What you need to know about finding and using quality information
Faculty workshop series

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Research in undergrad courses

Type some words into Google Scholar, and **presto!**

- Some papers on your topic
- Good enough
**Laser assisted bioprinting** of engineered tissue with high cell density and microscale organization

B Guillotin, A Souquet, S Catsos, M Duxpiault... - Biomaterials, 2010 - Elsevier

Over this decade, cell printing strategy has emerged as one of the promising approaches to organize cells in tw o and three dimensional engineered tissues. High resolution and high speed organization of cells are some of the key requirements for the successful fabrication of...

Cited by 402  Related articles  All 5 versions  Web of Science: 264

**Tissue engineered skin substitutes created by laser-assisted bioprinting** form skin-like structures in the dorsal skin fold chamber in mice

S Michael, H Sorg, CT Peck, L Koch, A Deiwicks... - PloS One, 2013 - journals.plos.org

Tissue engineering plays an important role in the production of skin equivalents for the therapy of chronic and especially burn wounds. Actually, there exists no (cellularized) skin equivalent which might be able to satisfactorily mimic native skin. Here, we utilized a laser...

Cited by 263  Related articles  All 15 versions  Web of Science: 176

**Laser-assisted bioprinting** for creating on-demand patterns of human osteoprogenitor cells and nano-hydroxyapatite

S Catsos, JC Fricain, B Guillotin, B Pippenger... - IOPscience, 2011 - iopscience.iop.org

Developing tools to reproduce and manipulate the cell micro-environment, including the location and shape of cell patterns, is essential for tissue engineering. Parallel to inkjet printing and pressure-operated mechanical extruders, **laser-assisted bioprinting** (LAB) has...

Cited by 111  Related articles  All 8 versions  Web of Science: 81

**Dispensing pico to nanolitre of a natural hydrogel by laser-assisted bioprinting**

M Gruene, C Unger, L Koch... - Biomedical ... - biomedical-engineering-online ... 2011 - biomedical-engineering-online... 2011

**Laser-assisted bioprinting** of multi-cellular replicates in accordance with CAD blueprint may substantially improve our understandings of fundamental aspects of 3D cell-cell and cell-matrix interactions in vitro. For predictable printing results, a profound knowledge about...

Cited by 77  Related articles  All 17 versions  Web of Science: 55
But...

- In grad school and in engineering practise, the game has changed
- You need to be able to quickly find and summarize the quality scientific literature on very specific topics
The process of researching and writing a paper

- **Choosing a Topic**: Do some preliminary searching to help think of ideas.
- **Searching**: While searching, you may decide you need to refine your topic.
- **Reviewing What You Find**: It's important to organize as you go.
- **Writing & Citing**: You may need to do more searching at this point.
- **Choosing Where to Search**: Look to a research guide or librarian for advice.
What I’ll be talking about

- Overview of quality sources
- Where to get background info
- Process for searching effectively for detailed info
- Organizing and referencing what you find
- Literature reviews
Types of sources in engineering

Textbooks, reliable news sources

Scholarly books, handbooks, industry publications/sites

Research articles, conference papers, patents

Broader (context)

More detailed
What does it mean to be a quality source in science and engineering?

- There are so many types of sources and information that it’s impossible for me to give you specific guidance about every type.
What does it mean to be a quality source in science and engineering?

- **Authoritative** – written/created by someone knowledgeable in the topic
- **Balanced** – acknowledges the strengths and limitations of the research discussed, without a clear conflict of interest
- **Supported** – references other authoritative sources to support their claims
- **Timely** – The conclusions are still valid and have not been superseded by newer work
Example

- Searching on Google for ‘skin cancer AI’, some of the results include
  - An article from ‘Healthcare IT News’ about a new product
  - An article in the Guardian describing the results of a scientific paper
  - A press release from the American Academy of Dermatology
Many of these pages are talking about and summarizing scientific/engineering research.

But the accuracy of the summary varies. It is hard to tell if you don’t read the original research too.

Ask yourself “is this source detailed? Balanced? Not in a biased position? Referencing its own sources?”
What distinguishes journal articles from most other sources?

