



## Master in **CHEMICAL** ENGINEERING AND SCIENCE

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The Master Degree in Chemical Engineering and Science is part of **CONACYT's National Program of Qualified Graduate Studies (PNPC) at the level of Consolidated Program.**

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### CONTEXT AND RELEVANCE

The development and social well-being in today's world is mostly based in the progress of science and technology. Each country is becoming increasingly aware of their need of having professionals and researchers with a sound academic training, able to collaborate in the generation of knowledge to address the demands of progress.

The Master Degree in Chemical Engineering and Science (MCIQ) seeks to train highly qualified professionals, capable of innovating and generating knowledge from a multi-disciplinary approach and a critical vision of our national reality. Our graduates must be able to find solutions to frontier problems, making the best use of resources, focusing in process engineering, sustainable development of new materials or improving the properties of those currently on the market.

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## LINKAGE

The program has formal and informal links with the following institutions:

- Cardiff University
- Centre National de la Recherche Scientifique, Laboratoires Internationaux Associés/Université Toulouse III-Paul Sabatier, México-Francia
- Centro de Investigación Tecnológica FQ, S. A. de C. V.
- Consejo Nacional de Ciencia y Tecnología
- Ge4 Association
- Industrias Polioles, S. A. de C. V.
- Institut Químic de Sarrià
- Instituto Politécnico Nacional
- International Life Sciences Institute de México
- Laboratorios Griffith, S. A. de C. V.
- Nestlé Servicios Industriales, S. A. de C. V.
- Secretaría de Relaciones Exteriores
- Universidad Autónoma Metropolitana, Unidades Cuajimalpa e Iztapalapa
- Universidad del País Vasco
- Universidad Nacional Autónoma de México

## OBJECTIVES

### General

To train competent specialists who can meet the scientific and technological challenges of Chemical Engineering in Mexico and worldwide, developing the necessary skills to undertake basic and/or applied research in Process and Materials Engineering, using a sustainability approach underscoring environmental care.

### Specific

At the end of the Program, the student will be able to:

1. To participate in the development of Chemical Engineering research projects focusing in process engineering (biotechnology, environmental engineering, electrochemistry and energy systems) and/or materials engineering (polymers, biopolymers and nanomaterials).
2. To find research-based novel solutions chemical industry problems.
3. To apply research-based knowledge with ethical and social responsibility in order to contribute to improve productivity and competitiveness.
4. To develop in interdisciplinary research teams to enhance the outcomes of research projects and technological developments, in partnership with industries and other institutions.
5. To disseminate research outcomes in seminars, congresses and/or national and international publications.

## APPLICANTS PROFILE

The candidate must hold a B.Sc. in Chemical Engineering or related field (Physical Engineering, Environmental Engineering, Food Engineering, etc.), have interest in conducting basic or applied research, have analytical and problem solving abilities, strong oral and written communication skills, knowledge of Mathematics, Thermodynamics, Process Engineering, and a high level English reading comprehension (standards of EXANI III-CENEVAL).

### Skills and attitudes

Critical, creative, and responsible person, with social solidarity, team-working abilities and inclination toward research and development.

## FIELD OF WORK

### Research and Teaching

At research centers and institutions, working with established researchers, providing services to industries and institutions, conducting requested projects or leading research groups.

### Industry

As part of a specific industry or institution, participating in the comprehensive development of solutions to scientific or technological problems, responsible of the different stages of innovation projects.

### Consultancy Firms

Working in professional teams giving integral support to industries.

## GRADUATES PROFILE

### Knowledgeable of

- Theoretical bases and laws governing processes, materials and systems to address the scientific and technological challenges related to Chemical Engineering, particularly those involved in Process Engineering and Materials Engineering.
- Methodology to conduct research and to apply science and technology to solve problems in the different fields of Chemical Engineering.

### Skills

- To recognize, analyze and solve scientific and technological developments issues with the best environmental-friendly alternatives based on the expertise of Engineering and Chemical Science
- To offer novel and proactive solutions.
- To solve industrial problems based on processes development new trends, state-of-the-art science and technology, and patents.
- To investigate and assess process and materials engineering scientific and technological issues of the chemical engineering industry.
- To actively participate in inter and multi-disciplinary teams dealing with the scientific and technological issues of Chemical Engineering.
- Being able to write scientific papers.

