

## Unit 6 - Week 5 : Essential characteristics of solar photovoltaic devices

### Course outline

How does an NPTEL online course work?

Week 1 : Introduction and Solar radiation fundamentals

Week 2 : Basic physics of semiconductors

Week 3 : Carrier transport, generation and recombination in semiconductors

Week 4 : Semiconductor junctions

Week 5 : Essential characteristics of solar photovoltaic devices

Lecture 21 : P-N Junction Analysis (Light)

Lecture 22 : P-N Junction Analysis ( Light)

Lecture 23 : P-N Junction Analysis (Light )

Lecture 24 : P-N Junction Analysis (Light)

Lecture 25 : Solar Cell Device Parameters

Quiz : Assignment 5

Solar Photovoltaics: Principles, Technologies and Materials: Week 5 Feedback

Assignment-5 Solution

Week 6 : First Generation Solar Cells

Week 7 : Second Generation Solar Cells

Week 8 : Third Generation Solar Cells

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## Assignment 5

The due date for submitting this assignment has passed.  
As per our records you have not submitted this assignment.

**Due on 2020-03-04, 23:59 IST.**

1) In PN junction diode under illumination, at short circuit condition 1 point

- The photocurrent flows from P to N side in the diode.
- Minority carriers move across the depletion region due to drift.
- Quasi Fermi levels are aligned across the diode.
- Recombination and generation currents are balanced.

No, the answer is incorrect.  
Score: 0

Accepted Answers:  
*Minority carriers move across the depletion region due to drift.*

2) Which of the following is correct statement for an illuminated PN junction diode? 1 point

- Carrier generation at short circuit condition is larger than at open circuit condition.
- There is no generation of charge carriers at open circuit voltage.
- Space charge region became wider under open circuit voltage.
- Recombination current in the diode balances the photocurrent at open circuit voltage.

No, the answer is incorrect.  
Score: 0

Accepted Answers:  
*Recombination current in the diode balances the photocurrent at open circuit voltage.*

3) For PV devices using direct bandgap semiconductors, ideality factor of the recombination current is likely to be. 1 point

- 0
- 2
- 1
- between 0 and 1

No, the answer is incorrect.  
Score: 0

Accepted Answers:  
2

4) Depletion approximation for PV devices in dark and without bias is 1 point

- Electric field is non-zero in both n and p quasi neutral regions.
- Electric field is zero in both n and p quasi neutral regions.
- Electric field is finite in the depletion region.
- Electric field is non-zero in the whole device.

No, the answer is incorrect.  
Score: 0

Accepted Answers:  
*Electric field is zero in both n and p quasi neutral regions.*  
*Electric field is finite in the depletion region.*

5) In a P-N junction diode at equilibrium, acceptor and the donor ion concentrations are  $10^{17} \text{ cm}^{-3}$  and  $10^{18} \text{ cm}^{-3}$  are respectively. What is the change in the minority carrier concentration (in  $\text{cm}^{-3}$ ) under illumination, if generation rate (G)  $10^{20} \text{ cm}^{-3} \text{ s}^{-1}$  and carrier life-time ( $\tau$ ) for electron and hole  $10^{-4} \text{ s}$ ? 1 point

- $10^4$
- $10^{16}$
- $10^{17}$
- $10^{18}$

No, the answer is incorrect.  
Score: 0

Accepted Answers:  
 $10^{16}$

6) When a P-N junction diode is illuminated at zero bias what may happen? 1 point

- No electric field in quasi neutral region.
- No net generation in the space charge region.
- Quasi Fermi energy of holes in n-type higher than p-type.
- Quasi Fermi energy of electrons in p-type higher than n-type.

