ANALYSIS OF BULK QUEUEING MODELS WITH THRESHOLD POLICIES FOR VACATION

Queueing theory deals with the study of waiting lines. A systematic study of the queueing system provides a knowledge base that can be applied to monitor and improve the efficiency of many queueing systems in the real world. The study of queueing systems has attracted the attention of researchers, since it has wide range of applications in the fields of manufacturing, transport systems, communication systems and local area networks.

The overwhelming majority of existing results in queueing theory pertain to systems that can provide services singly (one customer at a time). However, in many real life situations, service to the customers can be provided in bulk of different sizes. Also, there are situations in which customers arrive in bulk. In the queueing theory literature, such systems are investigated only in a lesser extent, may be due to inherent complexity. The idle time of the server may be effectively utilized by assigning other works (vacations). The server will be doing the secondary job when sufficient number of customers is not available to start a service. The objective of this thesis is to analyse some bulk queueing models with control policy for vacations and to discuss the application of the proposed models. The thesis is organized as follows:

The first chapter of this thesis deals with the basics of queueing theory. A brief survey of some relevant existing work on queueing models, viz., controllable services, state dependent arrivals and multiple vacations is presented.

A steady state analysis of a **Non-Markovian Bulk Queueing System with Overloading and Multiple Vacations** is considered in Chapter II. It is considered that the server may adjust the service rate and the service capacity depending upon the queue length. After completing a service, if queue length is less than a threshold value 'a', then the server leaves for a vacation of random length. When the server returns from a vacation, and if the queue length is still less than 'a', then the server leaves for another vacation and so on until the server finds at least 'a' customers waiting for service. After a service or a vacation, if the server finds at least 'a' customers waiting for service (say) ξ ($a \leq \xi < N$), then the server serves a batch of min (ξ,b) customers, where $b \geq a$. If $\xi \geq N$, then the server increases the service capacity and serves a batch of N customers with a different service rate. Thus, the general bulk service rule is modified with variable service capacity. The probability generating function of number of customers in the queue at an arbitrary time epoch is obtained, using supplementary variable technique. Expressions for the expected length of queue and expected length of idle and busy periods are derived. A cost model for the queueing system is discussed and illustrated numerically.

In Chapter III, a **Steady State Analysis of a Bulk Arrival General Bulk Service Queueing System with Modified M-Vacation Policy and Variant Arrival Rate** is considered. After a service completion, if the number of customers waiting in the queue is less than a threshold value ‘a’, then the server avails a vacation of random length. After a vacation, if the queue length is still less than ‘a’, then the server avails another vacation and so on until he finally finds at least ‘a’ customers waiting in the queue or he completes ‘M’ number of vacations, consecutively. After completing the M^{th} vacation, if the queue length is still less than ‘a’, then the server remains in the system till the queue length reaches ‘a’ (this period is known as dormant period). At a vacation completion epoch or a service completion epoch or during the dormant period, if the queue length ξ is at least ‘a’ then the server serves a batch of min (ξ,b) customers, where $b \geq a$. It is more realistic that the arrival rate may not be constant all the time. Addressing this, it is considered that the arrival rate is dependent on the state of the server. That is, the arrival rate is λ when the server is busy and the arrival rate is λ_o $(\lambda_o < \lambda)$ when the server is on vacation or in the dormant period .Using supplementary variable technique, the steady state queue size distribution at an arbitrary time is obtained. Performance measures like the expected queue length, expected length of busy and idle periods are derived. Expected waiting time in the queue is also obtained. A cost model is derived. Numerical illustration is also presented.

In Chapter IV, a **Steady State Analysis of a Poisson Bulk Arrival Single Service Queueing Model with Threshold Policy on Number of Primary services for Secondary Jobs** is considered. In most of the queueing systems with vacations, the operator of the service station will be allotted to secondary jobs (vacations) only if, the number of waiting customers is zero. But it may not be the case always; there are situations in which the operator has to shutdown the machine after some finite number of processes. Addressing this, it is assumed that after rendering M consecutive services, the operator of the service station closes the service and avails a vacation of random length. At a vacation completion epoch, if the number of waiting customers in the queue is less than a threshold value N (N > M), the operator waits in the system (dormant period) till the queue length reaches N. At a vacation completion epoch or during a dormant period, if the queue length is at least N, then the server starts the single service. Using supplementary variable technique, the probability generating function of the number of customers in the system at an arbitrary time is derived. Expected length of the system, busy period and idle period are derived. A cost model is developed. Numerical illustrations are provided.

In Chapter V, a **Steady State Analysis of a Non-Markovian Bulk Queue with Multiple Vacations, Accessible Batches and Close down times** is considered. The service starts only if, minimum of 'a' customers available in the queue. At the service completion epoch if the number of customers waiting in the queue is ξ where $\mathbf{a \le \xi \le d-1 (d \le b)}$, then the server takes the entire queue for batch service and admits the subsequent arrivals for service till the service of the current batch is over or till the accessible limit ‘d’ is reached, whichever occurs first. At the service initiation epoch if the number of customers waiting in the queue 'ξ' is at least‘d’, then the server takes min (ξ, b) customers for service and does not allow further arrival into the batch. On completion of a service, if the queue length is less than ‘a’, then the server performs a close down work such as like shutting down the machine, removing the tools etc,. Following the close down work, the server leaves for multiple vacations of random length irrespective of queue length. When the server returns from a vacation and if the queue length is still less than ‘a’, he leaves for another vacation and so on until he finally finds at least ‘a’ customers waiting in the queue. Using supplementary variable technique, the probability generating function of the number of customers at an arbitrary time is derived. Expected length of the queue, busy period and idle period are derived. A cost model is developed. Numerical illustrations are presented.

Thus the present work is devoted to the analysis of some bulk queueing models with overloading, multiple vacations, modified vacation and accessible batches with threshold policies for vacation.