### Attitudes and Values

- To provide solutions to our country's chemical engineering problems based on thorough understanding, using domestic scientific and technology resources.
- To conduct research based on social awareness, ethics and responsibility.
- Team-work in inter and multidisciplinary environments.
- Commitment to environmental and social well-being.
- Readiness to continuous learning in the field of Chemical Engineering and related areas.

# FACULTY MEMBERS

## Guillermo Fernández Anaya

Member of the National Research System (SNI) Level II

Ph.D. in Physics, M.Sc. in Physical Sciences and B.Sc. in Physics, Universidad Nacional Autónoma de México.

### Research interests:

Mathematical Control Theory; Properties Preservation in Linear and Non-linear Systems, and Control Applied to Dynamic Systems; Dynamic Systems in Physics and Engineering; Fractional Order Systems.

### Recent Publications:

Ferreira-Vazquez, E. D., Hernandez-Martinez, E. G., Flores-Godoy, J. J., Fernandez-Anaya, G., and Paniagua-Contro, P. "Distance-based Formation Control Using Angular Information Between Robots", Journal of Intelligent & Robotic Systems, 2016, DOI 10.1007/s10846-015-0312-1; Lopez-Gonzalez, Ferreira, E. D., Hernandez-Martinez, E. G., Flores-Godoy, J. J., Fernandez-Anaya, G., and Paniagua-Contro, P. "Multi-robot formation control using distance and orientation", Advanced Robotics, 2016, 10.1080/01691864.2016.1159143.; López-Rentería, J.A., Fernández-Anaya, G. "Robust Stability by Path-Connectivity of Fractional Order Polynomials", Acta Appl Math. 2016, DOI 10.1007/s10440-016-0047-4.

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## Jorge Ibáñez Cornejo

Member of the National Research System (SNI) Level III

Ph.D. in Chemistry, University of Houston. (USA)

B.Sc. in Chemical Engineering, Instituto Tecnológico y de Estudios Superiores de Occidente.

**Research interests:** Design and Performance of Simultaneous Electrochemical Reactions; Pollutants Degradation by Electrochemical Methods; and Research in Teaching Microscale Chemistry.

**Recent Publications:** Ibáñez, J.G., Zavala-Araiza, D., Sotomayor-Martínez Barranco, B., Torres-Perez, J., Camacho-Zuniga, C., Bohrmann-Linde, C., Tausch, M.W. "A Demonstration of Simultaneous Electrochemiluminescence." J. Chem. Educ. 2013, 90, 470-472; Ibáñez, J.G., Zavala-Araiza, D., Sotomayor-Martínez Barranco, B. "Simultaneous Electroluminescence." Invited Cover: J. Chin. Chem. Soc. 2013, 60, 407-411; Espinoza-Montero, P.J., Vasquez-Medrano, R., Ibáñez, J.G., Frontana-Urbe, B.A. "Anodic degradation of phenol coupled to the efficient cathodic production of H<sub>2</sub>O<sub>2</sub> using boron-doped diamond electrodes." J. Electrochem. Soc. 160 (7) G3171-G3177 (2013).

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## Lorena Leticia Pedraza Segura

M.Sc. in Biochemistry Engineering, Universidad Autónoma del Estado de Morelos.

B.Sc. in Biochemistry Engineering, Universidad Autónoma Metropolitana, Unidad Iztapalapa.

### Research interests:

Biorefining Processes; Microbial Metabolites Production; Design, Simulation and Bioprocesses Assessment.

### Recent Publications:

Flores-Sánchez, A., Flores-Tlacuahuac, A., Pedraza-Segura, L. "Model-Based Experimental Design to Estimate Kinetic Parameters of the Enzymatic Hydrolysis of Lignocellulose." Ind. Eng. Chem. Res. 2013, 52, 4834-4850; Pedraza-Segura, L., Toribio-Cuaya, H., Flores-Tlacuahuac, A. "Multiobjective Optimization Approach for Cellulosic Biomass Pretreatment." Ind. Eng. Chem. Res. 2013, 52, 5357-5364; Toribio-Cuaya, L., Pedraza-Segura, L. I., Macías-Bravo, S., González-García, I., Vásquez-Medrano, R., and Favela-Torres, E. "Characterization of Lignocellulosic Biomass Using Five Simple Steps." JCBPS; Section D: Dev. of Biotechnol. Process; Special Issue; 30 Nov.2014, Vol. 4, No. 5, 28-49.

