APPENDIX A – COURSE SYLLABI

INCLUDE ONLY COURSE SYLLABI FOR THE DISCIPLINE-SPECIFIC COURSES OF THE PROGRAM FOR READINESS REVIEW

Code	IMC101	Prerequisites	None
Yam	Mechatronics Engineering Seminar	Co-requisites	None

Credits	Contact Hours
00	12
Categorization of credits	
Math and basic science	
Engineering topic	X
other	

Instructor's course name:	Irvin E. Cedeño

Text-book
Cedeño, I. (2016). Prontuario Reforma 2016. Manuscrito inédito.
Other supplemental materials
Instituto Tecnológico de Santo Domingo, Information Technology Department (2017) Institutional Statistics Report [Periodic report]. Santo Domingo: Author. Instituto Tecnológico de Santo Domingo (2014) Regulation of the Center for Innovation and Entrepreneurship. Santo Domingo: INTEC. Instituto Tecnológico de Santo Domingo (2012) Student Academic Mobility Regulation. https://www.intec.edu.do/downloads/documents/institucionales/reglamentos/reglamento-movilidad-estudiantil.pdf Instituto Tecnológico de Santo Domingo. (2016). Curriculum Reform 2015-2016. Santo Domingo: INTEC.

Description	
The Mechatronics Engineering Seminar is the students' first contact with topics related to the career and introduces them to its fundamental concepts. In this, the motivations of the students to have selected the career are explored, emphasis is placed on the identity of the Mechatronics Professional, the history, the present and the future of it, both nationally and internationally, and the professional work of the graduates. The infrastructures available to the institution and career for the teaching of students are also shown and important details related to the study plan, transversal axes, concentrations, mobility programs and entrepreneurship are pointed out.	
Type of course	☒ Required ☐ Elective

Specific goals for the course	
Outcomes of instruction	1. Show openness and tolerance to new opinions, ideas and concepts in dialogue with peers and teachers.

	2. Show tranquility and preparation in the presentation of their proposed solutions to the problem presented. 3. Prepare didactic documentation and expose concepts through the visual information technology resources provided by the study center. 4. Expose problems and solutions of a mechatronic nature, attached to the problem solving method.
Student outcomes	SO1. Identify, formulate, and solve complex engineering problems by applying the principles of engineering, science, and mathematics. SO3. Communicate effectively with a variety of audiences. SO5. Work effectively in teams whose members collectively provide leadership, create a collaborative and inclusive environment, set goals, plan tasks, and meet objectives.

topics
Unit I. Introduction Unit II. Mechatronics and INTEC Unit III. Facilities Unit IV. Crosscutting Unit V. Student Committee Unit VI. Mobility Unit VII. Entrepreneurship Unit VIII. professional work Unit IX. Deliverable

Code	IMC102	Prerequisites	IMC101
Name	Hands-On Program I	Co-requisites	None

Credits	Contact Hours
00	twenty
Categorization of credits	
Math and basic science	
Engineering topic	X
other	

Instructor’s course name:	Ivan E. Jimenez

text-book
Agudo Vicente, B., Guerrero Valenzuela, M., & Hernandis Ortuño, B. (2014). Estudio comparativo de las acciones a considerar en el proceso de diseño conceptual desde la ingeniería y el diseño de productos. Ingeniare. Chilean Engineering Magazine, 22(3), pp. 398-411. Taken on October 7, 2017 from http://www.scielo.cl/pdf/ingeniare/v22n3/art10.pdf Gil, F., Rico, R., & Sánchez-Manzanares, M. (2008). Eficacia de Equipos de Trabajo. Papers of the Psychologist, 29(1), pp. 25-31 Selinger, C. (2004). Stuff You Don't Learn in Engineering School: Skills for Success in the Real World. Wiley-IEEE Press. Cardona, P., & Wilkinson, H. (2006). Teamwork. Occasional Paper, 07/10. Retrieved October 1, 2017 from http://www.iese.edu/research/pdfs/op-07-10.pdf
Other supplemental materials
Charyton, C. (2015). Creative Engineering Design: The Meaning of Creativity and Innovation in Engineering. In: Charyton C. (eds) Creativity and Innovation Among Science and Art. Springer. Chicago Architecture Foundation (2016). Discover Design Handbook. Retrieved from: https://www.discoverdesign.org/handbook Harvard BusinessEssentials. (2004). Project management: essential skills to stay on budget and meet deadlines. Deust Editions.

Description	
This is the first in a series of follow-up assignments in the Hands-On program. It is designed to guide Mechatronics Engineering students towards critical thinking regarding the design of their projects and to understand the benefits and conditions of teamwork. For this, the contents were organized in a logical and coherent way, starting with the analysis of teamwork, followed by the evaluation of the design and search for improvements, and the research and project unit concludes.	
Type of course	☒ Required ☐ Elective

Specific goals for the course	
Outcomes of instruction	1. Identify the qualities of them and their team members using introspection as a tool. 2. Establish the learning needs required for the project based on the discussion of the team's aptitude limitations.

	3. Compare the characteristics of the different components of their design, based on the established design requirements. 4. Identify potential problems in their design and project through discussion of observations and investigations. 5. Propose solutions to problems based on the shared knowledge of their team. 6. Evaluates solutions to problems through the consensus of their team.
Student outcomes	SO2. Apply the engineering design process to produce solutions that meet specific needs, taking into account public health, safety and well-being, as well as global, cultural, social, environmental and economic factors. SO5. Work effectively in teams whose members together provide leadership, create a collaborative and inclusive environment, set goals, plan tasks and meet objectives.

topics
Unit I. Teamwork Unit II. Project Definition Unit III. Search for Alternatives Unit IV. Project Design

Code	IMC103	Prerequisites	IMC102
Name	Hands-On 2 Program	Co-requisites	None

Credits	Contact Hours
00	20
Categorization of credits	
Math and basic science	
Engineering topic	X
Other	

Instructor's course name:	Iván E. Jiménez

Text book
Jiménez, I. (2017). Hands-On Final Report Guide. Instituto Tecnológico de Santo Domingo. Joffré Encinas, J. E. (2018). Guide for the Writing of Technical Reports. Retrieved from http://www.ingenieria.uaslp.mx/Metalurgia/Documents/APUNTES/Gu%C3%ADa%20para%20escrito%20reporte.pdf Sarli, RR, González, SI, & Ayres, N. (2015). Análisis FODA. Una herramienta necesaria. (Spanish). Revista de La Facultad de Odontología. (Spanish) Universidad Nacional de Cuyo, 9(1), 17. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=edo&AN=109277247&lang=es&site=eds-live
Other supplementary materials
Dym, CL, Agogino, AM, Eris, O., Frey, DD, & Leifer, LJ (2005). Engineering design thinking, teaching, and learning. Journal of engineering education, 94(1), 103-120. Harvard Business Essentials. (2004). Project management: essential skills to stay on budget and meet deadlines. Barcelona: Deusto Editions Laura Perez Granada. (2018). El aprendizaje basado en problemas como estrategia didáctica en educación superior. Voces de La Educación, Vol 3, Iss 6, Pp 155-167 (2018), (6), 155. Retrieved from https://doaj.org/article/6ebdfa03fe164fb0a5af047bcf5155f9? Lledó, P., & Rivarola, G. (2007). Projects management. Pearson Education. Selinger, C. (2004). Stuff You Don't Learn in Engineering School: Skills for Success in the Real World. Hoboken, NJ: Wiley -IEEE Press Torres Rodriguez, RS, & Ramirez, F. (2018). Buenas Prácticas de Ingeniería (GEP's). Instituto Tecnológico de Colima. Jiménez, I. (2017). Rúbrica Evaluación Desempeño Equipo. Instituto Tecnológico de Santo Domingo. Riquelme Leiva, Matias (2016, December). SWOT: Matrix or SWOT Analysis – An essential tool for the study of the company. Santiago, Chile. Retrieved from http://www.analisisfoda.com/

Description
This course is focused on analyzing the construction and testing process of the first robot for the Hands-On program, implementing basic analysis tools and generating reports based on the team's observations and conclusions, using mostly retrospect to evaluate the performance of its robot. team during the project.

Type of course	☒ Required ☐ Elective

Specific goals for the course	
Outcomes of instruction	1. Analyze the construction and testing process of the project, implementing basic analysis tools. 2. Compare the results of your project against the proposed criteria and requirements to reflect on the validity of your design and project execution. 3. Evaluate your team's performance during the project using observation and retrospect rubrics. 4. Report the results of their team's work at the different stages of the project, freely but clearly and concisely. 5. Generate a basic technical report with an adequate structure and format that serves as a reference both for team members in their future projects and for people outside the project.
Student outcomes	SO1. Identify, formulate, and solve complex engineering problems by applying the principles of engineering, science, and mathematics. SO2. Apply the engineering design process to produce solutions that meet specific needs taking into consideration public health, safety and welfare, as well as global, cultural, social, environmental and economic factors. SO5. Function effectively in a team whose members together provide leadership, create a collaborative and inclusive environment, set goals, plan tasks, and meet objectives.

