1. PV Basics

Problems

1.1. The ideal I-V characteristics of a solar cell, with cell voltage V_c and current I_c, can be written:

$$I_c(V_c) = I_{photo} - I_0 \cdot \left(e^{qV_c/nkT} - 1\right)$$

When parasitic resistance is present, the external voltage V and current I satisfy:

$$I(V) = I_c(V_c) - V_c/R_p = (V_c - V)/R_s$$

The parameters for various solar cells under various operating conditions are listed below:
(Assume $T = 300$ K .)

cell 1	cell 2	cell 3	cell 4
$I_{photo} = 10$ A	$I_{photo} = 15$ A	$I_{photo} = 10$ A	$I_{photo} = 10$ A
$I_0 = 1.0\times10^{-16}$ A	$I_0 = 1.0\times10^{-16}$ A	$I_0 = 1.0\times10^{-14}$ A	$I_0 = 1.0\times10^{-16}$ A
$n = 1.0$	$n = 1.0$	$n = 1.0$	$n = 2.0$
$R_s = 0$	$R_s = 0$	$R_s = 0$	$R_s = 0.0\ \Omega$
$R_p = 1.0\times10^{8}\ \Omega$	$R_p = 1.0\times10^{8}\ \Omega$	$R_p = 1.0\times10^{8}\ \Omega$	$R_p = 1.0\times10^{8}\ \Omega$

cell 5	cell 6	cell 7
$I_{photo} = 10$ A	$I_{photo} = 10$ A	$I_{photo} = 12.6$ A
$I_0 = 1.0\times10^{-16}$ A	$I_0 = 1.0\times10^{-16}$ A	$I_0 = 4.0\times10^{-15}$ A
$n = 1.0$	$n = 1.0$	$n = 1.5$
$R_s = 0.1\ \Omega$	$R_s = 0.0\ \Omega$	$R_s = 0.05\ \Omega$
$R_p = 1.0\times10^{8}\ \Omega$	$R_p = 0.01\ \Omega$	$R_p = 0.5\ \Omega$

Determine the following device characteristics for each cell, including units:

a) V_{OC} (open-circuit voltage)

b) I_{SC} (short-circuit current)

c) V_m (max.-power-point voltage)

d) I_m (max. power-point current)

e) P_m (max. power)

f) FF (fill factor)