RES

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1 Introduction

2 Pre-Work

2.1 Explain the working principle of the PV emulator.

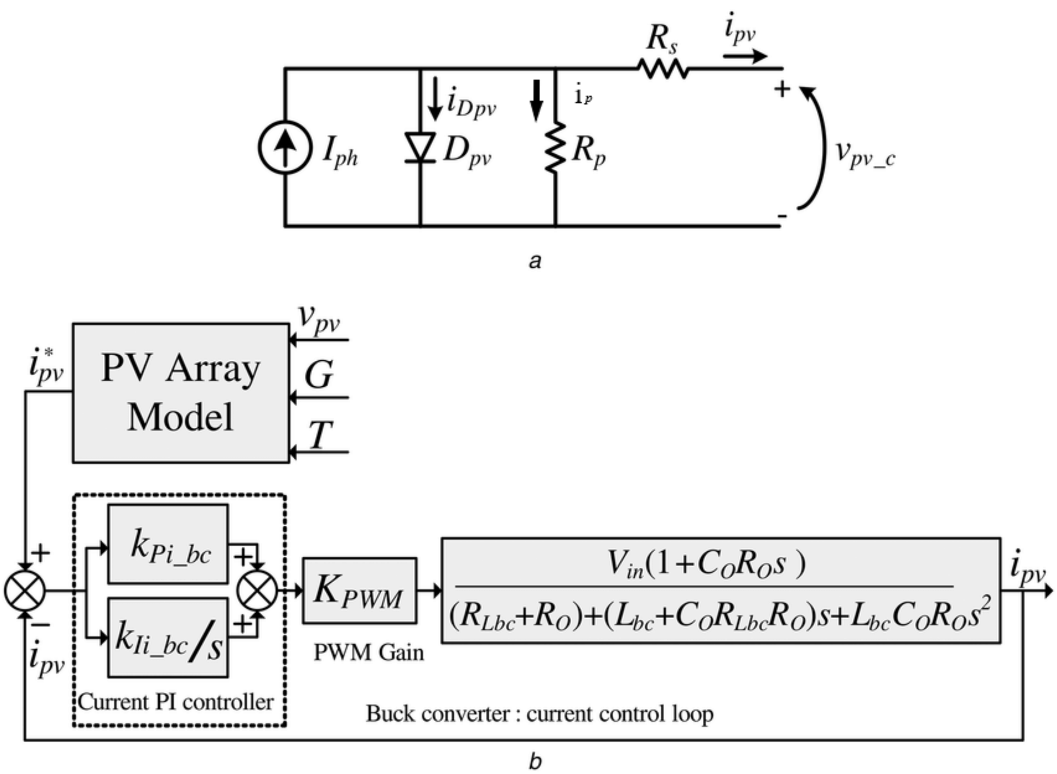

Figure 1: Diagram of PV emulator and voltage control

It can be seen from the above diagram that

$$I_{pv} = I_{ph} - i_{Dpv} - i_p \tag{1}$$

where the diode current i_{Dpv} is given by

$$i_{Dpv} = I_S(e^{\frac{V_D}{V_T}} - 1) \tag{2}$$

and the thermal voltage of the diode V_T is

$$V_T = \frac{K_B * T * A}{q} \tag{3}$$

where A is the ideality factor of the solar cell, q is the charge of an electron, K_B is the Boltzmann constant, T is the temperature in Kelvin and the voltage across the diode V_D is

$$V_D = V_{pv\_c} - I_{pv} * R_s \tag{4}$$

The leakage current I_p is given by

$$i_p = \frac{V_{pv\_c} + I_{pv} * R_s}{R_{sh}} \tag{5}$$

Combining eqs. (1) to (5) gives the output current as

$$I_{pv} = I_{ph} - I_S(e^{\frac{V_{pv\_c} - I_{pv} * R_s}{\frac{K_B * T * A}{q}}} - 1) - \frac{V_{pv\_c} + I_{pv} * R_s}{R_{sh}} \tag{6}$$

As R_{sh} does not affect the output voltage and is comparatively large compared to R_s, it can be ignored. Therefore, the power of the system is given by $P = I * V_{pv\_c}$ or

$$P = V_{pv\_c} * (I_{ph} - I_S(e^{\frac{V_{pv\_c} - I_{pv} * R_s}{\frac{K_B * T * A}{q}}} - 1)) \tag{7}$$

The equation parameters I_s, I_{ph} and R_s can either found experimentally or from technical literature.
The simulated PV emulator and the I-V and P-V curves from LTSpice are shown in figs. 2 and 3