Topics
Unit I. Analysis and Expected Results Unit II. Tests Setup Unit III. Testing and Results Unit IV. Result Analysis Unit V. Result Documentation

Code	IMC204	Prerequisites	IMC103
Name	Hands-On Program 3	Co-requisites	None

Credits	Contact Hours
00	22
Categorization of credits	
Math and basic science	
Engineering topic	X
Other	

Instructor's course name:	Ivan E. Jimenez

Text book
Nagel, R. L., Pierrakos, O., & Nagel, J. K. (2013). A versatile guide and rubric to scaffold and assess engineering design projects. In ASEE Annual Conference & Exposition. Kim, C. (2012). Project Proposal.
Other supplemental materials
Cardona, P., Wilkinson, H. (2006). Teamwork. Occasional Paper, 07/10. Retrieved on October 1, 2017 from http://www.iese.edu/research/pdfs/op-07-10.pdf Delgado, A., Mesquida, A.L., & Mas, A. (2014). Utilización de Trello para realizar el seguimiento del aprendizaje de equipos de trabajo. Jornadas de Enseñanza Universitaria de la Informática (20es: 2014: Oviedo). Dym, CL, Agogino, AM, Eris, O., Frey, DD, & Leifer, LJ (2005). Engineering design thinking, teaching, and learning. Journal of Engineering Education, 94(1), 103-120. Encuestas de Opinión (2011). Como presentarse para hacer una encuesta. http://encuestasdeopinion.blogspot.com/2011/09/como-presentarse-para-make-una.html Haik, Y., & Shahin, TM (2011). Engineering design process (2nd ed.). Stanford, USA: CENGAGE Learning, 2011. https://www.researchgate.net/publication/235959233 Harvard BusinessEssentials. (2004). Project management: essential skills to stay on budget and meet deadlines. Barcelona: Deusto Editions Lledó, P., & Rivarola, G. (2007). Gestión de proyectos. Pearson Education. OBS Business School. What is a Gantt chart and what is it for? https://www.obs-edu.com/en/blog-project-management/gantt-charts/what-is-a-gantt-chart-and-what-is-it-for Retos Directivos (2015). Priorizar tareas, clave para la buena gestión de nuestro tiempo. https://retos-directivos.eae.es/priorizar-tareas-clave-para-la-buena-gestion-de-nuestro-tiempo/ QuestionPro. Cree una encuesta exitosa en 7 pasos. https://www.questionpro.com/blog/create-a-successful-survey-with-questionpro-in-7-steps/

Description
In this course, students are challenged to explore and implement tools and methods to help them organize their Sumo robot construction project in a way that improves on the experience and results of the previous year's Monster project. They also continually work to mature their team and their interactions in order to apply principles of the engineering design process in finding solutions to the challenges presented by the new

project. Similarly, they delve into project management issues and discover their role in the Hands-On program community.	
Type of course	☒ Required ☐ Elective

Specific goals for the course	
Outcomes of instruction	1. Describe the project as a problem to be tackled with different key parts to attack and combine them in the form of project objectives with the needs, goals and scopes defined by the team. 2. Propose activities to achieve the team's objectives, their execution priority and duration, according to their capabilities. 3. Feed a document that serves as a reference to the team where the proposed design and management of your team is discussed and justified. 4. Apply different management and design tools with their team and discuss their use to choose alternatives suitable for his needs. 5. Performs a risk analysis to anticipate future complications of their project and propose adjustments and ways to handle them, according to their priorities. 6. Propose ways to support other teams and the community based on the needs of the project and their experiences.
Student outcomes	SO2. Apply the engineering design process to produce solutions that meet specific needs considering public health, safety and welfare, as well as global, cultural, social, environmental and economic factors. SO4. Recognize ethical and professional responsibilities in engineering situations and makes informed judgments considering the impact of engineering solutions in global, economic, environmental, and social contexts. SO5. Function effectively in a team whose members together provide leadership, create a collaborative and inclusive environment, set goals, plan tasks, and meet objectives.

Topics
Unit I. Mission Design Unit II. System Functions Unit III. Alternative Selection Unit IV. Concept Building Unit V. Project Planning and Documentation

Code	IMC205	Prerequisites	IMC204
Name	Hands-On Program 4	Co- requisites	None

Credits	Contact hours
00	twenty
Categorization of credits	
Math and basic science	
Engineering topic	X
Other	

Instructor's course name:	Ivan E. Jimenez

Text book
Aymes, G.L. (2012). Pensamiento crítico en el aula. Docencia e Investigación: revista de la Escuela Universitaria de Magisterio de Toledo, 37(22), 41-60. Kuster, J. et al. (2015). Project management handbook. Haik, Yousef & Shahin, Tamer (2010). Engineering Design Process. Nagel, R. L., Pierrakos, O., & Nagel, J. K. (2013). A versatile guide and rubric to scaffold and assess engineering design projects.
Other supplementary materials
Alda, FL, & Hernandez, MD (1998). Resolución de problemas. Cuadernos de Pedagogía, 265(31), 28-32. Guitart, M. E. (2011). Del "Aprendizaje Basado En Problemas" (ABP) al "Aprendizaje Basado En La Acción" (ABA). Claves para su complementariedad e implementación. REDU. Revista De Docencia Universitaria, 9(1), 91. doi:10.4995/redu.2011.6182 León Urquijo, A. P., Risco del Valle, E., & Alarcón Salvo, C. (2014). Estrategias de aprendizaje en educación superior en un modelo curricular por competencias. Revista de la educación superior, 43(172), 123-144. Prieto, J. H. P. (2012). Estrategias de enseñanza-aprendizaje. Pearson educación. Ugalde-Albístegui, M., & Zurbano-Bolinaga, V. (2009). Creatividad e innovación: Nuevas ideas, viejos principios. DYNA-Ingeniería e Industria, 84(2).

Description	
In this course, students find themselves with the need to find an adequate and effective way to transmit the experience accumulated during their first two years to the other teams participating in the Hands-On Program. The ability of each student to generate collaboration-oriented documentation through the analysis of their learning process and the generation of information and activities to share the things learned with the community is also put into perspective.	
Type of course	☒ Required ☐ Elective

Specific goals for the course	
Outcomes of instruction	1. Incorporate tests and analysis in the planning of their implementation process to verify the effectiveness of the design against the requirements that govern it. 2. Document their design and learning processes to communicate their results and problems in a way that allows analysis by others in the class.

	3. Generate collaboration-oriented documentation based on analysis of the effectiveness of their design process and issues resolved during the project.
Student outcomes	SO3. Communicate effectively with a variety of audiences. SO4. Recognize ethical and professional responsibilities in engineering situations and makes informed judgments considering the impact of engineering solutions in global, economic, environmental, and social contexts.

Topics
Unit I. Testing and Expected Results Unit II. Result Analysis and Documentation Unit III. Design Refinement Unit IV. Results Communication

Code	IMC328	Prerequisites	IMC205
Name	Hands-On Program 5	Co- requisites	None

Credits	Contact hours
00	20
Categorization of credits	
Math and basic science	
Engineering topic	X
Other	

Instructor’s course name:	Ivan E. Jimenez

Text book
Haik, Y., Shahin, T. (2010). Engineering Design Process. Kuster, J. et al. (2015). Project management handbook (1st ed., Management for Professionals). Berlin: Springer. doi:10.1007/978-3-662-45373-5 Master of Project Academy. (2018, June 08). 7 Elements of the Six Sigma Project Charter. Retrieved from https://blog.masterofproject.com/six-sigma-project-charter/ McBride M. (2016) Project Management Basics: How to manage your project with checklists. Berkeley, CA: Press. doi : 10.1007/978-1-4842-2086-3 Nagel, R. L., Pierrakos, O., Nagel, J. K. (2013). A versatile guide and rubric to scaffold and assess engineering design projects.
Other supplementary materials
Bilbao & Bejarano Architects. (2014, November 04). Gantt diagram. Retrieved from https://www.youtube.com/watch?v=oDFbPhmgqLQ DecisionSkills. (2014, May 22). SMART Goals - Quick Overview. Retrieved from https://www.youtube.com/watch?v=1-SvuFIQjK8 Lean Lab. (2017, December 10). What is a Project Charter. Retrieved from https://www.youtube.com/watch?v=yJQ8tFVbx3g ProjectLibre. (nd). ProjectLibre Open Source. Retrieved from http://www.projectlibre.com/product/projectlibre-open-source Whitt P. (2015) Project Planning, Inventory Management, and Time Tracking Software. In: Pro Freeware and Open Source Solutions for Business. Berkeley, CA: press

Description	
In this course, students formalize their knowledge of project planning and management, to effectively and realistically design the construction project for the latest robot in the Hands-On program. The development of the ability to plan and manage projects is worked, mainly, through the analysis and evaluation of their activities in previous projects and the comparison with methods and tools used professionally for project management.	
Type of course	☒ Required ☐ Elective

Specific goals for the course	
Outcomes of instruction	1. Define, together with their team, appropriate and realistic objectives, roles and communication methods for the effectiveness of their project.

	2. Define the detailed phases of their project structure. 3. Develop a project management plan based on the details of the planning phase. 4. Use digital tools to organize their project.
Student outcomes	SO2. Apply and use the engineering design process to produce solutions that meet specific needs, taking into consideration public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors. SO3. Communicate effectively with a variety of audiences. SO5. Function effectively in a team whose members together provide leadership, create a collaborative and inclusive environment, set goals, plan tasks, and meet objectives.