No, the answer is incorrect.  
Score: 0

Accepted Answers:  
*No electric field in quasi neutral region.*  
*Quasi Fermi energy of electrons in p-type higher than n-type.*

7) For a PN junction diode, as temperature increases then what may happen? 1 point

- $V_{oc}$  and  $J_{sc}$  both increase
- $V_{oc}$  and  $J_{sc}$  both decrease
- $V_{oc}$  increases and  $J_{sc}$  decreases
- $V_{oc}$  decreases and  $J_{sc}$  increases

No, the answer is incorrect.  
Score: 0

Accepted Answers:  
 *$V_{oc}$  decreases and  $J_{sc}$  increases*

8) Which of the following parameters does not affect the quantum efficiency of the device? 1 point

- Surface quality.
- Applied electrical Bias.
- Thickness of the device.
- Absorption coefficient.

No, the answer is incorrect.  
Score: 0

Accepted Answers:  
*Applied electrical Bias.*

9) Photocurrent in a PN junction diode depends on 1 point

- Quantum efficiency.
- Applied electrical bias.
- Intensity of illumination.
- Diffusion of majority carrier current.

No, the answer is incorrect.  
Score: 0

Accepted Answers:  
*Quantum efficiency.*  
*Intensity of illumination.*

10) Which of the following device characteristics are determined with J-V curve of illuminated PN junction diode? 1 point

- Maximum power point is the product of  $V_{oc}$  and  $J_{sc}$ .
- Fill factor of a PV device is the ratio of maximum power to product of  $V_{oc}$  and  $J_{sc}$ .
- Conversion efficiency of illuminated diode is the ratio of fill factor to power input.
- Open circuit voltage when photocurrent density compensates the forward bias dark current density.

No, the answer is incorrect.  
Score: 0

Accepted Answers:  
*Fill factor of a PV device is the ratio of maximum power to product of  $V_{oc}$  and  $J_{sc}$ .*  
*Open circuit voltage when photocurrent density compensates the forward bias dark current density.*

11) In an illuminated PN junction diode, one can achieve increase the quantum efficiency via following methods: 1 point

- Surface passivation.
- Decrease in the thickness.
- High diffusion length of carriers.
- High surface recombination velocity.

No, the answer is incorrect.  
Score: 0

Accepted Answers:  
*Surface passivation.*  
*High diffusion length of carriers.*

12) What is the recombination current density in the depletion region (in  $\text{mA/cm}^2$ ) under dark applied bias 0.3 V at temperature 300K and recombination saturation current density is  $10^{-2} \mu\text{A/cm}^2$  and ideality factor is 2? 1 point

- $1.16 \times 10^{-2}$
- $2.17 \times 10^{-3}$
- $3.19 \times 10^{-3}$
- $4.13 \times 10^{-4}$

No, the answer is incorrect.  
Score: 0

Accepted Answers:  
 $3.19 \times 10^{-3}$

13) Under illumination for a P-N junction, which of the following is appropriate? 1 point

- $n_p = n_i^2$
- $n_p > n_i^2$
- $n_p > n_{p0}$
- $p_n > p_{n0}$

No, the answer is incorrect.  
Score: 0

Accepted Answers:  
 $n_p > n_i^2$   
 $n_p > n_{p0}$   
 $p_n > p_{n0}$

14) Consider a PN junction diode of area  $2 \text{ cm}^2$  which under illumination of  $100 \text{ mW/cm}^2$  shows a short circuit current density  $35 \text{ mA/cm}^2$  and open circuit voltage 0.6 V and generates maximum power 34mW. 1 point

What will be the fill factor (in %) of the diode?

- 40
- 61
- 70
- 81

No, the answer is incorrect.  
Score: 0

Accepted Answers:  
81

15) Consider a PN junction diode of area  $2 \text{ cm}^2$  which under illumination of  $100 \text{ mW/cm}^2$  shows a short circuit current density  $35 \text{ mA/cm}^2$  and open circuit voltage 0.6 V and generates maximum power 34mW. 1 point

What will be the power conversion efficiency (in %) of the diode?

- 13
- 17
- 23
- 34

No, the answer is incorrect.  
Score: 0

Accepted Answers:  
17