



## Course guide

# 295324 - 295SE021 - Reliability, Life Cycle and Heat Dissipation

**Last modified:** 03/03/2026

**Unit in charge:** Barcelona East School of Engineering  
**Teaching unit:** 709 - DEE - Department of Electrical Engineering.

**Degree:** MASTER'S DEGREE IN TECHNOLOGIES FOR DISTRIBUTED ENERGY SYSTEMS (Syllabus 2025). (Compulsory subject).

**Academic year:** 2025    **ECTS Credits:** 6.0    **Languages:** Catalan

### LECTURER

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**Coordinating lecturer:** RAMON BARGALLO PERPIÑA

**Others:** Segon quadrimestre:  
RAMON BARGALLO PERPIÑA - Grup: T1  
OLIVER MILLÁN BLASCO - Grup: T1

### PRIOR SKILLS

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General knowledge to enroll in this master.

### REQUIREMENTS

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General knowledge to enroll in this master.

### LEARNING RESULTS

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**Knowledges:**

K2. Identify the structural and functional particularities and applicable regulations of decentralised electrical systems.  
K3. Recognise and compare the electronic subsystems used in processing and managing electrical energy in distributed electrical systems.

**Skills:**

S1. Analyse, design and evaluate the reliability and life cycle of decentralised electrical systems based on renewable energy sources. Assess the reliability and life cycle of a distributed system for energy generation from renewable resources.  
S3. Assess the impact and needs of new electricity consumption models and relate them to the change in energy model resulting from the decarbonisation of energy sources.

**Competences:**

C4. Apply the knowledge acquired and appropriate methodologies to analysis and design in the field of decentralised electrical systems with renewable sources.  
C2. Identify and analyse problems that require making autonomous, informed and reasoned decisions in order to act with social responsibility following ethical values and principles.



## TEACHING METHODOLOGY

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- AF.1.- Presentation of theoretical content.
- AF.2.- Resolution of exercises, problems and cases.
- AF.3.- Practical work sessions in the laboratory.
- AF.4.- Discussion of problems or scientific articles.
- AF.5.- Participation in seminars and conferences.
- AF.6.- Carrying out individual and cooperative work.
- AF.7. Sessions in computer or simulation laboratories

## LEARNING OBJECTIVES OF THE SUBJECT

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By taking the FCVGT subject, the student will acquire skills aimed at analyzing and determining the useful life and reliability of distributed energy systems, both as an isolated element and as part of a set that works in coordination with other energy systems, and with emphasis on distributed energy systems for processing electrical energy using renewable energies, paying special attention to the configurations of electric microgrids (smart microgrids).

They will also acquire knowledge and skills aimed at determining the thermal loads and temperature distribution in the elements that form part of a distributed electrical energy system and the effects that these temperatures produce on it, determining which solution is the most suitable to improve and optimize the effects of this thermal load.

## STUDY LOAD

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| Type              | Hours | Percentage |
|-------------------|-------|------------|
| Hours small group | 28,0  | 18.67      |
| Self study        | 94,0  | 62.67      |
| Hours large group | 28,0  | 18.67      |

**Total learning time:** 150 h

## CONTENTS

### Reliability analysis of distributed energetic systems

**Description:**

1. Fundamentals of reliability in electrical systems. Failure rate ( $\lambda$ ) and mean time between failures (MTBF). Customer-oriented indices: SAIDI (minutes of interruption/customer/year) and SAIFI (number of interruptions/customer/year) Cost of energy not supplied (EENS) and economic impact of interruptions. (2h)
2. Mathematical models. Reliability function. Analysis of series and parallel components. Models based on Markov chains. Reliability models for small and large systems. (4h)
3. Reliability analysis in distributed microgrids. Application examples. Consideration of different topologies. (4h)
4. Reliability and useful life of the subsystems of an electric vehicle. (2h)
5. Reliability aspects for the design of distributed energy systems. (2h)

**Specific objectives:**

The student will acquire skills aimed at analyzing and determining the useful life and reliability of distributed energy systems, both as an isolated element and as part of a set that works in coordination with other energy systems, and with emphasis on distributed energy systems for the processing of electrical energy using renewable energies, paying special attention to the configurations of electric microgrids (smart microgrids).

