Institute for the Wireless Internet of Things
at Northeastern University

EECE5155: Research Project

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Steps in the Research Project

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- **First step:** teaming and topic selection (due on **October 12th**)
- **Second step:** the paper (due on **December 3rd**)
- **Third step:** the video presentation (**during last week of classes and finals week**)

First Step: Teaming

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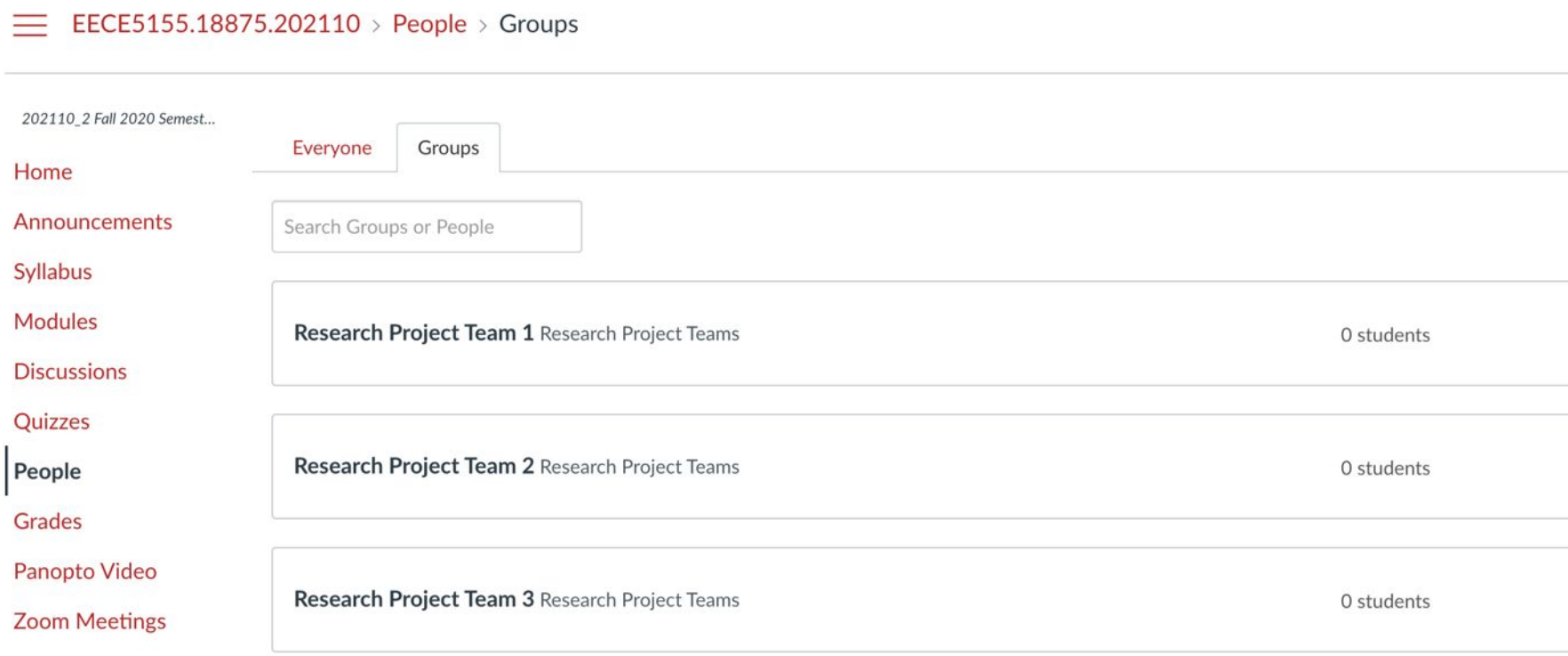
- The research project will be done in teams of **four** students
  - When you have a team, go ahead and self-enroll in Canvas:
    - Navigate to the course, select People on the left-hand column, look at the Groups tab, select an "empty team" and ensure that you and your teammates select the same



