optional re-service were included. Various performance measures of the model were established, such as the steady state probability of the server in different states, the expected number of customers in the system. The measures was numerically illustrated. This notion was also simulated, and the findings were interpreted, validated and verified.

An $M^X/G/1$ queueing system with multiple working vacation and restricted admissibility of arriving batches were considered in Chapter 3. In working vacation queueing model, the server worked at different rate instead of being completely idle during the vacation period. To avoid congestion in bulk arrival process restricted admissibility policy was applied during working vacation and normal busy period. Performance indices of the model were established. In order to validate the analytical approach, numerical illustration was performed.

In some circumstances, like specimens awaiting testing in a clinical laboratory or perishable commodities awaiting delivery, it was necessary to finish services before the expiration date. It might only be achievable if consumer's waiting times were kept under control. As a result, the Flexible General Bulk Service (FGBS) rule was developed in Chapter 4 to provide flexibility in batching. The effectiveness of FGBS implementation has been demonstrated using two examples: a clinical laboratory and a distribution centre. To justify the suggested model, a simulation study along with numerical illustration was provided.

Reducing energy consumption was the vital goal of green communication. Base Station(BS) consumes high energy to receive and transfer the signals. Power consumption in BS could be minimized by using effective sleep and wake-up/setup operations with a tolerable delay. In Chapter 5, the service process of the BS was considered as an $M/G/1$ queue with close down, multiple sleeps and setup. The strategy N-Policy was introduced to awake the BS from multiple sleeps (MS) after predefined number N of user requests (URs) accumulated in the system. The mean delay of the UR and mean power consumption of the BS were derived. Computational results showed that multiple sleeps with N-policy consumed less power than the multiple sleeps without N-policy.

Since UR queue is always time sensitive, a finite capacity queueing method was used to prevent congestion delays. In Chapter 6, MS with N-policy sleeping technique was applied to a finite buffer UR queue of a BS with Poisson arrivals, generally distributed service time, close down, and setup. The performance of the queueing system was analysed using simulation.