ABSTRACT

Classical queueing model is an effective tool to study congestion and delay in waiting lines. Retrial queue, a special type of queueing system, is initiated to deal blocked customers /reattempts which is not allowed in classical queueing models. Retrial queueing systems have been found beneficial in modelling many systems such as repeated calls of telephone switching systems, transmission of a packet in computer networks and collision avoidance in local area networks. Retrial queuing systems are identified by the following feature: an arriving customer, on finding the server busy, departs from the service area and joins the group, called orbit in order to acquire its service at a later stage. For analyzing the fields of queueing and telecommunications, discrete-time queues are better than their continuous-time counterparts. The entire focus of this dissertation is on the analytical study of discrete-time retrial queuing models with various patterns of arrivals and different types of vacations that fits with many real-world scenarios.

The dissertation begins with an overview of the retrial queues and their applications. It includes a brief related literature survey on retrial queueing models in continuous-time, discrete-time, different types of arrivals, server failures, server repair and different vacation policies. The proposed work explores five different discrete-time retrial queueing models with variant arrivals, unreliable server and different vacation policies. For all the models, analytical solution is obtained using supplementary variable technique. The probability generating functions of buffer size at an arbitrary time are derived. Performance measures such as mean orbit size and mean waiting time are obtained. Few particular cases are derived. Numerical illustrations are also presented graphically.

Malware infected system is modelled and its behavior is analysed in the first work. A hybrid model which is a combination of likelihood filtering technique and a discrete-time single server retrial queue with negative arrivals is applied in the work. A likelihood estimation is used for filtering malwares and for improving the performance of the system. A discrete-time single server retrial queue with two types of arrivals is modeled to address infected system characteristics. A request which is originally legitimate known as the positive arrival, finds the host free and gets the instant service; otherwise it joins the buffer. The malware (request) which is not detected by the filter known as the negative arrival will lead to breakdown of the server, irrespective of the fact that the server is idle or busy. Further, it is assumed that suspicious request has no impact on the system when the server is under repair.

In second work a discrete-time $Geo/G/1$ retrial queue with three types of arrivals and single vacation policy is analysed. The three types of arrivals, regular, negative and partially negative following the geometrical arrival processes is considered. When the server is free, an arriving regular customer receives regular service immediately. If not, when the server is busy the customer joins the orbit and seeks the service latter until it finds the server idle. If an arriving negative customer finds the server busy with service, it breaks the server down (device hangs down/ shutdown) and the customer under service loses its service. An arrival of partially negative customer (packet contains virus) will only slow down the performance of the server when the server is in busy state, but it will break the server down when the server is in slow service state. It is assumed that the negative customer and the partially negative customer do not have any effect when the server is in repair state and also when the server is in idle state. The failed server will be sent for repair immediately but the slowdown server will be sent for repair only after service completion. The server will avail a single vacation if there is no customer in the orbit at the regular service completion epoch. After the completion of regular or slow service, the served customer leaves the system and will have no further effect on the system.

In third work a discrete-time $Geo/G/1$ retrial queue where the server is subjected to operation dependent failures and avails working vacation is considered. Customer arrives to the system according to geometrical arrival process. If the server is not occupied, arriving customer gets regular service, otherwise the customer joins the orbit. At the service completion epoch, if the orbit is empty then the server avails working vacation. If a primary arrival occurs during working vacation, instead of availing vacation, the server will serve the customer with a smaller service rate. If the slow service is completed prior to the completion of vacation, the server avails remaining vacation; if the slow service time is extended beyond the vacation time, the server switches to regular service. If no customer arrives during a vacation period, the server avails full vacation. The server works at different service rates instead of completely stopping service during a working vacation. Further, it is also assumed that the server may breakdown occur during operation in which case the customer under service will be lost and the failed server is immediately sent for repair.

Performance analysis of a discrete-time $Geo^X/G^{(1,b)}/1$ bulk retrial queue with multiple vacations is discussed in fourth work. Primary customers arrive in batches at the service station according to a Bernoulli arrival process. If the arriving batch of customers of size ξ, $1 \leq \xi \leq b$, finds the server free , then all the customers immediately get service; while, if the size of the arriving batch is more than 'b', then 'b' customers enter the service station and the remaining $\xi - b$ customers join the orbit. On the other hand, if an arriving batch finds the server busy, then the entire batch joins the orbit to retry their service later. It is assumed that the customers in the orbit will try for service one by one when the server is idle. After completing a service of a batch, if the server finds the orbit empty, the server avails a vacation of random length. After completing a vacation, if the server finds atleast one customer in the orbit, the server returns for regular service. Suppose no customer in the orbit at the completion epoch of vacation, the server avails another vacation. The server continues vacation until the orbit size is minimum one.

Final work aims to investigate the behaviour of a discrete-time batch arrival, single server retrial queue with impatient customers under three vacation policies namely single vacation, multiple vacations, and J-vacations policy. Primary customers arrive in batches to the service station according to a geometric process. An arriving batch of L customers find the server free, one of the customers from the arrival batch gets its service immediately, while the remaining $L-1$ customers join the orbit with probability β. If the server is not available at the time of batch arrival, the batch decides whether to join the orbit with probability β or to abandon the system with the probability $1-\beta=\bar{\beta}$. The customers who leave the system never return later. It is assumed that customers in the orbit are usually persistent. At the time of service completion, the server avails a vacation if the orbit size is zero.

Further, the primary contributions of this entire study is summarised in the conclusion section and related future research to this study is proposed.