First Step: Teaming

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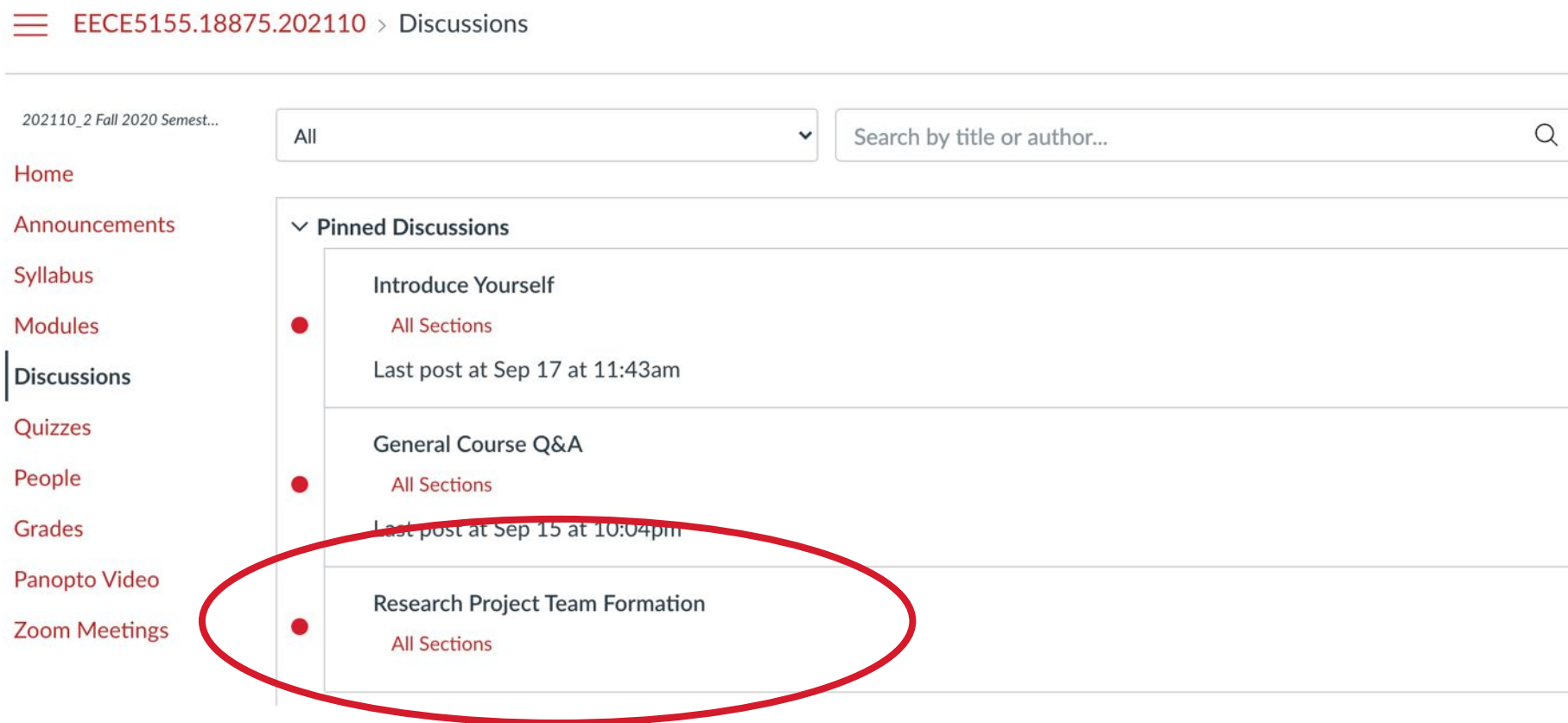
- If you do not have a team, you are strongly encouraged to utilize the Discussion thread titled, "Team Formation" to find teammates.
  - If you already know the IoT topics that interest you, you could list those out and look for classmates with similar interests.



First Step: Teaming

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- If you cannot find a team, you will be randomly assigned to a team with less than 4 members

*As everything at Northeastern: think of this as a **learning experience**. For example, do you think you will get to pick your teammates when you join a research lab or your next job?*

First Step: Topic Selection

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- A list of IoT-related research topics will be provided:
  - Each team should provide their top 4 preferences
  - Or suggest a new topic, relevant to the Internet of Things
    - I will try to accommodate all the requests, but it might always be possible
      - **Good news:** there are no bad topics!