Topics
Unit I. Project Constitution Unit II. Design Solutions Unit III. Work Definition Unit IV. Project Control

Code	IMC329	Prerequisites	180 credits approved
Name	Computer Assisted Design and Manufacturing	Co-requisites	IMC329L

Credits	Contact hours
04	40
Categorization of credits	
Math and basic science	
Engineering topic	X
Other	

Instructor's course name:	Solandy Sanchez

Text book
Fitzpatrick, M. (2013). Machining and CNC technology. McGraw-Hill. Overby, A. (2011). CNC machining handbook. McGraw-Hill.
Other supplementary materials
CNC Software Inc. (2010). Basic 3D Machining. Retrieved from http://eng.auburn.edu/~griffgj/training/Basic_3D_Machining.pdf CNC Software, Inc. (2018). Mastercam Basics Tutorial. http://colla.lv/wp-content/uploads/2018/07/Mastercam-Basics-Tutorial.pdf Evans, K. (2016). Student workbook to accompany programming of CNC machines, fourth edition. Industrial Press. Radhakrishnan , P., Subramanyan , S., & Raju , V. (2014). CAD/CAM/CIM. Daryaganj : New Age International.

Description	
This course aims to introduce the basic concepts of computer-aided design and manufacturing to improve quality, reduce costs and shorten design and part production times. Computer Aided Design and Manufacturing (CAD/CAM) is a discipline that studies the use of computer systems as a support tool in all the processes involved in the design and manufacture of any type of product.	
Type of course	☒ Required ☐ Elective

Specific goals for the course	
Outcomes of instruction	1. Use the appropriate tools to solve the problems presented according to the required need. 2. Use different techniques for solving problems that arise in the development of the subject.
Student outcomes	SO1. Identify, formulate, and solve complex engineering problems by applying the principles of engineering, science, and mathematics.

Topics
Unit I. Introduction to CAD/CAM Unit II. CAD/CAM systems Unit III. Basic Functions CAM Software

Unit IV. Advanced Features CAM Software

Code	IMC329L	Prerequisites	180 approved credits
Name	Computer Assisted Design and Manufacturing Laboratory.	Co-requisites	IMC329

Credits	Contact Hours
01	40
Categorization of credits	
Math and basic science	
Engineering topic	X
Other	

Instructor’s course name:	Deyslen Mariano Hernandez

Text book
INTEC - Learning Resources and Media (2014). CNC Milling Tutorial, (part 1) [video]. Recovered at https://www.youtube.com/watch?v=HxpzwhUbwbQ INTEC - Learning Resources and Media (2014). CNC Milling Tutorial, (part 2) [video]. Recovered at https://www.youtube.com/watch?v=5ua2A3TAjKg Haas Automation Inc. (2014). Vertical Mill Operator's Manual. Retrieved from http://diy.haascnc.com/sites/default/files/Locked/Manuals/Operator/2014/Mill/Translated/ Mill_Operators_Manual_96-ES8200_Rev_A_Spanish_January_2014.pdf Productivity Inc. (2015). Haas CNC Mill Programming. Retrieved from http://microfluidics.cnsi.ucsb.edu/tools/Haas_SMM/Haas%20Mill%20Programming%20Manual.pdf
Other supplemental materials
Overby A. (2011). CNC Machining Handbook. New York: McGraw Hill.

Description	
It is a subject oriented to the development of skills necessary for the visualization and development of designs that can serve to offer solutions in the different fields of professional practice. The student will know: the definitions of CAD, CAM, CAE, geometric modeling, assemblies and tolerances, rapid prototype design, finite element method, diagnostic systems, static, dynamic, magnetic and thermal analysis.	
Type of course	☒ Required ☐Elective

Specific goals for the course	
Outcomes of instruction	1. Performs machining with a CNC machine choosing the most appropriate technique to meet the needs of the parts or requirements of the mechanism. 2. Manipulates different functions of the machining software for the elaboration of parts or components, selecting the most appropriate ones for the mechanism it will perform.

	3. Distinguishes and uses the different techniques and good practices of machining with a CNC machine to guarantee a quick solution to the needs of parts or components of a mechanism.
Student outcomes	SO2. Apply and use the engineering design process to produce solutions that meet specific needs, taking into consideration public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.

Topics
Unit I. Geometric Foundations. Unit II. CNC programming Unit III. Simulation of Parts Unit IV. Machining of Parts.

Code	IMC330	Prerequisites	180 approved credits
Name	Design of Mechatronic Systems	Co-requisites	None

Credits	Contact hours
04	44
Categorization of credits	
Math and Basic Science	
Engineering Topic	X
Other	

Instructor's course name:	Irvin E. Cedeno De los Santos

Textbook
Álvarez Pulido, M. (2004). Controladores Lógicos. Automation Direct. (2017). PLC Handbook. Daneri P. (2008). Automatización y Control Industrial. Mandano P., E; Marcos A., J., & Fernández S., C. (2009). Autómatas Programables y Sistemas de Automatización. Terzi, E. Regber, H. Loffler, C. & Ebel, F. (1999). Controles Lógicos Programables.
Other Supplementary Materials
Bradley, DA, & Seward, D. (2000). Mechatronics and the Design of Intelligent Machines and Systems. CRC Press. Haik, Y. (2016). Engineering Design Process (3rd ed.). CENGAGE Learning. Popovic, D., & Vlacic, L. (1999). Mechatronics in Engineering Design and Product Development. Marcel Dekker Inc. Shetty, D., & Kolk, R. (2011). Mechatronic System Design (2nd ed.). CENGAGE Learning. Ulrich, K.T., & Eppinger, S.D. (2016). Product Design and Development (6th ed.) McGraw-Hill.

Description	
Design of Mechatronic Systems is a subject oriented to learning the engineering design process, applied to the development of intelligent devices that can carry out tangible operations, autonomously and efficiently; where students learn the necessary design tools to achieve a solution that meets existing needs, investigate the state of technology, exercise the formation of work teams, communicate their ideas and project management.	
Type of course	☒ Required ☐ Elective

Specific goals for the course	
Outcomes of instruction	1. Describe the necessary steps for the development of the engineering design process. 2. Identify the good practices used in the design of engineering solutions. 3. Select appropriate procedures and components, taking into account the compatibility, availability, reliability of these and between them.

	4 Develop a project with which to create an intelligent, autonomous device that efficiently performs tangible operations. 5. Explain the progress made in the development of the proposed solution. 6. Communicate advances in the development of the project, using drawings, simulations, videos, images, graphics or other means, to enrich the understanding of the ideas shown. 7. Show adherence to planned time. 8. Identify the economic, environmental, social and ethical impact of the proposals made, classifying them according to the standardized methods for these purposes. 9. Form a work team, choosing colleagues with complementary skills, identifying strengths and weaknesses, in view of the requirements for the development of a mechatronics project. 10. Interact with team members and develops a solution proposal. 11. Perform searches for technologies, materials, processes and more, which allow them to develop a proposal for a solution to the identified needs.
Student outcomes	SO2. Apply the engineering design process to produce solutions that meet specific needs taking into account public health, safety and welfare, as well as global, cultural, social, environmental and economic factors. SO3. Communicate effectively with a variety of audiences. SO4. Recognize ethical and professional responsibilities in engineering situations and makes informed judgments considering the impact of engineering solutions in global, economic, environmental, and social contexts.

Topics
Unit I. Introduction to the Mechatronics Engineering Design Process Unit II. Market research Unit III. Development of design specifications Unit IV. Concept Development Unit V. Evaluation and Selection of Concepts Unit VI. Detailed Design Development Unit VI. Manufacture Unit VII. Prototype

Code	IMC330L	Prerequisites	180 approved credits
Name	Mechatronic Systems Design Laboratory	Co-requisites	IMC330

Credits	Contact hours
01	20
Categorization of credits	
Math and Basic Science	
Engineering Topic	X
Other	

Instructor’s course name:	Edwin A. Sanchez Camilo

Textbook
Kuster, J. et al. (2015). Project management handbook (1st ed., Management for Professionals). Berlin: Springer. doi:10.1007/978-3-662-45373-5
Other Supplementary Materials
McBride M. (2016) Project Management Basics: How to manage your project with checklists. Berkeley, CA: Press. doi : 10.1007/978-1-4842-2086-3 Bilbao & Bejarano Architects. (2014, November 04). Gantt diagram. Retrieved from https://www.youtube.com/watch?v=oDFbPhmgqLQ Decision Skills. (2014, May 22). SMART Goals - Quick Overview. Retrieved from https://www.youtube.com/watch?v=1-SvuFIQjK8 Master of Project Academy. (2018, June 08). 7 Elements of the Six Sigma Project Charter. Retrieved from https://blog.masterofproject.com/six-sigma-project-charter/ Project Libre. (nd). Project Libre Open Source. Retrieved from http://www.projectlibre.com/product/projectlibre-open-source Whitt P. (2015) Project Planning, Inventory Management, and Time Tracking Software. In: Pro Freeware and Open Source Solutions for Business. Berkeley, CA: press

Description	
Design of Mechatronic Systems is a subject oriented to learning the engineering design process, applied to the development of intelligent devices that can carry out tangible operations, autonomously and efficiently; where students learn the necessary design tools to achieve a solution that meets existing needs, investigate the state of technology, exercise the formation of work teams, communicate their ideas and project management.	
Type of course	☒ Required ☐ Elective

Specific goals for the course	
Outcomes of instruction	1. Organize the design process into logical steps to obtain a work plan.
Student outcomes	SO2. Apply and use the engineering design process to produce solutions that meet specific needs, taking into consideration public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.

