Lighting Science, 6 ECTS, KU Leuven semester 2

Coordinator: Kevin Smet

Learning outcomes

Students will understand the basics of photometry, colorimetry, color difference formulas and will be aware of some common color appearance models (CAM) published in literature, as well as of the structure and basic processing steps of the human visual system implemented in one or more commonly used models (e.g. CIECAM02 or its recent update CIECAM16). They will have obtained knowledge on some of the most important factors (CCT, Duv, CRI, UGR, uniformity and flicker) determining lighting quality. Students will have a basic understanding of human centric lighting (HCL). They will know how to setup simple visual experiments and statistically analyse the results using the R programming language. Finally, students will be able to perform practical calculations in Python regarding most of the above topics using the Luxpy toolbox.

Content

Photometry (CIE Vlambda, Luminance, Illuminance, …), Colorimetry (CIE color matching functions, XYZ tristimulus values, chromaticity diagrams and color spaces), Color difference formula (DE_{L*a*b*}, DE2000, …), Chromatic adaptation, Colour appearance models (CAM18sl, CIECAM02, CIECAM16, …), experiment design and statistical analysis (parametric and non-parametric tests for independent and dependent, repeated measures data), Lighting quality (CCT, Duv, CRI, UGR, uniformity, flicker), HCL, Horticulture lighting. Practical calculations in R and Python.

Modes of study

Course and project work, active participation.

Teaching methods

Lectures (24 hours), hands-on sessions (12 hours), a project (3 hours).

To expose students to real life cases, a number of practical examples inspired by research and industrial consultancy at the Light&Lighting Laboratory will be presented.

Study materials

Course syllabus and slides, tutorial on the Luxpy python package for lighting and color science

A selection of journal papers and CIE documents is available to the students.

Evaluation criteria

Written and oral examination (lectures), reports (hands-on sessions), presentation of a scientific paper (project), active participation.

Scale 0-20 (>10= pass)

Prerequisites

None

Lighting Technology, 6 ECTS, KU Leuven semester 2

Coordinator: Youri Meuret

Learning outcomes
This course will provide a clear view on the basic principles of the different technological components out of which every lighting luminaire is build : the light sources, optics, housing, thermal management and (driving) electronics. For each of these components, students will get acquainted with advanced modelling & design tools and state-of-the-art manufacturing methods. Students will furthermore receive up-to-date information on special topics of interest such as visible light communication, connected lighting,… via invited lectures of different guest speakers.

Content
Light sources: LEDs, OLED, laser diodes, phosphors.

Optics: Ray-tracing, lenses, mirrors, diffusers, freeform optics.

Housing: Advanced manufacturing, thermal management, computational design.

Electronics: Drivers, dimming, flicker, sensors.

Capita Selecta on VLC, connected lighting…

Modes of study
Course and project work, hands-on sessions.

Teaching methods
Lectures (24 hours).

Hands-on sessions computational modelling and design (12 hours).

Project work and company visit: oral and written student presentations (3 hours)

Study materials
Course syllabus, slide hand-outs, selection of papers, books and manuals.

Evaluation criteria
Oral exam, modelling project, presentation of technological paper

Scale 0-20 (>10= pass).

Prerequisites
Photonics and Optics Fundamentals, Lighting Science

Lighting Metrology, 3 ECTS, KU Leuven semester 2
Coordinator: Peter Hanselaer

Learning outcomes
Students will understand the working principles of basic radiometric and photometric measurement instruments (filter-based and spectral based units) and of goniometrical measurement systems (goniometer, BRDF). They will have obtained practical experience in using these instruments, including performing optical power and wavelength calibration using primary and working standards. They will know how to handle measurement uncertainties and how to calculate their propagation.

Content

Basic principles of radiometrical (irradiance, radiance), photometrical (illuminance, luminance, imaging instruments), spectral (monochromators and spectrographs), thermal (camera's) and electrical (power and power factor) characterization of light sources. Performing measurements with an integrating sphere, a goniometer, a luminance and thermal camera. Setting up a measurement unit including calibration and control of measurement devices using software development kits.

Modes of study

Lectures (12 hours) and hands-on sessions (12 hours)

Teaching methods

During the lectures, some basic physical principles underlying radiometrical and photometrical characterization are discussed and applied to actual measurement systems and procedures. Practical examples, inspired by the Light&Lighting Laboratory daily experience, will stimulate the creativity of the students on how to tackle measurement issues.