First Step: Topic Selection

- Some examples:
  1. The Internet of Things in 2030: What is expected 10 years from now?
  2. The role of Artificial Intelligence in the Internet of Things
  3. Security and Data Privacy in the Internet of Things
  4. The role of Edge Computing in the Internet of Things
  5. Powering the IoT (from batteries to energy harvesting)
  6. The Internet of Underground Things
  7. The Internet of Underwater Things
  8. The Internet of Space Things
  9. The Internet of Nano-Things
  10. The Industrial IoT: Future Manufacturing Environments
  11. IoT and Vehicular Networks
  12. The role of IoT in Smart Health
  13. The role of IoT in Smart Cities
  14. Democratizing the IoT: Facilitating the access to IoT technologies and applications
  15. …

First Step: Due Date

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- The teams and they preferred topics should be finalized by **October 12**
  - Your team should have all its members
  - As a team, you will complete the topic selection assignment in Canvas:
    - Only one student per team needs to complete the assignment
    - Assignment is already on Canvas and will be activated by today

Second Step: The Abstract & References

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- Teams are expected to conduct an **independent survey on the state of the art** for the topic that they have been finally assigned based on their preferences

- To start with, each team should submit:
  - A **brief abstract** (less than 200 words)
  - A **preliminary list of references**

  This will be used to make sure that the team is working in the right direction and correct it if necessary

More in a few slides!

- There is no due date, but the submission is **strongly encouraged** **well before** the final paper deadline

Second Step: The Paper

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- The final papers should:
  - Be at least 6 pages long, two-column format, 10-point font size
  - Contain at least 20 references
  - Follow the IEEE template
    http://www.ieee.org/publications_standards/publications/authors/author_templates.html

More in a few slides!

- The submission will be completed on Canvas, only one team member needs to submit it:
  - **Due date: December 3rd**

Fourth Step: The video presentation

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- Teams will prepare and record a presentation of their paper, to be shared and evaluated with the class:
  - Presentations should be **20 minutes long**
  - A slide template will be provided

- The submission will be completed on Canvas, only one team member needs to submit it:
  - **Due date:** the video should be uploaded on Canvas by **December 7** before class.

Project Grade Distribution

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- The total project is worth **30%** of your final grade, out of which:
  - **40%** corresponds to the paper
  - **60%** corresponds to the presentation
- **Yes, the presentation is very important!!!**
  - Can you guess why?

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What is Research?

Research

- **Definition:** The systematic investigation into and study of materials and sources in order to establish facts and reach new conclusions

- **Origin:** from Old French
  - ***Re:*** expresses intensive force
  - ***Cerchier:*** to search

Search Engines

- There are many search engines for scientific papers:
  - **IEEE Xplore:**
    http://ieeexplore.ieee.org/Xplore/home.jsp
  - **ACM Digital Library:**
    http://dl.acm.org
  - **Science Direct:**
    http://www.sciencedirect.com
  - **Google Scholar:**
    http://scholar.google.com
  - **ArXiv:**
    http://arxiv.org

The "Search" Process

- It is easy to look for papers:
  - **Keyword search**
  - **Author search**
- But how to find **good quality papers**?
  - In the majority of the cases, good papers are published in top journals and conferences:
    - IEEE Transactions on:
      - Communications, Wireless Communications, Networking, Nanotechnology, Solid State Devices, Terahertz Science and Technology, Circuits and Systems, etc.
    - IEEE JSAC, Proceedings of the IEEE, IEEE INFOCOM, ACM MobiHoc
    - Nature, Science, Nature Electronics, Nature Nanotechnology, Applied Physics Letters
  - CS Conference rankings: https://tinyurl.com/CORECSRanking (A+/A means OK)

The "Search" Process

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- A good starting point:
  - **Survey and roadmap papers:**
    - Provide an "overview" of the problem to study and an updated discussion on the state of the art on the topic
    - Contain many references and pointers to the top groups in the field: the next step for you to search!
    - Good survey venues: ACM Computing Surveys, IEEE Communications Surveys & Tutorials

The "Search" Process

- Rarely, you will find "useful" **books** on an open research topic:
  - Usually they are just collections of papers related to the topic, but not a real "text book" with a well-defined and consistent flow…

Research Project

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- What should each team do next:
  - To conduct a **literature search**:
    - Look for papers related to your topic (usually no more than 5 years old, with exceptions)
    - If possible, try to find survey/roadmap papers, which can help you understand the "big picture"
    - Keep an eye on the **authors** of the papers:
      - Where are they? Are they still working on the topic?
      - Are they consistently publishing good papers?

