Chapter One
Introduction
1.1 Preface
Renewable energy sources are the sources which are continuously replenished by natural processes Renewable energy source is environmental friendly and pollution free. Solar energy is becoming one of the most important energies now days and will become essential in the near future.
A solar energy system convert the energy found in sunlight which we can use in the form of heat or electricity. To harvest the solar energy, the most common way is to use photovoltaic panels which will receive photon energy from sun and convert to electrical energy.
Photovoltaic (PV) systems convert light directly into electric power. The term photo comes from the Greek phos, which means “light.” The term volt is a measure of electricity named for Alessandro Volta a pioneer in the development of electricity. [1] Photovoltaic literally means light–electricity, commonly known as solar cells. The simplest PV systems power many of the small calculators and wrist watches which are used every day. Larger PV systems provide electricity for pumping water, powering communications equipment, lighting homes and also in aviation appliances.
The achievement of a solar powered aircraft capable of continuous flight was a dream some years ago, but this great challenge has become feasible today. The concept of solar powered aircraft is quite simple, the solar cells which equipped by covering the wing convert energy from the sun in order to supply power to the propulsion system and the control electronics, and charge the battery with the surplus of energy. [2]During 3

the night, the only energy available comes from the battery, which discharges slowly until the next morning when a new cycle starts.

The PV output voltage is largely determined by the solar irradiation and the temperature of the panel, the solar radiation never remains constant at the daytime due to motion of the sun. The PV cells are affected by many external influences such as ambient temperature, partial shading and the tendency of sunlight radiations, however due to these influences there is variation in output voltage continuously.

This project introduce approach design of a solar cell voltage regulator such that it delivers constant output and stepped up DC voltage to the load irrespective of the variation in solar irradiance and temperature. The voltage regulator consists of boost converter which is controlled by pulse width modulation. The photovoltaic module is designed to achieve the required power for the load.

1.2 Statement of problem

The solar cells output voltage is irregularly duo to inefficiency of the photovoltaic cell caused by the spectral distribution of solar radiation, Optical effects like reflections, incomplete absorption, shading by contacts.

1.3 Proposed solution

Design of a voltage solar energy regulator to boost the voltage up to the required level by introducing a boost converter and a feedback PI controller.

1.4 Objectives

- Study the basic theory of the PV cells.
- Study buck and boost converter.
- Design of voltage regulator.

1.5 Methodology
Theoretical and analytical methodology is adopted and simulation software programs are used to simulate the proposed design to analyze the behavior of the system. The software's used are MATLAB and PLECS.

1.6 Research outline
This project consisting of five chapters:

- Chapter one: Introduction, which include introduction and literature review of previous studies of PV converter design.
- Chapter two: Basic theory of the photovoltaic, which consist of PV definition, history and work.
- Chapter three: Buck and boost converters, which includes DC-DC converter definition, components and Clear explanation about buck and boost converter.
- Chapter four: Design of solar cell voltage regulator.
- Chapter five: Simulation, include the results of simulation.
- Chapter six: Conclusion and recommendation.

1.7 Rationale
P.Sathya, Dr.R.Natarajan introduced an approach to "*Design and Implementation of 12V/24V closed loop Boost Converter for Solar Powered LED Lighting System*". Their proposed system had consisted of solar photovoltaic module, a closed loop boost converter and LED lighting module. Their solar photovoltaic module was an array contains 36 cells and each cell can produce maximum of 0.5 volts thus maximum of 18 volts can be extracted from a PV panel.
They used a closed loop boost converter to convert a low level dc input voltage from solar PV module to a high level dc voltage required for the load. To regulate the output of the converter, closed loop voltage

feedback technique is used. The feedback voltage is compared with a reference voltage and a control signal is generated and amplified. The amplified signal is fed to 555 Timer which in turn generates a PWM signal which controls the switching of MOSFET. Thus by switching of MOSFET it would try to keep output as constant. Initially the boost converter, timer circuit, amplifier circuit and LED light circuits are designed, simulated and finally implemented in printed circuit board. The simulation studies are carried out in MULTISIM.

They presented experimental results for solar PV and boost converter obtained in both software and hardware .Their observed results in both hardware and software simulations are compared. The expected output is 24 volts and in software it is coming 23.6 volts while in hardware it is getting regulated to 22.76 volts.[3]

Asmarashid Ponniran , *Abdul Fatah Mat Said* focus in their project "*DC-DC Boost Converter Design for Solar Electric System*" to design and construct a DC to DC converter (boost type) which is one of the main parts in solar electric system. Besides, to ensure that the output voltage will be step up from 12 V to 24 V. The 12 V input voltage is from the battery storage equipment and the24 V output voltage will be the input of the inverter in solar electric system.

In designing process, the switching frequency, is set at 20 kHz and the duty cycle, D is 50%.The tool that been used for circuits simulation and validation are National Instrument MULTISIM software and Or CAD software. Then, all the parameter values that obtained from the hardware measurement are compared with the calculation estimation and the circuit simulation for validation purposes. Output of the project, 24 V regulated DC voltage is successfully met the requirement. [4]

The students of Bradley University Department of Electrical Engineering: *Thomas Carley*, *Luke Ketcham* and *Brendan Zimmer* with 6 their advisors*: Dr.Woonki Na* and *Dr. Brian Huggins* explore a design method of solar power converter in their project "*Photovoltaic Power Converte*". The solar power converter incorporates a photovoltaic panel, boost converter, and inverter system to create 60 Hz, AC grid power. First, the photovoltaic panel used in this project is the BP350J. This panel can provide up to 50 watts of power. It has a nominal voltage of 12 V. Second, the DC voltage from a photovoltaic panel is stepped up using a boost converter.

A Maximum Power Point Tracking (MPPT) algorithm known as Perturb and Observe method controls the duty cycle of the boost converter to ensure maximum possible power is drawn from the panel. The switching signal for the boost converter is generated by a Texas Instrument, 32 bit fixed point Digital Signal Processor (DSP), TMS320F2812. The stepped up voltage from the boost converter is then sent through a single phase inverter to output 60 Hz AC power. A Sinusoidal Pulse Width Modulation (SPWM) approach is used to control the inverter.

The PWM signals are realized with the DSP. An LC filter removes unwanted switching harmonics from the inverter output. MATLAB Simulink and Code Composer Studio were used to program, simulate, and debug the DSP based power converter. [5]

Sumita Dhali, P.Nageshwara Rao, Praveen Mande and *K.Venkateswara Rao* have presented a design and simulation of "*PWM-Based Sliding Mode Controller for DC-DC Boost Converter*" operating in continuous conduction mode. The general aspects of the performances and properties of the sliding mode controller were compared with the Proportional Integral Derivative (PID) controller and Proportional Integral (PI) controller. Simulations results have been shown that the sliding mode control scheme provides good voltage regulation and is 7 suitable for boost DC-to-DC conversion purposes. The derived controller/converter system is feasible for common step-up conversion purposes. Moreover, it is exposed to significant variations which may take this system away from nominal conditions, due to changes on the line voltage and parameters at the input keeping load as a constant.[6]

Daniel F. Butay and *Michael T. Miller* introduced a proposed design and implementation of a“ *Maximum Peak Power Tracker: A Solar Application*” for a photovoltaic array using boost DC-DC converter topology. Using a closed-loop microprocessor control system, voltage and current are continuously monitored to determine the instantaneous power. Based on the power level calculated, an output pulse width modulation signal is used to continuously adjust the duty cycle of the converter to extract maximum power. Using a Thevenin power source as well as a solar panel simulator, system design testing confirms simulation of expected results and theoretical operation is obtained.[7]