

# **Study and Analysis of Global Solar Radiation in Kurdistan Region-Iraq**

A THESIS

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**PHYSICS**

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## **Abstract:**

The main purpose of this thesis is to study and investigate extraterrestrial and global solar radiation over Kurdistan region. The study includes analysis of hourly, daily, monthly and seasonal fluctuations of solar radiation.

The study consists of two parts. In the first part hourly, daily and monthly mean hourly extraterrestrial solar radiation were calculated using universally recognized trigonometric relations between the sun and a horizontal surface on earth developed by Beckmann and Cooper (1969).

In the second part, hourly values of global solar radiation recorded by six automatic weather stations installed in six locations at Kurdistan region during three years period (2001-2003) were collected and carefully analyzed.

The six locations are Degala and Gopal in Erbil Governorate, Jelan and Qadish in Duhok Governorate, and Mawat and Qaradagh in Sulaymaniah Governorate.

The data and the results are all presented in both tabulated and graphical forms. Maps of fluctuations and variations of both extraterrestrial and global solar radiation are drawn using Surfer-8 program.

Different models available in the literature were used and tested to select the most useful and applicable radiation models in Kurdistan region.

Linear regression equations correlating global radiation with airmasses were deduced. The correlation coefficients obtained shows that statistically the results are highly significant. The normal (Gaussian) distribution equation relating the ratio of hourly values of global solar radiation to midday value of solar radiation with hour of the day were found applicable in Kurdistan region and this equation represents the variation of hourly solar radiation with time of the day with minimum error.

The study showed that solar radiation available in Kurdistan region is fruitful and can be utilized in many fields, such as extracting electricity, water pumping from shallow well on agriculture lands, central heating, etc...

The extraterrestrial hourly values vary from ( $4.32 \text{ kWh/m}^2.\text{day}$ ) in the month of December at Qadish location to ( $11.57 \text{ kWh/m}^2.\text{day}$ ) in the month of June at (Gopal, Jelan and Qadish) locations. The global recorded hourly values vary from ( $1.64 \text{ kWh/m}^2.\text{day}$ ) in the month of December at Qadish location to ( $9.14 \text{ kWh/m}^2.\text{day}$ ) in the month of June at Gopal location.

Kurdistan region is rich of solar radiation and its variability is almost stationary throughout the year due to stationary of its climate and its location on earth at the most suitable mid-latitude region.