Research Project

- First, each team member should conduct the literature search **independently**!

- Second, the team members should **go through the references together**
  - Hopefully many will be the same!

- Third, identify the main sub-topics in the field, divide the load, and continue with the literature search

The Abstract

Abstract

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- **Definition:** A complete but concise description of the contents in the paper

- **Parts of an Abstract:** Depend on the type of paper we are writing:
  - **Standard Research Paper:**
    - **Motivation:** Which is the topic and why is it important?
    - **Problem:** Which is the problem you are solving?
    - **Approach:** How do you solve the problem?
    - **Results:** Which are the outcome of your approach?
    - **Conclusions:** What did we learn? Future steps?

Abstract

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- **Survey Paper:**
  - **The field:** Which is the topic and why is it important?
  - **State of the Art:** What are the latest advancements in the field?
  - **Open Challenges:** Which problems still need to be solved?

Example

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- **Title:** The Internet of Nano-Things

- **Abstract:**
  - Nanotechnology promises new solutions for many applications in the biomedical, industrial and military fields as well as in consumer and industrial goods.
  - The interconnection of nanoscale devices with existing communication networks and ultimately the Internet defines a new networking paradigm that is further referred to as the Internet of Nano-Things.
  - Within this context, this paper discusses the state of the art in electromagnetic communication among nanoscale devices.
  - An in-depth view is provided from the communication and information theoretic perspective, by highlighting the major research challenges in terms of channel modeling, information encoding and protocols for nanonetworks and the Internet of Nano-Things.

100 words!

How to Cite Papers?

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- Journal papers:
  - S. Khan, J. Chan and H. Simpson, "An Example Manuscript with the IEEE LaTeX Template," IEEE Transactions on Random Contents, vol. 1, no. 3, pp. 584-585, March 2015.

- Conference:
  - S. Khan, J. Chan and H. Simpson, "An Example Manuscript with the IEEE LaTeX Template," in Proc. of First International Conference on Random Contents, Buffalo, NY, March 2015, pp. 1-2.

- Many other formats! (technical reports, books, patents,…):

https://ieeeauthorcenter.ieee.org/wp-content/uploads/IEEE-Reference-Guide.pdf

The Paper

Structure of the Paper

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- There is no general structure for the paper, it really depends on the topic!
- A generic survey paper would look like:
  - Abstract
  - Introduction:
    - What is the topic? Which are its applications?
    - Why is this topic important now? What has changed?
    - Contributions of the paper (e.g., Review of state of the art, list new challenges, propose new solutions)
    - Structure of the rest of the paper
  - (Applications)
  - (Basic concepts)
  - State-of-the art
    - You can have this divided into multiple sections…
  - Next Steps/Roadmap
    - You can have this divided into multiple sections…
  - Conclusions

Submission Guidelines

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- Papers should:
  - Follow the IEEE template:
    - http://www.ieee.org/conferences_events/conferences/publishing/templates.html
  - Be at least 6 pages long (2 columns format), preferably 8 (but not a requirement)
  - Contain at least 20 references:
    - Please be careful with the formatting!
    - https://ieeeauthorcenter.ieee.org/wp-content/uploads/IEEE-Reference-Guide.pdf

LaTeX

- The preparation of the paper might be a good excuse for you learn **LaTeX:**
  - A document preparation system for high-quality typesetting:
    - Widely used for medium-to-large technical or scientific documents
  - Simplifies the process of:
    - Incorporating equations
    - Handling references (**BibTeX**)
  - In the past, getting LaTex to run required installing many tools, now it can be done directly online with a free account on Overleaf (and you can all work simultaneously on it!)
    - www.overleaf.com
- For more information and details,
  - http://latex-project.org/intro.html

Questions?