

Calculator is not need/allowed in the exam.  
Remember to give feedback in the Kaiku-system to get the final grade.  
You can answer to the questions either in English or in Finnish.

## 53117 Solar Power Systems

Examination, 21.5.2015

Answer to each question 1, 2, 3 and 4 should fit into one page of a common writing paper.

1. a) When have been done the first observations of the photovoltaic effect in solid materials?  
b) When took place the first discoveries of the present photovoltaic (PV) cell?  
c) What were the first application areas of PV power production?  
d) How has the efficiency of silicon solar cells developed since their discovery?  
e) How has the price of PV power plant installations developed during the past 5 to 10 years?  
f) What has been the market share of solar PV power of the installed global power production capacity during the past few years?
2. Define the following quantities and concepts (with one or two sentences, figures or equations).
  - a) Incoming solar radiation  $G$  and its components on midday on a due south oriented PV module tilted at an angle  $\beta$  with respect to the horizontal plane.
  - b) Relative air mass number at a certain altitude above sea level.
  - c) The process of light absorption in direct and indirect band gap PV semiconductors and their effect on needed PV cell thickness.
3. Three strings of twenty series connected silicon PV cells have short circuit currents of 0.5 A, 1.5 A, and 3.0 A.
  - a) Draw the current-voltage and power-voltage curves of the three PV strings.
  - b) Draw the current-voltage and power-voltage curves of a PV system where the three PV strings are connected in parallel.
  - c) Draw the current-voltage and power-voltage curves of a PV system where the three PV strings are connected in series.
  - d) Draw the current-voltage and power-voltage curves of a PV system where each of the three PV strings are protected with a bypass diode connected in parallel with the string and the strings are then connected in series.
4. What is meant by the generator correction factor, which is used when designing and sizing PV power plants? What kind of sub-factors does it contain?