Topics
Unit I. Project Management Cycle Unit II. Problem Statement Unit III. Objectives Unit IV. Project Constitution Unit V. Proposal for solutions Unit VI. Workplan Unit VII. Work Planning Unit VIII. Project monitoring Unit IX. Briefcase

Code	IMC331	Prerequisites	INE377 INE377L 180 approved credits
Name	Industrial Instrumentation	Co-requisites	IMC331L

Credits	Contact hours
04	40
Categorization of credits	
Math and Basic Science	
Engineering Topic	X
Other	

Instructor's course name:	Edwin Sanchez

Textbook
Bolton, W. (2015). Mechatronics: Electronic control systems in mechanical and electrical engineering. Creus, A. (2011). Industrial instrumentation. (8th Edition). Alphaomega. Fraden , J. (2016). Handbook of Modern Sensors. (5th Edition). Springer Rockwell Automation, Inc., Allen-Bradley. (2013). Process Safety Manual 1: Functional Safety in the Process Industry. (Publication SAFEBK-RM003A-ES-P). Rockwell Automation, Inc., Allen-Bradley. (2011). Safebook 4: Safety System for Industrial Machinery. (Publication SAFEBK-RM002B-EN-P)
other supplementary materials
De Silva, C. (2005) Mechatronics an Integrated Approach. CRC Press. Rockwell Automation. (1999). Fundamentals of Sensing Training Manual. FSM-900. Rockwell Automation - Allen Bradley. Rockwell International Corporation (1998) Application Data. Industrial Automation Wiring and Grounding Guidelines. (Publication no. 1770-4.1) The International Society of Automation (1991) Instrument Loop Diagram (Standard ISA-5.4-1991). The International Society of Automation (1992) Instrumentation Symbols and Identification (Standard ISA-5.1-1984, R1992).

Description	
This subject aims to provide concepts related to the static and dynamic characteristics of industrial measurement instruments. It will be based on the design principle of plans based on international regulations, as well as the operation of sensors and actuators.	
Type of course	☒ Required ☐ Elective

Specific goals for the course	
Outcomes of instruction	1. Justifies the use of technologies and their applications in designs, based on national and international regulations. 2. Outlines plans for various industrial contexts, integrating basic electrical knowledge and circuits. 3. Designs electrical diagrams and instrumentation planning using specialized software.

	4. Models the operating principle of industrial sensors using knowledge acquired in previous subjects.
Student outcomes	SO3. Communicate effectively with a variety of audiences. SO4. Recognize ethical and professional responsibilities in engineering situations and makes informed judgments considering the impact of engineering solutions in global, economic, environmental, and social contexts.

Topics
Unit I. Introduction to the ISA Instrumentation regulations Unit II. Standardized wiring and connectivity of industrial instrumentation Unit III. General characteristics of the sensors Unit IV. Industrial presence sensors Unit V. Industrial condition sensors Unit VI. Final elements and interfaces Unit VII. Instrumentation and control part I Unit VIII. Instrumentation and control part II Unit IX. Introduction to machinery safety Unit X. Modern instrumentation techniques

Code	IMC331L	Prerequisites	INE377 INE377L 180 approved credits
Name	Industrial Instrumentation Laboratory	Co-requisites	IMC331

Credits	Contact hours
01	20
Categorization of credits	
Math and Basic Science	
Engineering Topic	X
Other	

Instructor's course name:	Deyslen Mariano Hernandez

Textbook
Rockwell Automation. (2017). Technical Data of Limit Switches. Retrieved from http://literature.rockwellautomation.com/idc/groups/literature/documents/td/limit-td001_-en-p.pdf Rockwell Automation. (2017). Technical Data of Capacitive Proximity Sensors. Retrieved from http://literature.rockwellautomation.com/idc/groups/literature/documents/td/875c-td001_-en-p.pdf Rockwell Automation. (2017). Technical Data of Inductive Proximity Sensors. Retrieved from http://literature.rockwellautomation.com/idc/groups/literature/documents/td/prox-td001_-en-p.pdf Rockwell Automation. (2017). Installation instructions for photoelectric sensors. Retrieved from http://literature.rockwellautomation.com/idc/groups/literature/documents/in/9000-in002_-en-p.pdf Rockwell Automation. (2017). Ultrasonic Sensor Installation Instructions. Retrieved from http://literature.rockwellautomation.com/idc/groups/literature/documents/in/873c-in001_-en-p.pdf
Other supplementary materials
Helmich J. (2008). Festo Compact Workstation Manual. Germany. ADIRO. Rockwell Automation. (2017). Lockout Interlock Switch Installation Instructions. Retrieved from http://literature.rockwellautomation.com/idc/groups/literature/documents/in/mtgd2-in001_-en-p.pdf Rockwell Automation. (2017). Installation instructions for fiber optic sensors. Retrieved from http://literature.rockwellautomation.com/idc/groups/literature/documents/in/45fvl-in001_-en-p.pdf Yings Electric. (2017). Rotary Encoders. Retrieved from http://yingselectric.com/product_show.asp?id=424

Description

This laboratory aims to make students aware of the most common instrumentation devices found in both national and international industrial environments.

Type of course	☒ Required ☐ Elective

Specific goals for the course	
Outcomes of instruction	1. Distinguishes and uses the different types of sensors standardized for the industrial environment to guarantee a solution that meets the requirements of the control system. 2. Classify and select industrial sensors according to your application to meet the requirements of the control system. 3. Uses industrial sensors to meet specific requirements in industrial facilities.
Student outcomes	SO2. Apply and use the engineering design process to produce solutions that meet specific needs, taking into consideration public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors. SO3. Communicate effectively with a variety of audiences.

Topics
Unit I. General Information. Unit II. Limit Switches Unit III. Inductive Detectors Unit IV. Capacitive & Ultrasonic Detectors Unit V. Photoelectric Sensors Unit VI. Reflective Sensors Unit VII. Security Sensors Unit VIII. Encoders

Code	IMC337	Prerequisites	IMC205
Name	Hands-On Program 6	Co-requisites	None

Credits	Contact Hours
00	20
Categorization of credits	
Math and basic science	
Engineering topic	X
Other	

Instructor’s course name:	Ivan E. Jimenez

Text book
Jiménez, I. (2020). Descubriendo el COH. Jiménez, I. (2020). Inducción a Hands-On. Jiménez, I. (2017). Reglamento General. Kuster, J. et al. (2015). Project management handbook (1st ed., Management for Professionals). Springer. doi:10.1007/978-3-662-45373-5 Nagel, R. L., Pierrakos, O., & Nagel, J. K. (2013). A versatile guide and rubric to scaffold and assess engineering design projects.
Other supplemental materials
Bados, A., & Garcia, E. (2014). Resolución de problemas. Universitat de Barcelona. http://deposit. ub.edu/dspace/bitstream/2445/54764/1/Resoluci%C3%B3n%20problemas.pdf. Gestión de proyectos: Habilidades fundamentales para no salirse del presupuesto y cumplir los plazos. (2004). Bilbao: Ediciones Deusto. Guitart, M. E. (2011). Del “Aprendizaje Basado En Problemas” (ABP) al “Aprendizaje Basado En La Acción” (ABA). Claves para su complementariedad e implementación. REDU. Revista De Docencia Universitaria, 9(1), 91. doi:10.4995/redu.2011.6182 Laberge, R. (2016). Collaborative Teamwork in Crossdisciplinarity. Universal Journal of Educational Research, 4(12), 2716-2723. doi:10.13189/ujer.2016.041204 Selinger, C. (2004). Stuff You Don't Learn in Engineering School: Skills for Success in the Real World. Hoboken, NJ: Wiley-IEEE Press. Means: Hands-on Organizing Committee. Hands-On General Rules.

Description	
In this subject, students close the construction cycle and enter into a process of getting involved in the administration and management of the Hands-On Program, in such a way that they test their ability to analyze situations that commonly occur between less experienced teams and generate propose activities in the Hands-On community that help the other teams to find solutions to these situations.	
Type of course	☒ Required ☐ Elective

Specific goals for the course	
Outcomes of instruction	1. Generate robust documentation, under established formats, that promotes the efficiency and collaboration of work teams.

	2. Develop and present solutions, within their role in their work team, to situations that affect the experience of community members and encourage collaboration within the community. 3. Use the available tools to analyze performance data from Hands-On participants. 4. Recognize their responsibility towards the well-being of the community by assisting with and enhancing events and activities that promote interdependence among community members.
Student outcomes	SO2. Apply and use the engineering design process to produce solutions that meet specific needs, taking into consideration public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors. SO3. Communicate effectively with a variety of audiences. SO4. Recognize ethical and professional responsibilities in engineering situations and makes informed judgments considering the impact of engineering solutions in global, economic, environmental, and social contexts.

