



PRODUCTION CONTROL – IIND2201

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OBJECTIVES OF THE COURSE

The student will be capable of:

- 1. Identify the relevant problems to production in real-life situations.
- 2. Identify, formulate and solve problems that are present in the control and management of production using basic tools illustrated during the course.
- **3.** Analyze the results obtained by the models proposed during the course.

COMPETENCES TO BE DEVELOPED (ABET)

The main skills expected to be developed by students through workshops, activities and tests are:

- **1** An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
- 6 An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.

PRE-REQUESTS

- Fundamentals of Production.
- Principles of Optimization.

CO-REQUESTS

Probability & Statistic I.

METHODOLOGY

- a. Lectures.
- b. Application project.

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- c. Laboratories.
- d. Optional additional sessions.
- e. Attention hours.
- f. Workshops.
- **g.** Lecture activities.
- **h.** The course has an official site at SicuaPlus. There will be published all the information pertinent to the course. The student will be responsible of review frequently this website, specially the contents, notices and emails, where we post information frequently.

CURSE RULES

- All the rules related to the workshops and the project's implementation will be published together with the statements of each activity.
- Any request for review a grade should be submitted in writing, in the established format, and involves the complete revision of the exam, laboratory, workshop or project review. Any claims must be made within the time limit set in accordance with the regulations of the University.¹
- The use of cell phones, laptops and other electronic devices during classes are **ABSOLUTELY PROHIBITED**, unless the professor approved their use. The use of programmable calculator during the exams is forbidden.
- A student cannot postpone/advance the exam presentation unless the student prove a circumstance approved in the university regulation. The student must take into account the latter at the moment of do inter-semester practices or scheduled trips. Remember that the semester finishes the last day of final exams.
- If a student is caught doing academic cheat², the professor will apply the disciplinary process describe in the "Reglamento General de Estudiantes de Pregrado"³. If the process prove the academic cheat, the professor can assign the grade that he/she consider in the case².
- The course will be approved with a grade equal or greater than 3.00⁴.
- The final grade is the approximated weighted average to two (2) decimals⁵.
- According to the regulation student⁶, the teacher of each lecture section is empowered to grant a final grade lower than 3.00 in cases where the student does not meet the minimum conditions of assistance. To verify attendance, different works and activities will be conducted in master classes, which will be collected by the teacher.

OPTIONAL COMPLEMENTARY SESSIONS

During the academic semester the course will do optional complementary sessions. The assistance is NOT mandatory. In the next table, the student can see the schedule of these sessions. All optional complementary sessions will be done in the ML_508 (AIA) classroom, from the second class week:

¹ Reglamento General de Estudiantes de Pregrado. Universidad de los Andes, ART. 64. Todo estudiante que desee formular un reclamo sobre las calificaciones de cualquier evaluación o sobre la nota definitiva del curso deberá dirigirlo por escrito y debidamente susten tado al profesor responsable de la materia, dentro de los cuatro (4) días hábiles siguientes a aquel en que se dan a conocer las calificaciones en cuestión. El profesor dispone de cinco (5) días hábiles para resolver el reclamo formulado; vencido el término, informará al estudiante la decisión correspondiente.

 $^{^2}$ Reglamento General de Estudiantes de Pregrado. Universidad de los Andes, ART. 115.

 $^{^{3}}$ Reglamento General de Estudiantes de Pregrado. Universidad de los Andes, <code>sección D.</code>

⁴ Reglamento General de Estudiantes de Pregrado. Universidad de los Andes, ART. 54. Una calificación inferior a 3.00 implica la pérdida de la materia y su consecuente repetición cuando ésta sea obligatoria. Si no es obligatoria, el estudiante deberá tomar en los periodos siguientes aquellas materias con las cuales complete el número de créditos requeridos en su programa de estudio.

⁵ Reglamento General de Estudiantes de Pregrado. Universidad de los Andes, ART. 53. Las calificaciones definitivas de las materias serán numéricas de uno cinco (1.50) a cinco (5.00), en unidades, décimas y centésimas. La calificación aprobatoria mínima será de tres (3.00).

⁶ Reglamento General de Estudiantes de Pregrado. Universidad de los Andes, ART. 43. Es facultativo de cada profesor controlar la asistencia de sus alumnos y determinar las consecuencias de la inasistencia, si ésta es superior al 20%.