**Related activities:**

1. Calculation of reliability, service life and other reliability parameters for a simple system (static converter) (2h)
2. Calculation of reliability of a microgrid with different working configurations. (4h)
3. Talk on determination of MTBF and FIT for an electronic board. (2 h).

**Full-or-part-time:** 44h

Theory classes: 14h

Practical classes: 8h

Self study : 22h

### title english

**Description:**

1. Heat transfer in power electronic systems. (2 h)
2. Thermal properties of materials. (2 h)
3. Heat dissipation systems. (2 h)
4. Determination and validation of the heat dissipation system. (4 h)
5. Improvements in system cooling. Passive and active methods. (2 h)
6. Calculation tools and design of heat dissipation systems. (2 h)

**Specific objectives:**

The student will acquire knowledge and skills aimed at determining the thermal loads and temperature distribution in the elements that form part of a distributed electrical energy system and the effects that these temperatures produce on it, determining which solution is the most suitable to improve and optimize the effects of this thermal load.

**Related activities:**

1. Calculation and simulation of a heat sink. Use of software. (2h)
2. Measurement of temperature in a static converter subjected to different loads. Effects of forced ventilation. (2h)
3. Talk on heat dissipation in SMD components. (2h).

**Full-or-part-time:** 42h

Theory classes: 14h

Practical classes: 6h

Self study : 22h

#### title english

##### Description:

Resolution of a project in informal collaborative groups. As an initial idea, they will be within the following areas:

1. Reliability calculation of a microgrid. The student, based on general indications, must choose a configuration for a microgrid with no less than four elements (for example, battery, network, consumption and photovoltaic) and must perform an analysis of the reliability of the chosen configuration. If necessary, the original structure must be modified in order to guarantee the minimum reliability required.
2. Based on given specifications, the student must determine the methodology to be implemented to improve the thermal management of a device (it can be a specific element such as an inverter, or an entire system that manages a microgrid - it can be the previous microgrid).

**Full-or-part-time:** 25h

Theory classes: 2h

Guided activities: 8h

Self study : 15h

## GRADING SYSTEM

Individual written exam grade (EE): 30%

Practice grade (PR): 30%

Proposed exercises grade (EP): 20%

Group work grade (TG): 20%

In summary, the final grade is given by:  $N_{curs}=0.3\cdot EE+0.3\cdot PR+0.2\cdot EP+0.2\cdot TG$

Apart from the scheduled tests indicated above, additional unscheduled tests may be taken, within class hours and without prior notice, such as aspects of formative assessment (theory, exercises), problem solving, improvement of evaluation results, etc., which may increase the grades of these initially scheduled tests.

In accordance with academic regulations:

This subject is considered a continuous assessment and, therefore, does not have a "final" exam in the classic sense.

It is not subject to reassessment.

Carrying out the practical activities (laboratory work, writing reports and, where applicable, prior preparations for the practicals) is a necessary condition to pass the subject. If the practicals are not carried out, the grade for the subject will be, at most, a Fail 3.5.

## EXAMINATION RULES.

You must bring, and if applicable show, a valid personal identifier (ID, passport or student card).

Online tests, if applicable, will be governed by the regulations that regulate them.

In accordance with section 3.1.3 of the Academic Regulations for Undergraduate and Master's Studies at the UPC, the completion of laboratory practices is mandatory in order to opt for the subject.

OTHER

[Plagiarism / Fraud] Irregular actions that may lead to a significant variation in the qualification of one or more students constitute a fraudulent performance of an assessment act. This action entails the descriptive qualification of failure and a numerical grade of 0 for the assessment act and the subject, without prejudice to the disciplinary process that may arise as a result of

the acts carried out. (Academic Regulations for Undergraduate and Master's Studies at the UPC. (Section 3.1.2.)

