Universidad de Puerto Rico
Recinto Universitario de Mayagüez
*Senado Académico*

# CERTIFICACION NUMERO 17-64

La que suscribe, Secretaria Interina del Senado Académico del Recinto Universitario de Mayagüez de la Universidad de Puerto Rico, **CERTIFICA** que en la reunión ordinaria celebrada en la sesión del martes, 28 de noviembre de 2017, este organismo **APROBÓ** la **PROPUESTA PARA LA CREACIÓN DE UNA CONCENTRACIÓN MENOR EN CIENCIAS E INGENIERÍA AEROESPACIALES**.

La propuesta pretende fortalecer la preparación académica de los estudiantes interesados en la tecnología aeroespacial, ya que esta se ha destacado como una de importancia en Puerto Rico en los últimos años. Entre los asuntos más importantes de la propuesta se destaca que:

- Existe la necesidad que los estudiantes interesados tomen un conjunto de cursos en temas relacionados a la Ingeniería y Ciencias Aeroespacial, y que el estudiante se le reconozca formalmente por esto.
- El programa está propuesto y será administrado por el Departamento de Ingeniería Mecánica.
- El programa consiste de 15 créditos requisitos, y los estudiantes deberán aprobar todos los cursos con una calificación de "C" o más.

El programa propuesto cumple con los elementos de la Certificación 69 (2013-2014) de la Junta de Gobierno.

**La propuesta forma parte de la certificación.**

Y para que así conste expido y remito la presente certificación a las autoridades universitarias correspondientes, bajo el Sello de la Universidad de Puerto Rico a los treinta días del mes de noviembre del año dos mil diecisiete, en Mayagüez, Puerto Rico.

Nilda E. Pérez Collazo
Secretaria Interina

LPM

Anejo

Universidad de Puerto Rico
Recinto Universitario de Mayagüez
*Senado Académico*

1 diciembre 2017 (enmienda)

Miembros del Senado Académico
Recinto Universitario de Mayagüez

David Sotomayor Ramírez
Presidente, Comité Asuntos Curriculares

**Propuesta para la creación de una Concentración Menor en Ciencias e Ingeniería Aeroespaciales**

El Comité de Asuntos Curriculares recibió la propuesta para la creación de una Concentración Menor en Ciencias e Ingeniería Aeroespaciales. La misma pretende fortalecer la preparación académica de los estudiantes interesados en la tecnología aeroespacial, ya que esta se ha destacado como una de importancia en Puerto Rico en los últimos años. Entre los asuntos más importantes de la propuesta se destaca que:

- Existe la necesidad de que estudiantes interesados tomen un conjunto de cursos en temas relacionados a la Ingeniería y Ciencias Aeroespacial, y que al estudiante se le reconozca formalmente por esto.
- El programa está propuesto y será administrado por el Departamento de Ingeniería Mecánica.
- El programa consiste de 15 créditos requisitos, y los estudiantes deberán aprobar todos los cursos con una calificación de "C" o más.

Este comité entiende que la propuesta será de beneficio para la formación académica de los estudiantes por lo que recomienda al Senado Académico su aprobación. El programa propuesto cumple con los elementos de la Certificación JG 69 2013-2014.

Anejo
Propuesta: *Proposal for Minor in Aerospace Science and Engineering*

Universidad de Puerto Rico
Recinto Universitario de Mayagüez
Colegio de Ingeniería

# Proposal for Minor in Aerospace Science and Engineering

## A. Objectives and Justifications

**Objectives:**

Throughout the Minor in Aerospace Science and Engineering (MASE), students will be exposed to the following educational and learning objectives:

1. Apply knowledge of mathematics, science and engineering to the field of aerospace science and engineering.
2. Identify, formulate and solve aerospace science and engineering problems.
3. Use the techniques, skills, and modern engineering tools necessary for aerospace science and engineering practice.
4. Communicate effectively in aerospace-related team projects.

