ABSTRACT

Bulk queueing models dealing controllable services, state dependent arrivals, multiple vacations of different policies, setup time, multiple vacations of alternate type with $d-$policy and instantaneous Bernoulli feedback are presented in this dissertation.

The first study is about **Steady State Analysis of a Non-Markovian Bulk Arrival General Bulk Service Queueing System with Fast and Slow Service Rates and Multiple Vacations.** The service rate can be controlled depending upon the queue length. The server does the service at a faster rate or at a slower rate based on the queue length. At a service initiation epoch, if the number of customers waiting in the queue is greater than or equal to $N(N>b)$, then the service is rendered at a faster rate, otherwise at a slower rate. After completing a service, if the queue length is less than 'a', then the server leaves for a vacation of random length. When the server returns from the vacation, 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, then the server serves a batch of $\min(\xi, b)$ customers, where $b \geq a$. Using supplementary variable technique, the probability generating function of the steady state queue size at an arbitrary time epoch is obtained. Expressions for the expected queue length, expected length of busy and idle periods are derived. A cost model of the queueing system is discussed. Numerical illustration is also presented.

The second study is about **Steady State Analysis of a Non-Markovian Bulk Arrival General Bulk Service Queueing System with State Dependent Arrivals and Multiple Vacations** is analysed. The arrivals occur in bulk with a rate λ, when the server is busy and with a rate λ_0, when the server is on vacation. This assumption is quite meaningful, because, in practice, the arrival rate may increase or decrease depending on

the server's position. The service starts only when there are at least 'a' customers waiting for service. After completing a service, if the queue length is less than 'a', then the server leaves for a vacation of random length. When the server returns again if the queue length is 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 number of customers waiting in the queue is ξ $(\xi \geq a)$, then the server serves a batch of $\min(\xi, b)$ customers, where $b \geq a$. Using supplementary variable technique, the probability generating function of the steady state queue size at an arbitrary time epoch is obtained. Expressions for expected queue length and expected length of idle and busy periods are derived. A cost model of the queueing system is discussed. Numerical solution for particular values of parameters is also presented.

The third study is devoted for the **Steady State Analysis of a Non-Markovian Bulk Arrival General Bulk Service Queueing System with Different Types of Vacation Policies and Setup Time.** At a service completion epoch, if the number of customers waiting in the queue is at least 'a' (say) ξ, then a batch of $\min(\xi, b)$ customers will be served, where $b \geq a$. On the other hand, if the number of customers waiting in the queue is less than 'a', then the server selects the i^{th} type of vacation with probability α_i $(i = 1, 2, \ldots, M)$ and cumulative distribution function $V_i(.)$, where $\alpha_1 + \alpha_2 + \cdots + \alpha_M = 1$. The vacations are assumed to be independent and identically distributed. When the server returns from a vacation, if the queue length is still less than 'a', then the server leaves for another vacation (with some probability) and so on until the server finds at least 'a' customers waiting for service. After a vacation if the server finds more than 'a' customers waiting for service, then the server requires a setup time R to start the service. After the setup time, if the number of customers waiting is ξ $(\xi \geq a)$, then the server serves a batch of $\min(\xi, b)$ customers, where $b \geq a$.

Using supplementary variable technique, the probability generating function of the steady state queue size at an arbitrary time epoch is obtained. Expressions for the expected queue length, expected length of busy and idle periods are derived. A cost model of the queueing system is discussed. Numerical illustration is also presented.

The fourth study is about the **Steady State Analysis of a Non-Markovian Bulk Arrival General Bulk Service Queueing System with Multiple Vacations of Alternate Type and Setup Time with d-Policy.** At a service completion epoch, if the queue length ξ is at least 'a' then a batch of $\min(\xi, b)$ customers will be served, where $b \geq a$. On the other hand, if the queue length ξ is less than 'a', then the server avails vacation according to the following procedure: If the queue length ξ, is less than the threshold value 'd' $(d < a)$, then the server leaves for a vacation of type V_1 with cumulative distribution function $V_1(.)$. After returning from a vacation of type V_1, if the queue length is still less than 'd', then the server leaves for another vacation of type V_2 with cumulative distribution function $V_2(.)$. The server avails these vacations V_1 and V_2 alternately, till the server finds, on returning from a vacation at least 'd' customers waiting for service. After a service, if the queue length ξ is such that $d \leq \xi < a$, then the server avails a single vacation. After a vacation, if the queue length is at least 'd', then the server requires a setup time R to start the service. After the setup time, if the queue length ξ is at least 'a', then the server serves a batch of $\min(\xi, b)$ customers, where $b \geq a$. Otherwise, the server remains in the system till the queue length reaches 'a'. This period is called the 'dormant period'. Using supplementary variable technique, the probability generating function of the steady state queue size at an arbitrary time epoch is obtained. Expressions for the expected queue length, expected length of busy and idle periods are derived. A cost model is discussed. Numerical illustration is also presented.

The fifth study is devoted for the **Steady State Analysis of a Non-Markovian Bulk Arrival General Bulk Service Queueing System with**

Instantaneous Bernoulli Feedback and Multiple Vacations. The queueing systems which include the possibility of a batch of customers returning to the counter for additional service are called queues with feedback. In the proposed system, a batch of customers which has received service, departs with probability 'd' and returns for more service with probability 'f', where $f + d = 1$. The batch that requires feedback joins at the head of the queue and is immediately taken for service. The service starts only when there are at least 'a' customers waiting for service. After completing a service, the batch may depart or feedback with corresponding probabilities 'd' or 'f'. After completing a service without feedback, if the queue length is less than 'a', then the server leaves for a vacation of random length. When the server returns, again if the queue length is 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 without feedback or after a vacation, if the number of customers waiting in the queue is ξ $(\xi \geq a)$, then the server serves a batch of min (ξ, b) customers, where $b \geq a$. Using supplementary variable technique, the probability generating function of the steady state queue size at an arbitrary time epoch is obtained. Expressions for the expected queue length, expected length of busy and idle periods are derived. A cost model is discussed. Numerical illustration is also presented.

In the last chapter, a production line problem is discussed to illustrate how the results obtained influence the production line system. Tables and graphs are presented to illustrate how the management can use the results to optimize the cost function.

Thus the present work is devoted to the analysis of some bulk queueing models with controllable services, state dependent arrivals, multiple vacations of different policies, multiple vacations of alternate type with d-policy, setup time and instantaneous Bernoulli feedback.