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CSC/CYB 490 Independent Research and Study

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Course Objective: The objective of this course is to immerse the student in guided research. The student learns to organize material, use the literature, obtain reproducible data, and synthesize the results of the study. If possible, the student will publish the results or present them at a scientific meeting. Available to Junior or Senior students or Sophomores with permission of the department chair.

University Policies: Students who wish to explore specific topics of inquiry as a result of coursework may take up to 12 semester hours of independent research and creative expression toward graduation. To be eligible for independent research and creative expression a student must be a junior or a senior in good academic standing. Only one project can be scheduled per semester for 1-4 credit hours. Each independent research and creative expression proposal must be approved by a faculty sponsor, the department chairperson, and the Associate Deans of the College of Arts and Sciences by **no later than the third week of the semester** in which the project is to be conducted. Planning for independent research and creative expression should begin during the semester before the student registers for the credits.

Requirements and Grading Rules

1. The final grade will be based on six components, each with a different weight: regular meeting attendance (20%), literature review (20%), research methodology and implementation (20%), results and analysis (20%), poster (10%), and final paper (10%).

2. Please be aware of that you're responsible to make all of your submissions meet the requirements as shown in the following.

3. All of the report submissions for this project must follow strictly the formatting template provided by IEEE. You can download the template from here.

4. **Regular Meeting Attendance (20%)** Students are required to schedule at least 10 one-on-one meetings (you can meet multiple times a week, but only one meeting will be counted for attendance each week) with the supervisor over the course of the project. Each meeting will be worth 2 points, contributing to the total attendance grade. Students are strongly encouraged to schedule additional meetings as needed for feedback, guidance, or discussion of research progress.

5. **Literature Review (20%)** Students are required to submit a literature review report that demonstrates a clear understanding of state-of-the-art developments related to their research topic. This review serves as a critical foundation for the project and should inform the research methodology, analysis, and overall direction. This is what is often mentioned as "standing on the shoulders of giants". The literature review report should:

    - Demonstrate familiarity with key concepts, theories, and prior work in the chosen topic area;
    - Identify relevant gaps, limitations, or ongoing debates in the literature that the project may address;
    - Provide a logical framework connecting the research question to the existing academic conversation;
    - Be at least one full page in length, excluding the title, figures, and references. Students must reference at least 10 high-quality scholarly sources, including peer-reviewed journal articles, academic books, or reputable conference proceedings. Popular websites, blogs, or non-peer-reviewed materials should be avoided.

6. **Research Methodology and Implementation (20%)** Students are required to submit a Research Methodology Implementation report. This document must provide a detailed account of how the research methods were executed, including all technical steps, tools utilized, and procedural details. The submission must meet the following requirements:

    - A detailed explanation of any core algorithm, model, or implementation logic applied in the project, written with sufficient clarity to enable reproducibility. Justifications for methodological choices must also be provided.
    - A clear and structured description of the steps taken to conduct the research, including: (i) Software, libraries, and tools employed; (ii) Data collection or simulation procedures; (iii) Experimental setup or system architecture; (iv) Parameters, configurations, and input settings used.
    - Proper citation of all external tools, frameworks, or techniques not originally developed by the student.

- The report must be a minimum of three full pages excluding references.

7. **Results and Analysis (20%)** Students are required to submit a Results and Analysis report. This document must clearly present the key outcomes of the research and provide a structured, well-reasoned interpretation of the findings. The analysis should objectively reflect the outcomes of the implemented methodology, offer meaningful insights supported by logical reasoning, and connect the findings to the original research question as well as the existing literature. The report must include the following components:

   - A clear and organized summary of the results, including relevant figures, tables, graphs, or statistical outputs as appropriate.
   - All visuals must be clearly labeled and referenced within the main text.
   - A reasoned discussion interpreting the results in the context of the research objectives.
   - Comparisons with expected outcomes, related studies, or benchmarks, where applicable.
   - A brief description of any challenges encountered during the research and a discussion of the study's limitations, including suggestions for future research directions.
   - The report must be a minimum of one full page, excluding references.