- Describe research done by the authors themselves (except for review articles)
- Peer-reviewed (checked) by other independent researchers
- Each article references many other articles and documents
- They can be advanced and quite difficult to read!
What distinguishes journal articles from other sources?

- Special type of article called a **review article**
- Summarizes developments in a topic of research
- Find them in the databases I’ll show later
Research Databases – what are they?

- Research databases are designed to help users find relevant info for academic or research purposes
- They are not journals – they don’t host the articles on their own sites
- Most research databases focus on journal articles and books
- Unlike a search engine, the contents are partly manually curated to ensure a minimum level of quality
## Comparison

<table>
<thead>
<tr>
<th>Google or Google Scholar</th>
<th>Research database</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOTS of results for a typical search</td>
<td>Many fewer results</td>
</tr>
<tr>
<td>Includes papers, theses, reports, course pages, corporate publications, etc. Google Scholar includes anything that looks like a paper to a robot</td>
<td>Focused on scholarly articles and papers. Has specific criteria for which journals/conferences are included.</td>
</tr>
<tr>
<td>Uses lots of AI to try to guess what you are looking for</td>
<td>Only uses a little AI, is quite literal</td>
</tr>
<tr>
<td>Has only a couple filtering options to help you sort through</td>
<td>Has many filtering options</td>
</tr>
</tbody>
</table>
Start searching with introductory sources
Start with introductory sources

- If you are researching a topic you’re not already knowledgeable about, start with broader info sources
- E-books on the topic from the library
- Trade/industry publications on a topic (you can google trade publication topic X’)
- See our research guides for each subject for specific recommendations
Start with introductory sources

- AccessEngineering textbooks – cover typical course subjects in all areas of engineering
- O’Reilly Safari online – books, videos, short case studies on programming, AI, cybersecurity, etc
- LinkedIn Learning – online courses and videos on software and business topics

- Access all of them using Databases list
Start with introductory sources

- Synthesis Lectures – short books on topics in computer, electrical and applied math

- Access all of them using Databases list
Advanced searching for detailed info
Example situation

- You’re writing a paper reviewing the most accurate AI image analysis methods to help detect cancerous skin growths like moles
Research Databases

- When you know how to use, you can find much more relevant articles for specific searches
- But you need to prepare your search
Choose your topic or question

Choose the databases / sites to search

Turn your question into a structured Boolean search (concepts, synonyms)

Run your search

Look over the results – how relevant are they?

Filter or modify search

Repeat with next database

Review and save the documents you want
Steps in preparing a detailed search query:

1. Break apart your question into key concepts - focus on scientific terms only

2. Find synonyms, variations, alternate spellings for each concept - can use Google and Wikipedia to do this

3. Connect your concepts together into a machine-readable question with Boolean search operators AND, OR, ()
You’re writing a paper reviewing the most accurate AI image recognition methods to help detect cancerous skin growths like moles.
Generate alternate terms for your concepts

<table>
<thead>
<tr>
<th>Concept 1</th>
<th>Concept 2</th>
<th>Concept 3</th>
</tr>
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<tr>
<td>skin cancer</td>
<td>AI</td>
<td>image, imagery</td>
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Generate alternate terms for your concepts

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<td>AI</td>
<td>image, imagery</td>
</tr>
<tr>
<td>melanoma</td>
<td>artificial intelligence</td>
<td>photo, photograph</td>
</tr>
<tr>
<td>moles</td>
<td>neural network</td>
<td></td>
</tr>
<tr>
<td></td>
<td>deep learning</td>
<td></td>
</tr>
</tbody>
</table>
Other commands

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asterisk * (wildcard)</td>
<td>electric* finds electric, electrical, electricity, etc</td>
</tr>
<tr>
<td>Quotes “”</td>
<td>“anaerobic digestion” finds exact phrase</td>
</tr>
<tr>
<td>(parentheses)</td>
<td>Specifies the order of operations for search engine</td>
</tr>
</tbody>
</table>
Run your search

- Demo: library search
- Demo: Scopus
- Sort your results by relevance

- Even if you’re an expert, it’s normal to take 5-10 tries to arrive at a great search for your topic!!
Comparison of Google Scholar and Scopus results

- Unstructured GS search vs Scopus structured search
- Top Google Scholar results included some influential papers on the topic
- But Scopus results were more on-topic overall
- If you use one tool you’ll miss out!
Citations

Citations

▸ What is the ‘citation count’ of an article?
▸ Articles with lots of citations are usually influential or highly-regarded in their field
▸ But newer articles, or articles on very niche topics, will naturally have fewer
▸ Don’t just look at highly-cited articles
How do you know what search tool to use?