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## Ruth Pedroza Islas

Member of the National Research System (SNI), Level II

Ph.D. in Chemical Sciences and B.Sc. in Chemical Farmaceutical Biology, Universidad Nacional Autónoma de México.

M.Sc. in Food Science and Technology, Universidad Iberoamericana.

### Research interests:

Microencapsulation of Bioactive Ingredients; Functional Properties of Emulsified Polymeric Solutions as Active Coatings of Mexican Regional Fruit Exports; Protein-Polysaccharide Interactions for the Production of Fat Substitutes.

### Recent Publications:

Escalona-García, L.A., Pedroza-Islas, R., Natividad, R., Rodríguez-Huezo, M.E., Carrillo-Navas, H., Perez-Alonso, C. "Oxidation kinetics and thermodynamic analysis of chia oil microencapsulated in a whey protein concentrate-polysaccharide matrix". Journal of Food Engineering 175 (2016) 93-103; Calderon-Oliver, Mariel, Escalona-Buendía, Hector B., Medina-Campos, Omar N., Pedraza-Chaverri, Jose, Pedroza-Islas, Ruth, Ponce-Alquicira, Edith. "Optimization of the antioxidant and antimicrobial response of the combined effect of nisin and avocado byproducts". LWT - Food Science and Technology 65 (2016) 46-52; Porrás-Godínez, Martín R., Pedroza-Islas, Ruth, Franco-Rodríguez, Guadalupe, San Martín-Martínez, Eduardo. "Thermal treatment effect on wettability of edible films from whey protein isolated and mesquite (Prosopis spp.) GUM." Agrociencia 49: 1-13. 2015.

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## Iván Rafael Quevedo Partida

Member of the National Research System (SNI), Level I

Ph.D. in Chemical Engineering, McGill University.

M.Sc. in Environmental Systems and B.Sc. in Chemical Engineering and Administrator, Instituto Tecnológico y de Estudios Superiores de Monterrey (ITESM) Campus Monterrey.

### Research interests:

Transport and Destination of Pollutants in the Environment; Environmental and Health Risks of Emerging Technologies; Innovative Technologies to Improve Water Quality.

### Recent Publications:

Qu, H; Quevedo, I.R; Linder, S.W; Fong, A; Mudalige, T.K; "Importance of material matching in the calibration of asymmetric flow field-flow fractionation: material specificity and nanoparticle surface coating effects on retention time". Journal of Nanoparticle Research 2016. 18 (10), 292. Bairi, V.G., Lim, J.H., Quevedo, I.R., Mudalige, T.K., Linder S.W. "Portable X-ray fluorescence spectroscopy as a rapid screening technique for analysis of TiO<sub>2</sub> and ZnO in sunscreens". Spectrochimica Acta Part B: Atomic Spectroscopy 2016, 116, 21-27., Mendoza-Gonzalez, N. Y., Avalos-Ramírez, A., Quevedo, I.R. "Responsible Nanotechnology". In Satinder Kaur Brar, Tian C. Zhang, Mausam Verma, Rao Y. Surampalli. Nanomaterials in the Environment. University of Québec: American Society of Civil Engineers, 2015, pp.563-592. American Society of Civil Engineers (ASCE); Quevedo, I. R.; Olsson A.L.J.; Clarke, R., Veinot, J., Tufenkji, N. "Interpreting the Deposition Behavior of Polydisperse Surface-Modified Nanoparticles using QCM-D and Sand-Packed Columns". Environmental Engineering Science (Special Issue: Environmental Nanomaterials) 2014, 31 (7), 326-337.

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### Jesús Alberto Quezada Gallo

*Ph.D. and M.Sc. in Food Science, Université de Bourgogne. (France)*

*B.Sc. in Biochemistry Engineering, Universidad Autónoma de Aguascalientes.*

#### Research interests:

Microencapsulation of Bioactive Ingredients; Study of the Properties of Emulsified Polymeric Solutions as Active Coatings of Mexican Regional Fruit Exports; Protein-Polysaccharide Interactions for the Production of Fat Substitutes.

