

# WEEKLY CONTENTS OF ET3034TU SOLAR ENERGY COURSE

## WEEK 1: INTRODUCTION

**Block 1.1:** General Introduction to the Course and the edX Platform

**Lecture 1.1:** Intro to the Course

**Video:** Intro to edX

**Video:** Courseware Accordion

**Video:** Top-Level Navigation

**Video:** Discussion

**Video:** Summary

**Text:** Online Behaviour & Collaboration

### Pre-questionnaire

**Block 1.2:** Energy Conversion

**Lecture 1.2:** Energy Conversion Part I

**Lecture 1.3:** Energy Conversion Part II

**Questions:** Q1.2.1 – Q1.2.2

**Block 1.3:** Photovoltaics

**Lecture 1.4:** Photovoltaics

**Questions:** Q1.3.1 – Q1.3.3

**Block 1.4:** History of Solar Energy

**Lecture 1.5:** History of Solar Energy

**Discussion**

**Block 1.5:** Status and Prospects of PV Technology

**Lecture 1.6:** Status and Prospects of PV Technology

**Questions:** Q1.5.1 – Q1.5.2

**Discussion**

**Block 1.6:** Solar Light

**Lecture 1.7:** Solar Light I

**Questions:** Formula Sheet & Q1.6.1

**Lecture 1.8:** Solar Light II

**Questions:** Q1.6.2

### **Homework Assignment 1**

**HW 1.1 + Instructions:** Cost of PV Technology Generations (3 points)

**HW 1.2:** Renewables in Global Electricity Supply Mix (1 point)

**HW 1.3:** Power Spectral Density and Photon Flux (1 point)

**HW 1.4:** PV Potential Around the World (4 points)

**HW 1.5:** PV System for The Smith Family (6 points)

**Extra:** Definitions of Terms

**Video:** Definitions of Terms

## **WEEK 2: WORKING PRINCIPLE OF A SEMICONDUCTOR BASED SOLAR CELL**

**Block 2.1:** How to Transform Light into Electricity

**Lecture 2.1:** How to Transform Light into Electricity

**Questions:** Q2.1.1 – Q2.1.2

**Block 2.2:** Bandgap

**Lecture 2.2:** Bandgap I: Electrons in Atoms

**Questions:** Q2.2.1

**Lecture 2.3:** Bandgap II: Electrons in Molecular Bonds

**Questions:** Q2.2.2

**Discussion**

**Block 2.3:** Charge Carriers

**Lecture 2.4:** Excitation of Charge Carriers Part I

**Lecture 2.5:** Excitation of Charge Carriers Part II

**Questions + Instructions:** Q2.3.1 – Q2.3.3

**Lecture 2.6:** Transport of Charge Carriers

**Questions:** Q2.3.4 – Q2.3.6

**Block 2.4:** Semiconductor Junction

**Lecture 2.7:** The Semiconductor Junction

**Questions:** Q2.4.1 – Q2.4.3

**Lecture 2.8:** The Solar Cell

**Questions:** Q2.4.4 – Q2.4.5

**Discussion**

## Homework Assignment 2

### Instructions

**HW 2.1:** Phosphorus Electron Configuration (1 point)

**HW 2.2:** Conductivity in Semiconductors (1 point)

**HW 2.3:** N-Doping of Silicon (1 point)

**HW 2.4:** Minority Carrier Concentration (1 point)

**HW 2.5:** Diffusion Current Density VS Drift Current Density (2 points)

**HW 2.6:** Minority Carrier Lifetime (1 point)

**HW 2.7:** P-N Junction (6 points)

**HW 2.8:** Open-Circuit Voltage (1 point)

## WEEK 3: SOLAR CELL OPERATION, PERFORMANCE AND DESIGN RULES

### Block 3.1: Solar Cell Operation

**Lecture 3.1:** Solar Cell Operation

**Questions:** Q3.1.1 – Q3.1.2

### Block 3.2: Solar Cell Performance

**Lecture 3.2:** The External Parameters of an Ideal Solar Cell

**Example:** Fill Factor and Open-Circuit Voltage

**Questions + Instructions:** Q3.2.1 – Q3.2.4

**Lecture 3.3:** The Series and Shunt Resistance

**Questions:** Q3.2.5 – Q3.2.6

**Example:** Series and Shunt Resistance

### Block 3.3: Solar Cell Design Rules

**Lecture 3.4:** Utilization of Bandgap Energy

**Questions:** Q3.3.1

**Lecture 3.5:** Spectral Utilization 1: The External Quantum Efficiency

**Questions + Instructions:** Q3.3.2 – Q3.3.4

**Lecture 3.6:** Spectral Utilization 2: The Shockley-Queisser-Limit

**Questions:** Q3.3.5 – Q3.3.6

**Lecture 3.7:** Light Trapping 1

**Questions:** Q3.3.7 – Q3.3.8

**Lecture 3.8:** Light Trapping 2

**Questions:** Q3.3.9 – Q3.3.10

**Example:** The Rayleigh Film

## EXAM 1

### Instructions

**Exam Question 1.1:** Drift of Charge Carriers (1 point)

**Exam Question 1.2:** Biased P-N Junction (1 point)

**Exam Question 1.3:** Open-Circuit Voltage (1 point)

**Exam Question 1.4:** Fill Factor and Efficiency (2 points)

**Exam Question 1.5:** Ideal IV Curve (4 points)

**Exam Question 1.6:** Non-Ideal JV Curve (5 points)

**Exam Question 1.7:** Absorption Coefficient (4 points)

**Exam Question 1.8:** Reflection in a Solar Cell (1 point)

## WEEK 4: PV TECHNOLOGY BASED ON C-SI WAFERS

### Block 4.1: Properties of c-Si

**Lecture 4.1:** Properties of c-Si

**Questions:** Q4.1.1 – Q4.1.2

### Block 4.2: Manufacturing of c-Si

**Lecture 4.2:** Manufacturing of c-Si

**Questions:** Q4.2.1 – Q4.2.3

### Block 4.3: Design Rules of the c-Si Solar Cell

**Lecture 4.3:** Design Rules of the c-Si Solar Cell

**Questions:** Q4.3.1 – Q4.3.4

### Block 4.4: High-Efficiency Concepts of c-Si Wafer Based Solar Cells

**Lecture 4.4:** High-Efficiency Concepts of c-Si Wafer Based Solar Cells

**Questions:** Q4.4.1 – Q4.4.3

### Block 4.5: From Solar Cells to Solar Modules

**Lecture 4.5:** From Solar Cells to Solar Modules

**Questions:** Q4.5.1 – Q4.5.3

## Homework Assignment 4

### Instructions

**HW 4.1:** Manufacturing of Poly-Silicon (1 point)

**HW 4.2:** Finger's Resistance (1 point)

**HW 4.3:** Surface Recombination at the Air/Silicon Interface (1 point)

**HW 4.4:** Choosing the Silicon Layer Thickness (1 point)

**HW 4.5:** Back Surface Field (1 point)

**HW 4.6:** Effect of By-Pass Diodes (3 points)

## **WEEK 5: THIN FILM PV TECHNOLOGIES**

### **Block 5.1: III-V PV Technology**

**Lecture 5.1:** III-V PV Technology

**Questions:** Q5.1.1 – Q5.1.2

### **Block 5.2: Thin Film Silicon PV Technology**

**Lecture 5.2:** Thin Film Silicon PV Technology – Part I

**Lecture 5.3:** Thin Film Silicon PV Technology – Part II

**Questions:** Q5.2.1 – Q5.2.4

### **Block 5.3: CIGS PV Technology**

**Lecture 5.4:** CIGS PV Technology

**Questions:** Q5.3.1

### **Block 5.4: Thin Film CdTe PV Technology**

**Lecture 5.5:** CdTe PV Technology

**Questions:** Q5.4.1 – Q5.4.4

### **Block 5.5: Organic PV Technology**

**Lecture 5.6:** Organic PV Technology

**Questions:** Q5.5.1 – Q5.5.2

## **Homework Assignment 5**

### **Instructions**

**HW 5.1:** Micromorph Module (1 point)

**HW 5.2:** CIGS and CdTe Fabrication (1 point)

**HW 5.3:** Triple Junction JV Curve (1 point)

**HW 5.4:** EQE of a Tandem Cell (6 points)

**HW 5.5:** Dye Sensitized Solar Cell (3 point)

## **WEEK 6: THIRD GENERATION PV, SOLAR THERMAL AND SOLAR FUELS**

### **Block 6.1: Third Generation PV Technology**

**Lecture 6.1:** Fundamental Concepts of Third Generation PV Technologies

**Questions:** Q6.1.1 – Q6.1.2

**Discussion**

**Block 6.2:** Solar Thermal Technologies

**Lecture 6.2:** Solar Thermal Energy I: Basic Principles

**Questions:** Q6.2.1 – Q6.2.3

**Lecture 6.3:** Solar Thermal Energy II: Solar Thermal Heating

**Questions:** Q6.2.4 – Q6.2.7

**Lecture 6.4:** Solar Thermal Energy III: Solar Thermal Power

**Questions:** Q6.2.8 – Q6.2.9

**Block 6.3:** Solar Fuel Technologies

**Lecture 6.5:** Solar Fuels

**Questions:** Q6.3.1 – Q6.3.4

**Discussion**