# ENGG*3070 Integrated Manufacturing Systems

01

Fall 2023
Section(s): C01

School of Engineering
Credit Weight: 0.50
Version 1.00 - September 01, 2023

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# 1 Course Details

## 1.1 Calendar Description

Common production machines and manufacturing systems are dealt with, particularly automated systems, robotics, computer control and integration techniques, materials handling, inspection processes and process control. The course addresses societal and environmental issues related to manufacturing.

**Pre-Requisites:** ENGG*2120
**Restrictions:** Non-BENG students may take a maximum of 4.00 ENGG credits.

## 1.2 Timetable

| **Lectures**: | | |
|---|---|---|
| Monday, Wednesday, Friday | 9:30 AM– 10:20 AM | ANNU, Room 156 |
| **Lab:** Multiple sections; see WebAdvisor | | |

## 1.3 Final Exam

Friday, December 15th, 2023.

11:30 AM - 1:30 PM, Room TBA

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# 2 Instructional Support

## 2.1 Instructional Support Team


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|---|---|
| **Instructor:** | Mohamed El Hamahmy |
| **Email:** | malhamah@uoguelph.ca |
| **Telephone:** | Zoom audio/video calls using the email address above |
| **Office:** | TBA |


| | |
|---|---|
| **Office Hours:** | **Virtual office hours (1 hour weekly):** |
| **Office Hours:** | 1 PM - 2 PM, every Thursday from September 14$^{th}$ to December 14$^{th}$. |
| **Office Hours:** | **Virtual / In-person office hours (1 hour weekly):** |
| **Office Hours:** | 1 hour per week, by appointment. |
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| **Office Hours:** | 1 hour per week, by appointment. |

A single hour has been pre-scheduled for the duration of the semester (see above). An additional hour is available every week by appointment, where students can choose to meet in person or virtually.

A Zoom link is available in the contents tab of the course website (Courselink). This link is valid for any virtual appointments throughout the semester.

## 2.2 Teaching Assistants

| | |
|---|---|
| **Teaching Assistant (GTA):** | Leonardo Gadelha Tumajan Costa de Melo |
| **Email:** | lgadelha@uoguelph.ca |
| **Teaching Assistant (GTA):** | Ibrahim Nouzil |
| **Email:** | inouzil@uoguelph.ca |

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# 3 Learning Resources

## 3.1 Required Resources

**Book (Textbook)**

Groover, M., Automation, Production Systems, and Computer Integrated Manufacturing, 5th

edition, 2018, Pearson. (Textbook)

**Courselink (Website)**

http://courselink.uoguelph.ca

Course material, news, announcements, and grades will be regularly posted on the ENGG*3070 CourseLink page. You are responsible for checking the site regularly. You may choose to turn on email notifications on Courselink to ensure you do not miss any important information.

**Lectures (Notes)**

Lectures are the primary source of information for this course. Lecture slides *will* be made available to students on Courselink after each lecture, but these are not intended to be stand-alone course materials.

During lectures, the instructor will expand on these slides, provide additional example problems, and promote class discussion. It is highly recommended that you attend these lectures and take notes.

**Lab instructional material (Other)**

This course includes lab sessions. Instructional material may include slides, handwritten notes, demonstrations, and video recordings.

These instructional materials will be posted on Courselink afterwards, where possible. You are advised to attend the lab sessions to benefit from classroom interaction, and to complete your lab assignments under the guidance of a GTA. You *may* choose to complete your lab assignment in your own time, using posted material, but this is inadvisable to most.

## 3.2 Recommended Resources

**Books (Textbook)**

Course content will also be incorporated from the following books:

1. Author: Ronald G. Askin and Charles R. Standridge; Title: : Modeling and Analysis of Manufacturing Systems; Publisher: Wiley; Year of Publication:1993; Edition 1st; ISBN 0-471-51418-7:
2. Author: Edward A. Silver, Daid F. Pyke, and Rein Peteson; Title: Inventory Management and Production Planning and Scheduling; Publisher: Wiley; Year of Publication: 1998; Edition: 1st; ISBN: 0-471-11947-4
3. Author: Kelton, W., Randall, S., and Nancy S.; Title: Simulation with Arena; Publisher: McGraw-Hill; Year of Publication: 2009; ISBN: 978-0073376288

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# 4 Learning Outcomes

## 4.1 Course Learning Outcomes

By the end of this course, you should be able to:

1. Identify the basic components of modern production systems.
2. List different methods of automation and control in manufacturing, as well as their pros and cons.
3. Develop ladder logic diagrams to control simple manufacturing operations.
4. Apply hand calculations to determine system parameters, including the optimization of assembly and transfer lines, cellular manufacturing, and facility layouts.
5. Create simulations of manufacturing systems using discrete event methodology (both by hand and using software).
6. Effectively critique different components of an integrated manufacturing system, such as material handling and storage, inspection, automation, etc.
7. Design basic manufacturing support systems by performing process/capacity planning, inventory control, etc.