- Usually for a thorough paper you’ll want to use tool
  - Scopus
  - PubMed
  - Web of Science
  - Google / Google Scholar
  - Library catalogue (e-books)
  - IEEE Xplore

These are linked from my research guide
How do you know what search tool to use?

- There are other specific publisher databases that you may hear about (ScienceDirect, Springer, ASME, etc)
- It is rarely useful to search them because the other databases I’ve mentioned are more effective and will include the articles in these databases anyway
How do you know what tool to use?

<table>
<thead>
<tr>
<th>Tool</th>
<th>Strength</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scopus, Web of Science</td>
<td>Searching for specific topics across STEM</td>
</tr>
<tr>
<td>Google Scholar</td>
<td>For natural language questions, and finding non-peer reviewed (e.g. reports, pre-prints)</td>
</tr>
<tr>
<td>PubMed</td>
<td>Questions with an application to medical research/care</td>
</tr>
</tbody>
</table>
Reading, citing and organizing your sources
Reading articles

- Seriously reading an article can be difficult! But it is possible

- https://www.sciencemag.org/careers/2016/03/how-seriously-read-scientific-paper
## The structure of an engineering paper

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>A short summary of the article – read this first to see if you want to read the rest</td>
</tr>
<tr>
<td>Introduction</td>
<td>The reason for doing the study – <strong>the problem with the existing situation</strong></td>
</tr>
<tr>
<td></td>
<td>The previous literature that was used</td>
</tr>
<tr>
<td>Methods (or procedure, design, setup, ...)</td>
<td>How the researchers did their study (Materials, fabrication of prototype, type of software used, ...)</td>
</tr>
<tr>
<td>Results and Discussion (analysis, ...)</td>
<td>What happened – how successful was the research compared to its goals?</td>
</tr>
<tr>
<td>References</td>
<td>The list of articles cited in the paper</td>
</tr>
</tbody>
</table>
Referencing your sources to avoid plagiarism

- When you write a term paper in your M.Eng. degree, you do not have to pretend that you are already a master expert on the entire topic – this is unrealistic
- This thinking can lead to plagiarism
Referencing your sources to avoid plagiarism

- Reminder: You need to cite everything that you learn in your research that contributes to your report – not just statistics and direct quotes
- This applies to any type of source you use
  - an assignment you find on the internet
  - an image you found on social media
  - A YouTube video
- Citing gives credit where it is due, and is required to avoid plagiarism
What do I need and not need to cite?

- You don’t need to reference facts that are well-known by everyone in your field.
- This normally includes the basic definitions of popular technical terms.
- For example, in a class on machine learning, you would not be expected to cite something for a short definition of supervised learning in your paper.
What do I need and not need to cite?

- But you need to cite *everything else*
- If you are writing several paragraphs explaining the steps in a supervised learning process, you need to cite your sources for that, even if it’s your course textbook
What do I need and not need to cite?

- But you need to cite everything else.
- If you are describing something included in multiple papers equally, you may cite multiple papers at once.

Macromixing in single and multiphase continuous reactors of all scales is measured using residence time distribution (RTD) (Trambouze and Euzen, 2004, Kalaga et al., 2012, Kalaga et al., 2017). Knowing the RTD can help predict yield and diagnose problems in reactor operations (Fogler, 2006a). Furthermore, Kuan et al.'s (2014) work with secondary flow in twisted pipes in the laminar regime indicates that heat transfer, mass transfer, and RTD are linked and can be optimized simultaneously. RTD is therefore useful to determine the appropriateness of a particular micro-reactor for a specific application when examined in conjunction with other characteristics.
Citation example

In text of a paper:
“Tayo, Caparanga, Doma and Liao (2018) reviewed six current oxidation treatment methods and found that....“

In the bibliography at the end of the paper
More help on citations

- This page from MacMaster University has more guidance on what needs to be cited in science and engineering.
- For examples of creating a citation, see the ‘How to Cite’ page in each program’s research guide.
Because of the importance of referencing, it’s very important to be organized when doing research.