Topics
Unit I. Implementation Results Unit II. Hands-On Program Details Unit III. Hands-On Organizing Committee Unit IV. Community Experience Proposals

Code	IMC310	Prerequisites	180 approved credits
Name	Automated Assembly System	Co-requisites	None

Credits	Contact hours
04	55
Categorization of credits	
Math and Basic Science	
Engineering Topic	X
Other	

Instructor's course name:	Carlos de Jesus

Textbook
Boothroyd, G. (2005). Assembly Automation and Product Design (2nd ed.). CRC Press, Taylor & Francis Group. Boothroyd, G. (2010). Assembly Automation and Product Design (3rd ed.). CRC Press.
other supplementary materials
Benhabib, B. (2003). Manufacturing: Design, Production, Automation, and Integration. CRC Press. Crowson, R. (2006). Assembly Processes: Finishing, Packaging, and Automation. CRC Press. Redford, A. H. (1994). Design for Assembly: Principles and Practice. McGraw-Hill Three, PA (2017). Designing Plastic Parts for Assembly. (8th ed.). Carl Hanser Verlag GmbH & Company

Description	
Automated Assembly Systems is an introductory course to the constituent elements of an automated assembly process and the products that can be automatically assembled. In it, students are additionally trained in the Design for Assembly (DFA) methodology, with which they can redesign products to improve their ease of assembly and subsequent cost.	
Type of course	☒ Required ☐ Elective

Specific goals for the course	
Outcomes of instruction	1. Build and modify different systems and/or components suitable for solving the problems presented according to the required need. 2. Distinguish the types of assembly technologies existing in the industry for the continuous improvement of processes. 3. Demonstrate respect for the established commitments, in order to meet the proposed goals in reference to time and quality. 4. Review industrial processes according to current regulations to make recommendations in a specific situation.
Student outcomes	SO2. Apply the engineering design process to produce solutions that meet specific needs taking into account public health, safety and welfare, as well as global, cultural, social, environmental and economic factors.

	SO4. Recognize ethical and professional responsibilities in engineering situations and makes informed judgments considering the impact of engineering solutions in global, economic, environmental, and social contexts. SO7. Acquire and apply new knowledge using appropriate learning strategies.

Topics
Unit I. Assembly Line Components Unit II. Mid Term Project Unit III. Product Development Unit IV. Final Project

Code	IMC319	Prerequisites	IMC330
Name	Mechatronics Engineering Project I	Co-requisites	None

Credits	Contact hours
03	66
Categorization of credits	
Math And Basic Science	
Engineering Topic	X
Other	

Instructor's course name:	Deyslen Mariano

Textbook
Haik, Y. (2016). Engineering Design Process (3rd Edition). CENGAGE Learning.
Other Supplementary Materials
Bradley, DA, Seward, D. (2000). Mechatronics and the Design of Intelligent Machines and Systems. CRC Press. Popovic, D., Vlacic , L. (1999). Mechatronics in Engineering Design and Product Development. Marcel Dekker Inc. Shetty, D., Kolk, R. (2011). Mechatronic System Design (2nd edition). CENGAGE Learning. Ulrich, K.T., Eppinger, S.D. (2016). Product Design and Development (6th edition) McGraw-Hill.

Description	
Mechatronic Engineering Projects I is a subject oriented towards the implementation and development of skills in the engineering design process, applied to mechatronic solutions; where the student identifies the parameters and design requirements that best meet the constraints of a project, with which to create an intelligent, autonomous device that performs tangible operations, to provide a solution to an existing need.	
Type of course	☒ Required ☐ Elective

Specific goals for the course	
Outcomes of instruction	1. Identify the economic, environmental, social and ethical impact of the proposals made and classifies them according to the standardized methods for these purposes. 2. Select appropriate procedures and components, taking into account the compatibility, availability, reliability of these and between them. 3. Develop the steps of the engineering design process and show a solution that meets the requirements of the problem to be solved.
Student _ outcomes	SO1. Identify, formulate, and solve complex engineering problems by applying the principles of engineering, science, and mathematics. SO2. Apply the engineering design process to produce solutions that meet specific needs taking into account public health, safety and welfare as well as global, cultural, social, environmental and economic factors.

	SO4. Recognize ethical and professional responsibilities in engineering situations and makes informed judgments considering the impact of engineering solutions in global, economic, environmental, and social contexts.

Topics
Unit I. Design Process Unit II. Virtual Prototype

Code	IMC332	Prerequisites	180 approved credits INE377
Name	Pneumatic and Hydraulic Circuits	Co-requisites	IMC332L

Credits	Contact hours
04	44
Categorization of credits	
Math and basic science	
Engineering topic	X
other	

Instructor's course name:	Jose Ezequiel Diaz Castillo

text- book
Merkle, D., Shrader, B., Thomes, M. (1998) Hydraulics: Basic Level. Study manual. (2nd edition). Festo Didactics KG. Deppert, W., Stoll, K. (1997). pneumatic applications. Editorial Marcombo Haring, W., Metzger, M., Weber, RC (2005) Pneumatics: basic level. Festo Didactics GimbH & Co. KG.
Other supplementary materials
Essays, UK. (November 2013). Using Pneumatic and Hydraulic System Engineering Essay. Retrieved from https://www.ukessays.com/essays/engineering/using-pneumatic-and-hydraulic-system-engineering-essay.php?cref=1 Pinches, M. Ashby, J. G. (1988). PowerHydarulics . _ Prentice Hall. Schmitt, G.A. (1981). Hydraulic Training: book of information and teaching of hydraulics. GL Rexroth. Warring, R.H. (1983) Hydraulic Handbook. Gulf Publishing Co. Wehner , M., Tolley, M., Mengüç , Y., Park, Y., Mozeika , A., Ding, Y. … Wood, R. (2014) Pneumatic Energy Sources for Autonomous and Wearable Soft. Robotics. Soft Robotics 2(00) http://micro.seas.harvard.edu/papers/SR14_Wehner.pdf Yang, D., Verma, M.S., Lossner , E., Stothers , D., & Whitesides , G.M. (2017). Negative-Pressure Soft Linear Actuator with a Mechanical Advantage. Advanced Materials Technologies, 2(1). Retrieved from: https://dash.harvard.edu/bitstream/handle/1/30353768/maintext_including_figures_and_SI_revision_for_production.pdf?sequence=4

Description	
The pneumatic and hydraulic circuits consider the use of compressed air and hydraulic oil as a source of energy for the processes, including their automation and control. The knowledge of the pneumatic, hydraulic and electrical symbologies required according to the DIN ISO 1219 standard is contemplated, research on flexible conduits and sealing joints, circuit creation, construction of equipment with a certain degree of autonomy and the reading of machinery plans are integrated. of the practical world.	
Type of course	☒ Required ☐Elective

Specific goals for the course

outcomes of instruction	1. Distinguish the types of hydraulic and pneumatic technologies existing in the industry for the continuous improvement of processes. 2. Demonstrate respect for the established commitments, in order to meet the proposed goals in reference to time and quality. 3. Reviews the plans and pneumatic and hydraulic processes of the industry according to current regulations to make recommendations in a specific situation.
Student outcomes	SO2. Apply and use the engineering design process to produce solutions that meet specific needs, taking into consideration public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors. SO4. Recognize ethical and professional responsibilities in engineering situations and makes informed judgments considering the impact of engineering solutions in global, economic, environmental, and social contexts. SO7. Acquire and apply new knowledge using appropriate learning strategies.

Topics
Unit I. Introduction to hydraulics and Pneumatics/Laboratory Introduction Unit II. Pneumatic-Hydraulic-Electric symbologies/ Lab Practice Characteristic Curve of a fixed flow pump Unit III. Pneumatic-Hydraulic-Electric symbologies/Lab Practice Stamping Machine Unit IV. Electrical Sensors/Distribution valves/ How to make hydraulics and pneumatics circuits/ Lab Practice Pressure Limiting Valve Unit V. Investigation of flexible ducts and sealing gaskets/ Lab Practice One-Way Flow Regulating Valve Unit VI. Oil functions/color code/hydraulics and pneumatics circuits/ Lab Practice Timers Unit VII. Pumps and compressors/30/5000/ Lab Practice Intermediate Stop Unit VIII. Drive elements and more valves/ Lab Practice Electric Event Counters Unit IX. Tips for avoiding hydraulic problems/ Lab Practice Hybrid system: Hydraulic / Pneumatic

Code	IMC332L	Prerequisites	180 approved credits INE377
Name	Laboratory of pneumatic and hydraulic circuits	Co-requisites	IMC332

Credits	Contact hours
01	22
Categorization of Credits	
Math and Basic Science	
Engineering Topic	X
Other	

