SOLAR ENERGY 21/22

①

a) F

b) F

c) T

d) F

e) F

② a)

$$\eta = \frac{210\ W}{1.26\ m^2 \times 1000\ \frac{W}{m^2}} = 16,7\%$$

$$ff = \frac{I_{mp} V_{mp}}{I_{sc} V_{op}} = \frac{5.09 \times 41.3}{5.57 \times 50.9} = 74\%$$

b) June

$\bar{T}_a = 20.6\ °C$

$\bar{G} = 2.32\ kWh/m^2/day$

$NOCT = 48°C$

$\frac{\Delta P}{\Delta T} = -0.3\%/°C$

$$T_c = T_a + \frac{NOCT - 20}{800} \cdot G$$

$T_c = 48$ (assuming $G = 800\ W/m^2$ which is likely too high)

$\Delta T = 48 - 25 = 23$

$\frac{\Delta P}{P} = -0.003 \times 23 = 0.069$

$P' = (1 - 0.069) \times 210 \times 20 = 3910.2\ W$ (average system power at nominal power $1000\frac{W}{m^2}$)

$E = 3910.2 \times 2.32 =$ **9071 Wh/day**

↑ hours of sunshine per day at nominal power $1000\ W/m^2$

(repeat approach for october; ΔT will be smaller)

c) 5 strings × 4 modules per string

$I_M = 1.25 \times I_{SC} \times 5$

- 5 → # strings
- I_{SC} → highest current
- 1.25 → safety factor

$I_m = 0.5 \times I_{MPP} \times 5$

$T_{min} = 10°C$

$T_{max} = 23°C$

$V_M = 4 \times V_{OC}$ (@ T_{min})

$V_m = 4 \times V_{MP}$ (@ T_{max})

(you need to calculate cell T_c for extreme temperatures and then use $\frac{\Delta V}{\Delta T} = -0.00252$ /°C to calcute voltages)

d) Modules should be connected in such a way that all shaded modules are in one single string (to avoid affecting more than one string!). If all modules had bypass diodes it wouldn't matter how they were connected.

no bypass: 4 strings of 4 modules

$$210 \times \frac{300}{1000} \times 16 = 1008 \text{ W}$$

with bypass: 4 strings of 4 modules + 1 string of 3 modules

$$210 \times \frac{300}{1000} \times 19 = 1197 \text{ W}$$

c) challenges of BiPV

- aesthetics
- shading
- higher maintenance cost

(3) protecting the battery

- avoid overcharge
- avoid over discharging
- avoid leakages

(4) 3000 mAh, 3.7 V } = 11.1 Wh (energy required to charge battery)

$11.1\ Wh = 12h \times 10\ \frac{W}{m^2} \times A(m^2) \times 0.2$ └ efficiency

$A = \frac{11.1}{12 \times 10 \times 0.2} = \underline{\underline{0.46\ m^2}}$