Indoor Environmental Quality (IEQ)

This course aims to show to the students the concepts necessary to investigate the problems of the Indoor Environmental Quality, in the built environment, related to the health, comfort and productivity of users. The module of the Indoor Environmental Quality focuses primarily on conditions inside buildings. In these conditions are included: air quality, also, natural lighting and appearance (visibility), satisfying acoustic conditions, and the ability of the control by the user, lighting and thermal comfort. Users (residents) of the building can improve the comfort of the building considering all the general aspects in environmental quality inside the building, not only focusing on the temperature and air quality detached from the rest.

The objective of the study module

The main objective of the course is to analyze the properties and the performance of the Indoor Environmental Quality of a building, closely related to specific personal needs of the users regarding comfort. Students will become familiar with the issues of health risks and separate enterprise will be taken to improve the indoor conditions. At the end of the module, students should have created narrow range of knowledge concerning the effects that causes heating and ventilation in the indoor air quality, as well as thermal comfort, and the implications for energy management in the built environment. Students will be able to distinguish between the aspects that must be taken into account to measure them and to give some solutions in order to improve indoor environmental quality.

This module will try to identify all environmental factors which affect and influence the health and comfort of the inhabitants. Achieving a healthy quality of the internal environment is a multifaceted problem which could become vulnerable only from a comprehensive and interdisciplinary approach to design, construction and management of the building itself.

Indoor Environmental Quality:
- Parameters that define a good quality environment
- Determination of the investigation methodology of data, depending on the function
- The role and influence of the human factor

Environmental Quality:
- Thermal comfort and humidity
- Air quality
- Lighting quality
- Acoustic quality

UNI EN 15251 normative / defining factors of the premises indoor comfort

Quality Certification / Audit

Techniques and measurements - Monitoring:
- instruments
- survey / questionnaires

Standards of living are in continuous change, increasing the quality > particular attention to the micro climate conditions of the indoor environment > Building Management & Systems > high comfort with the lowest cost.

EPDB (Energy Performance Building Directive)
- The use of renewable energy
- More efficient use of energy in the indoor environment
- The needs and requirements of the users > in order to find the most optimal ratio

The "general" quality of the indoor environment

The main focus > *Human Welfare* (users)
This is achieved thanks to:
- Project of the building (related to the function)
- Materials used
- Maintenance / Control / Management

> Need of a general all-inclusive strategy in building an ideal comfort

Comfort (measurable quality) is determined by:
- Temperature
- Relative humidity
- Acoustic
- Air quality
- Lighting
- Ventilation

Average values? Minimum? Maximum? The frequency of measurements?

On changing Standards ... depending on time and knowledge which is constantly changing thanks to the development of technology.

> Except the measurable values (instruments) is also important to know the perception of the environmental comfort of the users.

Human behavior and habits are a significant factor of the required environmental quality and its perception:
- behavior
- Culture
- Social Groups
- context

These factors affect a lot, especially when the building tend to has a climate as "natural" and not "artificial".

Thermal comfort

Human body temperature > constant temperature 37^{o}C > the environment affects the maintenance of this value > Warm and cold sensation

Heat exchange of the human body and the environment:
> Heat sensitive
> Heat Latency > is related to relative humidity

The exchange of heat depends on:
- Air temperature
- Relative humidity
- The speed of the air
- Average temperature radiated from the environment (walls)

The asymmetry of the temperature (not homogeneous)

Variable sensitivity brings sensations and perceptions differ according to different materials.

Floor temperature
18^{o}C - 29^{o}C / foot coated

Harassment of air currents (air current)

Air quality comfort

Sick-Building Syndrome (SBS) - the development of living environments through the years
- Direct impact on human behavior and productivity
- Allergies

Improving air quality:
- Control of the air source
- Ventilation personalized

Indoor Environment:
Temperature 20°C - 22°C
Humidity 40% - 60%
(not suggested to be reduced below 20% - too dry air affects evaporation strengthen lung > breathing problems.)

The general causes for the deterioration of the premises:
- Pollution from the plant ventilation filters
- Building Materials
- Electronic
- The impact of external pollution, the context (traffic, waste, etc.)
- Inadequate installation of plants
- Habits and inappropriate behavior
- Closed environments with extended time people

The composition of the air:
- Oxygen 21%
- Nitrogen 78%
- Argon 1%
- 0.04% of carbon dioxide

Air quality	Difference outside-inside CO2
High	≤ 400
medium	400 – 600
Low	601 – 1000
-	> 1000

Comfort Lighting
Optimum lighting affects > a good sight to perform activities correctly

Natural lighting effect positively in people's behavior.

(standards of Lx for each environment related to the function)

Acoustic comfort
The perception of noise that causes annoyance or inconvenience during the normal human activity.

Silence / whisper 30 dB
Silence / apartment 40 dB
Silence / office 50 dB
Normal conversation 60 dB
Heavy traffic / phone ringtone 70 dB

Defining the parameters for the quality of Indoor Environment:

Thermal environment
- determination of temperatures in the Summer and Winter (Max and Min).

Air Quality – Ventilation
- determining the percentage of ventilation depending on the function of the building; classification of facilities depending on the amount of CO2 for each environment.

Humidity
- determining the value of design systems that regulate the humidity indoors.

Lighting
- unified index of "lighting", and the perception of colors.

Noise – Acoustics
- determination of different intervals of sound pressure (noise) for building types, depending on the function.

	Parameters measured	*Instruments*
Thermal comfort	Air temperature (° C) Radiant temperature (° C) Relative humidity (%)	Thermometer Datalogger Microclimate control
Air Quality	The amount of CO2 TVOC	CO2 measuring -
Ventilation	Indices ventilation (air volume / hour)	Blower door
Air speed	Air speed	Anemometer
Lighting quality	The amount of lighting	Lux-meter
Acoustic quality	Sound pressure	Phonometer

Measuring Temperature and Relative Humidity > 3 times per year
> Winter (December - March)
> Summer (June - September)
> Seasons intermediate (September - November)

Questionnaire to ask to the users / inhabitants (subjective)

The level of satisfaction in the premises / in different seasons (the most direct method, economically and efficiently)