Instructor's course name:	Jose Ezequiel Diaz Castillo

Textbook
Merkle, D., Shrader, B., Thomes, M. (1998) Hydraulics: Basic Level. Study manual. (2nd edition). Festo Didactics KG. Deppert, W., Stoll, K. (1997). pneumatic applications. Editorial Marcombo Haring, W., Metzger, M., Weber, RC (2005) Pneumatics: basic level. Festo Didactics GimbH & Co. KG.
Other Supplementary Materials
Diaz Castillo, JE (s.f.). Guía de práctica de laboratorio. Merkle , D., Shrader , B., Thomes , M. (1998) Hydraulics: Basic Level. Study manual. (2nd edition). Festo Didactics KG. Deppert , W., Stoll , K. (1977). pneumatic applications. Editorial Marcombo Essays, UK. (November 2013). Using Pneumatic and Hydraulic System Engineering Essay. Retrieved from https://www.ukessays.com/essays/engineering/using-pneumatic-and-hydraulic-system-engineering-essay.php?cref=1 Haring, W., Metzger, M., Weber, RC (2005) Pneumatics: basic level. Festo Didactics GimbH & Co. KG. Pinches, M. Ashby, J. G. (1988). PowerHydarulics . _ Prentice Hall. Schmitt, G.A. (1981). Hydraulic Training: book of information and teaching of hydraulics. GL Rexroth. Warring, R.H. (1983) Hydraulic Handbook. Gulf Publishing Co. Wehner , M., Tolley, M., Mengüç , Y., Park, Y., Mozeika , A., Ding, Y. … Wood, R. (2014) Pneumatic Energy Sources for Autonomous and Wearable Soft. Robotics. Soft Robotics 2(00) http://micro.seas.harvard.edu/papers/SR14_Wehner.pdf Yang, D., Verma, M.S., Lossner , E., Stothers , D., & Whitesides , G.M. (2017). Negative-Pressure Soft Linear Actuator with a Mechanical Advantage. Advanced Materials Technologies, 2(1). Retrieved from: https://dash.harvard.edu/bitstream/handle/1/30353768/maintext_including_figures_and_SI_revision_for_production.pdf?sequence=4

Description
The pneumatic and hydraulic circuits consider the use of compressed air and hydraulic oil as a source of energy for the processes, including their automation and control. The knowledge of the pneumatic, hydraulic and electrical symbologies required according to the DIN ISO 1219 standard is contemplated. In this laboratory the elements learned in the theory of this subject are put into practice.

Type of course	☒ Required ☐ Elective

Specific goals for the course	
Outcomes of instruction	1. Distinguish the types of hydraulic and pneumatic technologies existing in the industry for the continuous improvement of processes. 2. Demonstrate respect for the established commitments, in order to meet the proposed goals in reference to time and quality. 3. Review the plans and pneumatic and hydraulic processes of the industry according to current regulations to make recommendations in a specific situation.
Student outcomes	SO6. Develops and conducts appropriate experimentation, in which they analyze and interpret data, as well as use engineering criteria to draw conclusions.

Topics
Unit I. Introduction to hydraulics and Pneumatics/Laboratory Introduction Unit II. Pneumatic-Hydraulic-Electric symbologies/ Lab Practice Characteristic Curve of a fixed flow pump Unit III. Pneumatic-Hydraulic-Electric symbologies/Lab Practice Stamping Machine Unit IV. Electrical Sensors/Distribution valves/ How to make hydraulics and pneumatics circuits/ Lab Practice Pressure Limiting Valve Unit V. Investigation of flexible ducts and sealing gaskets/ Lab Practice One-Way Flow Regulating Valve Unit VI. Oil functions/color code/hydraulics and pneumatics circuits/ Lab Practice Timers Unit VII. Pumps and compressors/30/5000/ Lab Practice Intermediate Stop Unit VIII. Drive elements and more valves/ Lab Practice Electric Event Counters Unit IX. Tips for avoiding hydraulic problems/ Lab Practice Hybrid system: Hydraulic / Pneumatic

Code	IMC333	Prerequisites	INL350 INL350L INL352 INL352L
Name	Design and Programming of Controllers	Co-requisites	IMC333L

Credits	Contact hours
04	40
Categorization of credits	
Math and basic science	
Engineering topic	X
other	

Instructor’s course name:	Jose Ezequiel Diaz Castillo

Textbook
Bai, Y., & Roth, Z. (2018). Classical and modern controls with microcontrollers. Springler. Parab, J., Shinde, S., Shelake , V., Kamat , R., & Naik, G. (2008). Practical Aspects of Embedded System Design using Microcontrollers. Springler. Rafiquzzaman, M. (2018). Microcontroller Theory and Applications with the PIC18F. Wiley.
Other Supplementary Materials
Godse, A., & Godse, D. (2008). Microprocessors & Microcontroller Systems. Technical Publications Pune Wilmshurst, T. (2009). Designing Embedded Systems with PIC Microcontrollers, Second Edition: Principles and Applications. Newnes

Description	
It is a subject oriented to the knowledge of microcontrollers and microprocessors for the design of different types of controllers, where the student will have the opportunity to come into contact with these devices, learn about their structure and develop control systems for devices with a certain degree of intelligence. In addition, it aims to be the gateway for the design and management of control systems in a more efficient and safe way.	
Type of course	☒ Required ☐ Elective

Specific goals for the course	
Outcomes of instruction	1. Use the appropriate tools to solve controller design problems presented according to the required needs. 2. Use different techniques for solving control problems that arise in the development of the course. 3. Demonstrates knowledge of the different characteristics that microcontrollers and/or microprocessors have for the selection of the appropriate control system according to the need of the application presented

	4. Build control systems based on microcontrollers and/or microprocessors that can meet the current user needs, consistent with the context and type of application.
Student outcomes	SO1. Identify, formulate, and solve complex engineering problems by applying the principles of engineering, science, and mathematics. SO2. Apply and use the engineering design process to produce solutions that meet specific needs, taking into consideration public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors. SO4. Recognize ethical and professional responsibilities in engineering situations and makes informed judgments considering the impact of engineering solutions in global, economic, environmental, and social contexts. SO7. Acquire and apply new knowledge using appropriate learning strategies.

Topics
Unit I. General concepts of automatic control Unit II. Introduction to Microprocessors and Microcontrollers Unit III. microcontrollers Unit IV. Introduction to Microcontrollers for Communications Unit V. Instructions and Assembly Language Unit VI. Microcontroller Programming Techniques Unit VII. System Integration with Microcontrollers

Code	IMC333L	Prerequisites	INL350 INL350L INL352 INL352L
Name	Controller Design and Programming Laboratory	Co-requisites	IMC333

Credits	Contact hours
01	22
Categorization of credits	
Math and basic science	
Engineering topic	X
other	

Instructor's course name:	Carlos de Jesus

Textbook
Bai, Y., & Roth, Z. (2018). Classical and modern controls with microcontrollers. Springler. Godse, A., & Godse, D. (2008). Microprocessors & Microcontroller Systems. Technical Publications Pune. Parab , J., Shinde, S., Shelake , V., Kamat , R., & Naik, G. (2008). Practical Aspects of Embedded System Design using Microcontrollers. Springler Rafiquzzaman, M. (2018). Microcontroller Theory and Applications with the PIC18F. Wiley. Wilmshurst, T. (2009). Designing Embedded Systems with PIC Microcontrollers (2nd ed.: Principles and Applications). Newnes.
Other supplementary materials
Ali Mazidi, M., Causey, D., & McKinlay, R. (2016). PIC Microcontroller and Embedded Systems: Using Assembly and C for PIC18 (2nd ed.). MicroDigitalEd . Gillis, J., & Microcontrollers Lab. (2019, April 24). Pic microcontroller tutorials for beginners with video lectures. Retrieved from https://microcontrollerslab.com/pic-microcontroller-tutorials-beginners/ Ibrahim, D. (2014). PIC microcontroller projects in C: Basic to advanced. Elsevier/ Newnes.

Description	
This laboratory intends to present microcontrollers, which are currently used for the development of embedded control applications .	
Type of course	☒ Required ☐ Elective

Specific goals for the course	
Outcomes of instruction	1. Use the appropriate tools to solve controller design problems presented according to the required needs. 2. Use different techniques for solving control problems that arise in the development of the course.

	3. Demonstrate knowledge of PIC microcontrollers to develop appropriate embedded control systems according to the needs of the application presented. 4. Implement programming in assembly language and C/C++ of control systems based on microcontrollers that can meet the user needs.
Student outcomes	SO1. Identify, formulate and solve complex engineering problems by applying the principles of Engineering, Science and Mathematics. SO2. Apply and use the engineering design process to produce solutions that meet specific needs, taking into consideration public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors. SO4. Recognize ethical and professional responsibilities in engineering situations and makes informed judgments considering the impact of engineering solutions in global, economic, environmental, and social contexts. SO7. Acquire and apply new knowledge using appropriate learning strategies.