8. **Poster (10%)** Students are required to design and submit a research poster that effectively communicates the core aspects of the project to a broader audience. The poster should visually and concisely present the research question, methodology, key findings, and conclusions. Serving as a visual summary of the research project, the poster should be designed to:

   - Engage viewers in brief academic dialogue
   - Communicate the essence of the research clearly and concisely
   - Highlight the originality, relevance, and outcomes of the work

   For additional guidance on poster design, please refer to the Appendix.

9. **Paper (10%)** As the culminating component of the research project, students are required to submit a formal research paper that documents the full scope of the project. The paper should be written in a professional academic style and follow the structure and standards commonly used in scholarly publications.

I hereby confirm that I fully understand and acknowledge the rules outlined in the syllabus as fair and reasonable. I agree to comply with these rules throughout the

semester and accept full responsibility for any consequences resulting from failure to do so.

Signature: **Date**:

Appendix A: How to Conduct a Research Project?

Step 1: Identify a Research Topic A well-chosen topic sets the foundation for a successful research project, making the entire process more enjoyable and fulfilling. Here are some critical considerations for selecting an effective research topic:

1. Identify Your Interests: Start by exploring topics that fascinate you. Think about subjects you've enjoyed in your courses or issues you are passionate about. A topic that genuinely interests you will keep you motivated throughout your research.

2. Consider Relevance and Significance: Assess the relevance of your topic to your field of study. Is it addressing a current issue or gap in research? Selecting a topic that contributes to existing knowledge can enhance the impact of your work and attract the attention of readers and researchers alike.

3. Review Existing Literature: Conduct a preliminary literature review to understand your area's current state of research. This will help you identify gaps, ongoing debates, and under-explored topics. It can also spark new ideas and refine your research question.

4. Narrow Down Your Focus: Once you have a broad topic in mind, narrow it down to a specific research question. A focused topic will make your research more manageable and provide a clear direction. Ask yourself, "What specific aspect of this topic do I want to explore?"

5. Seek Feedback: Discuss your topic ideas with peers, or instructors. Their feedback can provide valuable insights and help you refine your question. They may also suggest additional angles to consider or highlight potential challenges.

6. Assess Feasibility: Consider the resources available to you, such as time and access to data. Ensure that your chosen topic can be realistically researched within these constraints. A

feasible topic will save you from unnecessary stress later in the research process.

You can also visit a job information website, such as cyber security jobs, and find a position you're most interested in, review the job requirements or description to identify a knowledge area where you could use improvement. Then, consider how this course could help bridge that gap and better prepare you for the role. Some of the example ideas include:

1. Creative applications of concepts learned in this course to real-world scenarios.
2. Innovative implementations of algorithms, mechanisms, or ideas covered in this course.
3. Original exploration of topics briefly mentioned in this course but not explored in detail.
4. One state-of-the-art technology or tool that related to this class.
5. .....

Step 2: Formulate a Research Question or Hypothesis A sound research question is one of the most important characteristics of good research. A good research question details exactly what a researcher wants to learn and defines a study's scope. A good research question is often: (i) feasible; (ii) interesting; (iii) novel; (iv) ethical; (v) relevant.

Step 3: Literature Review and Information Retrieval The literature review is where you will analyse and evaluate existing research within your subject area. It is essential to use credible sources as failing to do so may decrease the validity of your research project. Places to find your information include: (i) articles from peer-reviewed journals/conferences; (ii) books; (iii) technical reports. Google Scholar is a great website to find academic works. **Please avoid citing websites, as they are typically not peer-reviewed and are therefore not considered credible sources within the scientific community.**

Step 4: Develop Research Plan and Methodology The overall quality and success of a research study are largely determined by the research methodology it uses. It refers to the systematic procedures or techniques a researcher uses to ensure that their study achieves valid, reliable results. Research methodologies are often classified into qualitative research and quantitative research.

1. *Qualitative research methodology* involves collecting and analyzing non-numerical data, such as language to interpret subjects' beliefs, experiences, and behaviors. Qualitative research techniques include interviews, focus groups, and case studies, etc.
2. *Quantitative research methodologies* involve the collection and analysis of numerical data to discover patterns, test relationships, and make predictions. In doing quantitative

research, surveys, experiments, and systematic observation can be used to collect accurate data. Writing programs to demonstrate the effectiveness of a method is a common practice of quantitative research methodologies in computer science.

