**Mansoura University**
**Faculty of Engineering**
**Electrical Engineering Department**
**2nd term final examination**
**2013/2014**

**3rd Year**
**Elective course**
**Renewable energy systems**
**Time allowed: 3 hrs.**
**Prof.Dr. M.Adel El-Sayes**

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رجاء: عدم إستعمال القلم الرصاص في الاجابه و إلا تعتبر مسوده

Answer all the following questions:

Q.1:

a. On the I-V curve of a silicon solar cell, demonstrate that the curve is divided into three sections.

b. Show the experimental circuit used in executing the P-V curve of the solar cell.

c. If the energy density in Langleys is 1.6, and if the strength of the sunlight is 1 sun, estimate the time continuity of the sunlight.

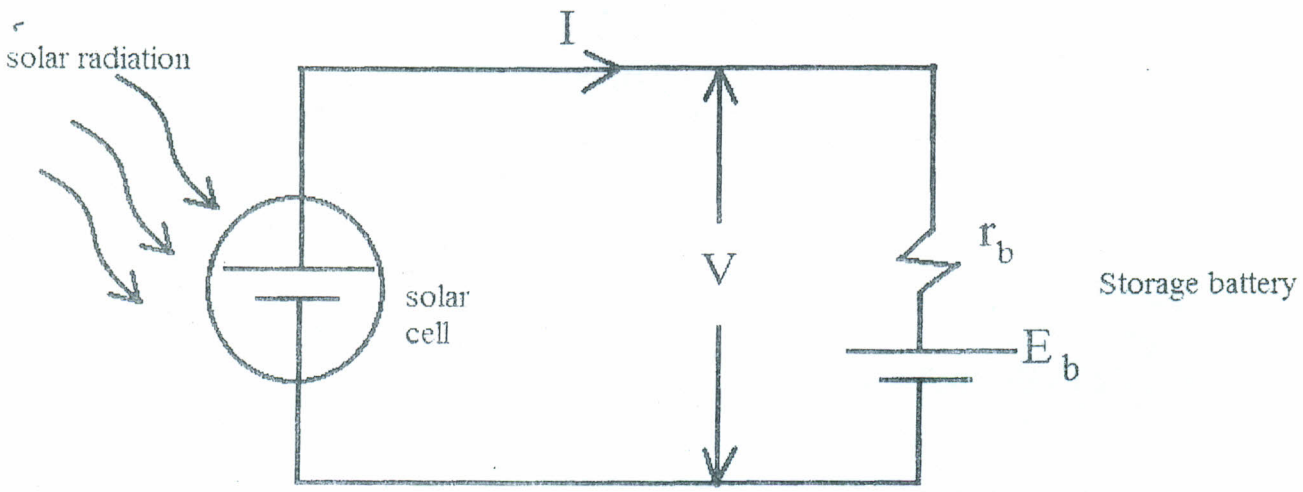
d. Calculate the rooftop area covered with solar cells to produce an average daily electrical energy of 5 KWh. (peak sun hours= 5, % $\eta_{conversion}$ =16%)

Q.2:

a. For the solar cell's c/c's described in the following table, complete the missing data.

| R | R1=∞ | R2=10 Ω | R3=8 Ω | R4=2 Ω | R5=0 Ω |
|---|---|---|---|---|---|
| V | V1=?? | V2=30 V | V3=?? | V4=10 V | V5=?? |
| I | I1=?? | I2=?? | I3=1 A | I4=?? | I5=?? |

b. For the storage battery charged by the solar cell, show the operating point of the circuit (V, I). Compute how the $r_b$ and $E_b$ are selected to make the solar cell to operate at the operating maximum power point.




c. A solar cell is rated 800mA, 0.45V at 25°C. The solar cell area is $25cm^2$. Calculate:

1. Output power and load resistance at 25°C.
2. Output power and load resistance at 50°C and 70°C.
3. The percentage reduction in the output power due to the increase in the temperature rise.

Q.3:

a. Show the I-V curve of the solar cell:
   1. At different solar radiation levels.
   2. At different ambient temperature.

b. An 8cm square solar cell has a rating at 25°C of 1500 mA and 0.45V in a full sun, what is the cell's efficiency at: 25°C, 50°C, and 70°C.

c. Show how the cell described in the above (in Q3.b) can be modified so that it supplies the followings:
   a. I= 375 mA, V=1.8 V.
   b. I= 750mA, V=0.9V.

Q.4:

a. Remember the temperature coefficients of the cell: ΔMax.p/ΔT, $\Delta V_{o.c.}$ /ΔT, and $\Delta I_{S.C.}$/ΔT , demonstrate the construction and theoretical efficiencies of the silicon solar cells.

b. Illustrate the schematic figures showing the followings:
   1. Pure silicon crystals.
   2. N-type silicon materials.
   3. P-type silicon material.
   4. Barrier formation.
   5. P-N Junction silicon solar cell.

c. Demonstrate how the solar cell converts directly the solar energy into electrical energy.

d. Draw the schematic figure of a silicon solar cell showing their different layers.

Q.5:

a. A silicon solar cells are rated at 0.4V and 1.1A, how many solar cells are required to produce 3.3A at 2.4V, also, show the used series-parallel combination.

b. Demonstrate the concentrator cells used for achieving a magnification factor of 16.

c. A solar module in rated 5.2V, 35W. It is used to power 28V supply requiring 20A of current. Find:
   a. The number of modules needed.
   b. Their connection.
   c. The required value of load resistance to achieve the rated power.