Conclusions and Future Work

In this research we considered the transient behavior of batch arrival queueing system $M^{[X]}/G/1$ with Bernoulli scheduled vacations. We assumed that the arrival of customers to the system are in batches of variable size, but are served individually by a single server accordingly “first come, first served” basis and the service times have been assumed to follow general distribution. After completion of any service, the server may take a single vacation of random length. Employing Bernoulli scheduled vacation such that after completion of the service of a customer the server may take a vacation with probability $\theta$ or stay in the system to serve customers with probability $1-\theta$ if any.

We investigated this system by extending it in to more different advanced queueing systems by including different aspects such as balking, feedback, server breakdowns, server setup, restricted admissibility policy, retrial policy. In each chapter, we aimed to find the necessary and sufficient condition for the system to be stable, the closed form solution of important system performance indices including the intensity parameter (the utilization factor), the proportion of idle time, the mean number of customers in the queue, the mean number of customers in the system, the mean waiting time in the queue and reliability indices such as availability of the server, Blocking probability, server failure density function of retrial queueing systems.

We applied supplementary variable technique to solve the system of equations by taking the elapsed service time, elapsed vacation time, elapsed repair time,
elapsed delay time and the elapsed extended vacation time have been introduced as supplementary variables.

In chapter two, we considered one of the customer impatience behavior balking by considering both state independent and dependent arrival rates. In chapter three we added two assumptions that the server provide an essential service followed by an optional service in a such a way that only a part of arriving customers need the second optional service and the server may goes for a k-optional vacation.

In next four chapters we considered batch arrival queueing system with Bernoulli vacations and the server meets breakdowns time to time with different aspects.

In chapter four we considered an aspect called feedback in which customers go for repeating their services until the service in being successful and also the server provides a second optional service for demanding customers.

In chapter five we considered two models. In first model we added an assumption that the server vacation has two phases in which the second phase is optional and in model 2 we considered that, whenever the server breaks down it should be sent for a repair process with two phases in which a second phase repair is optional.

In chapter six, we developed two models in which, at the end of a busy period, the server needs a random setup time before actually starting the service. In model 2, it is also assumed that when the server breaks down, repair process does not start immediately, where there is a delay time waiting for repairs to start.

In chapter seven we added an assumption that there is a restricted admissibility policy on arriving batches of customers to the system. Also in model 2, it is assumed that the server provides two stages of heterogenous service in succession.
In chapters eight, nine and ten, we considered batch arrival queueing systems with retrial policy, non-persistent customers and Bernoulli vacations.

In chapter eight, we considered two retrial queue models that discuss about second optional service and delayed repair respectively.

In chapter nine we added two assumptions that after the completion of vacation, the server has also take a setup time before providing service to the customers and balking.

In chapter ten, one of the feature, orbital search is added in retrial queueing system.

For each of the described queueing models, the necessary and sufficient condition for the system to be stable and some useful system queue indices such as the mean queue size and the mean waiting time in the queue have been obtained. Also some particular cases are discussed by dropping some assumptions on models which reduce the models into models investigated earlier by researchers.

Numerical results and some two dimensional graphs are presented for each of the queueing systems discussed. These illustrations show the effect of arrival, vacation and breakdown parameters on the system performance indices. As a general observation, when the probability that the server takes a vacation or the rate of breakdowns increase or the rate of arrival rate, the utilization factor, the mean system size and the mean waiting time of customer all increase while the proportion of time that the server is idle decreases. The trends that have been found are expected.

As queueing models are very much useful in designing perspective. The queueing systems have been studied in this research and the results obtained, can be
used to model many real problems where the servers are not continuously available for providing service for arriving customers and the server meets breakdown from time to time. These results provide essential information useful for management sectors, manufacturing industries, computer networks, telecommunication networks and other fields where decisions on systems having queues is vital.

**Future Work**

Based on the results found in this research, the researcher suggests further development to be conducted on the following queueing systems:

- Batch arrival queueing systems that includes also another customer impatience behavior reneging.

- Batch arrival queueing systems with random breakdowns, Bernoulli schedule vacations and two-stage heterogeneous service in which the breakdown rates are different for the two stages of service.

- Batch arrival queueing systems with setup times and repair times are generally distributed.

- One of the interesting feature stochastic decomposition property of the system size distribution could be studied in vacation models.

- To determine a control policy which gives the best estimate for the probabilities and which minimizes the total cost of the service system in retrial queueing systems.

- Queueing systems with batch service by considering different vacation policies.

- Batch arrival multi server queueing systems with different vacations policies.