INTEGRATED MASTER IN PHYSICAL ENGINEERING (MIEF)

IMAGING SYSTEMS (2020/21)

ASSESSMENT

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The goal of **IMAGING SYSTEMS** is not applications *per se*, but the architecture of IMAGING SYSTEMS, their enabling technologies and the most relevant system properties: resolution, dynamics and sensitivity.
Key concepts: 1. Imaging, 2. Systems

I – Components of the Assessment

Laboratory (participation and Lab Book) – 35%

Essay – 35%

Problems – 30%

Short Oral Presentations – 0% - not applicable in 2020/21

II – Laboratory reports

The aim of the laboratory reports is to objectively describe each of the experiments carried out, identifying the materials and methods used, the schematic and functional representation of the experimental setup and the results, according to what is requested in the work plan - which will be distributed in advance.

For a better understanding of each work, the following guidelines should be followed when writing the reports:

1. Brief introduction to the subject, with the theory and mathematics relevant to the analysis of the results
2. Explanation of methods and materials / systems used
3. Overview of the results and suitable analysis (in relation to the underlying theory)
4. Conclusions, well supported by the analysis
5. References or bibliography identified
6. Activities common to several experiments (e.g. characterization of the lenses used) should be addressed in annexes

Evaluation will also address:

- The language used and quality of the information
- Critical thinking and clear separation between observations and interpretations (based on theory or explanatory hypotheses).

Experiments may be carried out in groups of 2-3 students, at most, with a common laboratory report. The participation of each student in the experiments will be taken in consideration

Students should demonstrate clearly that they have prepared, in advance, the topics of each session.

The set of laboratory reports will be gathered in a single document (Laboratory Notebook), in digital format, with independent experiences well identified within the document. The length of the laboratory notebook shall not exceed 30 pages.

The laboratory reports/notebook shall be delivered at the same time of the Essay, in digital form. The Lab Notebook can be written in either Portuguese or English.

III - Essay

Students will write and orally present an Essay covering one type or family of an imaging system, at their discretion. The document shall not exceed 20 pages.

The document can be written in Portuguese or in English. Use this template (submission of papers to the Journal of the Optical Society of America) to write your essays: https://www.osapublishing.org/submit/templates/wordwp/ao_josa.dotx. A Latex template is also available.

The oral presentation shall not exceed 20 minutes, with at most 10 minutes of questions and comments. It must be made in English whenever foreign students are attending the course; otherwise, the student may choose the language he/she is most comfortable with. Presentation skills and overall graphic quality will be valued, representing 20% of the Essay classification.

Some general guidelines follow – most being also applicable to the oral presentations:

1. Need of the instrument: we use it to measure certain properties of the world, which should be identified.
2. General architecture of the instrument and function of each subsystem
3. Physical principles of the measurement
4. Sampling

5. Overall geometry: relation between image “point” elements and direction or 3D coordinates in the world reference system
6. Identification of the factors determining resolution
7. Typical numerical values (or ranges) for resolution, field of view, temporal issues, …
8. Identification of the most relevant sources of noise
9. Critical subsystems which mostly affect performance
10. If possible, an example of an actual instrument available on the market (analysis of a typical data sheet)

Numerical values, or range of values, must be used wherever necessary. Qualitative words (large, small, …) should not be used. Specifications and characteristics shall always be expressed numerically.

Students are supposed to clearly identify topics which they cannot understand in full, therefore demonstrating:

A. Systemic reasoning, address the instrument as a system composed of several functional subsystems
B. Ability to clearly separate requirements from specifications

It is **MANDATORY** to **adopt an engineering perspective** and to explain clearly the following (main drivers for evaluation of the ***Essay)***:

1. What is the object property being measured
2. System architecture and main functional subsystems
3. Drivers and constrains 2D/3D sampling (spatial resolution)
4. Drivers and constrains for dynamic range and sensitivity issues

Signal and data processing is outside the scope of the Essay and presentation unless they play a relevant role in defining engineering parameters (such as resolution).

IV – Problem solving

As a baseline, a list of around 20 problems will be made available, eventually from reference books, and around half must be solved and delivered:

- Track A, until the 15 of January 2021, small number of more complex problems;
- Track B, a certain number of problems per topic, to be delivered at most one week following the classes for that topic.

Some of the problems may be small mini-projects, may require some research, and several may require digital modelling (in whatever language or environment – Matlab, Phyton, C, …)

Students may team in groups of 2 (at most).

During the public presentation of the Essay, a random selection of problems and/or students will be invited to comment on specific issues of the delivered solutions, to assess if all group members have worked together to analyze and solve the problems.

The evaluation will address:

- The logics and overall architecture of the solution
- The final result
- Clarity, conciseness and content of the written document.

V – Short Oral Presentations

Students must present 1 short presentations (~10-15 minutes, each) to implement the continuous assessment of IMAGING SYSTEMS.

The theme is selected by the student but must be related to one family of systems and its component technologies. Clear identification of technological issues and systems issues are mandatory.

Some general guidelines follow – which are common also to the Essay, although with much smaller level of sophistication:

1. Need of the instrument: we use it to measure certain properties of the world, which should be identified.
2. General architecture of the instrument and function of each subsystem
3. Physical principles of the measurement
4. Sampling
5. Overall geometry: relation between image "point" elements and direction or 3D coordinates in the world reference system
6. Identification of the factors determining resolution
7. Typical numerical values (or ranges) for resolution, field of view, temporal issues, …
8. Identification of the most relevant sources of noise
9. Critical subsystems which mostly affect performance
10. If possible, an example of an actual instrument available on the market and its datasheet.

Numerical values, or range of values, must be used wherever necessary. Qualitative words (large, small, …) should not be used. Specifications and characteristics are always numerically presented.

4rd year students of MIEF are not supposed to understand in detail all the aspects of the instrument. But they must demonstrate:

A. Systemic reasoning, addressing the instrument as a system composed of a number of functional subsystems (each with its specific technologies)
B. Ability to clearly separate requirements from specifications
C. Presentation skills
D. Overall graphic quality of the presentation.

Remember: a picture summarizes nicely a huge number of words. Pictures should be large enough for all their informational content be clearly visible to the audience.