**Justification:**

1. The Program:

   a) Aerospace Technology has become a focal point of interest for industry and academia in Puerto Rico. In response to this eventuality, PRIDCO has established the Puerto Rico Aerospace Technology Consortium, which has located its offices in Mayagüez, Puerto Rico.

   b) Since 2003, several industries requiring engineers with knowledge of aerospace related issues have businesses in the Commonwealth of Puerto Rico. Companies both overseas and in Puerto Rico requiring engineers knowledgeable in aerospace sciences have hired many UPRM engineering students since 2003. In addition, other industries that design and manufacture aircraft components have demonstrated interest in establishing businesses in Puerto Rico. These industries require engineering students with a background in aerospace sciences; in the next two years, hiring forecasts envision over 1000 job openings.

   c) In recent years, there has been a surge in interest within aerospace industry to establish operations on the Island. Examples are Infotech Aerospace Services Inc., Lockheed Martin, Florida Turbine Technologies, Honeywell, and Lufthansa Technik, among others. Air Force and NAVAIR have also shown strong interest to begin collaboration with UPRM with aerospace engineering students.

   d) UPRM holds several research collaborations in the field of aerospace science. There is a growing interest from government and corporate aerospace industries to collaborate with the College of Engineering and faculty in aerospace-related research and projects.

e) At UPRM, students do not have an in-depth exposure to aerospace-related topics and this option is available in only a limited number of courses. Hence, the MASE will satisfy the need for students to obtain a background in Aerospace Science and Engineering.

2. From Curricular Sequence IV to Certification # 69 (2014-15):

a) There is a well-established Curricular Sequence IV in Aerospace, which will be eliminated and will be substituted by this minor.

b) The number of credits has been reduced from 21 credits to 15 credits to fit with the new certification. In the previous certification, students could take all credits for double counting of credits. However, in the new certification students are only allowed to take up to 12 credits for double counting of credits, and these are classified as free electives.

c) Moreover, the intent is to expand the opportunity for students from other departments to complete this minor.
   i. In this revision, multidepartment program is intended without removing the structure or the original description of the program.
   ii. The College of Engineering will manage the proposed minor through the Department of Mechanical Engineering.
   iii. As the program grows and courses are added, other departments will align their aerospace course track and will oversee such courses under their department's codifications.

## B. Curriculum: courses, codes and numbering

1. Students must take five courses (15 credits) to earn a Minor in Aerospace Science and Engineering.

**Table 1: List of core courses**

| Required Courses | | | |
|---|---|---|---|
| **Course Code** | **Title** | **Pre-requisites** | **Credits** |
| INME 4709 | Aircraft Performance | (INGE 3032 or INGE 3035) and (MATE 4009 or MATE 4145) and INGE 3016 | 3 |
| INME 4705 | Applied Aerodynamics | INGE 3016 and [INGE 4010 or (INGE 4015 and INGE 4016)] and (MATE 4009 or MATE 4145) | 3 |
| INME 4717 | Introduction to Aircraft Structural Analysis | INGE 3016 and (INGE 3035 or INGE 3032) and (MATE 4009 or MATE 4145) | 3 |
| INME 5717 | Aircraft Structural Analysis and Design | INME 4717 and (INGE 4019 or INGE 4012) | 3 2 |

| | | | |
|---|---|---|---|
| *INME 5707 | Gas Turbine System Operation | (INME 4002 or INME 4045 or INQU 4012) and INGE 3016 and INME 4707. | 3 |
| **Total of credits required for Minor in Aerospace Science and Engineering** | | | 15 |

2. A course cannot be double counted as part of the requirements for a major and part of the minor, except the 12 credits that can be counted as free electives.

3. If a student uses any course towards his/her major concentration specialty such course will not count for this minor.

4. Projection is to add specialized aerospace courses as new faculty in the field is hired.
   a. These courses will be included in the curriculum after evaluation by the UPRM Academic Senate.
   b. Each new course should have proper codification to add it to the list.