Topics
Unit I. Basic concepts of the PIC microcontroller Unit II. Basic configuration and programming Unit II. Indicators and displays Unit III. Character input and actuators Unit IV. Timers and switches V. PWM drive and RGB LED Unit VI. Communications Unit VII. Sensors

Code	IMC334	Prerequisites	200 credits approved
Name	Industry Tour	Co-requisites	None

Credits	Contact hours
00	12
Categorization of credits	
Math and basic science	
Engineering topic	X
Other	

Instructor's course name:	Deyslen Mariano Hernandez

Textbook
Aquino J.A., Corona L. (2017). Mechatronics Engineering in Research, technological development and innovation. Retrieved from https://www.researchgate.net/publication/310797457_LA_INGENIERIA_MECATRONICA_EN_LA_INVESTIGACION_EN_EL_DESARROLLO_TECNOLOGICO_Y_EN_LA_INNOVACION_I_D_I Aquino JA, Corona L., Fernández C. (2017). Green Mechatronics as an actor and the fight against climate change as a stage. Retrieved from https://www.researchgate.net/profile/Jose_Aquino2/publication/310613393_La_Mecatronica_Verde_como_actor_y_la_lucha_contra_el_change_climatico_como_escenario/links/5833e59b08ae102f073693c2/La-Mecatronica-Verde-como-actor-y-la-lucha-climatico-contra-el-escenario scenario.pdf Aquino JA, Corona L., Trujillo JC (2017). Trend in the teaching of Mechatronics Engineering and its disciplinary field. Retrieved from http://www.palermo.edu/ingenieria/pdf2014/13/CyT_13_17.pdf Mexican Association of Mechatronics AC (2017). Code of Ethics of the Mechatronics Engineer. Retrieved from https://www.mecamex.org/codigo-de-tica-del-mecatrnico
Other Supplementary Materials
Espiro Román P., Lizárraga Lizárraga A, Montoya Mejía CF (2017). Mechatronics Engineering and its Contribution to Sustainable Development. Retrieved from https://www.researchgate.net/profile/Piero_Espino/publication/303541378_La_Ingenieria_Mecatronica_y_su_Contribucion_al_Desarrollo_Sustentable/links/5747285a08ae14040e28cd81/La-Ingenieria-Mecatronica-y-su-Contribucion-al-Desarrollo-Sustentable.pdf?origin=publication

Description	
The industrial tour consists of several technical visits to different companies in which each student can have contact with systems, processes and machinery related to mechatronic engineering. It is intended to be a first approach to local companies, where the group will have the opportunity to meet companies in which knowledge of mechatronics engineering is applied, as well as being able to interact with professionals related to their career.	
Type of course	☒ Required ☐ Elective

Specific goals for the course

Outcomes of instruction	1. The students will learn to evaluate the mechatronic systems they use to solve specific problems. 2. Ability to analyze different mechatronic systems establishing a relationship with the concepts assimilated during the career and the systems used in local companies. 3. The students will learn to analyze a proposed system to solve the specific problem, considering the different tools, techniques, and mechanisms that companies used to achieve a said solution.
Student outcomes	SO7. Acquire and apply new knowledge using appropriate learning strategies.

Topics
Unit I. Mechatronic Systems

Code	IMC309	Prerequisites	IMC319
Name	Mechatronics Engineering Project II	Co-requisites	None

Credits	Contact hours
03	66
Categorization of credits	
Math and basic science	
Engineering topic	X
Other	

Instructor's course name:	Grey Guzman

text- book
Shetty, D., & Kolk, R. (2011). Mechatronic System Design (2nd ed.). CENGAGE Learning.
other supplementary materials
Bradley, DA, & Seward, D. (2000). Mechatronics and the Design of Intelligent Machines and Systems. CRC Press. Haik, Y. (2016). Engineering Design Process (3rd ed.). CENGAGE Learning. Popovic, D., & Vlacic , L. (1999). Mechatronics in Engineering Design and Product Development. Marcel Dekker Inc. Ulrich, K.T., & Eppinger, S.D. (2016). Product Design and Development (6th ed.) McGraw-Hill.

Description	
Mechatronics Engineering Projects II constitutes the Professional Practice of the student body in the Investigative Practice modality. It is linked to the integrated project developed.	
Type of course	☒ Required ☐ Elective

Specific goals for the course	
Outcomes of instruction	1. Identify the economic, environmental, social and ethical impact of the proposals made and classifies them according to standardized methods for these purposes. 2. Execute the activities in the planned time, cost and quality. 3. Integrate the appropriate solutions, procedures and components, taking into account the compatibility, availability, reliability of these and between them. 4. Implement the steps of the design process in engineering and manufacturing a solution that meets the requirements of the problem to be solved. 5. Analyze the situational state of the processes for the manufacture, acquisition and assembly of the components with which the problem will be solved and gain control for their implementation.
Student outcomes	SO2. Apply the engineering design process to produce solutions that meet specific needs taking into account public health, safety

	and welfare as well as global, cultural, social, environmental and economic factors. SO4. Recognize ethical and professional responsibilities in engineering situations and makes informed judgments considering the impact of engineering solutions in global, economic, environmental, and social contexts. SO7. Acquire and apply new knowledge using appropriate learning strategies.

Topics
Unit I. Programming of Activities Unit II. Prototype Development Unit III. Demonstration

Code	IMC313	Prerequisites	180 credits approved
Name	Reliability Centered Maintenance (RCM)	Co-requisites	None

Credits	Contact hours
04	44
Categorization of credits	
Math and basic science	
Engineering topic	X
Other	

Instructor's course name:	Jose Ezequiel Diaz Castillo

Textbook
SAE International (2002). A Guide to the Reliability-Centered Maintenance (RCM) Standard (JA1012 Standard). SAE International (1999). Idhammar , T. (nd). Checking Best Practices for Preventive Maintenance [blog article]. IDCON INC: Resource Library. Retrieved from: http://www.idcon.com/resource-library/articles/preventive-maintenance/461-checking-best-practices-for-preventive-maintenance.html SAE International (1999). Evaluation Criteria for Reliability-Centered Maintenance (RCM) Processes (Standard JA1011).
Other Supplementary Materials
ABB Service (2015, April 30). Reliability-Centered Maintenance [video] Retrieved from: https://www.youtube.com/watch?v=XuzPttYmGgc August, J. (1999) Applied Reliability Centered Maintenance. Penn Well Books. Cohesive Solutions (2017, February 2017). Reliability Centered Maintenance (RCM) for Maximo [video]. Retrieved from: https://www.youtube.com/watch?v=c3pLdHYo7tA Moubray , J. (1997) RCM II. Reliability Centered Maintenance. Butterworth Heinemann Ltd ReliaSoft Software (2015, Aug 13). Failure Modes and Effects Analysis: How to Become an Effective FMEA Practitioner [video]. Retrieved from: https://www.youtube.com/watch?v=RK8g1DXUb5M&t=10s Smith, AM (1993). Reliability Centered Maintenance. McGraw Hill, Inc. UESystems (2013, January 29). 7 steps of RCM [video]. Retrieved from: https://www.youtube.com/watch?v=5VmNHQUfYbw

Description	
Reliability/Reliability Centered Maintenance (RCM) includes knowledge of maintenance at an industrial level and for assets in general, understanding the different types of maintenance from preventive, corrective, improvement and predictive. Carrying out an application of preventive maintenance in a company, as well as the search for information on preventive maintenance management at a general level. It integrates the RCM standard as a guide to take the next step in maintenance, which is the application of the RCM methodology in a practical field.	
Type of course	☒ Required ☐Elective

Specific goals for the course	
Outcomes of instruction	1. Demonstrate respect for the established commitments, in order to meet the proposed goals in reference to time and quality. 2. Review best local and international maintenance practices to make recommendations for a specific situation. 3. Analyze the types of maintenance existing in the industry to make proposals for continuous improvement of the processes.
Student outcomes	SO7. Acquire and apply new knowledge using appropriate learning strategies.

Topics
Unit I. Types of maintenance Unit II. Preventive Maintenance plan Unit III. The basic functions of maintenance Unit IV. Operational reliability Unit V. Midterm project Unit VI. Reliability, Availability, Maintainability Unit VII. Maintenance evolution Unit VIII. RCM implementation plan Unit IX. Final project

Code	IMC335	Prerequisites	IMC333 IMC333L
Name	Industrial Robotics	Co-requisites	IMC335L

Credits	Contact Hours
04	44
Categorization of credits	
Math and basic science	
Engineering topic	X
Other	

Instructor's course name:	Grey Guzman

Text book
Morejon, A. (2018). Introduction to robotics. COMIMSA. Barrimientos, A., Peñin, F., Balaguer, C. & Arasil, R. (2007). Robotics fundamentals. McGraw-Hill.
Other supplemental materials
Hughes T. (1990). Programmable Controllers: Issues and Applications. ISA. McCloy, D., & Harris, D.M.J. (1993). Robotics, an Introduction. limousine Parkin, R. (1991). Applied RoboticAnalysis. Prentice Hall.

Description	
Industrial Robotics is an Introduction to Robots, Manipulators, Mobile Robots, Entertainment Robots, among others. The mathematical bases of robotics are covered: spatial references, transformations and homogeneous matrices (rotation and translation), direct and inverse kinematic analysis, dynamic analysis and control, movement planning and robot programming. Students also receive training in handling sensors, actuators, and controllers. Also included is an understanding of the electronic, mechanical, and computer systems that make up an industrial robot. As a final result, the development of projects will be required, with which to practice and strengthen the knowledge acquired, which contain all the necessary tools to design and manufacture a process considering an industrial robot, as its main element.	
Type of course	☒ Required ☐ Elective

Specific goals for the course	
Outcomes of instruction	1. Formulate the problem taking into account the relevant needs, constraints and selection criteria. 2. Create a working solution or prototype and evaluate its performance on specific tasks.
Student outcomes	SO1. Identify, formulate, and solve complex engineering problems by applying the principles of engineering, science, and mathematics.