[Code of Ethics of the UPC] (Agreement CG/2022/02/30 of the Governing Council, section 4.2) Students, ..., must make efficient and responsible use of all the resources that the University makes available to them, whether material or immaterial. Therefore, they must not only strive to achieve the highest level of knowledge, but must also have special consideration for the public nature of the resources that society invests in their training. They must maintain a participatory attitude in all training activities, must facilitate the work of the teaching staff and must actively participate in the teaching staff evaluation process. They must also value their personal effort in all actions, must prove their honesty and integrity in evaluation acts, and must promote these attitudes among their fellow students.

## BIBLIOGRAPHY

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### Basic:

- Tuinema, Bart W.; Rueda Torres, J.L.; Stefanov, Alexandru I.; Gonzalez-Longatt, Francisco M.; van der Meijden, Mart A. M. M. Probabilistic Reliability analysis of power systems : A student's introduction [on line]. Cham: Springer International Publishing, 2020 [Consultation: 16/09/2025]. Available on: <https://link-springer-com.recursos.biblioteca.upc.edu/book/10.1007/978-3-030-43498-4>. ISBN 3030434982.
- Reliability analysis of modern power systems. New Jersey: Wiley IEEE Press, 2024. ISBN 9781394226771.
- Lienhard, John H. A Heat transfer textbook [on line]. Cambridge: Phlogiston Press, 2004 [Consultation: 19/09/2025]. Available on: <https://ahtt.mit.edu/>.
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- Dhillon, B. S. Life cycle costing for engineers. Milton: CRC Press, 2009. ISBN 9781439816899.

### Complementary:

- Haque, Ahteshamul. Reliability of power electronics converters for solar photovoltaic applications. London: Institution of Engineering and Technology, 2021. ISBN 9781839531170.
- Ellison, Gordon N. Thermal computations for electronics : conductive, radiative, and convective air cooling. Milton: CRC Press, 2020. ISBN 9781000047462.
- Shabany, Younes. Heat transfer : thermal management of electronics. Boca Raton, FL: CRC Press, 2020. ISBN 9781439814680.
- Dorkel, Jean-Marie. Semi-conducteurs de puissance – problèmes thermiques (partie 1). Techniques de l'Ingénieur, D-3112V1, 2003.
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- Jamnia, Ali. Practical guide to the packaging of electronics : thermal and mechanical design and analysis. Boca Raton: Taylor & Francis, 2016. ISBN 9781498753951.
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- Abramushkina, Ekaterina [et al.]. "A Thorough Review of Cooling Concepts and Thermal Management Techniques for Automotive WBG Inverters: Topology, Technology and Integration Level". Energies [on line]. Tomo 14, N.º 16, (2021) [Consultation: 19/09/2025]. Available on: <https://www.proquest.com/docview/2565244697/CD7054B931694260PQ/1?accountid=15300&sourcetype=Scholarly%20Journals>.
- Jones-Jackson, Samantha [et al.]. "Jet Impingement Cooling in Power Electronics for Electrified Automotive Transportation: Current Status and Future Trends". IEEE transactions on power electronics. PP (99) : 1-1 Feb. 2021.
- IEEE Industry Applications Society. IEEE recommended practice for the design of reliable industrial and commercial power systems. [New York, N.Y.]: IEEE, 2007. ISBN 073815301X.
- Karki, Rajesh. Reliability modeling and analysis of smart power systems [on line]. New Delhi: Springer India, 2014 [Consultation: 19/09/2025]. Available on: <https://link-springer-com.recursos.biblioteca.upc.edu/book/10.1007/978-81-322-1798-5>. ISBN 8132217985.

## RESOURCES

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### Audiovisual material:

- Nom recurs. Resource