5. Course Descriptions

| **INME 4709 – Aircraft Performance** |
|---|
| Study of performance and design characteristics of conventional aircraft using atmospheric properties, and the concepts of lift and drag. Design for specified flight conditions and the flight conditions for best performance using the physical characteristics of an aircraft. Analysis of level flight performance, rates of climb, service and absolute ceilings, range, take-off and landing, and turn performance. |
| **INME 4705 – Applied Aerodynamics** |
| Analysis of fluid flow behavior around a rigid body by applying the continuity, momentum and energy equations, two-dimensional potential flow, and the panel method. Analysis of finite wings models using two-and three-dimensional lifting theory and vortex lattice solutions. Study of compressibility effects to analyze fluid flow behavior around transonic wings. Introduction to computational fluid dynamics. |
| **INME 4717 – Introduction to Aircraft Structural Analysis** |
| Introduction and application of solid mechanics to analyze aerospace structures. Study of aircraft components and their design philosophy. Environmental load design diagrams. Development and application of elasticity to describe the stress, strain, and displacement fields of one-and two-dimensional problems in aerospace structures. Analysis of bending, shear and torsional theories for arbitrary, multimaterial, and multicell wing cross-sections. Analysis of thin-walled single and multicell stiffened shell sections using analytical and numerical solutions. |
| **INME 5717 – Aircraft Structural Analysis and Design** |
| Application of work and energy principles, and numerical methods, to the design of flight vehicles. Study of deflection and load analysis using the principle of virtual work, principle of complementary virtual work, analytical weak form solutions, and the finite element formulation. Wing design considering: fatigue, aeroelasticity, divergence, environmental loads, aerospace materials, dynamic stability of thin-walled compression members, and |

| |
|---|
| structural dynamics. |
| **INME 5707 – Gas Turbine System Operation** |
| Study of jet engine performance using energy budgets and its optimization in the jet engine cycle. Study of turbomachine components, such as compressors, combustors, turbines and nozzles, as integrated into a system that produces power aircrafts. Development of a thermodynamic model for a turbofan engine to investigate design and off-design behavior, and the response to external and internal parameters. Study the influence of design criteria such as structural integrity, emissions, acoustics, and operationally-stable throttle response on the integration process. |

## C. General and Specific Requirements for Qualifying Students

To apply to the Minor in Aerospace Science and Engineering (MASE), the student:

1. Must be an active student, in good standing, at UPRM. Students in good standing are those in accord with the definition as stated in the UPRM undergraduate catalog at the time of application.

2. Fill the application for the MASE, which will be available at the Office of the Registrar.

Academic admission requirements for the MASE will be according to the university policies.
Also:

1. Language: All applicants are strongly encouraged to have a working knowledge of both English and Spanish.

2. Application deadlines will be according to those established in the Academic Calendar for each semester.

3. Students will be allowed to repeat courses according to the university policies

4. Students should apply as early as possible in their program of study in order to complete the Minor Concentration with their Major area of study and within 150% of the time to complete said Major program.

## D. Criteria for satisfactory completion for certification and graduation

Completion requirements for the MASE will be according to the university policies. In addition:

1. At the time of graduation, the student must complete all 15 credit hours of the MASE, as specified in section 6.

2. There is no minimum GPA. However, students need to complete minor courses with an average of 2.75 on a 4.00 scale with a minimum grade of "C" in each minor course.

## E. Evaluation Plan

Assessment of the minor will answer the following information:

*How useful was the curricular sequence and content of the MASE?*
*How would the students improve the MASE?*

| Objetive | Instrument | Responsable Party | Itinerary |
|---|---|---|---|
| Minor transitioned from the current Curricular Sequence in Aerospace | Office of the Registrar, UPRM | Number of students applying and registered in the minor | Fall 2017 and every three years afterward |
| Minor Promotion | Brochures, electronic media (email, website), newspaper ads. | Demand/ number of students registered | Fall 2017 and every three years afterward |
| Assess the knowledge and skills of the students completing the minor | Exit interviews, surveys | Positive evaluation by faculty members who conduct the assessment process | At the end of completion of each student |
| Job placement | Exit survey and follow-up | Students employed or studying graduate degree in Aerospace related topics | At the end of the completion of each student |

## F. Minor Administration

The MASE will be administered by the Department of Mechanical Engineering under the leadership of the:

Dr. Sheilla Torres Nieves, Director, CAUSE
Dr. Emmanuel Arzuaga Cruz, Co-Director, CAUSE
Director, Department of Mechanical Engineering

College of Engineering