جامعة بيرزيت

BIRZEIT UNIVERSITY

ANSWER BOOKLET

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Course: Department:	Number:
Division:	Instructor:
Date: Day / Month / Year	

For Instructor's Use

Question	Grade
1	20
2	16
3	12
4	9
5	31
6	
7	
8	
9	
10	
11	
12	
Total	88/100

Q1)

20/20

(a) Voc at the intersection with V axis

$V_{oc} = 72.5$ V.

~~Voc~~ I_{sc} at the intersection with A axis (I)

$I_{sc} = 21$ A.

(b) maximum power point @ the ~~m~~ Knee of the IV curve

$\Rightarrow V_{mp} = 60$ v , $I_{mp} = 19$ A , $P_{mp} = V_{mp} I_{mp} = (19)(60) = 1140$

(c) $FF = \frac{\text{Power @ max Powe point}}{V_{oc} I_{sc}} = \frac{1140}{72.5(21)} = 0.748 \times 100\%$

$FF = 74.8\%$.

(d) $\eta = \frac{P_{max}}{E(A)} = \frac{1140}{1000(7)} = 0.1628 \times 100\% = 16.28\%$.

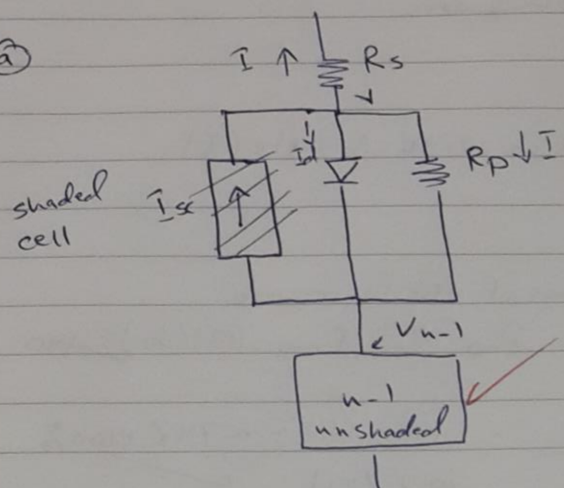
(F) I_{mp} @ $25c^\circ$ = 19 A, V_{mp} @ $25c^\circ$ = 60 v

I_{mp} @ $50c^\circ$ = $19 + (0.003 \times 25) = 19.075$ A.

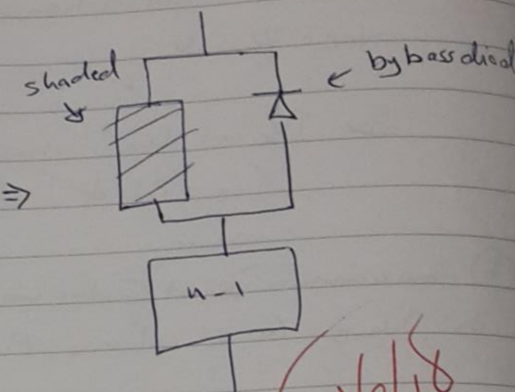
V_{mp} @ $50c^\circ$ = $60 - (0.004 \times 25) = 59.9$ V

Q2) $n=36$, $P=120\,W$, $R_p=6$, $R_s=0.005$, $I=2.2$, $V=18$

(a)



⇒



16/18

(b) $\Delta V = \frac{V}{n} + I R_p = \frac{18}{36} + 2.2(6) = 13.7$

⇒ the new model output: $18 - 13.7 = 4.3\,V$.

⇒ Power $= 4.3(2.2) = 9.46$ watt.

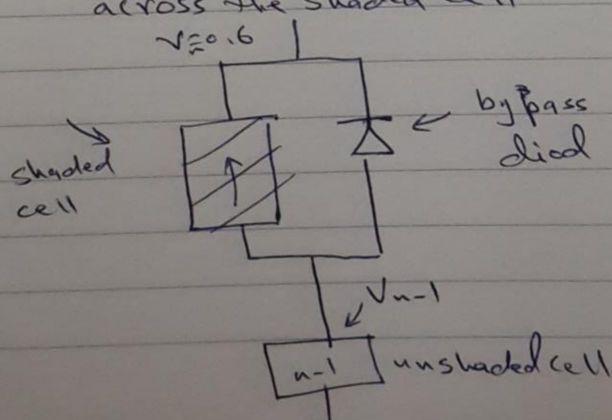
(c)

the voltage drop across the shaded cell $= I(R_p + R_s)$ ⇒

$V_c = 2.2(6 + 0.005) = 13.211\,V$.

(d) $P_{dissipated}: I V_c = 13.211(2.2) = 29.0642\,W$.

