A number of analytical models for MESFET PDs are developed and presented in this thesis. Three different types of MESFET, i.e. front illuminated GaAs MESFET, front illuminated In$_x$Ga$_{1-x}$As MESFET and back illuminated GaAs MESFET PDs are modeled. Complete DC models are developed for GaAs MESFET and other configurations. The physics based models developed and presented in this thesis take into account all the major factors that shape the characteristics of the device in the illuminated condition. The models developed here also make an attempt to give a better inside of various physical mechanisms operative in the device. The major effects considered in modeling the devices are photovoltaic, photoconductive and change in the minority carrier lifetime with frequency and illumination. For GaAs MESFET PD the stability model is developed, this work is reported for the first time and hence is the novelty of the work. In all the models the losses of the optical radiation due to reflection at the various interfaces is taken into account. The models can be used as basic tools for the design of various types of PD.

While the GaAs MESFET PD is modeled for DC operation, AC operation, intrinsic parameter, noise behavior and stability rigorously, the other models are modeled for only DC operation and AC operation. The models of GaAs MESFET PDs presented here are developed by using realistic velocity–electric field relationships for determining the I–V characteristics of the device under the illuminated condition but the surface recombination rate and channel–substrate depletion region are neglected in the characterization of the device.

From the above discussion it is evident that there is a scope for developing more rigorous models of the devices by giving due consideration to the following factors:

1. The effect of internal photo–voltage on device parameters.
2. Microwave characterization of front illuminated In$_x$Ga$_{1-x}$As MESFET and back illuminated GaAs MESFET.
3. The noise behavior and noise equivalent power of front illuminated In$_x$Ga$_{1-x}$As MESFET and back illuminated GaAs MESFET.
4. 2D modeling of front illuminated In$_x$Ga$_{1-x}$As MESFET and back illuminated GaAs MESFET.