Analysis of Continuous and Discrete-Time Infinite Buffer Queues with Batch Renewal Arrival Process

Thesis Abstract

The infinite buffer queueing models with renewal or batch renewal arrival process can be experienced in many real-life situations. The analytical study of these models are relatively difficult as compared to the models with Poisson or compound Poisson arrival process. In this thesis, we study a number of infinite buffer single server continuous and discrete-time queueing models and a population model, with batch renewal arrival process. The queueing models involve various kinds of service policies whereas the population model is subject to geometric catastrophes. The procedure used for the analysis is based on (i) supplementary variable technique, which is used to formulate the steady-state governing equations of the model, and (ii) difference equation method, which is applied on the governing equations in order to obtain the queue or system-length distribution at various epochs, in terms of the roots of the associated characteristic equation lying inside the unit circle. The steady-state distributions are then further used to determine some significant quantitative measures of the system. We also study the asymptotic behavior of the system at pre-arrival epoch. The methodology used throughout the thesis is analytically tractable and easily implementable as illustrated by several numerical examples.

This thesis consists of seven chapters where the first chapter is introductory and covers the literature survey along with the motivation behind the work done. In **Chapter 2** we study a batch renewal input queue where service is provided in batches according to random serving capacity rule and service time follows exponential distribution. In **Chapter 3** we extend the model considered in **Chapter 2** in discrete-time set up under the late arrival system with delayed access policy. In **Chapter 4** we study a discrete-time queue with batch renewal arrival process, geometric service time distribution and multiple working vacations under both early arrival system and late arrival system with delayed access policy. We assume that during the vacation period the server serves the customers with a rate lower than the usual service rate. In **Chapter 5** we consider a batch renewal input queue with N threshold policy where the server turns into the idle state if it finds the queue empty and switches to busy state when the queue-length becomes N or more. In this chapter, we develop an algorithm to obtain the steady-state system-content distribution at various epochs. Meanwhile, in **Chapter 6** we study a population model subject to geometric catastrophes. The units/individuals in the population grow according to batch renewal process and the catastrophes occur according to Poisson process which has a sequential impact on the population. Finally, in **Chapter 7** we give the concluding remarks and provide some future scope of study along this direction.

Keywords: Asymptotic distribution; Batch renewal arrival; Difference equation; Geometric catastrophe; Infinite buffer; Multiple working vacations; N policy; Performance measures; Population size; Queue-length; Supplementary variable; System-length.