#### Recent publications:

Altamirano-Fortoul, R., Moreno-Terrazas, R., Quezada-Gallo, A., Rosell, C.M. “Viability of some probiotic coatings in bread and its effect on the crust mechanical properties” *Food Hydrocolloids*, vol. 29, núm. 1, 2012, pp. 166-174; “Delivery of food additives and antimicrobials using edible films and coatings”. In *Edible Films and Coatings for Food Applications*. Springer, 2009, pp. 315-333;

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### Esther Ramírez Meneses

*Member of the National Research System (SNI), Level I*

*Ph.D. in Science in Transition Elements Physical Chemistry, Université Paul Sabatier. (France)*

*M.S. in Metallurgical Engineering and B.S. in Industrial Chemistry Engineering, Instituto Politécnico Nacional.*

#### Research interests:

Metallic Nano-Structure Synthesis (Chemical Methods) with Diverse Applications (Electrode Materials for Reactions of Interest in Combustion Cells).

#### Recent Publications:

Manzo-Robledo, A. Costa, N.J.S., Philippot, K., Rossi, L. M., Ramírez-Meneses, E., Guerrero-Ortega, L.P.A., Ezquerro-Quiroga, S. “Electro-oxidation of methanol in alkaline conditions using Pd-Ni nanoparticles prepared from organometallic precursors and supported on carbon Vulcan”. *Journal of Nanoparticle Research* 17 (2015) 474; Ramírez-Meneses, E., Montiel-Palma, V., Domínguez-Crespo, M. A., Izaguirre-López, M. G., Palacios-Gonzalez, E., Dorantes-Rosales, H. “Shape-and size-controlled Ag nanoparticles stabilized by in situ generated secondary amines”. *Journal of Alloys and Compounds* 643 (2015) S51-S61; Ramírez-Meneses, E., Torres-Huerta, A.M., Domínguez-Crespo, M.A., Ponce-Varela, M.G., Hernández-Pérez, M.A., Betancourt, I., Palacios-González, E. “Synthesis and Electrochemical Characterization of Ni Nanoparticles by Hydrazine Reduction using hydroxyethyl cellulose as Capping Agent.” *Electrochimica Acta*, 2014, 127, 228-238.

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### Martín Rivera Toledo

*Ph.D. in Engineering, M.Sc. in Chemical Engineering (Processes) and B.Sc. in Chemical Engineering, Universidad Nacional Autónoma de México.*

#### Research interests:

Mathematical Modeling of Chemical Processes; Simulation and Optimization of Chemical Processes in Permanent and Dynamic Systems.

#### Recent Publications:

Rivera-Toledo, M., Antonio Del Río-Chanona, E., Flores-Tlacuahuac, A. “Multiobjective Dynamic Optimization of the Cell-Cast Process for Poly(methylmethacrylate)”, *Industrial and Engineering Chemistry Research*, 53 (37), 14351- 14365, 2014; Rivera-Toledo, M., Flores-Tlacuahuac, A. “A Multiobjective Dynamic Optimization Approach for a Methyl-Methacrylate Plastic Sheet Reactor”, *Macromolecular Reaction Engineering*, 8(4), 358-373, 2014; Santibanez-Aguilar, E., Flores-Tlacuahuac, A., Rivera-Toledo, M., Ponce-Ortega, J.M., “A Mixed-Integer Dynamic Optimization Approach for the Optimal Planning of Distributed Biorefineries”, *Computers & Chemical Engineering*, 80(2), 37-62, 2015.

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### Alberto Ruiz Treviño

*Member of the National Research System (SNI), Level II*

*Ph.D. in Science (Modification of Gas Separation Membrane Materials by Antiplasticization), University of Texas. (USA)*

*M.S. in Chemical Engineering, Universidad Autónoma Metropolitana, Unidad Iztapalapa.*

*B.S. in Chemical Engineering, Universidad Autónoma de Nuevo León.*

#### Research interests:

Synthesis and/or Modification of Polymer Properties Used as Separation Media, Purification or Sequestration of Industrial Gas, Pollutants, and Corrosive Materials.