(E) the benefit of bypass diod is to control the voltage dropp across the shaded cell.



power & voltage calculations to show diode benefits

(-2)

Q3) (a) @ -20c° ⇒ MDoD = 0.62 ≅ 62%. (12/18)

days = 2, C = 500 Ah/day

$\Rightarrow C_{new} = \frac{500(2)}{12(0.62)} = 134.4$ Ah. /6

V desired = 12V, C desired = 500 Ah/day ⇒ 500 (2) = 1000 Ah ?

(b) V = 24, n = 3, ac = 2KW, h = 5, inverter efficiency = 0.95
MDod = 0.8

$dc\,load = \frac{ac}{efficiency} = \frac{2000}{0.95} = 2105.26$ w

+6

⇒ dcload (h) = 2105.26 (5) = 10526.3

$\Rightarrow C = \frac{10526.3}{24(0.8)} = 548.24$ Ah.

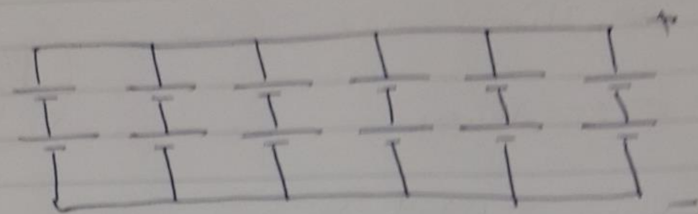
(c) C desired = 548.24 Ah
V desired = 24V.
V battary = 12 V
C battary = 100 Ah

+6

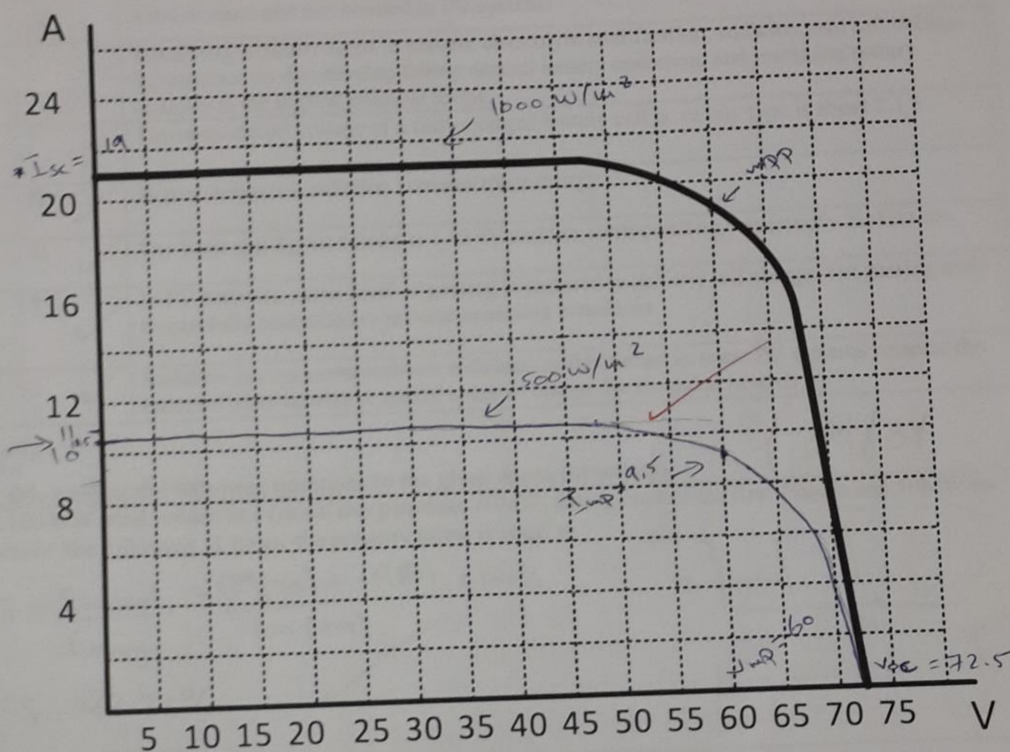
$\Rightarrow \frac{24}{12} = 2$ ⇒ So we need tow battaries in series

$\frac{548.24}{100} = 5.4824$ ⇒ So we need six strings of series battaries

⇒



Q1 (E)



End of Exam

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6/10

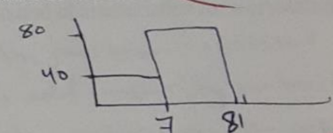
T	C ✓	A battery that has had three-quarters (3/4) of its capacity removed is at a 25% state of charge and at 75% depth of discharge
F	D ✓	Automotive batteries (i.e. Car, truck) are deep-cycle batteries with depth of discharge 80% or more and can be used in PV systems.
T	E ✓	Equalizing a battery helps to prevent electrolyte stratification, sulfation, and cell voltage inconsistencies that develop during normal battery operation, and maintains battery capacity at the highest possible levels.
F	F ✗	The open-circuit voltage of a fully charged battery cell is of any type is about 2.1 V.
T	G ✓	Higher frequency radiation contains more energy
T	H ✓	The band-gap *Eg* for silicon is 1.12 eV and the corresponding wavelength is 1.11 μm
T	I ✓	In PV batteries, some level of gassing is required to achieve full charge, but gassing must be carefully controlled to prevent excessive water loss.
T	J ✓	Sulfation is a common problem with lead-acid batteries in some PV systems because the batteries often operate at partial states of charge for extended periods