Topics

Unit I. Fundamentals of industrial robotics
Unit II. Industrial robot morphology
Unit III. Industrial robotics drive
Unit IV. End effectors
Unit V. Industrial robot motion control
Unit VI. Programming of industrial robots
Unit VII. Machine vision

Code	IMC335L	Prerequisites	IMC333 IMC333L
Name	Industrial Robotics Laboratory	Co-requisites	IMC335

Credits	Contact Hours
01	22
Categorization of credits	
Math and basic science	
Engineering topic	X
Other	

Instructor's course name:	Grey Guzman

Text book
NC (2019). ABB. Switzerland: Operator's manual ABB robostudio. https://new.abb.com/products/robotics/en/robotstudio/downloads
Other supplemental materials
Morejon, A. (2018). Introduction to robotics. COMIMSA. Barrimientos, A., Peñin, F., Balaguer, C. & Arasil, R. (2007). Robotics fundamentals. McGraw-Hill. Hughes T. (1990). Programmable Controllers: Issues and Applications, ISA, NC (2018). ABB. Switzerland: Robostudio ABB. https://new.abb.com/products/robotics/en/robotstudio/downloads

Description	
The objective of the Industrial Robotics Laboratory is the practical exercise of the concepts and use of the elements associated with industrial robotics, referring to the elements, both the mechanisms and the control systems that make up a robot and its capabilities. A series of practices will be presented in which both actuators, sensors and controllers are combined for the solution of typical tasks for industrial robots, allowing the development of programming capabilities and integration between control and electronic mechanisms for the development of articulated chains. In addition, it is intended that the student becomes familiar with the generalities of robot control software, basic concepts of robot programming and others.	
Type of course	☒ Required ☐Elective
Specific goals for the course	
Outcomes of instruction	1. Create a working solution or prototype and evaluate its performance on specific tasks.
Student outcomes	SO1. Identify, formulate and solve complex engineering problems by applying the principles of Engineering, Science and Mathematics

Topics
Unit I. Controlled actuators

Unit II. Feedback positioning Unit III. Trajectory control Unit IV. Sensorization Unit V. Controllers I Unit VI. Controllers II Unit VII. Industrial Controllers

Code	IMC336	Prerequisites	IMC333, INL352 and INL343
Name	Programmable Logic Controller	Co-requisites	IMC336L

Credits	Contact hours
04	44
Categorization of credits	
Math and basic science	
Engineering topic	X
Other	

Instructor's course name:	Deyslen Mariano Hernandez

Textbook
Alvarez Pulido, M. (2004). Logic Controllers. Barcelona: Marcombo. Daneri, P. (2008). PLC. Automation and Industrial Control. Buenos Aires: HASA. Mandano Pérez, E., Marcos Acevedo, J., & Fernández Silva, C. (2009). Programmable Controllers and Automation Systems. Barcelona: Marcombo. Terzi, E. Regber, H. Loffler, C. & Ebel, F. (1999). Programmable Logic Controls. Esslingen: Festo Didactic.
other supplementary materials
Automation Direct (2017). PLC Handbook. Retrieved from http://library.automationdirect.com/plc-handbook/

Description	
It is a subject oriented to the basic knowledge of programmable logic controllers, where the student will have the opportunity to come into contact with these devices, learn about their basic structure and develop applications for automated system control. In addition, it aims to be the gateway for the design of control systems and process management in a more efficient and safe way.	
Type of course	☒ Required ☐ Elective

Specific goals for the course	
Outcomes of instruction	1. Selects and uses Programmable Logic Controllers (PLC) which implements control systems with a certain degree of intelligence, for machinery and/or industrial processes. 2. Demonstrates knowledge of the different characteristics of PLCs for the selection of the appropriate control system according to the need of the application presented. 3. Builds PLC-based control systems for machinery and/or processes that can meet the needs that users currently require in coherence with the context and type of application.
Student outcomes	SO2. Apply and use the engineering design process to produce solutions that meet specific needs, taking into consideration public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.

Topics
Unit I. Automation with PLC Unit II. Design and mode of operation Unit III. How to select a controller Unit IV. Programming software Unit V. Programming a PLC Unit VI. Ladder diagram Unit VII. Function block diagram Unit VIII. Network Design Basics Unit IX. PID loop control methods Unit X. Commissioning and functional safety

Code	IMC336L	Prerequisites	IMC333, INL352 and INL343
Name	Programmable Logic Controller Lab	Co-requisites	IMC336

Credits	Contact hours
04	18
Categorization of credits	
Math and basic science	
Engineering topic	X
other	

Instructor's course name:	Deyslen Mariano Hernandez

Textbook
Programming practices and examples with S7-1200 PLCs. Retrieved from http://www.infoplc.net/descargas/103-siemens/automatas/s7-1200/2137-practicas-y-exemples-de-programaci%C3%B3n-con-aut%C3%B3mata-s7- 1200 Rockwell Automation (2017). Programming & Configuration. Retrieved from http://www.rockwellautomation.com/global/support/connected-components/workbench.page?#tab3 Rockwell Automation (2017). Micro810 programmable logic controller systems. Retrieved from http://ab.rockwellautomation.com/es/Programmable-Controllers/Micro810#documentation Rockwell Automation (2017). Micro850 programmable logic controller systems. Retrieved from http://ab.rockwellautomation.com/es/Programmable-Controllers/Micro850#documentation Terzi, E. Regber , H. Loffler , C. & Ebel , F. (1999). Programmable Logic Controls. Esslingen: Festo Didactic .
Other Supplementary Materials

Description	
This laboratory aims to publicize the Allen Bradley brand, which is a leader in innovation and quality in the local and international market in automation components and integrated control systems. For this subject, the use of the micro and nano range of the manufacturer with the Micro810 and Micro850 PLCs will be taught, as well as the configuration and programming software CCW.	
Type of course	☒ Required ☐ Elective

Specific goals for the course	
Outcomes of instruction	1. Designs and develops solutions, corresponding to the level of complexity of the control system using PLCs and its commissioning tool. 2. Demonstrates knowledge of PLCs to develop appropriate control systems according to the need of the application presented. 3. Creates ladder and function blocks language programming of PLC-based control systems that can meet the needs of users.

Student outcomes	SO2. Apply and use the engineering design process to produce solutions that meet specific needs, taking into consideration public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.

Topics
Unit I. Micro850 and Micro810 Basics Unit II. I/O diagnostics Unit III. Logical Operations Unit IV. Timers - Part I Unit V. Timers - Part II Unit VI. Accountants - Part I Unit VII. Accountants - Part II Unit VIII. Analog Signals

Code	IMC338	Prerequisites	IMC337
Name	Hands-On Program 7	Co-requisites	None

Credits	Contact hours
00	20
Categorization of credits	
Math and basic science	
Engineering topic	X
Other	

Instructor's course name:	Ivan E. Jimenez

Text book
Jiménez, I. (2020). Descubriendo el COH. Jimenez, I. (2020). Inducción a Hands-On. Jimenez, I. (2017). Reglamento General. Kuster, J. et al. (2015). Project management handbook (1st ed., Management for Professionals). Springer. doi:10.1007/978-3-662-45373-5 Nagel, R. L., Pierrakos, O., & Nagel, J. K. (2013). A versatile guide and rubric to scaffold and assess engineering design projects.
Other supplementary materials
Bados, A., & García, E. (2014). Resolución de problemas. Universitat de Barcelona. http://diposit. ub.edu/dspace/bitstream/2445/54764/1/Resoluci% C3% B3n% 20problemas.pdf. Guitart, M. E. (2011). Del "Aprendizaje Basado En Problemas" (ABP) al "Aprendizaje Basado En La Acción" (ABA). Claves para su complementariedad e implementación. REDU. Revista De Docencia Universitaria, 9(1), 91. doi:10.4995/redu.2011.6182 Laberge, R.P. (2016). Collaborative Teamwork in Crossdisciplinarity. Universal Journal of Educational Research, 4(12), 2716-2723. Selinger, C. (2004). Stuff You Don't Learn in Engineering School: Skills for Success in the Real World. Hoboken, NJ: Wiley-IEEE Press. Gestión de proyectos: Habilidades fundamentales para no salirse del presupuesto y cumplir los plazos. (2004). Ediciones Deusto.

Description	
This is the last subject of the Hands-On Program and represents the sum of the experiences collected by the Mechatronics Engineering student throughout their progression through the program. In this subject, students will work to test their leadership skills and propose tools to analyze, evaluate and improve the results of teams in the community, as well as evaluate, propose and organize activities to improve the results of the Hands-On Program.	
Type of course	☒ Required ☐ Elective

Specific goals for the course	
Outcomes of instruction	1. Produce documentation aimed at promoting improvement and continuity of work.

	2. Explore, with their work team, ways to organize and evaluate activities to improve the results of the Hands-On Program. 3. Propose tools to analyze, evaluate and improve the results of the teams in the community. 4. Propose improvements to the goals of the program based on the results and experiences in the organized activities.
Student outcomes	SO3. Communicate effectively with a variety of audiences. SO4. Recognize ethical and professional responsibilities in engineering situations and makes informed judgments considering the impact of engineering solutions in global, economic, environmental, and social contexts. SO5. Function effectively in a team whose members together provide leadership, create a collaborative and inclusive environment, set goals, plan tasks, and meet objectives.

Topics
Unit I. Hands-On Events Unit II. Event Setup and Execution Unit III. Program Enhancements Unit IV. Documentation and Infographics