2. half-exam (2. välikoe) 17 April 2014
PHYS-E6570 Solar Energy Engineering (5 cr, L)

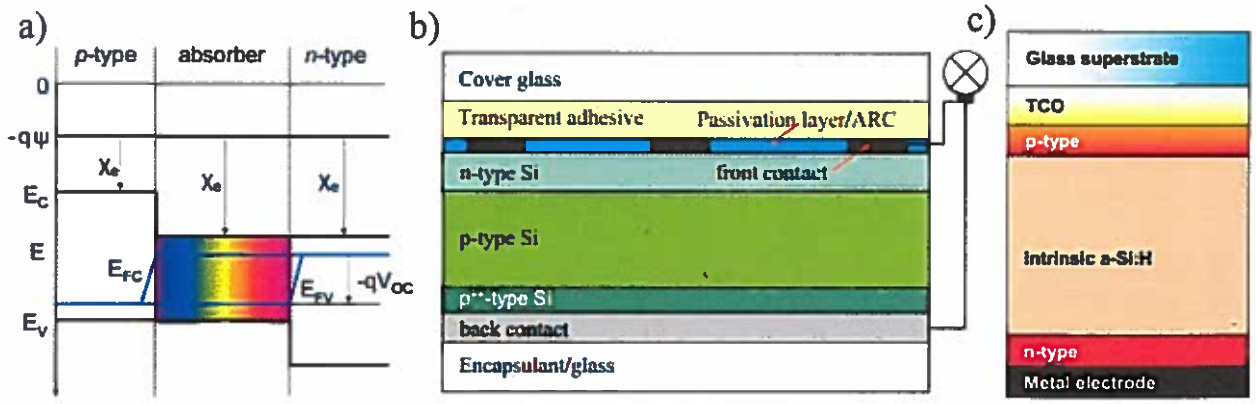
1. a) The concentration ratio of a parabolic dish is $C = 200$. How much solar radiation is received in the focal point of the concentrator if solar radiation on a plane is 800 W/m^2 direct radiation and 200 W/m^2 diffuse radiation? (2 p)

   b) How much heat (W/m^2) could the above concentrator deliver if its optical efficiency is 0.8 and the heat loss factor is 5 W/m^{2}K (per m^2 = per absorber area)? (2p)

   c) How accurately needs the concentrator follow the movement of the sun in order to be able to concentrate the radiation to the focal point (choose A, B, C, or D; maximum misalignment error A = about 5°, B = about 2°; C = about 1°, D < 0.5°)? (2p)

2. Explain and compare with each other the structure and operating principle (light absorption, charge separation, charge collection) of the following three types of solar cells:

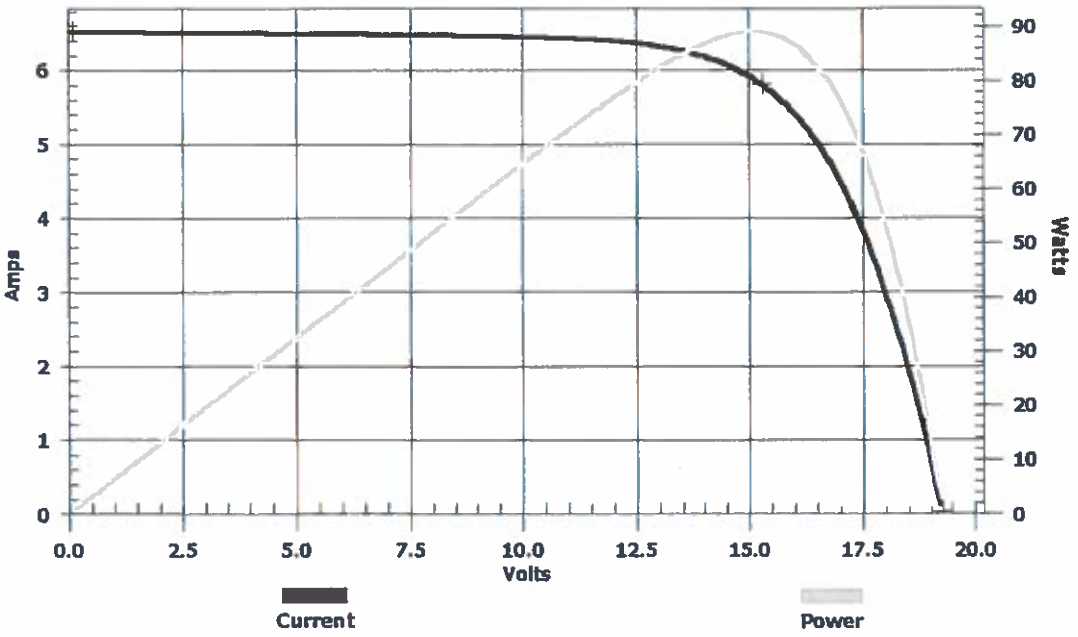
   a) Generalized and simplified solar cell structure
   b) Crystalline silicon solar cell
   c) Amorphous silicon thin film solar cell



3. Plan and sketch with components, and dimension key components for a stand-alone PV system in a village electrification application in Africa. Daily average solar radiation is 6 kWh/m^2 and the daily demand of electricity is 5000 Wh. (6p)

4. The figure below shows the current (I) – voltage (V) curve of a solar module (black curve) and corresponding power curves (power as the function of voltage, gray curve), measured at the standard test conditions (STC, radiation intensity 1000 W/m^2, T = 25°C, AM1.5G spectrum). The dimensions of the module are 600 × 1000 mm. Estimate the open circuit voltage (V_{OC}), short circuit current (I_{SC}), fill factor (FF), and energy conversion efficiency (η) of the module in the following two cases:

   a) Initial case, as in the figure. (3p)
   b) Initial case, but with series resistance (R_S) of the module increased from its initial value by 1 Ω. (3p)



5. Explain shortly following definitions (each 1p)
   a) Trombe-wall
   b) Thermosyphon
   c) Heat produced by a typical solar heating system in Southern Finland (kWh/m^2 per year)?
   d) Hottel–Whillier–Bliss (HWB) equation
   e) Fin efficiency of a solar collector
   f) Threshold intensity (kynnysintensiteetti)