

**1 ENERGY STORAGE**

- 1.1 A water well is in a location with a mean daily solar radiation of 4.8 hours of sun. The PV powered pump is able to produce 16m<sup>3</sup> /day from a depth of 18m.
- Determine the required capacity of the batteries for autonomy of 3 days.
  - Determine the required installed PV power.
- 1.2 How much water would have to be pumped to a tank raised 3 meters from the ground in order to be able to recover 1kWh of electricity? [Assume 100% conversion efficiency.]

**2 MODULE TEMPERATURE**

- 2.1 A module datasheet states the following module parameters:  $I_{sc} = 3A$ ;  $V_{oc} = 20.4V$ ;  $P_{max} = 45.9W$ ;  $NOCT = 43^{\circ}C$ . Determine the parameters ( $I_{sc}$ ,  $V_{oc}$ ,  $FF$ ,  $P_{max}$ ) of a module formed by 34 solar cells under the following operating conditions:  $G = 700W/m^2$ ;  $T_a = 34^{\circ}C$ .
- 2.2 A PV module is found to operate at 60°C when  $T_a = 30^{\circ}C$  and  $G = 980W/m^2$ . Determine the NOCT of the module.
- 2.3 Determine the variation with ambient temperature (between -25°C and +75°C) of the power of a module (under standard 1000W/m<sup>2</sup>) with 36 Si cells in series each with  $I_m = 5.85A$  and  $V_m = 0.5V$  at 25°C and a  $NOCT=45^{\circ}C$ .

**3 SIZING A GRID CONNECTED SYSTEM**

Modules as those described in Table 1 are to be connected to an inverter with the specifications presented in Table 2. The modules' temperature range is -10 to 40°C.

Table 1: Module specification

Voc	30.2 V
Vm	24 V
Isc	8.54 A
Im	7.71 A
T coeff P	-0.485 %/°C
T coeff V	-0.104 V/°C

Table 2: Inverter specification

Max DC power	3200 W
Max DC voltage	600 V
MPP voltage range	268 - 480 V
DC nominal voltage	350 V
Min DC voltage	268 V
Max input DC current	12 A
Max output AC current	15 A

- Determine the module voltage range.
- Determine the minimum number of modules in a string, considering a 2% drop loss in the DC cables and a 10% safety margin for the minimum inverter input voltage.

- c) Determine the maximum number of modules in a string, considering a 5% safety margin for the maximum inverter input voltage.
- d) Determine the number of strings by matching the current specifications (neglecting temperature effects).
- e) Compare the array DC power of the configuration specified in the previous questions to the max DC power of the inverter.

**4      HOMEWORK**

Design a self-consumption PV system for a museum using PVSYST.  
Demand data will be provided as well as details of the building rooftop.