#### Recent Publications:

Olvera, L.I., Guzmán-Gutiérrez, M.T., Zolotukhin, M.G., Fomine, S., Cárdenas, J., Ruiz-Trevino, F.A., Villers, D., Ezquerro, T.A., and Prokhorov, E. “Novel High Molecular Weight Aromatic Fluorinated Polymers from One-Pot, Metal-Free Step Polymerizations”. *Macromolecules*, 2013, 46 (18), pp 7245–7256; Martínez-Mercado, E., Cruz-Rosado, A., Zolotukhin, M.G., González-Montiel, A., Cardenas, J., and Gaviño-Ramirez, R.I. “Tuning Gas Permeability and Selectivity Properties by Thermal Modification of Side Groups of Poly(oxindolebiphenylene)s”. *Ind. Eng. Chem. Res.* 2014, 53, 15755-15762; Hernández-Cruz, O., Zolotukhin, M.G., Fomine, S., Alexandrova, L., Aguilar-Lugo, C., Ramos-Ortiz, G., Maldonado, J.L. and Cadenas-Pliego, G. “High-Tg Functional Aromatic Polymers”. *Macromolecules*, 2015, 48, 1026-1037.

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### Rubén C. Vázquez Medrano

*Member of the National Research System (SNI), Level I*

*Ph.D. in Physics, M.Sc. in Physical Sciences and B.Sc. in Physics, Universidad Nacional Autónoma de México.*

#### Research interests:

Mathematical Control Theory, Properties Preservation in Linear and Non-Linear Systems and Control Applied to Dynamic Systems; Dynamic Systems in Physics and Engineering; Fractional Order Systems.

#### Recent Publications:

Ferreira-Vazquez, E. D., Hernandez-Martinez, E. G., Flores-Godoy, J. J., Fernandez-Anaya, G., and Paniagua-Contro, P. “Distance-based Formation Control Using Angular Information Between Robots”. *Journal of Intelligent & Robotic Systems*, 2016; Lopez-Gonzalez, E.D., Ferreira, E. G., Hernandez-Martinez, Flores-Godoy, J. J., Fernandez-Anaya, G., and Paniagua-Contro, P. “Multi-robot formation control using distance and orientation”. *Advanced Robotics*, 2016, 10.1080/01691864.2016.1159143; López-Rentería J.A., Fernández-Anaya, G. “Robust Stability by Path-Connectivity of Fractional Order Polynomials”. *Acta Appl Math.* 2016.

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## LINES OF RESEARCH

### 1) PROCESS ENGINEERING

The objective of this area is to develop experimental activities and/or mathematical modeling, optimization, control of processes and development of new technologies in the fields of energy systems, bio-engineering, treatments of pollutants, and environmental risk analysis and assessment.

### 2) MATERIALS

This area focusses in the systematic scientific study of the relation between structure/properties of materials, and the relations between processing/functional properties of engineering materials. Its emphasis is on the development and formulation of functional materials with potential applications in: i) Polymers, ii) Biopolymers with functional properties in food industry and iii) Synthesis of nanomaterials with diverse applications.

The program is comprised by **80 credits**, which must be accredited in **two years (four school periods)**.

## SYLLABUS

<b>First semester</b>	<b>16 credits</b>
Advanced Mathematics	8
Advanced Thermodynamics	8
<b>Second semester</b>	<b>20 credits</b>
Transport Phenomena	8
Chemical Reaction Engineering	8
Research Seminar I	4
<b>Third semester</b>	<b>12 credits</b>
Elective I	8
Research Seminar II	4
<b>Fourth semester</b>	<b>12 credits</b>
Elective II	8
Research Project	4
<b>Graduation credits</b>	<b>20 credits</b>
<b>Total</b>	<b>64 credits</b>

## ELECTIVE SUBJECTS

- Process engineering
- Processing systems engineering
- Electrochemical engineering
- Environmental electrochemistry
- Functional properties of hydrocolloids
- Advanced topics in food chemistry
- Polymer science
- Polymer processing
- Biotechnology
- Biotechnological processes
- Risk assessment and environmental impact
- Effluent treatment technologies
- Synthesis of nanomaterials
- Materials characterization
- Advanced topics in chemical engineering

## ADMISSION PROCEDURES

The applicant must meet the following requirements:

1. Hold a Bachelor's degree and a professional license in Chemical Engineering or related field
2. B.Sc. minimum GPA of 8.0/10
3. Curriculum Vitae
4. Interview with the program coordinator
5. Two letters of recommendation from university professors or employers
6. Statement of purpose
7. Admission Examination: EXANI III – CENEVAL (minimum: 1000 points)
8. EGEL-IQ (satisfactory performance testimony with minimum: 1000 points)

For further information please contact:

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