Q5 (31/34)

~~Q6~~. Answer the following questions in the given space (34 points)

A) A 100 MW wind turbine in a typical day generates 40MW during each of the first 7 hours and 80MW for each of the following 11 hours, the capacity factor is equal to :

$$CF = \frac{E_{actual}}{E_{theory}} = \frac{(7)(40) + 11(80)}{100(24)} \times 100\%$$



$CF = 48.33\%$. ✓ +4

B) What is the value of Solar Declination angle (δ) for the start of the four seasons?

δ for Summer (soltics) = 23.45° ⇒ above the ~~cancer~~ tropic cancer

δ for winter (equnix) = −23.45° ⇒ ~~below~~ above the cabricorn tropic

δ for fall & spring at the edge of equator ⇒ δ = 0° +4

C) What is the most popular type of PV batteries? What is its main characteristics? What are factors affecting battery life?

types of battaries : 1) lead acid battary 2) ~~[illegible]~~ Nickle cadimum. +3

factors affecting battary life : 1) tempreture 3) construction.. 2) capacity, charging & discharging −1

characteristics:-

consists of thin & thick plates ~~[illegible]~~ either positive or negative plates & electrolyte to provide a medium for the transfer of ions between the ~~[illegible]~~ plates of battary. used for storag energy at good time to provide power at bad time for diffirent loads.

F) What is the highest theoretical efficiency of PV cell? What is the highest practical efficiency for silicon cells ? Why the practical efficiency is different from the theoretical value?

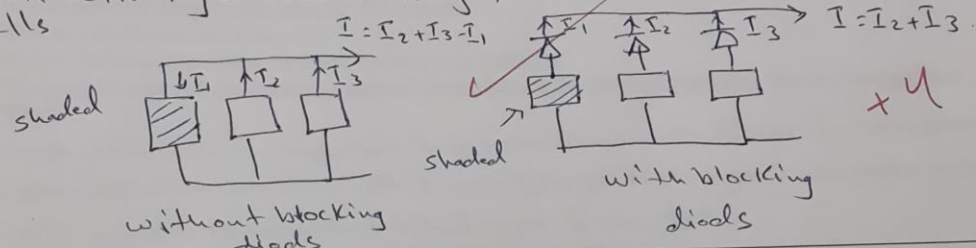
highest efficiency of pv cell 40% - 50% , highest efficiency for silicon 25% . there is diffirent due to pv cell construction, consentration of silicon .

×2

/2

G) What is blocking diodes? Explain where and why they are used in PV systems?

blocking diodes is diods used to prevent reverse current flowing down malfunctioning or shaded strings , used in series with shaded cells



×4

H) Provide a brief (short) description of PV cell construction, operation and characteristics for a crystalline silicon cell

a Pv cell construct from P-n junctions , the Pn junction consist of P-type and n-type , P-type results when we add impurity material from group 3 to silicon and that result in hole , n-type results when we add impurity material from group 5 to silicon and we got free electron . when photons reaches the top of cell the electric field push the holes to the p side & the electrons to the n-side the p-side acomolated to holes and n-side acomolated to electrons this provide a voltage acrross the cell that result in a current used to deliver. to many loads , when we connect the top of the cell & the botomm to wires a current will pass from the n-side (type) through the wires and the load and return back to p.type (side), crystaline silicon cell efficiency ≈ 25% .

×4

D) Find the optimum tilt angle for a south-facing photovoltaic module in an area at latitude 32.1° at solar noon on March 1.

tilt angle $= 90° - \beta_n$, $\beta_n = 90 - L + \delta$, $L = 32.1$, $n = 60$

$\delta = 23.45 \sin\left(\frac{360}{365}(60 - 81)\right) = -8.29°$

$\Rightarrow$ ~~tilt~~ $\beta_n = 90 - 32.1 - 8.29 = 49.61°$

$\Rightarrow$ tilt $= 90 - 49.61 = 40.39°$.

+4

E) Why is array orientation important in PV systems?
What are the factors affecting it ?
What is the best orientation for fixed PV arrays in Palestine?
What are the types of sun tracking systems? And what are the quantities (angles) that are changed and Why?

(1) array orientation is important to get maximum irradiance for max power.
(2) geographical location, ~~to~~ time of day, tilt angle, azimuth angle.
(3) tilt angle to be equal to latitud angle aprox 35°
azimuth angle to south within -45° to 45°.
(4) types of tracking systems : (1) single axis tracking system.
(2) double axis " " .
(5) angles are tilt angle ~~&~~ ~~of~~ azimuth angle.

+6