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Schedules

Additional optional Session			

Topics

Week	Additional optional Session
2	SES and SED forecasts and Error measures
3	Forecasts SET
4	Forecast in R
5	Aggregate planning
6	Models EOQ and EPL
7	Models of discounts by amount
8	Heuristic methods
9	RECESS WEEK
10	Wagner-Whitin algorithm
11	Discrete and continuous newsvendor model
12	HOLYWEEK
13	Model S, T y Q, R
14	LABORATORY
15	MRP and Single Machine
16	Flow Shop
17	Job Shop
18	LABORATORY

ATTENTION HOURS

Every week there will be office hours for students. These spaces are designed for the solution of questions and problems associated with the course. There will be in the ML_508 (AIA), at the times listed below are:

Day	Schedule	

EVALUATION

The course has a number of activities, and each one has a specific weight in the final grade. The percentages of each one of the activities presented in the next table:

Warkshons (3)	15%
vorkshops (5)	1370

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Exam 1	20%
Exam 2	20%
Exam 3	15%
Laboratories (2)	5%
Project	15%
Lecture activities	10% *
Additional complementary classes	5% **

* 40% of the lecture activities grade corresponds to the activities carried out until Friday, March 6th, 2020.

** Additional percentage. Optional complementary classes, which are designed as spaces for the development of practical exercises will be held throughout the semester. At the end of the semester, there will be a **simple average**, of the total amount of activities carried out during the entire semester, of the grades that students obtain in the proposed activities. Students must **NOT** attend all the complementary classes to have right to this additional grade, but your grade will be benefited if you attend to the most of them.

Note: On March 13th will be available for review the **30.5%** of the final grade of the course.

WORKSHOPS

The workshops must be done in **groups of three (3)** which will be formed by teachers, randomly. Once the groups are created, these only can be changed after desertions and prior professor authorization. Additionally, every workshop has some specific deliverables, written in the workshop statement, that the student will be follow. The post and due dates for physical and magnetic versions are:

	Date of publication	Due date	Thematic
Workshop 1	February 12 th	March 2 nd	Forecasts, aggregate planning, linear programming, EOQ, EPL, discount models.
Workshop 2	March 25 th	April 22 nd	Heuristics, Wagner Whitin, levels of service, daily vendor models, model QR and model ST
Workshop 3	April 30 th	May 20 th	MRP, Single Machine, Flow Shop, Job Shop

Note: All workshops must be deliver at the due date before ten in the morning (10:00 am) in the locker #61 (located behind the elevators on the seventh floor of the ML).

Additionally, **per workshop**, each student group should complete **a form of Google Drive** of a **evaluation between peers** of the work done by the group. The instructions are:

- Each student must qualify between 0 and 5 each of his partners. The assigned final mark of the activity of interest will be proportional to the average of the grades assigned by his partners. For example, if the evaluation between peers obtained by a student are 4.00 and 5.00, your final note will correspond to the note obtained at the workshop multiplied by the average of the co-evaluations and divided by 5.00. It means, the note of the workshop is multiplied by (4.5÷5.0) = 0.9
- The deadline for filling of the form is the same deadline for delivery of the workshop. In the event that you do not
 perform this process of evaluation between peers, you will be penalized with 0.5 on the final grade, which was
 previously weighted with the co-evaluation carried out by the partners of the group).

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• The link of the form will be published in the SicuaPlus unified section, in the *advertising* carpet, on the delivery day of each workshop.

LABORATORIES

During the semester two (2) laboratory practices will take place at the Ambiente Integrado de Aprendizaje (AIA). These laboratories will be held on the following dates:

Laboratory	Week	Dates	Pre-inform delivery	Inform delivery
MRP	14	April 20 th – April 24 th	Monday, April 20 th	Tuesday, May 5 th
Scheduling	18	May 18 th – May 22 nd	Monday, May 18 th	Tuesday, June 2 nd

In the week in which laboratory practice is performed, each section will be divided into two (2) groups of students: one of the groups will be conducting the laboratory while the other will attend the lecture class. In the next session of class of the same week, the groups will be exchanged. In this way, both groups may perform the laboratories and will attend the same lecture theme.

For each lab, students must provide **physical and magnetic**, a pre-inform (1) and (1) inform on the dates set out in **the locker #61** (located behind the elevators on the seventh floor of the ML), and through a link that will be enabled in SicuaPlus. These reports must be made together with the groups that are assigned to each practice and the limit delivery time is at **ten** in the morning **(10:00 am)**.