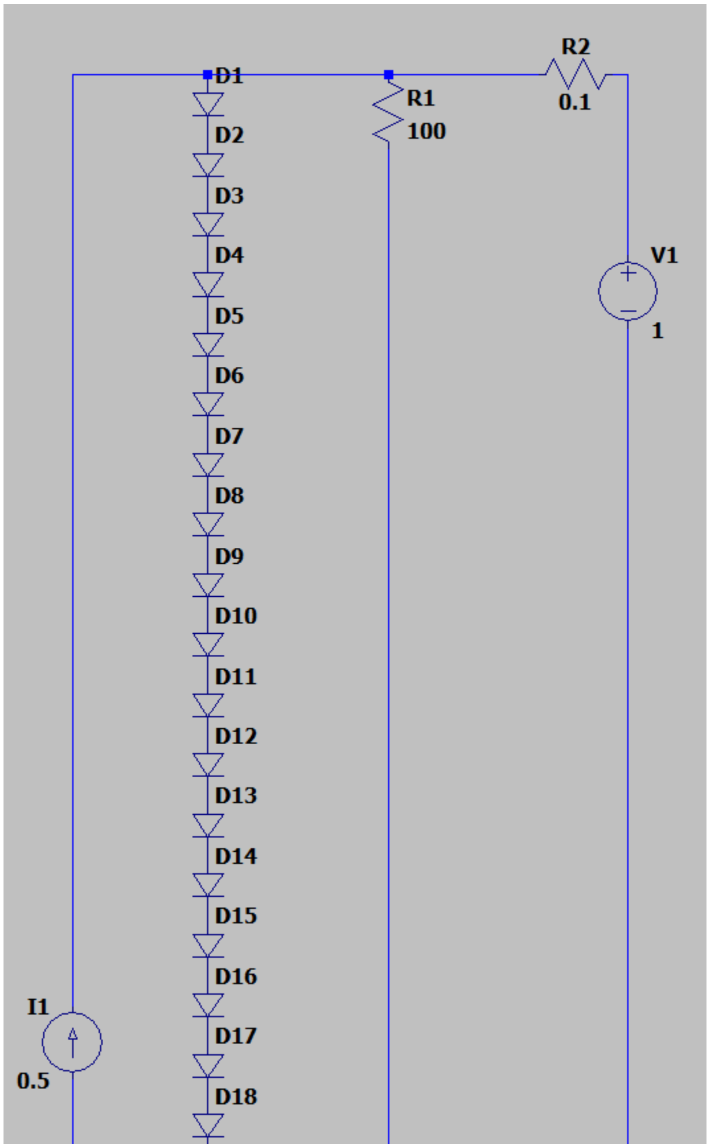

Figure 2: LTSpice circuit

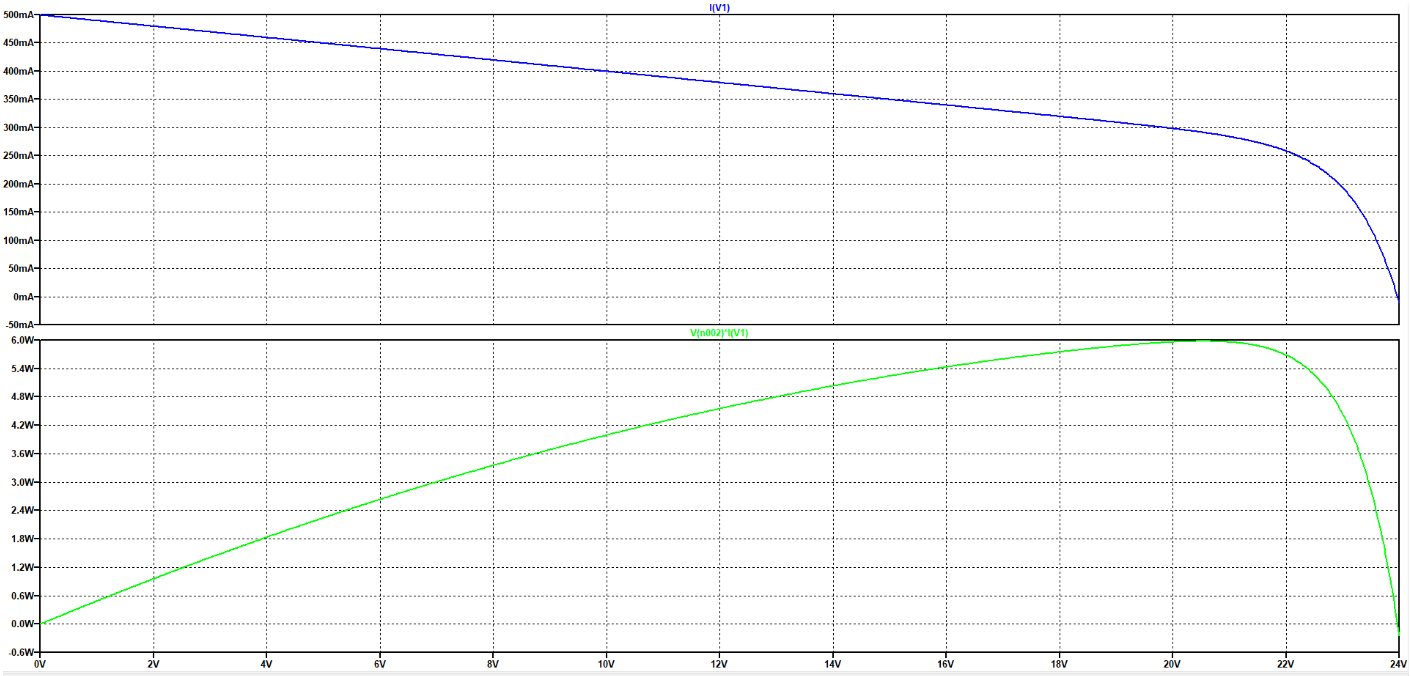

Figure 3: I-V and P-V curves

2.2 Explain how the duty cycle should change to make the PV panel voltage constant and operate at the reference

If the PV panel voltage drops below the reference value, the duty cycle should be decreased in orer to bring the voltage back to the reference value. Similarly, if the PV voltage rises above the reference value, the duty cycle should be increased to ensure the PV voltage drops to the reference voltage.