## 4.2 Engineers Canada - Graduate Attributes (2018)

Successfully completing this course will contribute to the following:

| # | Outcome | Learning Outcome |
|---|---|---|
| 1 | Knowledge Base | 2, 4, 6 |
| 1.4 | Recall, describe and apply program-specific engineering principles and concepts | 2, 4, 6 |
| 2 | Problem Analysis | 5, 6 |
| 2.3 | Construct a conceptual framework and select an appropriate solution approach | 5, 6 |
| 5 | Use of Engineering Tools | 3, 5 |
| 5.2 | Demonstrate proficiency in the application of selected engineering tools | 3, 5 |

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# 5 Teaching and Learning Activities

## 5.1 Lecture Schedule

| Lecture | Lecture Topics | References | Learning Objectives |
|---|---|---|---|

| | | | |
|---|---|---|---|
| 1, 2 | **Introduction**<br><br>• Automation in Production Systems<br>• Manual Labor in Production Systems<br>• Types Manufacturing Operations and Production Facilities<br>• Basic Elements of Automation<br>• Level of Automation<br>• Components of Manufacturing Systems<br>• Classification Scheme for Manufacturing Systems | Chapters 1, 2, 3, 4, 13 | 1, 2, 6 |
| 3, 4 | **Introduction to Discrete Event Systems Simulation**<br><br>• Fundamentals of Simulation<br>• Time Advance Event Scheduling Algorithm | Other resources, lecture note | 1, 5 |
| 5, 6 | **Discrete Control Using Programmable Logic Controller**<br><br>• Discrete Process Control<br>• Ladder Logic Diagrams<br>• Programmable Logic Controller | Chapter 9 | 2, 3 |
| 7, 8 | **Materials Transportation and Storage Systems**<br><br>• Overview of Materials Handling and Storage<br>• Analysis of Material Transportation Systems<br>• Analysis of Storage Systems | Chapters 10-11 | 1, 4, 6 |
| 9 | **Single Station Manufacturing Cells**<br><br>• Single Station Manned Cells<br>• Single Station Automated Cells<br>• Application of Single Station Cells | Chapter 14 | 1, 4, 6 |
| 10-14 | **Manual and Automated Production and Assembly Lines** | Chapters 15-17 | 1, 2, 4, 6 |

| | | | |
|---|---|---|---|
| | • Fundamental of Manual Assembly Lines<br>• Analysis of Single Model Assembly Lines<br>• Line Balancing Algorithms<br>• Mixed Model Assembly Lines<br>• Fundamentals of Automated Production and Assembly Lines<br>• Applications of Automated Production and Assembly Lines<br>• Analysis of Transfer Lines and Assembly Systems | | |
| 15-17 | **Cellular Manufacturing System**<br>• Part families<br>• Part Classification and Coding<br>• Production Flow Analysis<br>• Cellular Manufacturing<br>• Application of Group Technology<br>• Quantitative Analysis in Group Technology | Chapter 18, Other resources, lecture note | 1, 2, 4, 6 |
| 18-20 | **Flexible Manufacturing Systems**<br>• FMS Components<br>• FMS Applications and Benefits<br>• FMS Planning and Implementation Issues<br>• Quantitative Analysis of Flexible Manufacturing Systems | Chapter 19, Other resources, lecture note | 1, 2, 4, 6 |
| 21-36 | **Manufacturing Support Systems**<br>• Inventory control<br>• Flow Shop Sequencing<br>• Job Shop Sequencing | Lecture and other resources | 1, 2, 7 |