PROJECT

During the semester, the course will develop an application project with the course's topics. The goal of this is to approximate students to an application case where the student can propose different alternatives to improve the inventory and scheduling management problems. The project looks for evaluating:

- Apply acquired knowledge in the course and tools and techniques own industrial engineering.
- Understand and analyze data to solve problems.
- Use engineering tools and software.

This project must be done with the same groups of the workshops and it will be divided in three (3) phases: phase 0 (company selection), phase 1 (Description and diagnosis of the company chosen) and phase 2 (selection of the problem and alternative solutions). Below is shown the posting and delivery dates:

	Posting date	Delivery date
Phase 0		February 14 th
Phase I	January 24 th	March 24 th
Phase II		May 11 th

Note: All phases will have as a time limit of delivery the ten in the morning (10:00 am) in the locker #61 (located behind the elevators on the seventh floor of the ML).

Additionally, **per phase**, each student group should complete **a form of Google Drive** where to perform a process of **evaluation between peers** of the work done by the group. The instructions are:

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- Each student must qualify between 0 and 5 each of his partners. The assigned final mark of the activity of interest will be proportional to the average of the grades assigned by his partners. For example, if the evaluation between peers obtained by a student are 4.00 and 5.00, your final note will correspond to the note obtained at the workshop multiplied by the average of the co-evaluations and divided by 5.00. It means, the note of the workshop is multiplied by (4.5÷5.0) = 0.9
- The deadline for filling of the form is the same deadline for delivery of the workshop. In the event that you do not perform this process of evaluation between peers, you will be penalized with 0.5 on the final grade, which was previously weighted with the co-evaluation carried out by the partners of the group).
- The link of the form will be published in the SicuaPlus unified section, in the *advertising* carpet, on the delivery day of each workshop.

EXAMS

All exam will be done in SicuaPlus website with the following guidelines:

- The students will have 120 minutes to realize the exam. This ends when the time in SicuaPlus finishes in the website.
 If the student finishes the exam before limit time, he/she will wait sitting in front of the desktop until all students complete the exam.
- The student only can use a basic calculator (not programmable calculator), pencil, pen, eraser and paper given by graduated assistants.
- During the exam, the student will receive a formula sheet and he/she must deliver it at the end of the exam.
- Use of phones, laptops, iPads and similar are **PROHIBITED** during each exam.

The exam	dates are:
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	DATES	TOPICS	
Evom 1	March 9 th	Forecast models, aggregated planning, linear programming, EOQ model,	
	6:30 pm - 8:30 pm	EPL model, Discounts models.	
Evam 2	April 27 th	Heuristics, Wagner Whitin, service levels, newsvendor models, Q, R and S, T	
Exam 2	6:30 pm - 8:30 pm	models.	
Exam 3	Scheduled by registry	MRP, Single Machine, Flow Shop, Job Shop	

COURSE SCHEDULE

The themes to be studied during the semester are divided by class sessions, in next table:

WEEK	SESSION	TOPICS	LECTURES
		Introduction to "Production Control"	[NHAM Cap. 1]
Week 1	1	Forecast: Introduction and Measures of forecast accuracy: MSE, MAD,	[NHAM Cap. 2]
20 - 24		MAPE y error charts	Pg. 52-63
January	2	Forecast: Simple moving average and SES	[NHAM Cap. 2]
			Pg. 63-73
Week 2	3	Forecast, SED or Holt method. Simple linear regression	[NHAM Cap. 2]
Veek 2 27 – 31 January		Forecast. SED of Holt method, simple lineal regression	Pg. 74-78
	4	Forecast: SET or Winters method	[NHAM Cap. 2]
			Pg. 79-89
Week 3	5	Forecast: SET or Winters method	[NHAM Cap. 2]