In the hands-on sessions, a manual will guide the students through the measurement procedures. Team work (2 to 3 students in each team) is required. If possible, mixed teams including people from industry will be established.

Study materials

Course syllabus and Laboratory manual

A selection of journal papers and CIE documents is available to the students.

Evaluation criteria

Written exam (Lectures) and measurement reports (hands-on).

Scale 0-20 (>10= pass)

Prerequisites

Lighting Science

Lighting Design, 6 ECTS, KU Leuven semester 2

Coordinator: Bruno Depré

Learning outcomes

In the first part, students will understand and apply the principles and calculation method to study functional lighting systems, daylight and how to deal with a combination of both. We will analyse how sun, natural daylight and artificial lighting influence our environment, indoor as well as outdoor. E.g. it is known that a bio-adaptive lighting solution in the working environment improves employees’ wellbeing.

The second part focusses on how we can top up light from “just light” to “a tool for creating emotions”. We explore how to create a unique concept of illumination, developed with the intension of transmitting emotions, artistic expression or information, e.g. how can we convert a simple façade into an interface between the city and the world.

All these elements will be integrated into the design of an architectural area.

Content

Part 1 : Basic principles and calculation methods for functional lighting

- Daylight and impact of daylight

- Standards on functional design values: EN 12464 Lighting of work places, EN 1838 emergency Lighting, EN 13201 Road lighting

- The practical use of Dialux Evo/Relux : advanced topics

- Visual Renderings as a tool in lighting design

Part 2 : exploring the “EQ” of lighting (Referring to emotional intelligence)

- Light - space – (no) sun

- Emotions and light in theatre and art

- Architectural lighting: an extra dimension

- Interaction between light and the materialization of architecture

- Indoor lighting design: museums, cultural centres, offices, schools, retail,…

- Outdoor lighting design: street, tunnel, guided walk,…

Modes of study

Lectures (16 hours), Site visits (8 hours) and hands-on sessions (24 hours)

Teaching methods

During the lectures, some basic principles and calculation methods for functional lighting are discussed. There will also be lectures on how to create a unique concept of illumination.

All these elements will be applied during hands-on design sessions. Team work (2 to 3 students in each team) is required. If possible, mixed teams including students from architecture department will be established.

Study materials

Course syllabus and Lectures

A selection of publications and case studies.

Software : f.e. Dialux Evo / Relux

Evaluation criteria

Oral exam: presentation of hands-on design through posters + A3 print-out of topics studied during design stage.

Scale 0-20 (>10= pass)

Prerequisites

Lighting Science, Lighting Technology

Lighting Business, 6 ECTS, KU Leuven semester 2

Coordinator: Frédéric Leloup

Learning outcomes

Students will be able to define a lighting project as well as the basic concepts of project management processes, and to apply skills, tools, and techniques into different of these management processes. Each student will be capable of working in a team, analysing a (part of a) complex practical lighting project for which a global solution needs to be found and presented in collaboration with peers. For this, students will be able to acquire relevant information, consider preconditions, and analyse previous research results.

Content

General structure of lighting project management based on the Guide to the Project Management Body of Knowledge (PMBOK Guide).

Tools and techniques for life cycle analysis, cost (cost oriented vs. market oriented) and investment (net present value, pay-back period, internal rate of return,…) analysis, new business models (Light as a Service, Circular Economy), and project scope, time, and marketing management.

Practical team assignment, which is a case study defined by a lighting company, for which students must investigate and make recommendations for possible solutions.

Modes of study

Lectures (12 hours) and team assignment (project) (12 hours)

Teaching methods

During the lectures, the basic principles of and processes within project management are explained, and tools and techniques for assessing different aspects within a project are discussed theoretically and by use of practical examples, inspired by experiences of industrial lighting partners.

For the team assignment, each team of students visits a lighting company. Alternative solutions can be weighed against each other in terms of technical feasibility, technical and economic return, and sustainability, and are reported in an intermediate presentation. The final outcome is a report of typical 20 pages to the management of the company (recommendations, advantages, disadvantages).

Study materials

PMBOK® Guide and presentations.

Evaluation criteria

Lectures: written exam (35%).

Team assignment: process evaluation (15%), presentation (20%) and assignment reports (30%).

Scale 0-20 (>10= pass)

Prerequisites

Lighting Science, Lighting Technology