## 5.2 Labs

| **Topic** | **Week of:** |
|---|---|

| | |
|---|---|
| Introduction to process simulation using Arena | September 18th |
| Basic operations: Simulating an electronic assembly and testing system | September 25th |
| Simulating a simple manufacturing system | October 2nd |
| **FALL BREAK - NO LAB** | **October 9th** |
| Advanced entity transfer | October 16th |
| Accumulating and non-accumulating conveyors | October 23rd |
| Entity transfer using Automatically Guided Vehicles (AGV) | October 30th |
| Tutorial / Advanced topics in Arena | November 6th |
| Tutorial / Advanced topics in Arena | November 14th |

# 6 Assessments

## 6.1 Marking Schemes & Distributions

| Name | Scheme A (%) |
|---|---|
| Assignments | 15 |
| Labs | 15 |
| Quizzes | 20 |
| Midterm Exam | 20 |
| Final Exam | 30 |
| Total | 100 |

## 6.2 Assessment Details

**Assignments (15%)**
**Learning Outcome:** 1, 2, 3, 4, 5, 6, 7

- Assignment 1, September 22nd
- Assignment 2, October 6th
- Assignment 3, October 20th
- Assignment 4, November 17th
- Assignment 5, December 1st

Assignments are due at 5 PM on the indicated date. All assignments are to be submitted as a soft copy through the relevant Dropbox on Courselink.

**Labs (15%)**

**Learning Outcome:** 5, 6

In the lab, you will be taught how to simulate manufacturing systems using the software Arena.

Lab report submission will be done through the relevant Dropbox folder on Courselink. Lab reports are due before the start of the following lab.

**Quizzes (20%)**

**Learning Outcome:** 1, 2, 3, 4, 5, 6

- Quiz-1 September 29th
- Quiz-2 October 13th
- Quiz-3 November 10th
- Quiz-4 November 24th

All quizzes will be delivered in class.

**Midterm Exam (20%)**

**Date:** Wednesday, October 25 and Friday, October 27, Location TBA

**Learning Outcome:** 1, 2, 3, 4, 5

The midterm will be split into two parts: One delivered on Wednesday, and the other delivered the following Friday. This is to ease exam stress and ensure students have sufficient time.

**Final Exam (30%)**

**Date:** Thu, Dec 15, 11:30 AM - , 1:30 PM, TBA

**Learning Outcome:** 1, 4, 6, 7

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# 7 Course Statements

## 7.1 Course Grading Policies

**Missed Assessments**: If you are unable to meet an in-course requirement due to compassionate reasons, physical or mental health, please email the course instructor. Typically, if you are granted an accommodation, it will involve shifting the weight of the

assessment to a future assessment.

See the undergraduate calendar for information on regulations and procedures for Academic Consideration:
http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.shtml

**Accommodation of Religious Obligations**: If you are unable to meet an in-course requirement due to religious obligations, please notify the course instructor during the first two weeks of the semester to make alternate arrangements (i.e. by September 21st).

See the undergraduate calendar for information on regulations and procedures for Academic Accommodation of Religious Obligations:
http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-accomrelig.shtml

**Missed lab, quiz, and midterm**: As discussed above. If you miss a lab, quiz, or midterm due to grounds for granting academic consideration or religious accommodation, the weight of the missed evaluation will be added to a future assessment (likely the final exam).

**Late submissions:** Late submission of assignments and/or lab assignments will incur a 50% penalty in the first 24 hours (50% of the maximum grade will be deducted). Submissions that are more than 24 hours late will not be accepted.

# 8 School of Engineering Statements

## 8.1 Instructor's Role and Responsibility to Students

The instructor’s role is to develop and deliver course material in ways that facilitate learning for a variety of students. Selected lecture notes will be made available to students on Courselink but these are not intended to be stand-alone course notes. Some written lecture notes will be presented only in class. During lectures, the instructor will expand and explain the content of notes and provide example problems that supplement posted notes. Scheduled classes will be the principal venue to provide information and feedback for tests and labs.

## 8.2 Students' Learning Responsibilities

Students are expected to take advantage of the learning opportunities provided during lectures and lab sessions. Students, especially those having difficulty with the course content, should also make use of other resources recommended by the instructor. Students who do (or may) fall behind due to illness, work, or extra-curricular activities are advised to keep the instructor informed. This will allow the instructor to recommend extra resources in a timely manner and/or provide consideration if appropriate.

## 8.3 Lab Safety

Safety is critically important to the School and is the responsibility of all members of the School: faculty, staff and students. As a student in a lab course you are responsible for taking all reasonable safety precautions and following the lab safety rules specific to the lab you are

working in. In addition, you are responsible for reporting all safety issues to the laboratory supervisor, GTA or faculty responsible.