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WEEK	SESSION	TOPICS	LECTURES	
3 – 7 February			Pg. 78-92	
	6	Aggregated planning: Introduction and Chase strategy	[NHAM Cap. 3] Pg. 124-140	
Week 4 10 – 14 February	7	Aggregated planning: Introduction and Level strategy	[NHAM Cap. 3] Pg. 124-140	
	8	Known demand inventory systems: Introduction. EOQ model	[NHAM Cap. 4] Pg. 198-217	
Week 5 17 – 21 February	9	Known demand inventory systems: Sensitivity analysis and EPL	[NHAM Cap. 4] Pg. 218-219	
	10	Known demand inventory systems: Quantity discount models	[NHAM Cap. 4] Pg. 220-226	
Week 6 24 – 28 February	11	Known demand inventory systems: Quantity discount models	[NHAM Cap. 4] Pg. 220-226	
	12	Heuristics for deterministic and dynamic demand: Heuristic methods, L4L, EOQ, POQ	[NHAM Cap. 7] Pg. 376-381	
Week 7 2 – 6 March	13	Heuristics for deterministic and dynamic demand: PPB, MUC, Silver-Meal. Introduction to Wagner Whitin	[NHAM Cap. 7] Pg. 376-381	
	14	Wagner-Whitin method	[NHAM Cap. 7] Pg. 411-415 [HOPP-SPEAR Cap. 2] Pg. 59-63	
Week 8 9 – 13 March	15	Unknown demand inventory systems: Inventory classification with unknown demand, Service levels models	[NHAM Cap. 5] Pg. 248-256	
	16	Known demand inventory systems: Introduction. Newsboy model	[NHAM Cap. 5] Pg. 257-265	
Week 9 16 – 20 March		REST WEEK		
Week 10 23 – 27 March	17	Known demand inventory systems: Introduction. Newsboy model	[NHAM Cap. 5] Pg. 257-265	
	18	Known demand inventory systems: Continuous review models (Q,R). Service levels	[NHAM Cap. 5] Pg. 266-280	
Week 11 March 30 – April 3	19	Known demand inventory systems: Continuous review models (Q,R). Service levels	[NHAM Cap. 5] Pg. 266-280	
	20	Known demand inventory systems: Periodic review models (S,T). Service levels	[NHAM Cap. 5] Pg. 281-282	
Week 12 6 – 10 April		HOLYWEEK		
Week 13 13 – 17	21	Material Requirement Planning (MRP): Introduction. Bill of materials	[NHAM Cap. 7] Pg. 364-392	

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WEEK	SESSION	TOPICS	LECTURES
April	22	Material Requirement Planning (MRP): Introduction. Bill of materials	[NHAM Cap. 7] Pg. 364-392
Week 14 20 – 24 April	23	Scheduling: Introduction. Single Machine: SPT, EDD, CR. Gantt Chart MRP LABORATORY	[NHAM Cap. 8] Pg. 417-429
	24	Scheduling: Introduction. Single Machine: SPT, EDD, CR. Gantt Chart MRP LABORATORY	[NHAM Cap. 8] Pg. 417-429
Week 15 April 27 – May 1	25	Scheduling: Exact and heuristic algorithms for specific problems of Single Machine. Hodgson Moore algorithm	[NHAM Cap. 8] Pg. 430-436
	26	Scheduling: Flow-Shop models with M-machines: Johnson algorithm. Heuristic algorithms	[NHAM Cap. 8] Pg. 437-440
Week 16 4 – 8 May	27	Scheduling: Flow-Shop models with M-machines: Johnson algorithm. Heuristic algorithms	[NHAM Cap. 8] Pg. 437-440
	28	Scheduling: Job Shops. Ackers.	[NHAM Cap. 8] Pg. 441-445
Week 17 11 – 15 May	29	Scheduling: Job Shops. Non Delay.	[NHAM Cap. 8] Pg. 441-445
	30	Project presentations	
Week 18 18 – 22 May	31	Project presentations SCHEDULING LABORATORY	
	32	Project presentations SCHEDULING LABORATORY	
		FINAL EXAMS	

* This Schedule is subject to changes during the semester by professors, if they consider it needed.

REFERENCES

- [1] S. NAHMIAS. Production and Operations Analysis. McGraw Hill International Edition. SixthEdition. 2009. (TEXTO GUÍA)
- [2] S. NAHMIAS. Análisis de la Producción y las Operaciones. Mc Graw Hill. Quinta edición en español, traducida de la quinta edición en inglés. 2007. (TEXTO GUÍA)
- [3] R. SCHROEDER. Administración de Operaciones. McGraw Hill, Inc, U.S.A. 3ª. ed. 1996.
- [4] W. HOPP, M. SPEARMAN. Factory Physics: Foundations of Manufacturing Management. IRWIN. 2001
- [5] L. A. JOHNSON, D.C. MONTGOMERY. Operations Research in Production Planning, Scheduling, and Inventory Control. John Wiley&Sons, 1974.
- [6] E.A. SILVER, D.F. PYKE, R. PETERSON. Inventory Management and Production Planning and Scheduling. John Wiley & Sons, Inc, U.S.A. 3^a. ed. 1996.
- [7] G. HADLEY, T.M. WHITIN. Analysis of Inventory Systems. Prentice-Hall, Inc, U.S.A. 1963

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