Never copy text into your draft essay without including the source with it.

Take notes (paper or electronic) describing the key points of an article.

Save journal articles and book chapters as PDFs with proper file names.
Organizing your sources with a citation manager

▸ A citation manager like Zotero or Mendeley will save you a lot of time and will help you avoid plagiarism by keeping organized!

▸ Both are free to download

▸ Make sure the citation info created by the program is correct!

▸ Check that there are links to all electronic documents in your bibliography (including books, articles, etc)
Citation workflow

Searching

Organizing papers

Zotero / Mendeley

Writing

Google Docs
Writing resources

- Guides for STEM (available online):
  1. *How to Write a Good Scientific Paper.*
     Michael Alley, 2018.
  3. *From Research to Manuscript.*

  https://doi.org/10.1371/journal.pcbi.1003149
Reviewing the literature

- For term papers or directed readings, your professors want you to **synthesize the state-of-the-art literature** on a topic
  - What does this mean?
Reviewing the literature

- For term papers or directed readings, your professors want you to **synthesize the literature** on a topic
  - What does this mean?
  - They don’t want you to just re-write the abstracts of some papers (for example,
    
    *Paper A conducted experiments in...*
    
    *Paper B did an analysis of another thing...*
    
    *Paper C did something different...*
Reviewing the literature

- For term papers or directed readings, your professors want you to synthesize the literature on a topic.
  - It’s better if you can do the following: Traditional Method A for this problem (papers X, Y, Z).
  - Alternative Method B (papers W, U, V) has these strengths and weaknesses in comparison.
Reviewing the literature

- For term papers or directed readings, your professors want you to **synthesize the literature** on a topic
  - It’s very important to pick a good, specific topic so that you are able to do this well
  - Don’t be afraid to adjust your topic partway through (with permission of your instructor)
Reviewing the literature

- Note-taking, organizing your digital files, and connecting the ideas are very useful

At work

- You won’t have access to most of the research databases and articles you have now (even working for a large engineering company)
  - Use Google Scholar or 1findr to search and find technical info
- The same expectations re: what you cite apply to reports, documents, and emails you produce in professional practice
At work

- The expectations re: the particular citation style you use are often not as formalized, depending on the type of document
- But you cannot pass off someone else’s words as your own
- This includes even text you find on a webpage without an author identified
Intellectual property

- Innovations and work you create professionally may be your own “intellectual property” (IP), or the property of your employer
- Categories include
  - Copyrighted material
  - Patenable innovations/inventions
  - Industrial designs and circuit designs
  - Trade secrets
- Canadian Intellectual Property Office
Intellectual property

- Drawings, models, plans and documents created in engineering and design work are protected automatically by copyright in Canada.
- This means you cannot re-use someone else’s engineering work without their permission, unless they have published it.
- This would be a violation of the Code of Ethics of the Professional Engineers Act of Ontario.
By default, IP may belong to either you or your employer - depending on the category of IP, the type of employment you have, and who created the IP.

- Is often governed by an employee or contractor agreement.
- If you work as a contractor, you must be aware of this area.
- If you are bringing IP that you have created or found into a job, you must also be careful.
LinkedIn

- Highly recommended if you are job-hunting in industry in North America - used by managers and recruiters

- Add as much detail as you can:
  - Headline summary
  - Advanced courses taken here and in undergrad
  - Specific details about what you have done in professional jobs
  - Experience in clubs or community showing ‘transferable skills’

https://www.linkedin.com/in/kate-neigel/
More help

See Research Guides for each subject on the library website
Contact info for us is there

**Evan Sterling**
- Civil and Enviro Eng
- Mechanical and Biomedical
- Engineering and Business/Management

**Jolene Hurtubise**
- ECE and CompSci

**Nigèле Langlois**
- Chemical and Biological Engineering