Step 5: Collect and Analyze Data One of the distinguishing characteristics of research is that the entire process is guided by logic. Using logic, for instance, can help researchers determine what kind of data they need for answering their research question. Being guided by logic throughout the research process also helps researchers spot fallacies and inconsistencies in their claims and findings. Good research has external validity and reliability if its results or findings can be applied to the real world. If your research findings can be generalized to other situations or applied to a broader context, your study has high external validity. Since generalizable knowledge is almost always the aim of scientific research, external validity is an important component of good research as well.

Step 6: Draw Conclusions and Communicate Results Replicability, reproducibility, and transparency are some of the most important characteristics of research. The replicability of a research study is important because this allows other researchers to test the study's findings. Replicability can also improve the trustworthiness of a research's findings among readers. Though replicability and reproducibility are often used interchangeably, research is reproducible if researchers achieve consistent results using the same data and analysis methods. For research to be replicable or reproducible, it must also be transparent or available to other researchers. Research must follow proper research paper formatting or be written or presented in such a way that it provides comprehensive details on how data was collected and analyzed and how conclusions were reached. This is why most scholarly articles provide clear descriptions of their corresponding research process.

In addition to information on data collection and analysis methods, good research also opens doors for future research on the topic. In many cases, these suggestions for future research stem from the research's limitations. Researchers must acknowledge their study's limitations and potential flaws and present these along with the study's findings and conclusion.

To get more information of how to do a good research project and the guidelines, please check out this book: Bell, Judith. *Doing Your Research Project: A guide for first-time researchers.* McGraw-hill education (UK), 2014.

Appendix B: What Makes Good Academic Writing?

The goal of academic writing is to present new insights or perspectives about the world—ideas that readers may not already know—making originality a key to success. It follows a structured and formal style intended to communicate ideas clearly, logically, and persuasively. Helpful tips for effective academic writing include:

- **Evidence-based arguments** Academic writing requires objective, evidence-based arguments rather than personal opinions or unsupported claims. Therefore, one should always support arguments with data (such as collected datasets or experimental results), analysis (such as mathematical proofs or derivations), or references from credible sources (including books, peer-reviewed academic articles, and technical reports). **Most websites are not considered credible sources.**

- **Formal and objective tone** Academic writing employs a formal tone that is neutral, objective, and narrative in style. It avoids colloquialisms, slang, and emotional language. Writers are expected to use the third person rather than the first person—for example, avoiding pronouns such as "I", "me", or "we", also, avoiding being too personal, such as using "you".

- Avoid using contractions such as 'don't' or 'can't'; use 'do not' or 'cannot' instead, if needed. Also, refrain from overly casual language. Choose precise vocabulary and avoid vague expressions like "a lot", "stuff", "perhaps", "maybe", etc.

- **Focused and well structured** Divide long texts into chapters or sections with clear headings. Use short, focused paragraphs, each beginning with a topic sentence. Ensure smooth and logical transitions between paragraphs to guide the reader through your argument.

- Use short, and straightforward sentences if possible.

- Clearly outlining your methodology and being honest about the limitations of your research.

Appendix C: What Makes a Good Poster?

Posters are widely used in the academic community, and most conferences include poster presentations as part of their programs. A poster should be viewed as a snapshot of your work, designed to engage viewers in a dialogue. It typically combines brief, focused text with tables, graphs, images, and other visual elements to convey your key findings. You can download free poster templates from platforms such as poster nerd, PosterPresentations. There's also an

informative video on how to structure poster content, which you can view here. Some common practices for good poster design include:

1. Large and readable font size. Important information should be readable from about 10 feet away.
2. Text is clear and to the point, simply and tightly written. Word count of about 300 to 800 words.
3. Use of bullets, numbering, and headlines make it easy to read.
4. Focus on key findings or takeaways rather than exhaustive detail.
5. Effective use of graphics, color and fonts, make it visual appealing. A picture worth 1K words!
6. Each visual should serve a purpose—avoid decorative or unrelated images.
7. Keep a balanced layout with sufficient white space to reduce visual clutter.
8. Design your poster so that your audience can grasp the key points within two minutes or less of reading.

The poster dimensions used for this research project is 48×36. The instructor will provide necessary help on the printing.