The use of non-linear control theory to design guidance laws with the primary objective of intercepting targets has been explored extensively for the last several decades. The solution of this practical problem poses significant challenges due to variation in the system parameters, external disturbances, time-varying uncertainties, limited time and fuel availability etc. The initial high heading error during the launch of an interceptor while dealing with maneuvering targets also makes capture a demanding task for a missile. Thus, consolidated guidance approaches have been proposed in this thesis to achieve successful interception with efficient time-energy utilization and robustness against external disturbances. Modern optimal control and optimization methodologies have been explored to obtain near-optimal guidance laws and to generate reference trajectories which are time-energy efficient. Robust guidance laws are then proposed, which are capable of tackling external disturbances and track these reference trajectories to introduce a sense of time-energy efficiency.

To further improve the overall time-energy utilization of the system, a deployment approach which chooses either a robust guidance law or a near-optimal guidance scheme based on the occurrence of external disturbances is also proposed in the thesis. Additionally, due to constraint on space, weight, and cost, the state-of-art processors whose computational capabilities have increased many folds over the last few decades cannot be generally installed onboard a missile. An efficient way of minimizing the computational burden can be ensured by reducing the updates in the control input, thereby minimizing the load on the onboard processors. Hence, along with ensuring time-energy minimization and robustness, update reduction is also addressed in this thesis by introducing the concept of event-trigger control and quantized control.

This thesis also incorporates the practical aspect of input saturation for the interceptor which enhances its applicability for practical real-time systems. Simulation studies with non-maneuvering as well as maneuvering targets performing bank-to-bank and step maneuvers in both tail-chase and head-on engagements are included to highlight the efficacy of the guidance strategies. Stability analysis employing Lyapunov method is also carried out to establish the convergence of the system states on application of the proposed control approaches.