# 9 University Statements

## 9.1 Email Communication

As per university regulations, all students are required to check their e-mail account regularly: e-mail is the official route of communication between the University and its students.

## 9.2 When You Cannot Meet a Course Requirement

When you find yourself unable to meet an in-course requirement because of illness or compassionate reasons please advise the course instructor (or designated person, such as a teaching assistant) in writing, with your name, id#, and e-mail contact. The grounds for Academic Consideration are detailed in the Undergraduate and Graduate Calendars.

Undergraduate Calendar - Academic Consideration and Appeals
https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.shtml

Graduate Calendar - Grounds for Academic Consideration
https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/index.shtml

Associate Diploma Calendar - Academic Consideration, Appeals and Petitions
https://www.uoguelph.ca/registrar/calendars/diploma/current/index.shtml

## 9.3 Drop Date

Students will have until the last day of classes to drop courses without academic penalty. The deadline to drop two-semester courses will be the last day of classes in the second semester. This applies to all students (undergraduate, graduate and diploma) except for Doctor of Veterinary Medicine and Associate Diploma in Veterinary Technology (conventional and alternative delivery) students. The regulations and procedures for course registration are available in their respective Academic Calendars.

Undergraduate Calendar - Dropping Courses
https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-drop.shtml

Graduate Calendar - Registration Changes
https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/genreg-reg-regchg.shtml

Associate Diploma Calendar - Dropping Courses
https://www.uoguelph.ca/registrar/calendars/diploma/current/c08/c08-drop.shtml

## 9.4 Copies of Out-of-class Assignments

Keep paper and/or other reliable back-up copies of all out-of-class assignments: you may be

asked to resubmit work at any time.

## 9.5 Accessibility

The University promotes the full participation of students who experience disabilities in their academic programs. To that end, the provision of academic accommodation is a shared responsibility between the University and the student.

When accommodations are needed, the student is required to first register with Student Accessibility Services (SAS). Documentation to substantiate the existence of a disability is required; however, interim accommodations may be possible while that process is underway.

Accommodations are available for both permanent and temporary disabilities. It should be noted that common illnesses such as a cold or the flu do not constitute a disability.

Use of the SAS Exam Centre requires students to make a booking at least 14 days in advance, and no later than November 1 (fall), March 1 (winter) or July 1 (summer). Similarly, new or changed accommodations for online quizzes, tests and exams must be approved at least a week ahead of time.

For Guelph students, information can be found on the SAS website
https://www.uoguelph.ca/sas

For Ridgetown students, information can be found on the Ridgetown SAS website
https://www.ridgetownc.com/services/accessibilityservices.cfm

## 9.6 Academic Integrity

The University of Guelph is committed to upholding the highest standards of academic integrity, and it is the responsibility of all members of the University community-faculty, staff, and students-to be aware of what constitutes academic misconduct and to do as much as possible to prevent academic offences from occurring. University of Guelph students have the responsibility of abiding by the University's policy on academic misconduct regardless of their location of study; faculty, staff, and students have the responsibility of supporting an environment that encourages academic integrity. Students need to remain aware that instructors have access to and the right to use electronic and other means of detection.

Please note: Whether or not a student intended to commit academic misconduct is not relevant for a finding of guilt. Hurried or careless submission of assignments does not excuse students from responsibility for verifying the academic integrity of their work before submitting it. Students who are in any doubt as to whether an action on their part could be construed as an academic offence should consult with a faculty member or faculty advisor.

Undergraduate Calendar - Academic Misconduct
https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-amisconduct.shtml

Graduate Calendar - Academic Misconduct
https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/index.shtml

## 9.7 Recording of Materials

Presentations that are made in relation to course work - including lectures - cannot be recorded or copied without the permission of the presenter, whether the instructor, a student, or guest lecturer. Material recorded with permission is restricted to use for that course unless further permission is granted.

## 9.8 Resources

The Academic Calendars are the source of information about the University of Guelph's procedures, policies, and regulations that apply to undergraduate, graduate, and diploma programs.

Academic Calendars
https://www.uoguelph.ca/academics/calendars

## 9.9 Illness

Medical notes will not normally be required for singular instances of academic consideration, although students may be required to provide supporting documentation for multiple missed assessments or when involving a large part of a course (e.g.. final exam or major assignment).

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